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EAES Guidelines for Endoscopic Surgery

Twelve Years Evidence-Based Surgery in Europe

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Edmund A. M. Neugebauer, **Professor, PhD**
University Witten-Herdecke
Institute for Research in Operative Medicine
Director and Chair for Surgical Research
Ostmerheimer Str. 200
51109 Cologne, Germany

Stefan Sauerland, **MD, MPH**
University Witten-Herdecke
Institute for Research in Operative Medicine
Ostmerheimer Str. 200
51109 Cologne, Germany

Abe Fingerhut, **Professor, MD**
Centre Hopitalier Intercommunale
Service de Chirurgie Viscérale Digestive
Rue de Champ Gaillard 10
78300 Poissy, France

Bertrand Millat, **Professor, MD**
Hôpital Saint Eloi
Service de Chirurgie Viscérale Digestive
34295 Montpellier, France

Gerhard Buess, **Professor, MD**
University Tübingen
Section for Minimally Invasive Surgery,
Hoppe-Seyler-Straße 3
72072 Tübingen, Germany

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Preface

Every new idea needs enthusiasts convinced that the idea is solid and prosperous. The concept of minimally invasive surgery was introduced to the field of visceral surgery first by Gerhard Bueß, who performed the first clinical operations in transanal endoscopic microscopy in 1983. Cholecystectomy was performed by a special approach used by Erich Mühe in 1985. In 1987 the first laparoscopic cholecystectomy with the technique we are using today was performed by Mouret from France.

This laparoscopic approach was the idea which infected surgeons around the globe. Without doubt, the idea of minimally invasive surgery, and in particular laparoscopic or endoscopic surgery, can nowadays be considered as a major breakthrough in surgical technique which, with appropriate associated technology, has translated into tremendous improvements in clinical diagnostics, clinical outcomes, as well as surgical education.

At the very beginning of the laparoscopic revolution, clinical intuition and personal experience of pioneers were the only "evidence" base as concerned performance and teaching of this new approach to surgery. Heavily supported by the medical device industry, laparoscopic surgery started a legendary career, without any prior solid scientific testing and often outside centers of excellence. As a result, serious complications of laparoscopic surgical procedures were reported. Moreover, the advent of laparoscopic surgery was accused of contributing significantly to the rising healthcare expenditure in times of money shortages. Therefore, the executive office of the European Association of Endoscopic Surgery (EAES) under the presidency of Hans Troidl (Cologne) decided in 1993 to appoint an ad hoc working group to critically review and systematically assess the progress of laparoscopic surgery in the different developing fields of surgery. The scientific mandate was given to Edmund Neugebauer.

At that time consensus development conferences (CDCs), according to the policy of the National Institute of Health (NIH), was the accepted method of choice. However, the NIH format was time-consuming, expensive, and did not adequately reflect the needs for rapid assessment in the evolving field of laparoscopic surgery. The EAES executive office felt that there was dire need for a more practical approach in order to provide specific guidelines as soon

as possible, early in the development of new indications when evidence was still sparse, to prevent harm and to critically appraise the potential benefits of this new technology. A novel type of CDC was developed including essential elements of the NIH process such as panel selection by specific transparent criteria, a formal consensus procedure, and specific statements formulated as guidelines. Up until 1999, six CDCs took place including topics such as laparoscopic cholecystectomy, appendectomy, hernia repair, surgery for gastroesophageal reflux disease, treatment of common bile duct stones, and colonic diverticular disease.

Owing to the evolving field of evidence-based medicine with rigorous evaluation of the scientific evidence and the necessity to keep CDC statements in synchronous pace with medical knowledge, the EAES ad hoc committee, under the guidance of Neugebauer and within the Scientific Committee of the EAES, started a critical revision of the consensus methodology at the EAES conference in 1999 in Linz, Austria. Moreover, it was felt that there was a need for improved methods of dissemination and implementation of these EAES guidelines. One of the key factors for acceptance and impact of clinical practice guidelines is the strength and validity of the development process itself. The critical appraisal and analysis showed that further improvement was needed in identification, evaluation, synthesis of scientific evidence, as well as for the transparency of the recommendations. This was achieved by connecting the levels of scientific evidence with the grades of recommendation, through participation of all relevant stakeholders in the guideline panel, and application of formal consensus development methods. With use of this updated methodology, starting in Maastricht in 2001, evidence-based guidelines have been developed for the creation of pneumoperitoneum, laparoscopic surgery in colonic cancer, quality of life after laparoscopic surgery, obesity surgery, and laparoscopy for abdominal emergencies. After open discussion between the panel and all members of the EAES at the annual congresses of the EAES in 2-h plenary sessions, and diligent work of the ad hoc committee, all evidence-based guidelines have been expediently published over the years in *Surgical Endoscopy*, the official organ of the EAES, for quick and wide dissemination.

Endoscopic surgery is still an area of rapid development. Nearly not one month goes by without new studies being published that need to be examined to link and relate the new information to the impact on existing guidelines. Regular updates are therefore necessary. The first update, concerning the guidelines developed from the start until 1999, was published in the Springer booklet released at the EAES Congress in Nice (2000) [1]. It was only natural that a new book be undertaken. The Berlin EAES and World Congress was the ideal occasion to publish a further and ever so necessary update. It summarizes all the original recommendations, followed by updates

in 2006 originating from leading laparoscopic surgeons in Europe. All statements are based not only on the expert's opinion, but also on formal assessment of the scientific evidence as it has appeared in the literature since the publication of the guidelines in *Surgical Endoscopy*. Therefore, this book allows the readers to gain an overview of the cutting edge of laparoscopic surgical research. All recommendations described herein are those surgical procedures and techniques for which a benefit has been proven. Most guidelines contain key statements and all chapters follow a structured format to enhance easy and quick identification of all useful information.

Guidelines can only be as good as the evidence available. During the process of guideline development it became apparent that we still have weak evidence in several fields of endoscopic surgery. This should be taken as a request to our readers to perform more randomized controlled studies in "their institution" and to provide patients for multicenter trials.

Several and sometimes wide variations may appear according to differences in surgeons' fields of competence, accreditation for practice, and social health care and reimbursement systems in Europe and other places of the world. Local adaptations of the guidelines are therefore needed and mandatory.

The editors think that this book gives a perfect overview of what laparoscopic surgery has achieved within a little more than one decade of performance as expressed in our subtitle: *Twelve Years Evidence-Based Surgery in Europe*. It is our intention to follow up with this same book format in regular time frames under the auspices of the EAES while developing new evidence-based guidelines in parallel. All our efforts, however, will be useless if these guidelines are not translated into practice. It is therefore our hope that they will be introduced in teaching courses and clinical algorithms in our hospitals, throughout Europe, and the rest of the world.

The editors of this book would finally like to thank all contributors for the excellent work without which this book would not have been possible, the EAES for its support and generous sponsorship, as well as Springer, and especially Stephanie Benko, Desk Editor Clinical Medicine, for her professional service.

Cologne, August 2006

Edmund A. M. Neugebauer
(for the Editors)

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Contents

List of Contributors

C.C. Abbou
Department of Urology, Centre Hospitalier Universitaire Henri Mondor, 51, Avenue du Maréchal de Lattre de Tassigny, 94010 Creteil, France

F. Agresta
Department of General Surgery, Presidio Ospedaliero di Vittorio Veneto (TV), Via Forlanini 71, 31029 Vittorio Veneto, Italy

B. Anderberg
Department of Surgery, University of Linköping, 58183 Linköping, Sweden

L. Angrisani
S. Giovanni Bosco Hospital, University Federico II, 80131 Naples, Italy

J. Arbuckle
Upper GI and Laparoscopic Unit, Ealing Hospital, Uxbridge Road, Southall, Middlesex UB1 3HW, UK

M. Belachew
Service de Chirurgie Universitaire, CHRH, 2, Rue des Trois Points, 4500 Huy, Belgium

R. Bergamaschi
Department of Research and Development, Forde Health System, 6807 Forde, Norway

J.C. Berthou
Clinique Chirurgicale Mutualiste, 3 Rue Robert de la Croix, 56324 Lorient, France

A.L. Blum
Division de Gastro-Entérologie, Centre Hospitalier, Universitaire Vaudois (CHUR), Rue de Bugnon 46, 1911 Lausanne, Switzerland

H.J. Bonjer
Department of Surgery, Dalhousie University, Halifax, N.S. B3H-4J2, Canada

G. Borzellino
1ª Chirurgia Clinicizzata, Ospedale di Borgo Trento, Piazzale A. Stefani 1, 37126 Verona, Italy

H.-J. Brambs
University of Ulm, Department of Radiology, Steinhövelstraße 9, 89070 Ulm, Germany

A. Budzynski
Second Department of General Surgery, Collegium Medicum of Jagiellonian University, ul. Kopernika 21, 31-501 Krakow, Poland

G. Buess
Section for Minimally Invasive Surgery, University of Tübingen, Hoppe-Seyler-Straße 3, 71072 Tübingen, Germany

M. Buunen
Department of General Surgery, Erasmus MC, 3000 DR, Rotterdam, The Netherlands

M.G. Caballero
Department of Surgery, Málaga University, 29080 Málaga, Spain

R. Caprilli
La Cattedra di Gastroenterologia, Policlinico Umberto I, Università degli Studi di Roma "La Sapienza", 00185 Roma, Italy

G. Champault
Department of Digestive Surgery, CHU J. Verdier, Avenue du 14 Juillet, 93140 Bondy, France

J.M. Chevallier
Department of Digestive and General Surgery, Hôpital Européen G. Pompidou, 75015 Paris, France

E. Chouillard
Centre Hospitalier Intercommunal, 78300 Poissy, France

D. Collet
Department of Surgery, University of Bordeaux, 33000 Bordeaux, France

C. Cordiano
1ª Chirurgia Clinicizzata, Ospedale di Borgo Trento, Piazzale A. Stefani 1, 37126 Verona, Italy

M.A. Cuesta
Department of Surgery, VU Medical Center, Amsterdam 1007 MB, The Netherlands

A. Cuschieri
University Department of Surgery, Ninewells Hospital and Medical School, Dundee DD1 9SY, UK

B. Dallemagne
Department of Surgery, Saint Joseph Hospital, 4000 Liège, Belgium

J.E. Dominguez-Muñoz
Zentrum für Medizin, Otto-von-Guericke-Universität Magdeburg, 39104 Magdeburg, Germany

C. Dziri
Hôpital Charles Nicolle, Tunis, Tunisia

E. Eypasch
Klinik für Viszeral-, Gefäß- und Thoraxchirurgie, Markus-Krankenhaus, Wilhelm-Epstein-Str. 2, 60431 Frankfurt am Main, Germany

F. Favretti
Obesity Unit, Department of Medical and Surgical Sciences, University of Padova, Contra Chioare 13, 36100 Vicenza, Italy

H. Feussner
Chirurgische Klinik und Poliklinik Rechts der Isar, Universität München, 81675 München, Germany

N. Finer
Wellcome Clinical Research Facility, Addenbrooke's Hospital, Hills Road, Cambridge CB2 2QQ, UK

A. Fingerhut
Service de Chirurgie Viscerale Digestive, Centre Hospitalier Intercommunal, 78300 Poissy, France

F. Fischer
Surgical Clinic Merheim, II Department of Surgery, University of Cologne, Ostermerheimer Str. 200, 51109 Cologne, Germany

J.W. Fleshman
Division of General Surgery, Washington University, 63102 St. Louis, MO, USA

A. Frilling
Clinic for General Surgery and Transplantation, University Hospital Essen, Hufelandstr. 55, 45122 Essen, Germany

K.-H. Fuchs
Klinik für Viszeral-, Gefäß- und Thoraxchirurgie, Markus-Krankenhaus, Wilhelm-Epstein-Str. 2, 60431 Frankfurt am Main, Germany

M. Gholghesaei
Department of Surgery, Reinier de Graaf Gasthuis, 2629 HS Delft, The Netherlands

H. Glise
Department of Surgery, Norra Älvsborgs Länssjukhus, Trollhättan, Sweden

P. Goh
Department of Surgery, National University Hospital, Singapore, Singapore

P.J. Guillou
Academic Surgical Unit, St. James's University Hospital, Leeds LS9 7TF, UK

J.A. Guisado Macias
Mental Health Department, Servicio Extremeno de Salud, Junta de Extremadura, C/Jesus Rincon Jimenez n°82, 5°D, 06010 Badajoz, Spain

N.Y. Haboubi
Department of Histopathology, Withington Hospital, Manchester M20 2LR, United Kingdom

E. Haglind
Department of Surgery, Sahlgrenska University Hospital, 41110 Göteborg, Sweden

L.E. Hammarström
Department of Surgery, Malärsjukhuset, 633342 Eskilstuna, Sweden

J. Himpens
Department of Thoracic, Abdominal and Minimally Invasive Surgery, Saint Blasius General Hospital, 9200 Dendermonde, Belgium

U. Holthausen
Surgical Clinic Merheim, II Department of Surgery, University of Cologne, Ostmerheimer Str. 200, 51109 Cologne, Germany

L. Hultén
Department of Surgery, Sahlgrenska Sjukhuset, 41110 Göteborg, Sweden

C.G.S. Hüscher
Divisione di Chirurgia Thoracica, Istituto Nazionale per lo Studio e la Cura dei Tumori, 20133 Milano, Italy

D. Ignjatovic
Department of Research and Development, Forde Health System, 6807 Forde, Norway

A. Isla
Upper GI and Laparoscopic Unit, Ealing Hospital, Southall, Middlesex UB1 3HW, UK

C.A. Jacobi
Department of Surgery, Humboldt University of Berlin, 10099 Berlin, Germany

J.J. Jakimowicz
Department of Surgery, Catharina Hospital, Eindhoven, The Netherlands

A. Jansen
Department of Surgery, Kennemer Gasthuis, Haarlem, The Netherlands

F.W. Jansen
Department of Gynecology, Leiden University, PO Box 9600, 2300 RC Leiden, The Netherlands

K.W. Jauch
Ludwig Maximilian University, Department of Surgery, Grosshadern, Marchioninistr. 15, 81377 Munich, Germany

J. Jeekel
Department of General Surgery, Erasmus MC, Rotterdam, The Netherlands

M. Johansson
Department of Surgery, Sahlgrenska University Hospital, 41345 Gothenburg, Sweden

H.-U. Kauczor
Klinik und Poliklinik für Radiologie, Johannes-Gutenberg-Universität Mainz, 55128 Mainz, Germany

H. Kehlet
Section for Surgical Pathophysiology 4074, The Juliane Marie Centre, Rigshospitalet, 2100 Copenhagen, Denmark

M.R.B. Keighley
Department of Surgery, Queen Elizabeth Hospital, Birmingham B15 2TH, United Kingdom

F. Koeckerling
Department of Surgery and Center for Minimally Invasive Surgery, Siloah Hospital Hannover Hospital, 30449 Hannover, Germany

L. Köhler
Surgical Clinic Merheim, II Department of Surgery, University of Cologne, Ostmerheimer Str. 200, 51109 Cologne, Germany

A.-M. Koivusalo
Department of Anaesthesia, University of Helsinki, 00130 Helsinki, Finland

D. Korolija
University Surgical Clinic, Clinical Hospital Center Zagreb,
Kispaticeva 12, 10000 Zagreb, Croatia

M.E. Kreis
Ludwig Maximilian University, Department of Surgery, Grosshadern,
Marchioninistr. 15, 81377 Munich, Germany

W. Kruis
Department of Gastroenterology, Evangelisches Krankenhaus Kalk,
51103 Köln, Germany

C.K. Kum
Department of Surgery, National University Hospital, Singapore, Singapore

A.M. Lacy
Department of Surgery, Hospital Clinic i Provincial, Villarroel 170,
08036 Barcelona, Spain

J.J.B. van Lanschot
Academisch Ziekenhuis, Department of Surgery, University of Amsterdam,
Amsterdam, Netherlands (Representative of Prof. Dr. Tytgat, Netherlands)

K. Lauterbach
Institut für Gesundheitsökonomie, Universität zu Köln, 51103 Köln, Germany

J. Leroy
Department of Digestive Surgery, Digestive Cancer Research Institute
(IRCAD) and European Institute of Telesurgery (EITS), 67091 Strasbourg,
France

T. Lerut
Department of Thoracic Surgery, University Hospital Leuven, 3000 Leuven,
Belgium

E. Lezoche
Università degli studi di Roma, La Sapienza, Dipartimento di Chirurgia,
00185 Rome, Italy

M.A. Lumsden
Department of Obstetrics and Gynaecology, 3rd Floor, Queen Elizabeth Building, Royal Infirmary, 10 Alexandra Parade, Glasgow, G31 2ER, UK

L. Lundell
Department of Surgery, Sahlgrenska Hospital, University of Göteborg, 41110 Göteborg, Sweden

P. Lundorff
Department of Obstetrics and Gynaecology, Viborg Sygehus, Heibergs Alle 4, 8800 Viborg, Denmark

M.J. McMahon
Leeds Institute for Minimally Invasive Therapy (LIMIT), Great George Street, Leeds LS1 3EX, UK

D.W. Meijer
Department of General Surgery, Erasmus MC, Rotterdam, The Netherlands

B. Millat
Service de Chirurgie Viscerale et Digestive, Hôpital Saint Eloi, 34295 Montpellier, France

M. Miserez
Surgical Clinic, II Department of Surgery, University of Cologne, Ostmerheimer Str. 200, 51109 Cologne, Germany

R. Mittermair
Department of General Surgery, University Hospital Innsbruck, Anichstr. 35, 6020 Innsbruck, Austria

A.-C. Moberg
Department of Surgery, Malmö University Hospital, 20502 Malmö, Sweden

J.R.T. Monson
Academic Surgical Unit, The University of Hull, Castle Hill Hospital, Castle Road, Cottingham HU16 5JQ, UK

A. Montgomery
Department of Surgery, Malmö University Hospital, 20502 Malmö, Sweden

M. Morino
Chirurgia Generale II e Centro di Chirurgia Mini-Invasiva,
Department of Surgery, University of Turin, 10126 Turin, Italy

S. Msika
Service de Chirurgie Generale et Digestive, Hôpital Louis Mourier,
78, Rue des Renouillers, 92701 Colombes, France

J.M. Müller
Department of Surgery, Charité, Humboldt-Universität, 10117 Berlin, Germany

H.E. Myrvold
Department of Surgery, Regionsykehuset, University of Trondheim,
Trondheim, Norway

B. Navez
Service de Chirurgie, Hôpital St Joseph, 6 rue de la Duchère, 6060 Gilly,
Belgium

J. Neudecker
Department of Surgery, Charité Campus Mitte, Humboldt-University
of Berlin, Schumannstr. 20/21, 10117 Berlin, Germany
Biochemical and Experimental Division, II Department of Surgery,
University of Cologne, Ostmerheimer Str. 200, 51109 Cologne, Germany

E.A.M. Neugebauer
Institute for Research in Operative Medicine, University of Witten-Herdecke,
Ostmerheimer Str. 200, 51109 Cologne, Germany

G. Nilsson
Department of Nursing, Lund University, Box 157, 22100 Lund, Sweden

A. Paul
Clinic for General Surgery and Transplantation, University Hospital Essen,
Hufelandstr. 55, 45122 Essen, Germany

A. Peracchia
Department of Surgery, University of Milan, School of Medicine,
20133 Milan, Italy

J. Périssat
Service de Chirurgie Digestive, Hopitaux de Bordeaux, 33076 Bordeaux, France

H. Petersen
Department of Medicine, Regionsykehuset, University of Trondheim, Trondheim, Norway

R. Pointner
Department of General Surgery, Zell am See Hospital, 5700 Zell am See, Austria

P. Rossi
Istituto di Radiologia, Università degli Studi di Roma, La Sapienza, 00185 Roma, Italy

M. A. Röthlin
Klinik für Viszeral-Chirurgie, Universitätsspital Zürich, 8091 Zürich, Switzerland

R. C. G. Russell
Department of Surgery, Middlesex Hospital, Sterlin Way, London N18 1QX, England

F. Rubino
Department of Surgery, Hopitaux Universitaires, BP 426, 67091 Strasbourg, France

S. Saad
Department of Abdominal, Vascular and Transplantation Surgery, Merheim Hospital, University of Witten-Herdecke, Ostmerheimer Str. 200, 51109 Cologne, Germany

S. Sauerland
Institute for Research in Operative Medicine, University of Witten-Herdecke, Ostmerheimer Str. 200, 51109 Cologne, Germany

W. Schwenk
Department of General, Abdominal, Vascular and Thoracic Surgery, Campus Charité Mitte, Schumannstr. 20/21, 10117 Berlin, Germany

G. Scozzari
Chirurgia Generale II e Centro di Chirurgia Mini-Invasiva, Department of Surgery, University of Turin, 10126 Turin, Italy

A. Shamiyeh
Ludwig Boltzmann Institute for Operative Laparoscopy, II Surgical Department, Academic Teaching Hospital Linz, AKH Linz, Krankenhausstr. 9, 4020 Linz, Austria

P. Spinelli
Divisione di Diagnostica e Chirurgia Endoscopica, Istituto Nazionale per lo Studio e la Cura dei Tumori, 20133 Milano, Italy

A. Szold
Department of Surgery B, Sourasky Medical Center, Weizmann Street 6, 64239 Tel Aviv, Israel

R. Tacchino
Department of Surgery, Catholic University of Rome, Viale della Tecnica 205, 00144 Roma, Italy

E. Targarona
Department of General and Digestive Surgery, Hospital de Sant Pau C/Padre Claret 167, 08025 Barcelona, Spain

Y. Tekant
Hepatopancreatobiliary Surgery Unit, University of Istanbul, Istanbul 55004, Turkey

I. Tomasi
1ª Chirurgia Clinicizzata, Ospedale di Borgo Trento, Piazzale A. Stefani 1, 37126 Verona, Italy

J. Treckmann
Clinic for General Surgery and Transplantation, University Hospital Essen, Hufelandstr. 55, 45122 Essen, Germany

H. Troidl
Surgical Clinic Merheim, II Department of Surgery, University of Cologne, Ostmerheimer Str. 200, 51109 Cologne, Germany

S. Uranues
Departments of General Surgery and Surgical Research, University Surgical Clinic, Auenbruggerplatz 29, 8036 Graz, Austria

B. Ure
Department of Paediatric Surgery, Medical University of Hannover, Carl-Neuberg Str. 1, 30623 Hannover, Germany

R. Veldkamp
Department of Surgery, Medisch Centrum Rijnmond-Zuid, Locatie Zuider, Groene Hillerdijk 315, 3075 Rotterdam, The Netherlands

N. Veyrie
Hôpital Hôtel Dieu, AP-HP, 75004 Paris, France

W. Wayand
Ludwig Boltzmann Institute for Operative Laparoscopy, II Surgical Department, Academic Teaching Hospital Linz, AKH Linz, Krankenhausstr. 9, 4020 Linz, Austria

R. Weiner
Department of Surgery, Krankenhaus Sachsenhausen, Schulstr. 31, 60594 Frankfurt, Germany

S.D. Wexner
Department of Colorectal Surgery, Cleveland Clinic Florida, 33331 Weston, FL, USA

R.L. Whelan
Section of Colon and Rectal Surgery, Columbia University College of Physicians & Surgeons, New York, NY 10025, USA

S. Wood-Dauphinée
Department of Epidemiology and Biostatistics, School of Physical and Occupational Therapy, McGill University, 3630 Promenade Sir-William-Osler, Montreal, Quebec H3G 1Y5, Canada

J. Zehetner
Ludwig Boltzmann Institute for Operative Laparoscopy, II Surgical Department, Academic Teaching Hospital Linz, AKH Linz, Krankenhausstr. 9, 4020 Linz, Austria

The EAES Clinical Practice Guidelines on the Evaluation of Quality of Life After Laparoscopic Surgery (2004)

Dragan Korolija, Stefan Sauerland, Sharon Wood-Dauphinée, Claude C. Abbou, Ernst Eypasch, Manuel García Caballero, Mary A. Lumsden, Bertrand Millat, John R. T. Monson, Gunilla Nilsson, Rudolf Pointner, Wolfgang Schwenk, Andreas Shamiyeh, Amir Szold, Emilio Targarona, Benno Ure, Edmund A. M. Neugebauer

Introduction

When a new procedure or technology is introduced, it is expected to achieve "better" or at least equal results than the more traditional approaches. Classical outcomes for the evaluation of surgical procedures are usually perioperative case fatality, morbidity, recurrence rate, and long-term survival. However, from the patient's point of view, the so-called heuristic end points, such as symptom resolution, duration of convalescence, patient satisfaction and well-being, and quality of life (QoL), are at least as important as the "classical" outcomes. Furthermore, although of particular interest to caregivers and payers, they are rarely considered in studies testing the efficacy and effectiveness of new surgical approaches [12].

Minimally invasive (laparoscopic) surgery promised to improve health-related outcomes. The classical outcomes of laparoscopic and open surgery have been extensively compared according to the literature and discussed in the previous consensus development conferences organized by the European Association for Endoscopic Surgery (EAES) [87]. Approximately 15 years after the first laparoscopic cholecystectomy, it is essential to answer the question of whether laparoscopic surgery, compared to open surgery, improves the patient's QoL.

An evidence-based approach was therefore undertaken to evaluate existing information about different areas of laparoscopic surgery and to assess for which diseases laparoscopic surgery results in better postoperative QoL compared to open surgery. QoL is a multidimensional construct comprising physical, psychological, social, and functional domains [88]. Our second aim was to appraise QoL instruments used in the literature and to give recommendations for their future use in laparoscopic surgery. These recommendations are based on a systematic review combined with a formal consensus development conference (CDC).

Methods

Selection of Topics

At the meeting of the scientific committee and the executive board of the EAES in Lisbon in June 2002, there was a unanimous vote to implement a mechanism to evaluate QoL after laparoscopic surgery. Topics of interest were selected according to their overall prevalence and the use of laparoscopic surgery as an operative approach: gastroesophageal reflux disease (GERD), achalasia, paraesophageal hernia, obesity, cholecystolithiasis, inguinal hernia, and colorectal spleen, kidney, ovarian, and uterine diseases. In addition, the pediatric aspects of some of these diseases were addressed. The Cologne Group was asked to organize a CDC, according to previously established methodology [86]. For this purpose, the methods of a systematic review and a CDC were combined.

Literature Searches

Under the guidance of a clinical epidemiologist (S.S.), a surgeon with education and experience in evidence-based medicine and systematic reviews (D.K.) performed comprehensive literature searches in Medline, Embase, the Cochrane Library, and other sources. The medical subject headings "Laparoscopy" and "Quality of life" were used. Additionally, Medline was searched using the words "laparosc*," "gynecol*," "urolog*," and "quality of life." The reference lists of obtained articles were also checked. There were no language restrictions. The search was limited to the years 1990–2002. Additionally, abstracts presented at the EAES congresses in 2001 and 2002 were searched by hand. If related abstracts were identified, contacts were made with the authors to obtain complete results.

Our primary intention was to identify existing systematic reviews or meta-analyses and relevant randomized controlled trials (RCTs). In the absence of such evidence, we searched for concurrent cohorts (CCHs), externally or historically controlled cohorts population-based outcome studies, and case series. All articles were graded according the hierarchy of evidence defined by Sackett et al. [110], as shown in Table 1.1. Critical appraisal of papers was carried out as recommended by Muir Gray [84]. Articles were considered relevant if they reported QoL outcomes using standardized or self-developed questionnaires. Multiple publications of the same study were included only once in the review. For each study, the first author, publication year, number of patients analyzed, type of questionnaire, type of procedure, length of follow-up, level of improvement, and characteristics of the control group were extracted.

As the surgical articles were being reviewed, QoL measures that had been employed as outcomes were noted. The focus was on known and standard-

ized generic and disease-specific measures, but ad hoc questionnaires and single-item questions were also listed. Generic instruments include health profiles, which describe patient feelings and behaviors on a number of domains, as well as preference or utility measures, which reflect the value people place on specific disease states or outcomes of care, and can incorporate death. These instruments can be used across a wide variety of populations and patient samples with different levels of disease severity to compare either the impact of different diseases or the effectiveness of different approaches to care. Disease-specific measures concentrate on the problems faced by the patient due to the disease and incorporate symptoms. They are known to be responsive to change in patient status. It is common to find that a generic measure and a disease-specific measure are used in a study. Ad hoc questionnaires have often been originally designed for clinical practice and then incorporated in a study as an outcome measure. Questions tend to use different formats and different response sets. Most questions are treated as individual pieces of information, and usually questions are not summed to create overall scores. No data are available on the measurement properties of these instruments: thus, the term ad hoc is applied.

Single-item questions are also used and may ask about symptoms, function, or QoL, but the most frequent request is for patients to estimate the time (weeks or days) from operation to a pain-free state or return to usual activities or to work.

In addition to extracting measures from the literature review, members of the consensus group were asked to provide the names of QoL instruments that they knew or had used. These suggestions were added to the list of measures. All measures were then divided into the four groups defined previously. The generic measures were reviewed in terms of their psychometric or measurement properties, reliability, validity, and responsiveness [116]. Reliability reflects the degree to which a measure is free from random error, and it includes estimates of precision or how well the questions within a scale "hang together" as well as estimates of stability over time. Validity evaluates the degree to which the instrument actually assesses what it is supposed to measure. It determines if the content of the instrument is adequately representative of the construct under study, in this case QoL. It also tests if the measure performs according to theoretical expectations by examining the direction and magnitude of relationships with other variables. This is called construct validity. Criterion validity demonstrates the extent to which the measure being reviewed relates to a criterion measure or "gold standard" concurrently or in the future. Finally, responsiveness or the ability to accurately detect chance in patient status over time is determined. All this information was recorded, but we were particularly interested to find out if any of the generic measures had been validated on patient samples of interest to the consen-

Table 1.1. The Oxford evidence hierarchy for therapeutic studies (modified from Sackett et al. [110])

Level of evidence	Study design
1a	Systematic review of RCTs
1b	Individual RCT
1c	All-or-none case series
2a	Systematic review of cohort studies
2b	Individual cohort study
2c	"Outcomes" research
3a	Systematic review of case–control studies
3b	Individual case–control study
4	Case series
5	Expert opinion, bench or animal research

RCT randomized controlled trial

sus group. The psychometric properties of the disease-specific instruments were also recorded, and information on content of the ad hoc questionnaires and the single-item questions was added to our files.

Expert Panel

For the CDC, the conference organizers in Cologne, together with the scientific committee of the EAES, nominated a multidisciplinary expert panel. The selection criteria were clinical and scientific expertise in the field of laparoscopy, open surgery, methodology, or QoL assessment, together with a geographical location in Europe. Four months before the conference, a methodologic plan and the results of the initial literature search were sent to the panelists. They were asked to check the literature list for completeness and to answer the following questions regarding QoL after laparoscopic surgery for a given disease:

- What is the patient's major problem at different time points after surgery?
- Which domains of quality of life are affected after surgery?
- Which instruments are useful to evaluate quality of life after surgery?

The answers of the experts regarding the literature were compared with the systematic reviews completed in February and March 2003. As noted previously, the QoL questionnaires used in the literature were critically appraised and compared with the questionnaires recommended by the expert panel. After integration of the existing evidence and recommendations of the experts, the first draft of the CDC guidelines was prepared and sent to the experts at the end of April 2003, along with the rankings of the affected domains that contained the average values for the different time-points.

Members of the expert panel were asked to review the preconsensus material and to attend the CDC in Cologne on May 16, 2003. At that meeting, comments of the experts and conference organizers were discussed. Disagreements between the experts were resolved through the use of a nominal group process. Initially, 11 topics had been selected. At the Cologne meeting several additional topics were proposed by the expert panel. After discussion and voting it was decided to include radical prostatectomy as one additional topic. Adrenalectomy was proposed but not included because QoL data are sparse for this procedure. Appendectomy was not included because it is an acute illness, in which QoL is not usually affected in the long term. Finally, because there are no QoL data available for laparoscopic adhesiolysis in patients with chronic pain or chronic intestinal obstruction, the panel decided not to include this topic.

For each selected topic, consensus as to the level of evidence of QoL improvement after laparoscopic compared with open surgery was reached. Because there are no existing levels of recommendations for QoL instrument use, this was not done. The suggestions for QoL assessment tools were made according to the appraisals made in Table 1.4 and the consensus reached during the CDC meeting in Cologne. After the meeting, changes were added to the material and the second draft of the CDC guidelines was produced.

The CDC results were presented in a 1.5-h session to the attendees of the annual congress of the EAES in Glasgow on June 16, 2003. All suggestions made by the audience were discussed by the panelists. The resulting statement was mailed to all the experts for final approval (Delphi process) before publication.

Results

Literature Search Results

The search of the literature resulted in an initial set of 272 titles. The papers that used QoL questionnaires were selected (154 titles) and sent to the panel. After further articles had been retrieved from the experts, all 182 articles were assessed for study design, clinical relevance, and QoL evaluation. The final list included 67 papers that reported on QoL outcomes after laparoscopic compared to open surgery (Table 1.2).

Carefully developed and standardized questionnaires were used in 38 papers. Twenty-nine papers used questionnaires developed by the authors without prior psychometric testing (ad hoc questionnaires). The results are presented in Table 1.3. The number of validated questionnaires exceeds the number of selected papers because some authors used more than one questionnaire. The domains of QoL included in the ad hoc questionnaires are presented in Table 1.4.

Validation of a measure is never complete. One should ask, “valid for which patient population and in which setting?”. Psychometricians advocate

Table 1.2. Systematic reviews (*SR*), meta-analyses (*MA*), RCT, and concurrent cohorts (*CCH*) on quality of life after laparoscopic versus open surgery

Disease/procedure	SR/MA	RCT	CCH	Total
GERD	–	7	7	14
GERD in childhood	–	–	1	1
Obesity	–	2	–	2
Splenectomy	–	–	1	1
Achalasia	–	–	2	2
Paraesophageal hernia	–	–	1	1
Cholecystolithiasis	–	2	8	10
Colorectal	–	4	3	7
Groin hernia	5	10	1	16
Nephrectomy	–	–	4	4
Hysterectomy	–	5	4	9
Prostatectomy	–	–	1	1

GERD gastroesophageal reflux disease

Table 1.3. The use of validated and ad hoc questionnaires

Disease/ procedure	No. of validated question-naires	Questionnaires	No. of ad hoc questionnaires	Total
GERD	9	GIQLI ($n=2$); GERD-HRQL; SF-36; Visick ($n=3$); PGWB ($n=2$); GSRS ($n=2$); VAS reflux; VAS pain, fatigue; VAS dysphagia, flatus, bloating	5	14
GERD in childhood	–		1	1
Obesity	1	BAROS	1	2
Splenectomy	1	SF-36	0	1
Achalasia	1	SF-36	1	2
Paraesophageal hernia	1	SF-36	–	1
Cholecystolithiasis	8	GIQLI ($n=5$), NHP ($n=2$), VAS ($n=2$), HADS, SF-36 ($n=2$), QLI	2	10
Colorectal	4	SDS, QLI; GRS; SF-36 ($n=2$); GIQLI; BIQ; EORTC QLQ-C30	3	7
Groin hernia	10	SF-36 ($n=6$); VAS pain ($n=6$), SIP, P-o-M; NHP; Kald; LASA, EuroQol, LAS pain	6	16
Nephrectomy	1	PRS, VAS pain	3	4
Hysterectomy	2	SF-36, EuroQol	7	9
Prostatectomy	1	EORTC prostate cancer QoL, IIEF-5, ICS_{male}	0	1

Numbers refer to the number of studies, even if one study used more than one questionnaire. Abbreviations are defined in the text and in the footnote to Table 1.5

Table 1.4. Ad hoc questionnaires and domains covered

	No. of studies	Physical	Psychological	Social relations	Functional capacity
GERD	5	[5, 20, 66, 103, 106]	[20, 66, 103, 106]	[103, 106]	
GERD in childhood	1	[75]		[75]	[75]
Obesity	1	[144]	[144]	[144]	[144]
Splenectomy	–				
Achalasia	1	[24]	[24]	[24]	[24]
Paraesophageal hernia	–				
Cholecystolithlosis	2	[56, 111]	[56, 111]	[56, 111]	[56, 111]
Colorectal	2	[71, 97]	[97]	[13, 71, 97]	[13, 71, 97]
Groin hernia	6	[18, 21, 77, 112, 113, 125]	[113, 125]	[18, 21, 77, 112, 113, 125]	[18, 21, 77, 112, 113, 125]
Nephrectomy	3	[3, 43, 78]	[43, 78]	[43, 78]	
Hysterectomy	7	[31, 39, 59, 89, 101, 114, 118]	[31, 39, 89, 101, 114]	[31, 39, 59, 89, 101, 114, 118]	[31, 39, 59, 89, 101, 114, 118]
Prostatectomy	–				

The numbers in *brackets* represent the references that report on particular domains

that measures be reexamined for their measurement properties, particularly validity, prior to applying them to a new patient population. Measurement studies revalidating the generic measures using appropriate diagnostic patient samples for this CDC were not found. Rather, investigators relied on information from patients with other diagnoses and used the measures. This leap of faith is often made in clinical research. It is probably reasonable since all the generic instruments have been extensively tested for reliability, validity, and responsiveness to change on a variety of patient samples. This statement pertains to the Short Form (SF) 36 [138], Quality of Life Index [119], Sickness Impact Profile [8], Nottingham Health Profile [50], EuroQol [34], Psychological General Well-Being Index [29], Hospital Anxiety and Depression Scale (HADS) [147], Linear Analogue Self-Assessment (LASA) [22] scales, and, to a lesser extent, the Health and Activity Limitation Index, which is relatively new [32].

Information about the content, mode of administration, scoring, and psychometric properties of the specific instruments is presented in Table 1.5. In addition, one investigator used a battery of standardized measures to capture QoL of people with inguinal hernia repair [41], and other investigators used the Visick Classification [94, 96, 102], which is very old and not well validated but traditionally accepted by the surgical community.

Table 1.5. Condition-specific measures of quality of life in related literature

Appraisal properties	Gastrointestinal					Colorectal				Obesity			Groin hernia Pain-O-Meter (tool)	Nephrectomy
	GIQLI	GSRS	QOL-RAD	GERD-HRQL	Achalasia QOL index	FACT-C	FIQL	BIQ	SDS	EORTC-QLQ-C 30	IWQOL-Lite	BAROS		PRS
Dimensions														
Physical	+		+		+	+	+	+	+	+	+	+		+
Emotional	+		+		+	+	+	+		+	+	+		
Cognitive									+	+				
Social	+		+		+	+	+			+	+	+		+
Symptoms	+	+	+	+		+			+	+		+	+	+
Response format														
Categorical	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Mixed														+
VAS													+	+
Administrative mode														
Self-report	+	+	+	+	+	+	+	+	+	+	+	+		+
Interview		+								+			+	
Caregiver												+		
Scoring														
Subscale scores	+	+	+		+	+	+	+		+	+			
Total score	+	+	+	+		+			+		+		+	+
Classification												+		

Reliability																	
Internal consistency	+	+	+			+	+	+	+	+	+						
Test–retest	+	+	+				+				+					+	
Validity																	
Content	+	+	+	+		+				+	+	+					
Criterion	+										+						
Construct-convergent	+	+	+			+	+	+	+	+	+	+					
Contruct-divergent	+	+	+	+		+	+	+	+	+	+	+					
Factorial								+		+							
Responsiv-ness	+	+	+	+		+		+	+	+	+					+	
Estimated time to administer																	
<2 min				+	+												
3–10 min		+	+				+	+	+								
>10 min	+					+				+	+	+	+			+	

Gastrointestinal Quality of life Index (*GIQLI*) [37]; Gastrointestinal Symptom Rating Scale (*GSRS*) [122]; Quality of Life in Reflux and Dyspepsia Patients (*QOLRAD*) [146]; Gastroesophageal Reflux Disease – Hea1th-Related Quality of Life (*GERD-HRQL*) [133]; Achalasia QOL Index [83]; Functional Assessment of Cancer Therapy – Colorectal (*FACT-C*) [135]; Fecal Incontinence Quality of Life (*FIQL*) [108]; Body Image Questionnaire (*BIQ*) [28]; Symptoms Distress Scale (*SDS*) [76]; European Organization for Research and Treatment of Cancer (*EORTC QLQ-C30*) [2]; Impact of Weight on Quality of Life–Lite questionnaire (*IWQOL-Lite*) [60]; Bariatric Analysis and Reporting Outcome System (*BAROS*) [92]; Pain-O-Meter [40]; Postoperative Recovery Scale (*PRS*) [136]

A number of investigators in each surgical area used ad hoc questionnaires or individual questions related to symptoms or QoL variables. Items in the ad hoc questionnaires were of interest to surgeons and often reflected the recovery of the patients postoperatively as well as their satisfaction with the surgery. Each item in the questionnaire was treated statistically as a unique piece of information; item scores (if present) were not summed. Items were compared by surgical group (i.e., open versus laparoscopic surgery).

Other investigators asked individual questions. Sometimes, questions were scaled in terms of response categories (i.e., no, mild, moderate, or severe pain), but most often the patient was asked to report time from operation (in days or weeks) to recovery of full physical activities or to return to usual social activities, to a "normal" lifestyle, to work, or to a pain-free state. Occasionally, patients were asked to provide information on medication use. As with the ad hoc questionnaires, responses between surgical groups were compared.

The answers of the experts were used at the CDC in Cologne when specific time points for QoL instrument application had been suggested. For example, if there were two QoL measures that addressed different domains, we selected the measure that included the clinically more relevant domain.

Gastroesophageal Reflux Disease

Key Points and Suggestion for QoL Assessment

Laparoscopic fundoplication provides faster improvement of QoL when compared with open fundoplication (EL 1b). Long-term improvement of QoL is not different when compared to open surgery (EL 1b).

For GERD we suggest the use of the SF-36 or the PGWB (generic measures) in addition to the GIQLI and the QOLRAD (disease-specific measures). If the interest is primarily in symptom resolution the GSRS or the GERD-HRQL (symptom scales) are alternatives. Preoperative QoL assessment may be a useful adjunct in clinical decision-making. The suggestion is that the first postoperative evaluation of QoL should be done between 1 and 3 months after surgery and repeated at least at 1 year.

Background and Evidence

Seven randomized trials and seven nonrandomized trials compared laparoscopic and open antireflux procedures. When assessing the trials, we did not differentiate between Nissen and Toupet fundoplication. In GERD, more than in other diseases, QoL assessment is very important for patient selection in routine practice. Kamolz et al. [55] have shown that some patient populations,

such as those with major depression, showed less QoL improvement than other groups of patients, despite normal physiologic postoperative data.

In one of the seven RCTs, Heikkinen et al. [48, 49] compared laparoscopic and open Nissen fundoplication 1, 3, and 24 months after surgery (1b). They used the GIQLI [37] and a Visual Analogue Scale (VAS) [104] for pain as well as an ad hoc questionnaire on patient satisfaction. The laparoscopic group experienced less postoperative pain and returned earlier to work and normal life. Two years after the surgery, GIQLI scores were significantly improved, compared to preoperative data, but did not differ between the laparoscopic and open groups. In a similar study by Chrysos et al. [20], patients were given an ad hoc questionnaire after laparoscopic and open Nissen fundoplication (1b). Follow-up at 12 months included 106 patients. One year after surgery, the laparoscopic group reported significantly greater postoperative satisfaction when compared with the open group. Laine et al. [66] studied a total of 110 patients over a period of 12 months (1b). They used an ad hoc questionnaire. One year after surgery, all patients in the laparoscopic group and 86% of patients in the open group were satisfied with the operation. The fourth RCT by Bais et al. [5] also compared laparoscopic and open Nissen fundoplication (1b). They analyzed data on 103 patients from an ad hoc questionnaire. The follow-up was 2 years. The primary end points were dysphagia, recurrent GERD, and intrathoracic hernia. The laparoscopic group had significantly more patients with dysphagia 3 months after surgery. A further study by Nilsson et al. [91] compared laparoscopic Nissen with open Nissen fundoplication (1b). They used the standardized PGWB [29], together with an ad hoc questionnaire developed by the authors. The follow-up was for 6 months and included 60 patients. One and 6 months after surgery, there were no significant differences between the groups with regard to PGWB scores. Six months after surgery, the laparoscopic group reported significantly more sleep disturbances on the ad hoc questionnaire. In another publication from the same study, the authors used the GSRS [122] to analyze the differences in QoL between the two surgical approaches [143]. The GSRS scores did not differ between the two groups 1 and 6 months after surgery. Velanovich [130] compared laparoscopic and open Nissen and Toupet fundoplication (2b). The follow-up at 6 weeks used the GERD-HRQL [133] questionnaire and the SF-36, the generic QoL instrument developed for the Medical Outcomes Study [138]. There were 80 patients included in the study. The laparoscopic group had better results in the physical functioning scale of the SF-36. The results on the GERD-HRQL (symptoms) scale were not different between the groups.

Among the nonrandomized studies, Peters et al. [96] used the Visick score [134] and an ad hoc questionnaire to compare laparoscopic and open Nissen (2b). The follow-up was 54 months and incorporated 70 patients. There were no significant differences between the two groups. Blomqvist et

al. [9] used three standardized scales to compare laparoscopic and open Nissen and Toupet patients (2b). Specifically, they applied the PGWB questionnaire [29], the GSRS [122] and a visual analog scale depicting specific reflux-related symptoms (RVAS) [4]. The follow-up was 12 months for the 50 patients enrolled in the study. There were no significant differences in PGWB scales. In the GSRS scale, differences were shown between the two procedures, with more dyspeptic and indigestion symptoms in patients having undergone a laparoscopic Nissen procedure. Rantanen et al. [102] compared laparoscopic and open Nissen groups (2b). Using the Visick scale [134] and VAS [4] for dysphagia, flatus, and bloating, they studied a total of 57 patients. Three years after the operation, there were no differences between the two groups except for belching ability and temporary dysphagia. Richards et al. [106] compared laparoscopic and open Nissen groups with an ad hoc questionnaire (2b) given to 232 patients over a 3-month period. The laparoscopic group returned to work and reported better general health earlier than the open group. In the study by Rattner and Brocks [103], 86 patients were evaluated over 12 months after laparoscopic and open Nissen fundoplication approaches (2b). The laparoscopic group returned to work earlier than the open group. Overall satisfaction scores as measured with an ad hoc questionnaire were similar, irrespective of the operative technique. Finally, a nonrandomized study reported by Pelgrims et al. [94] compared 210 patients after laparoscopic and open Nissen procedures (2b). One year after surgery, there were no significant differences in Visick scores between the groups.

GERD in Childhood

Key Points and Suggestion for QoL Assessment

In children, there is no evidence that laparoscopic antireflux surgery provides different QoL when compared to open antireflux surgery (EL 2b).

For children with GERD we suggest that the use of the Child Health Questionnaire (CHQ) [68] or the Pediatric Quality of Life Inventory (PedsQL) [128] be tried. Both questionnaires are generic and need to be evaluated for this condition. Disease-specific instruments are not available. QoL assessment is suggested 3, 6, and 12 months after surgery.

Background and Evidence

In children, many diseases are treated laparoscopically, but only GERD has been evaluated on QoL outcomes. Mattioli et al. [75] compared laparoscopic and open Nissen fundoplication in children aged 1–14 years (2b). Data on 66 children from an ad hoc questionnaire were analyzed. Six months after

surgery, there were no differences between the groups in terms of pain relief and ability to play without symptoms. As in adults, the preoperative assessment of QoL is very important for patient selection, and further studies on QoL improvement after laparoscopic pediatric surgery are needed.

Obesity

Key Points and Suggestion for QoL Assessment

Randomized studies comparing open and laparoscopic vertical gastroplasty or gastric banding have not examined QoL. Laparoscopic gastric bypass provides QoL faster improvement of QoL when compared to open gastric bypass (EL 1b), but long-term results are similar (EL 1b).

For obesity surgery, we suggest the use of the SF-36 (generic measure) and the Impact of Weight on Quality of Life (IWQOL-Lite) (disease-specific measure). We recommend QoL evaluations for at least 2 years, but ideally they should be continued lifelong.

Background and Evidence

Two randomized trials compared laparoscopic and open gastric bypass for morbid obesity. On a sample of 155 patients, Nguyen et al. [90] used two standardized questionnaires to assess QoL (1b): the SF-36 [138] and the Moorhead–Ardelt quality-of-life questionnaire (BAROS) [92]. One month after surgery, SF-36 scores in four of the eight domains (physical functioning, social functioning, general health, and bodily pain) were significantly better in the laparoscopic group than in the open group. At 3 months after surgery, SF-36 scores in all eight domains had improved in the laparoscopic group and were equal to US norms, although physical functioning was still significantly impaired in the open group. Six months after surgery, SF-36 scores on all eight domains for both the laparoscopic and the open group were comparable with U.S. norms and were not significantly different between the groups. The Moorhead–Ardelt scores (BAROS) for sexual interest/activity at 3 months after surgery were significantly higher after laparoscopic surgery. At 6 months, there were no significant differences in any of the five QoL domains. Weight loss outcomes were comparable between the two groups at 1-year follow-up, but the laparoscopic group had significantly greater weight loss at 3 and 6 months. Westling and Gustavsson [144] administered an ad hoc questionnaire to 51 patients (1b). The laparoscopic group experienced less postoperative pain and shorter sick leave compared to the open group. One year after surgery there were no significant differences between the laparoscopic and open groups in weight loss and patient satisfaction, which was high in both groups.

QoL measurements in morbidly obese patients require long-term observations since weight loss takes time to complete and the incidence of complications, such as incisional hernia or band slippage, does not decrease considerably after the first postoperative year.

Splenectomy for Benign Diseases

Key Points and Suggestion for QoL Assessment

Laparoscopic splenectomy produces less pain in the early postoperative period compared to open splenectomy (EL 2b).

When splenectomy is undertaken for benign diseases, further information is required to make a recommendation for using the SF-36 (generic) or another instrument. QoL should be evaluated in the early postoperative period.

Background and Evidence

Only one nonrandomized study of 44 patients compared QoL results between laparoscopic and open splenectomy. In the study by Velanovich and Shurafa [132], the SF-36 was administered 6 weeks after the operation (2b). The laparoscopic group had significantly better scores in only one of eight domains (bodily pain).

Achalasia

Key Points and Suggestion for QoL Assessment

Laparoscopic Heller myotomy provides faster improvement of QoL when compared with open Heller myotomy (EL 2b).

For achalasia, we suggest the use of the SF-36 or the PGWB (generic measures) in addition to the GIQLI or the QOLRAD (disease-specific measures). If the interest is primarily in symptom resolution, the GSRS or the GERD-HRQL (symptom scales) are alternatives. The suggestion is that the first postoperative evaluation of QoL should be done between 1 and 3 months after surgery and repeated at least at 1 year.

Background and Evidence

In achalasia, short-term data are important in comparing results between laparoscopic and open surgery. However, achalasia is a disease that attacks the whole esophagus; therefore, long-term follow-up is more relevant for the patient's outcome. When examining GIQLI scores between 1 and 3 years after

surgery, Decker et al. [23] noted a significant deterioration, but in their 40 patients postoperative results were still better than preoperative ones.

Two small nonrandomized studies compared laparoscopic and open Heller myotomy. Katilius and Velanovich [57] used a validated generic questionnaire (SF-36) [138] to evaluate QoL (2b). Although the study included only 26 patients, they were able to detect significant differences: six weeks after the operation, the laparoscopic group scored better on the subscales reflecting physical functioning, role-physical, and vitality. Dempsey et al. [24] used an ad hoc questionnaire that covered all domains of QoL (2b). The study examined the postoperative course of 22 patients over a 16 month follow-up. The laparoscopic group experienced less postoperative pain and returned to work earlier than the open surgery group. Notably, follow-up length differed between the groups.

Paraesophageal Hernia

Key Points and Suggestion for QoL Assessment

Laparoscopic paraesophageal hernia repair provides better QoL when compared to open surgery (EL 2b). Until further data are available, we suggest the same instruments and time shedule for paraesophageal hernia as for GERD.

Background and Evidence

Only one study compared laparoscopic and open paraesophageal hernia repair. Velanovich and Karmy-Jones [13] used the SF-36 [138] to evaluate QoL 6 weeks after the procedure (2b). The study included 38 patients. Patients in the laparoscopic group reported better scores in the physical functioning, role-physical, role-emotional, vitality, and social functioning scales. The authors did not report on the long-term QoL scores.

Cholecystolithiasis

Key Points and Suggestion for QoL Assessment

Laparoscopic cholecystectomy improves QoL faster than open surgery (EL 1b). Long-term results after laparoscopic cholecystectomy are slightly better or not different compared to those of open surgery (EL 1b). The suggestion is to use the SF-36 or the PGWB (generic instrument) in conjunction with the GIQLI (disease-specific instrument). If time and resources are limited, the GIQLI may be used alone because it incorporates all domains of a QoL assessment. Postoperatively, a QoL assessment is suggested at 1 and 6 months.

Background and Evidence

Two randomized and eight nonrandomized trials reported on QoL after laparoscopic or open cholecystectomy. Whereas the results on short-term outcomes are homogeneous, long-term data are conflicting.

In a randomized trial of laparoscopic versus open cholecystectomy, Barkun et al. [6] used the NHP, the GIQLI, and the VAS for QoL assessment (1b). Using paired analysis, significant improvement in the laparoscopic group was detected as early as 10 days after surgery with the VAS ($p = 0.047$) and at 1 month with the NHP and the GIQLI ($p = 0.0001$). The open group did not show significant improvement until 1 month after surgery with the GIQLI ($p = 0.002$) and until 3 months with the NHP ($p = 0.03$). The extent of improvement in all QoL scores after surgery was similar in both groups. The second randomized trial was performed by McMahon et al. [81] (1b). QoL results in terms of a modified SF-36 score and the Hospital Anxiety and Depression Scale (HADS) [147] were reported at the 1-, 4-, and 12-week follow-ups. The only significant long-term advantage for laparoscopic surgery was a higher satisfaction rate with the appearance of the scar. As early as 1993, Sanabria et al. [111] (2b) studied 120 patients over an 8-week period after laparoscopic or open cholecystectomy. A significantly faster recovery was found, but at the final evaluation, the patients' answers did not differ when asked to subjectively rate the change in the quality of their lives. In the second nonrandomized trial, Eypasch et al. [36] in 1993 compared QoL after open ($n = 21$) and laparoscopic ($n = 158$) cholecystectomy (2b). The GIQLI, the QOL-Index (QLI) [119], and a VAS were used to assess QoL 2 and 6 weeks after surgery. At both time points, there was a trend toward better QoL in the laparoscopic group. Similar data were reported by Ludwig et al. [113] in a comparative study of 103 patients (2b). The authors modified the GIQLI and found a slightly quicker convalescence after laparoscopic cholecystectomy. However, in the final evaluation 5 weeks after surgery, both groups experienced a similar QoL. In a prospective controlled study of 31 patients, Plaisier [98] reported NHP data for the 3-, 6-, and 12-month intervals after surgery (2b). A significant difference in favor of laparoscopic surgery was found 6 months after cholecystectomy, but this difference vanished after 1 year with the exception of questions related to nausea, stomach swelling, and fatty food avoidance. A study from China also confirmed that GIQLI scores were initially better after laparoscopic cholecystectomy, but Chen et al. [19] did not find any long-term benefit of laparoscopic surgery in their series of 51 patients over 16 weeks (2b). In a large study by Kane et al. [56] (2b), 2481 patients were mailed a questionnaire 6 months after cholecystectomy. After adjusting for baseline differences, it was found that patients were more likely to perform their usual activities after laparoscopic surgery. There were no differences in pain, symptoms, or general health as measured with an ad hoc questionnaire.

Topcu et al. [124] (2b) performed a retrospective comparative study on 200 patients. Prior to surgery, both groups were comparable, but 4 years after surgery laparoscopically treated patients reported significantly better QoL in all eight domains of the SF-36. In another study, Quintana et al. [99] used the SF-36 and GIQLI to compare laparoscopic and open cholecystectomy (2b). There were 887 patients followed during the first three postoperative months. Additionally, the authors used ad hoc questions that focused on satisfaction with the intervention and the number of days before returning to work and daily activities. No significant differences between the open and laparoscopic groups either in the SF-36 scores or in the GIQLI scores were detected.

The occurrence of a bile duct injury has a significant impact on QoL in the long term. Moreover, the incidence of bile duct injury remains as high as 1.4%. Boerma et al. [10] used the SF-36 to examine QoL 5 years after bile duct injury during laparoscopic cholecystectomy. Despite the excellent objective outcome, QoL was both physically and mentally reduced when compared with controls ($p < 0.05$). In a similar observational study by Melton et al. [82], 89 patients were asked about their QoL after successful surgical repair of a major bile duct injury. However, the QoL instrument used in that study was developed for and validated in cancer patients only. QoL scores of bile duct injured patients were comparable to those of patients undergoing uncomplicated laparoscopic cholecystectomy and healthy controls in the physical and social domains but were significantly worse in the psychological domain.

Colorectal Diseases

Colorectal Cancer

Key Points and Suggestion for QoL Assessment

Laparoscopic colectomy produces less postoperative pain compared to open colectomy (EL 1b). In the early postoperative period, a higher QoL is reported earlier after laparoscopic than after open colectomy (EL 1b).

For patients with colorectal carcinoma, either the FACT-C or the EORTC QLQ-C30/CR38 will provide comprehensive information about all QoL domains, including symptoms. If fecal incontinence is an issue, the FIQL could be added. Because significant differences have been shown as long as 1 month after surgery but not at 2 months, QoL should be measured at least during the short-term follow-up. Long-term studies are needed.

Background and Evidence

Four randomized controlled trials and two nonrandomized trials reported on QoL outcomes in laparoscopic versus open colorectal procedures. Weeks et al. [141] used the Symptoms Distress Scale (SDS) [76], the QLI [119], and

the Global Rating Scale (GRS) [126] to study 428 patients over 2 months (1b). The laparoscopic group had significantly better GRS scores 2 weeks after surgery. This group also needed less postoperative analgesics. Two months after surgery there were no significant differences between the laparoscopic and open groups. The second randomized study, by Schwenk et al. [115], used the EORTC QLQ-C30 to compare QoL after laparoscopic or open colorectal resection (1b). One week after surgery, physical and emotional functions were more impaired in the open group ($p < 0.05$). Four weeks after surgery, only physical function differed between the two groups, and after 3 months the differences were no longer detectable. In addition to the QLQ-C30, a disease-specific add-on module, the QLQ-CR38, has been developed and validated by the EORTC [120].

Braga et al. [13] measured early postoperative morbidity in a randomized trial that included 269 patients. They used the time until return to full physical and social activities as a surrogate for QoL. The laparoscopic group recovered after 32 days, compared to 65 days for the open group. Finally, Liang et al. [71] reported on pain and return to partial activity, full activity, and work after laparoscopic or open sigmoid resection for large sigmoid polyps. Despite the small sample size, the authors found that patients in the laparoscopic group had a significantly lower incidence of pain. Return to full functional recovery was measured blindly and was 2 weeks earlier in the laparoscopic group ($p < 0.05$).

Dunker et al. [27] followed 35 patients over a period of 15 months (2b). They used the SF-36, the GIQLI, and the Body Image Questionnaire (BIQ) [28]. The laparoscopic group was significantly more often satisfied with the cosmetic result of the operation. There were no significant differences in other QoL scores. Pfeifer et al. [97] used an ad hoc questionnaire to assess QoL in 69 patients undergoing colorectal resection for a variety of diseases, including cancer (2b). There were no significant differences 2 months after surgery. In addition to the previous comments, some experts noted that there are no data on QoL outcomes from randomized controlled trials with total mesorectal excision.

Diverticular Disease

Key Points and Suggestion for QoL Assessment

For diverticular disease, laparoscopic and open approaches have similar long-term results in QoL improvement (EL 2b).

For patients with diverticular disease, the SF-36 will provide comprehensive information about QoL. If fecal incontinence is an issue, the FIQL could be added. QoL should be measured 1 month after surgery and repeated after 12 months. Further studies comparing QoL outcomes after laparoscopic and open surgery are needed.

Background and Evidence

There is only one retrospective comparative study on QoL after laparoscopic and open surgery for diverticular disease. Five years after surgery, Roblick et al. [107] asked 45 matched patient pairs to assess their QoL using the SF-36 (2b). No significant differences were found at this late point in time after the surgery. Short or intermediate-term results were not available.

Groin Hernia

Key Points and Suggestion for QoL Assessment

Compared to open hernia repair, laparoscopic surgery (TAPP and TEP) improves QoL more quickly (EL 1a). This is also true for bilateral hernia repair (EL 1b). Long-term restoration of QoL is not different (EL 1a).

The SF-36 (generic measure) is suggested as the primary HRQL measure of outcome. In addition, the VAS or a single-item rating of pain is recommended. The status of QoL should be measured after 1 and, at least, 6 and 12 months postoperatively.

Background and Evidence

Three meta-analyses, one systematic review, ten randomized trials, and nonrandomized trial compared QoL outcomes using standardized or ad hoc questionnaires.

The Cochrane review by the European Hernia Trialists was first published in 2000 and updated in 2003 (1a) [77]. The reviewers compared TAPP and TEP with open mesh and nonmesh procedures. As can be expected from the large number of primary trials, the duration and completeness of follow-up varied considerably among the studies. In the meta-analysis, a significant reduction in persisting postoperative pain (overall 290/2101 versus 459/2399; Peto OR = 0.54; 95% CI, 0.46–0.64; $p < 0.0001$) and in sick leave (HR 0.56; 95% CI, 0.51–0.61; $p < 0.0001$; equivalent to 7 days) was found. The other systematic reviews by Chung and Rowland [21] (1a), Cheek et al. [18] (1a), and Schmedt et al. [113] (1a) gave very similar results since they mainly included the same primary studies.

Among these primary RCTs, the study by Lawrence et al. [69] was one of the first that examined QoL (1b). A linear analogue scale for pain, the SF-36, and the Euroqol (linear analogue section) [34] were used to compare TAPP with Lichtenstein repair in 124 patients. The laparoscopic group had less pain and significantly higher scores in social function and energy by 10 days and at 6 weeks after the operation. When describing later results, 3 and 6 months postoperatively (1b) [70], the SF-36 demonstrated no differences in scores. In a sec-

ond RCT including 258 patients, Liem et al. [72] used the SF-36 to compare laparoscopic extraperitoneal hernia repair with the Lichtenstein procedure (1b). QoL was better in the laparoscopic group both 1 and 6 weeks after surgery. The differences were significant for physical functioning, role-physical, bodily pain, social functioning. In a smaller third trial of only 53 patients, the Sickness Impact Profile (SIP) [8] and the Pain-O-Meter [40] were applied to compare the 6-week results after TAPP or Lichtenstein repair (1b) [40]. The laparoscopic group had less pain postoperatively and returned to work earlier, but the differences were not significant. Barkun et al. [7] used the Nottingham Health Profile (NHP) [50] and the VAS to compare laparoscopic transabdominal with open tension and nontension repair (1b). Ninety-two patients were followed over 3 months. One month after surgery, the laparoscopic group had better QoL scores on the NHP ($p = 0.035$), but there were no differences in pain.

Another RCT from the United Kingdom by Wellwood et al. [142] used the SF-36 to compare laparoscopic transabdominal with Lichtenstein repair (1b). The follow-up was 3 months and included 392 patients. One month after surgery the laparoscopic group had significantly better SF-36 scores for role-physical, bodily pain, vitality, social functioning, and mental health. At 3 months after surgery there were greater improvements in mean scores from baseline in the laparoscopic group for all scales except general health, but none of these differences reached significance. Tschudi et al. [125] compared laparoscopic abdominal with Shouldice repair (1b). They used an ad hoc questionnaire and followed 84 patients over 5 years. The laparoscopic group had less postoperative pain and returned to work earlier, but at 5 years post-surgery there was only 1 patient in each treatment arm who had persistent pain and impaired capability (not statistically different). In a three-armed RCT, Bringman et al. [15] compared TEP with Lichtenstein and open mesh-plug procedures (1b). There were 294 patients, who were followed for 3 months. They used the questionnaire developed by Kald and Nilsson [54] and the VAS for pain. The laparoscopic group returned to work earlier and had less postoperative pain. Fleming et al. [41] compared TEP and the Shouldice technique after enrolling 232 patients (1b). They employed a battery of standardized measures to assess QoL [22]. The follow-up was 12 months. The laparoscopic group had less postoperative pain and returned to full activity earlier. Sarli et al. [112] used an ad hoc questionnaire to compare bilateral laparoscopic transabdominal repair with bilateral Lichtenstein repair in 43 patients (1b). The laparoscopic group returned to work earlier and had less pain postoperatively. In the long term, at 36 months QoL was similar. Stengel and Lange [121] compared laparoscopic transabdominal with Lichtenstein and Shouldice repair in 269 patients (2b). They used the SF-36 and a VAS for pain and followed patients for 6 months. The laparoscopic group had less pain postoperatively and returned to work earlier than the open

group. Jones et al. [53] analyzed return to work in 93 patients operated by one surgical group. In a bivariate analysis they showed that age, educational level, occupation, symptoms of depression, and expected time to work acounted for 61% of the variation in actual return to work. According to this evidence, the expert panel concluded that other factors besides the surgical technique used influence the return to work. To examine the impact of chronic pain and recurrence on QoL, annual long-term follow-up for 5 years is necessary. The details of different laparoscopic (endoscopic) techniques are beyond the scope of this article.

Nephrectomy for Malignancy

Key Points and Suggestion for QoL Assessment

No RCTs on QoL that compared laparoscopic and open nephrectomy either for benign or for malignant disease were identified. Laparoscopic nephrectomy (transabdominal or retroperitoneal) produces less pain in the postoperative period and enables earlier return to normal activities when compared to open surgery (EL 2b).

In addition to the use of a VAS for pain, we tentatively suggest the use of the SF-36 or the EORTC QLQ-C30 (generic measures). This recommendation for the generic measure has no basis in data. Because differences have been shown at 1 year after surgery, measurement of QoL in future trials should be done within this time frame.

Background and Evidence

Four nonrandomized trials compared laparoscopic and open nephrectomy with regard to postoperative QoL. McDougall et al. [78] compared radical laparoscopic transabdominal nephrectomy with its open counterpart (2b). Using an ad hoc questionnaire, it was shown in a sample of 24 patients that the laparoscopic group had significantly less postoperative pain. The laparoscopic group returned earlier to normal activities, and full recovery was also reached more rapidly. Gill et al. [43] compared radical laparoscopic (retroperitoneal) with open nephrectomy in 68 patients (2b). They used an ad hoc questionnaire. The laparoscopic group experienced less postoperative pain and returned to normal activities sooner. From a sample of 58 patients, Abbou et al. [3] showed that the laparoscopic (retroperitoneal) group experienced less pain in the postoperative period compared to the open nephrectomy group (2b). In the fourth study, Pace et al. [93] compared laparoscopic (transperitoneal) with open nephrectomy in a series of 61 patients (2b). They used the Postoperative Recovery Scale (PRS), which is based on the acute version of the SF-36 [136]. The laparo-

scopic group had significantly higher QoL scores at the 1-, 2-, 3-, and 6-month and 1-year postoperative assessments. This indicates a potential long-term benefit of laparoscopic nephrectomy.

Hysterectomy

Key Points and Suggestion for QoL Assessment

Laparoscopic-assisted hysterectomy improves QoL faster than abdominal hysterectomy (EL 1b). Long-term results of QoL status are similar (EL 1b).

For women undergoing a hysterectomy, the SF-36 (generic measure) may be used. Additional standardized questionnaires related to urinary and sexual function might be useful. Because differences have been shown at 6 months after surgery, measurement of QoL in future trials should be done at least 6 months.

Background and Evidence

Five randomized and four nonrandomized trials compared laparoscopic with open hysterectomy. Ellström et al. [30] administered the SF-36 to 76 patients (1b). Three weeks after operation, the laparoscopic group had significantly better scores in physical functioning, role-physical, bodily pain, and social functioning. At the end of follow-up, 12 weeks after surgery, there were no significant differences between the two patient groups. Lumsden et al. [74] used the Euroqol Health Questionnaire (Euroqol HQ) [34] for 166 hysterectomy patients (1b). The groups were compared 1, 6, and 12 months after surgery, but there were no significant differences in QoL. Schütz et al. [114] used an ad hoc questionnaire for QoL evaluation and the VAS for pain. A total of 35 patients were followed for 12 months (1b). The laparoscopic group had less postoperative pain and reported greater satisfaction with the operation. Falcone et al. [39] studied 48 patients using an ad hoc questionnaire and VASs for pain and activity (1b). Follow-up lasted 6 weeks. The laparoscopic group reported a shorter duration of fatigue and an earlier return to work. Eighty patients, randomized by Raju and Aold [101], were given an ad hoc questionnaire to evaluate return to normal activities over a 6-week postoperative period (1b). Laparoscopic hysterectomy with adnexectomy as opposed to open hysterectomy with adnexectomy resulted in an earlier return to normal activities.

In a similarly designed but nonrandomized study of 30 patients, Spirtos et al. [118] compared laparoscopic with open hysterectomy (2b). They used an ad hoc questionnaire to monitor the recovery of women over 17 weeks. Return to normal activity occurred earlier in the laparoscopic group. An ad

hoc questionnaire was also used by Kolmorgen et al. [59], who studied 132 women over a 3-month follow-up period (2b). Again, less pain and an earlier return to normal activity were noted. In a small study of only 20 women, Nezhat et al. [89] confirmed that an earlier resumption of normal activities can be achieved by the use of laparoscopic hysterectomy (2b). Follow-up was 6 weeks. In the only study comparing QoL after open and laparoscopic hysterectomy for endometraial carcinoma, Eltabbakh et al. [31] followed 143 patients over a period of 17 months (2b). The laparoscopic group reported higher satisfaction with the procedure and returned earlier to full activity.

Prostatectomy

Key Points and Suggestion for QoL Assessment

Postoperative improvements in QoL are faster after laparoscopic than after open prostatectomy (EL 2b), but long-term results are similar (EL 2b).

Before and after prostatectomy, men should be assessed with the SF-36 or the EORTC QLQ-C30 questionnaire (generic measures). In addition, continence, sexual potency, and voiding symptoms may be evaluated separately, or they may be evaluated jointly with the new EORTC prostate-specific module. All QoL measurements should be done at least during the first 6 months.

Background and Evidence

Only one nonrandomized trail has compared laparoscopic with open prostatectomy with regard to QoL: Hara et al. [47] found no differences in QoL 6 months after surgery, but patient satisfaction was higher after laparoscopic surgery (2b). This study used a prostate-specific QoL questionnaire, which was under development by the EORTC. As symptom-specific instruments, the International Index of Erectile Function 5 (IIEF-5) and the International Continence Society Male (ICS_{male}) questionnaire were used to evaluate urinary and erectile function. Both instruments have been validated [26, 109]. Currently, the disease-specific EORTC module, the QLQ-PR25, is being tested for validity and reliability.

Discussion

The scope of this CDC was broad since we wanted to evaluate QoL after laparoscopic compared to open surgery for many different conditions. We have tried to include the most important diseases in laparoscopic surgery, for which evidence on QoL assessment is available. Although there are a large number of studies reporting QoL after laparoscopic surgery, only one third have compared laparoscopic with open surgery.

Here we provide some general remarks on QoL assessment in clinical and research settings. First, it should be kept in mind that no single QoL measure is ideal for all diseases or patient groups or settings. This implies that all instruments must be checked carefully for the psychometric properties in the context of endoscopic surgery. Occasionally, it may be necessary to extend existing instruments to fit the scope of a specific clinical problem or patient group, but only the reporting of standard measures allows readers to compare results across studies. Any modification of existing measures requires a new validation of the new measure. Second, it is often recommended to combine a generic instrument and a disease-specific instrument. For most diseases, the generic instruments have lower responsiveness compared to specific ones [145], but the generic measures are useful to compare the patient cohort against cohorts with other diseases or with the normal population. Third, the proof of superior QoL after one type of surgery is a strong but not a sufficient argument to use this type of surgery. Although QoL is a broad construct, it does not necessarily include all aspects that are relevant for clinical decision making. Therefore, we did not use grades of recommendations for the key statements.

With regard to choosing a QoL instrument, there is no hierarchy for grading the quality of QoL assessment tools. Since the different psychometric properties of an instrument are not a unidimensional issue, the choice of an instrument depends on the various practical and theoretical aspects of a study. Some projects on the development of such classifications are in progress and are the focus of experts in that field. A further methodologic problem is the difference between choosing a valid study design and a valid outcome measure: We think that a RCT should not automatically be considered high-level evidence, if the study does not report clinically relevant outcomes such as QoL via the use of standardized measures.

The overall quality of QoL research in endoscopic surgery compares well with other fields. In 1989, Guyatt et al. [46] found that less than half the RCTs in major journals examined QoL as an outcome, and two-thirds of these QoL measures had not been validated. Similarly, Gill and Feinstein [44] criticized that most clinical studies of QoL failed to define QoL, lacked a reliable QoL measure, and mixed up symptom checklists, proxy outcomes, QoL, and health-related QoL measures. Nevertheless, surgical researchers should increase the use of QoL measures in clinical trials. Since many validated instruments are obtainable free of charge from the primary investigators, there are no real obstacles to conduction more patient-centered research. For the well-known general instruments, further information can be found on the Internet.

Again, the importance of QoL assessment in laparoscopic surgery should be noted. QoL as an outcome is much more important to the patient than, for example, laboratory values and other traditional clinical end points. After

biliary duct injury and successful repair of the injury, patients can have normal laboratory findings but permanently impaired QoL [45, 82]. This reinforces the question as to whether we are measuring what is relevant for the patients. Furthermore, the experts pointed out the importance of the preoperative QoL assessment for patient selection for laparoscopic surgery in specific diseases. This is especially true for GERD, for example, when deciding on surgery for depressed patients [55].

Evidence on QoL after laparoscopic compared to open surgery reported in this article represents all relevant data regarding this issue. Suggestions made for QoL assessment in different conditions are universal and can be used in every European country. We believe that the use of these suggestions will increase the quality of care in everyday practice as well as the quality of research. Implementation strategies and the evaluation of the impact of these guidelines need further discussion and will present a basis for further research.

Appendix: Information on Recommended Measures

Child Health Questionnaire

The CHQ, designed to measure the physical and psychological well-being of children 5 years or older, has several forms related to the age of the child and who completes the questionnaire [67]. There are three parent forms and a form to be completed by children aged 10 years or older (87 items). The questionnaires tap 14 concepts related to health and well-being. Item responses are on 4- to 6-point scales. Scale scores are transformed to range from 0 to 100. Higher scores reflect better health. Physical and psychological summary measures can be calculated. In addition to self-completion by child or parent, the forms may be administered in person or over the phone.

Psychometric performance is adequate in terms of internal consistency and test–retest reliability as well as content, criterion, and construct validity [67, 95, 139, 140]. The measure has been translated, adapted, and revalidated for use in a number of countries [68]. To obtain a manual and the questionnaire, contact J.M. Landgraf (Fax: +1-617-3757801).

European Organization for Research and Treatment of Cancer

The EORTC is a cancer-specific questionnaire that has a core component to be used in conjunction with one of a number of modules reflecting different sites of cancer [1, 2]. The core questionnaire EORTC QLQ-C30 contains 30 items that form seven subscales: physical functioning, role functioning, common physical symptoms of cancer and its treatment, emotional functioning, role functioning, financial impact, and overall perceived health status

and global QoL. Most items are scored on a 4-point scale ranging from "not at all" to "very much"; the physical and role functioning subscales are scored dichotomously, and the global questions on health status and QoL have been expanded to a 7-point scale. The time frame of the questions is the past week. For the functional and global subscale, a higher score represents a higher QoL, whereas for the symptom subscales the reverse is true. The site-specific modules provide more detailed information on symptoms related to the specific tumor site and may tap additional areas.

A variety of studies attest to the adequate reliability and validity of the questionnaire. In particular, the symptom scales have shown sensitivity to clinical change. The questionnaire was developed by an international group of researchers. In consequence, careful attention was given to ensuring that the questions had a similar meaning across languages and cultures. The modules for colorectal and prostate cancer are forthcoming [120].

Fecal Incontinence Quality of Life Scale

The FIQL scale is a symptom-specific measure of QoL developed from input from both patients and caregivers [108]. It is composed of 29 items that form four scales: lifestyle (10), coping/behavior (9), depression/self-perception (7), and embarrassment (3). Each item has four to six response categories. Scale scores are the mean response to all items in a scale. A total score was not calculated by the developer, but one has been used by Jess and colleagues [52].

Confirmatory factor analysis supported use of four scales. Internal consistency estimates were 0.80 or greater for each scale. Mean scale scores of a test–retest situation were not significantly different, but agreement was not measured directly. Each scale was able to differentiate between a group of individuals with fecal incontinence and patients with other gastrointestinal problems. Convergent validity was demonstrated by significant correlations with selected scales of the SF-36. A Danish version of the measure has been developed, and the psychometric evaluation of this version produced results similar to those of the developers except that total scores were included [52]. The measure is included as an appendix in the original article [108].

Functional Assessment of Cancer Therapy

The FACT-G is a general measure of QoL for use with people who have cancer. It is the core instrument of the measurement system [16, 17]. FACT-G contains 29 items that constitute five subscales: physical well-being, social/family well-being, relationship with doctor, emotional well-being, and functional well-being. Items are scored on a 5-point scale and summed to provide subscale and total scores. The five subscales are included in the site-specific scales, and

each has an additional subscale containing items related to the cancer, its symptoms, or its treatment. A number of site-specific scales, including the FACT-C (colorectal) [135] and the FACT-P (prostate), [33] are available.

Extensive documentation exists on the psychometric properties of FACT-G and its various versions. A manual is available [16] and the scales have been translated and adapted for use in different countries and cultures [11]. For information about using the measurement system, see http://www.facit.org.

Gastroesophageal Reflux Disease – Health-Related Quality of Life

The GERD-HRQL is a measure of symptom severity for use with individuals who have GERD [130, 133]. Ten common and distressing symptoms are listed. The first six are ordered in terms of their relative annoyance to patients. Each symptom is rated on a 6-point categorical scale that ranges from 0 (no symptoms) to 5 (symptoms are incapacitating – unable to do daily activities). The overall score is from 0 to 50, but there is an additional question asking about satisfaction with the patient's "present condition."

No data were found on test–retest reliability, but the developers reported evidence supporting construct validity and responsiveness to clinical change. When patients were grouped according to their level of satisfaction with their present condition, the median scores discriminated between those who were satisfied and those who were not. Sensitivity to the effects of both medical and surgical treatment provided preliminary evidence of responsiveness. A copy of the scale is provided in the article by Valanovich [130].

Gastrointestinal Quality of Life Index

The GIQLI is a self-reported, system-specific measure designed for use with people who have different gastrointestinal disorders [35, 37, 38]. The 36 items, reflecting physical, emotional, and social function as well as typical gastrointestinal symptoms, are each scored on a 5-point scale. Items are summed to produce a total score ranging from 0 to 176, with higher scores denoting better QoL. The measure was developed in German and English. French and Spanish GIQLI versions have been validated [100, 117].

A comprehensive process of development assured content validity. The internal consistency estimates were high, suggesting that the measure reflects an underlying dimension, QoL. Test–retest reliability was demonstrated in clinically stable patients (ICC = 0.92). Correlations between the GIQLI and appropriate measures supported construct validity. Scores on the measure were also able to differentiate groups of gastrointestinal patients with different levels of function, as well as between those with gastrointestinal disease and those who were ostensibly normal. Responsiveness is obviously highest in

gastroesophageal disorders, but the GIQLI has also been used with variable responsiveness in other abdominal operations [14, 19, 42, 65, 73]. The GIQLI is available on the Quality of Life Database developed by the nonprofit Mapi Research Institute. This database can be found at http://www.qolid.org.

Gastrointestinal Symptom Rating Scale

The GSRS is a clinical symptom rating scale originally designed for patients with irritable bowel syndrome and peptic ulcer disease [122]. It has subsequently been evaluated in patients with GERD [105, 123]. GSRS for use with GERD patients contains 15 items, each assessed on a 1-point to 7-point scale, with 7 representing extreme discomfort. The items combine into five syndromes labeled reflux, abdominal pain, indigestion, diarrhea, and constipation. Mean scores are calculated from the items in each syndrome. The measure may be administered as a self-report or by an interviewer. The GSRS has been used in UK, Scandinavian, and US populations. It demonstrates acceptable reliability, both internal consistency and stability, evidence of construct and discriminative validity, as well as responsiveness to change. A copy of the US version of the GSRS is included in the article by Revicki and colleagues [105].

Impact of Weight on Quality of Life-Lite

The IWQOL-Lite is a 31-item version of its parent instrument, the Impact of Weight on Quality of Life (IWQOL) questionnaire [63, 64]. Data collected from 996 obese patients and controls were used to develop the shorter measure [61]. Items were selected by predefined criteria. The items are divided among five scales: physical function (11), self-esteem (7), public distress (5), sexual life (4), and work (4). Each item is scored on a 5-point scale (always true – never true). Lower scores indicate higher QoL. Exploratory factor analysis supported the scale structure.

Based on data from the cross-validation sample ($n = 991$), individual scales and the total IWQOL-Lite questionnaire demonstrated strong measurement properties. Confirmatory factor analyses confirmed the adequacy of the scale structure. Internal consistency coefficients (alphas) ranged from 0.90 to 0.94 across the scales, with an overall alpha coefficient of 0.96. Correlations between appropriate IWQOL-Lite scales and appropriate standardized measures upheld construct validity. The measure also demonstrated the ability to differentiate between adjacent groups of obese individuals. Changes to scales over time correlated with changes in weight, verifying responsiveness to change. According to the authors, the IWQOL-Lite has been translated and pilot-tested for use in 23 countries [62]. To obtain further information, contact R.L. Kolotkin (1004 Norwood Avenue, Durham, NC, USA; e-mail: kolot001@mc.duke.edu).

Pediatric Quality of Life Inventory

The PedsQL is a generic instrument developed in modular format for measuring health-related QoL in children and adolescents aged 2–18 years [128, 129]. The PedsQL 4.0 Generic Core Scales assess functioning in four areas: physical (8), emotional (5), social (5), and school (5). Both parent and child versions of the inventory are available and use different response sets for scoring items. For parents and children aged 8–18, the inventory is generally self-administered, and for children aged 5–7 it is normally interviewer administered. Modules are available for a number of pediatric conditions, including cancer [127]. Higher PedsQL scores indicate better QoL.

The inventory has been extensively tested for reliability and validity. Internal consistency is adequate for group comparisons and the measure correlated moderately with measures of morbidity and illness burden as well as distinguishing between healthy children and those with a variety of acute and chronic illnesses. It is available in English and Spanish. Further information about the PedsQL is available at http://www.pedsql.org. To order the PedsQL, contact Caroline Anfray at the Mapi Research Institute (e-mail: canfray@mapi.fr).

Psychological General Well-Being Index

The PGWB index was developed as a measure of subjective well-being or distress [29]. This self-administered index contains 22 items, reflecting both positive and negative affect. These are divided into six dimensions: anxiety (5), depressed mood (3), positive well-being (4), self-control (3), general health (3), and vitality (4). Each item is scored on a 6-category scale (0–5 or 1– 6). The dimension scores combine for a total score ranging from 0–110 or 22–132.

Extensive tests of reliability and validity have been conducted, most often on the original version of the measure that contained 68 items and was referred to as the General Well-Being Schedule. These psychometric tests were carried out in a variety of normal populations and patient samples. Many have been reviewed by Dupuy [29]. Internal consistency estimates have most often been between 0.70 and 0.90, and test–retest reliability coefficients have ranged from moderate to strong. Construct validity has been shown by moderately strong correlations with a number of depression scales. Correlations with stressful life events and the use of health services were lower. Norms for the PSGWB index have been described for the Swedish population [25]. When used in a trial of patients with reflux disease, estimates of internal consistency were above 0.92 and decreased symptoms corresponded to an increase in PGWB scores [91]. Concurrent validity has also been confirmed in a variety of studies [85].

Quality of Life in Reflux and Dyspepsia Questionnaire

The QOLRAD is a disease-specific QoL questionnaire designed to address the health concerns of people with GERD or dyspepsia [146]. The measure contains 25 items encompassing five domains of importance to patients: emotional distress, sleep disturbance, eating and drinking issues, physical/social functioning, and vitality. Each item is scored on a 7-point scale and domain scores are calculated by averaging the item scores in that domain.

Good reliability in terms of both internal consistence and stability has been reported [123, 146]. Content, convergent, and discriminant validity as well as responsiveness to clinical change have been carefully documented, and results support the use of the measure in clinical studies [123, 146]. The measure was developed in English and French. For information on how to obtain the measure, contact Ingula Wiklund (Quality of Life Research, Astra Hassle AB, 431 83 MoIndal, Sweden).

Short Form 36

The SF-36 is a generic measure of perceived health status that incorporates behavioral functioning, subjective well-being, and perceptions of health by assessing eight health concepts: limitations in physical activities due to health problems, limitations in role activities due to physical health problems, pain, limitations in social activities due to health problems, general mental health, limitations in usual role activities due to, emotional problems, vitality (energy and fatigue), and general health perceptions [138]. The questionnaire is made up of 36 items that are divided into eight scales. The scores on all scales range from 0 to 100, with higher scores reflecting better health. The SF-36 takes 10–15 min to complete. It can be self-administered or used by a trained interviewer in person or over the telephone.

Reliability has been demonstrated, as have content, criterion, and construct validity [58, 79, 80, 138] and responsiveness to clinical change [58]. Recently, a method of scoring two components, physical and mental health, has been developed. Each component has been standardized to have a mean of 50 and a standard deviation of 10 [137]. There is also an acute version of the SF-36 that uses a 1-week recall, making it useful when treatment effects occur rapidly. As part of an international initiative that used a standard protocol, the SF-36 has been translated, culturally adapted, and revalidated in more than 50 languages. Norms for many countries are available [51].

For further information about the SF-36 and instructions for use, visit the SF-36 Web site (http://www.sf-36.com or http://www.qlmed.org/mot). The IQOLA Web site (http://www.iqola.org) provides information about the international project, and information on the availability of the translations can be found on the SF-36 Web site.

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The EAES Clinical Practice Guidelines on the Pneumoperitoneum for Laparoscopic Surgery (2002)

Jens Neudecker, Stefan Sauerland, Edmund A. M. Neugebauer, Roberto Bergamaschi, H. Jaap Bonjer, Alfred Cuschieri, Karl-Hermann Fuchs, Christoph A. Jacobi, F. W. Jansen, A.-M. Koivusalo, Antonio M. Lacy, M. J. McMahon, Bertrand Millat, Wolfgang Schwenk

Introduction

Only 15 years after the introduction of laparoscopic cholecystectomy, laparoscopic techniques (used either as a diagnostic tool or as a therapeutic access method) are among the most common procedures in surgery worldwide. However, concerns about higher surgical complications rates (such as vascular and intestinal injuries) compared to conventional techniques and anesthesiological risks have remained. Since the start of the laparoscopic era, numerous studies have described pathophysiological or clinical problems that are related to laparoscopy. Therefore, many technical innovations and modifications have been developed to improve safety and effectiveness of laparoscopy, but not all of them have been studied adequately before clinical use.

With these developments in mind, the European Association for Endoscopic Surgery (EAES) decided to develop authorative and evidence-based clinical practice guidelines on the pneumoperitoneum and its sequelae. The scope of these guidelines covers all important general surgical aspects of the pneumoperitoneum but not special laparoscopic procedures for defined pathologies. They address the pathophysiological basis for the clinical indications, aspects to establish the pneumoperitoneum, and perioperative aspects such as adhesions and pain. In addition, a clinical algorithm was formulated for practical use.

Methods

Under the mandate of the EAES Scientific Committee with the aim to set up evidence-based clinical practice guidelines, we combined the methodologies of a systematic review and a consensus development conference (CDC) because previous CDCs (both within and outside the EAES) had difficulties in identifying all relevant articles [218, 262, 280]. As a framework of the process, the key aspects pertaining to the pneumoperitoneum were precisely formulated in separate questions, which then were answered concurrently by the use of literature and expert evidence.

For the systematic review, one researcher (J.N.) performed comprehensive literature searches in Medline, Embase, and the Cochrane Library. We used the medical subject headings Laparoscopy and Pneumoperitoneum. Our primary intention was to identify all clinically relevant randomized controlled trials (RCTs). However, other trials using concurrent cohorts (CCTs), external or historical cohorts, population-based outcomes studies, case series, and case reports were accepted for a comprehensive evaluation of the pneumoperitoneum and its sequelae (Table 2.1). Included articles were scrutinized and classified by two reviewers (J.N. and S.S.). Furthermore, all panelists were asked to search the literature according to a list of defined questions. The reference lists of all relevant articles were also checked.

For the CDC, the conference organizers in Cologne, together with the scientific committee of the EAES, nominated a multidisciplinary expert panel. The criteria for selection were clinical and scientific expertise in the field of laparoscopy and geographical location within Europe.

Six months before the conference, the questions on laparoscopy were sent to the panelists. In parallel, the questions were answered by literature evidence found in systematic searches. One month before the conference, all answers from the panel and the literature searches were analyzed and subsequently combined into a provisional preconsensus statement and a clinical algorithm. Each panel member was also informed about the identities of the other members, which had not been previously disclosed.

In Maastricht, all panelists (except A.C. and H.J.B.) met for a first meeting on June 13, 2001. Here, the provisional bottom-line statements typed in bold and the clinical algorithm with the grades of recommendation were scrutinized word by word in a 5-h session in a nominal group process. For all statements, internal (expert opinion) and external evidence was compared. The following day the modified statement and the algorithm were presented to the conference audience by all panelists for public discussion (1.5-h session). During a postconsensus meeting on the same day, all suggestions from the audience were discussed again by the panelists, and the statement was further modified. The finalized statement as given later was mailed to all panelists for final approval (Delphi process) before publication.

To increase readibility, a short version of the clinical practice guidelines with a clinical algorithm was prepared (Fig. 2.1). The extended version consists of a detailed appraisal of pathophysiologic background and clinical research evidence. Each recommendation is graded according to its reliability and the rigor of research evidence behind the statement (Table 2.1).

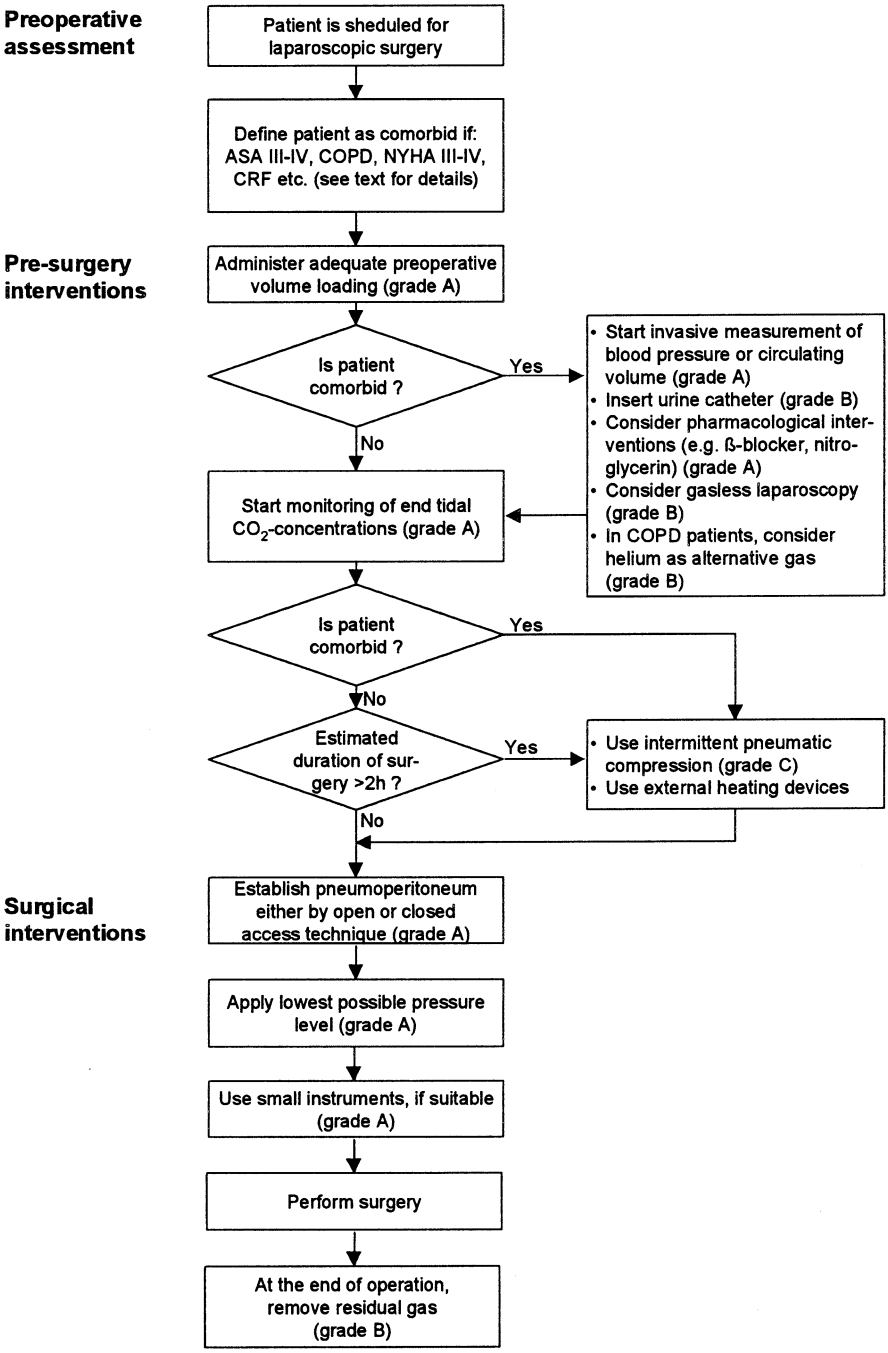

Fig. 2.1. Evidence-based clinical algorithm on the pneumoperitoneum for laparoscopic surgery. The recommendation is graded according to Table 2.1. *Diamond boxes* decision boxes, *square boxes* action boxes [255]

Table 2.1. A method for grading recommendations according to scientific evidence

Grade of recommendation	Level of evidence	Possible study designs for the evaluation of therapeutic interventions
A	1 a	Systematic review (with homogeneity) of RCTs
	1 b	Individual RCT (with narrow confidence interval)
	1 c	All-or-none case series
B	2 a	Systematic review (with homogeneity) of cohort studies
	2 b	Individual cohort study (including low-quality RCT)
	2 c	"Outcomes" research
	3 a	Systematic review (with homogeneity) of case-control studies
	3 b	Individual case-control study
C	4	Case series (and poor-quality cohort and case-control studies)
D	5	Expert opinion without explicity critical appraisal, or based on physiology, bench research, or "first principles"

From Sackett et al. [255]
RCT randomized controlled trial

Pathophysiological Basis for the Clinical Indications

Cardiovascular system

Cardiovascular effects of pneumoperitoneum occur most often during its induction, and this should be considered when initial pressure is increased for introduction of access devices. In ASA I and II patients, the hemodynamic and circulatory effects of a 12–14-mmHg capnoperitoneum are generally not clinically relevant (grade A). Due to the hemodynamic changes in ASA III and IV patients, however, invasive measurement of blood pressure or circulating volume should be considered (grade A). These patients should also receive adequate preoperative volume loading (grade A), beta-blockers (grade A), and intermittent sequential pneumatic compression of the lower limbs, especially in prolonged laparoscopic procedures (grade C). If technically feasible, gasless or low-pressure laparoscopy might be an alternative for patients with limited cardiac function (grade B). The use of other gases (e.g., helium) showed no clinically relevant hemodynamic advantages (grade A).

Pneumoperitoneum decreases venous return, preload, and cardiac output (CO) and increases heart rate (HR), mean arterial pressure (MAP), as well as systemic (SVR) and pulmonary vascular resistence (PVR). These hemodynamic and cardiovascular – changes mostly occur because of increased intraabdominal pressure (IAP) (1b [159, 221, 291]) and the stimulated neuro-

humoral vasoactive systems [vasopressin and rennin–aldosterone–angiotensine system (RAAS)] (1b [142, 158]), but are independent of type of gas (1b [28]). However, in otherwise healthy patients these changes are not dangerous when IAP does not exceed 15 mmHg (1b [27]).

Increased IAP, up to 12–15 mmHg, decreases venous return, which results in reduced preload and CO, without adequate intravascular volume loading (1b [63, 142, 162, 201, 221]). Additionally, changes in body position, especially head-up tilt position, intensify these negative effects of a pneumoperitoneum (2b [115, 116]), whereas head-down or Trendelenburg position has a positive effect on venous return (1b [162]). Furthermore, the use of positive end-expiratory pressure (PEEP) of 10 H_2O during pneumoperitoneum decreases preload and CO (4 [164]). Pneumoperitoneum increases sympathetic cardiac activity (1b [260]) and induces a hemodynamic stress response by activation of the neurohumoral vasoactive system (i.e., vasopressin and RAAS) resulting in increased HR, increased SVR and PVR, and increased arterial blood pressure (1b [142, 159]). This stress response leads to an increase in oxygen consumption, which might be deleterious for patients with compromised cardiac function. In clinical studies on ASA III and IV patients distinct intraoperative hemodynamic changes during pneumoperitoneum were described (4 [127]), but cardiovascular stability was unimpaired (4 [64, 83, 111, 322]) if appropriate invasive monitoring and pharmacologic interventions were used (4 [79, 292]). In contrast, there are reports of cardiovascular alterations persisting after release of the pneumoperitoneum (4 [108]). Most of these studies used an IAP of 12–15 mmHg without preoperatively volume loading. Without adequate intravascular volume loading a pneumoperitoneum in connection with head-up tilt position decreases CO significantly (up to 50%) (1b [142, 221]). In comorbid patients (ASA III and IV), RCTs with adequate sample size are missing.

In the majority of patients (ASA I and II), the hemodynamic effects of a pneumoperitoneum are without consequences and vanish after desufflation. Therefore, most patients without comorbidities (ASA I and II) do not need invasive hemodynamic monitoring. However, in ASA III and IV patients an invasive monitoring of blood pressure and circulating volume must be considered because only these measures allow early recognition and adequate treatment of severe cardiovascular changes (1b [162]). For intraoperative monitoring, a pulmonary artery catheter or COLD (cardiac oxygenation and lung water determination) monitoring should be applied, because transesophageal echocardiography in patients with cardiac disease has not been proven to be useful (4 [241]). For patients with severley compromised circulation, measurement of the pulmonary artery pressure (PAP) and CO can be necessary. However, interpreting changes in central venous pressure (CVP) and PAP may be difficult (4 [213]). Due to the consecutive increase in intrathoracic pressure during laparoscopy CVP and PAP also increase, but right arte-

rial volume is not decreased. Therefore, CVP may only incorrectly describe the effective circulating blood volume and could be misinterpreted [162].

Since the effects of increased IAP on hemodynamics are volume dependent, adequate preoperative intravascular loading is essential, especially in patients with cardiac diseases, to prevent cardiovascular side effects of a pneumoperitoneum (1b [162]). Another intervention of proven effectiveness that also increases cardiac preload and thereby prevents hemodynamic changes (2b [6]) is intermittent sequential pneumatic compression of the lower extremities to augment venous blood return (1b [273, 274], 2b [273, 274]).

To minimize the effects of hemodynamic stress response on myocardial oxygen consumption, esmolol or clonidine can safely be used (1b [142, 163]) if volume depletion is not present. Intraoperative hemodynamic alterations in patients with underlying cardiopulmonary disease can be effectively controlled by appropriate pharmacological intervention (use of intravenous nitroglycerin) (2b [80]).

Hemodynamic and circulatory changes are independent from the used gas (CO_2 or helium) (1b [28]) but decreased during gasless laparoscopy (1b [5, 91, 159, 201, 22 1]). Therefore, gasless laparoscopy might be an alternative for patients with limited cardiac function. In summary, cardiac diseases are associated with an increased risk of general complications after laparoscopic surgery (and even higher risk after conventional surgery). Since various surgical and nonsurgical treatment options can be recommended to reduce these risks, the presence of heart disease does not principally contraindicate laparoscopic surgery (2b [239, 240]). There is a need for further trials in ASA III and IV patients.

Lung Physiology and Gas Exchange

Carbon dioxide pneumoperitoneum causes hypercapnia and respiratory acidosis. During laparoscopy, monitoring of end-tidal CO_2 concentration is mandatory (grade A) and minute volume of ventilation should be increased in order to maintain normocapnia. Increased intraabdominal pressure and head-down position reduce pulmonary compliance and lead to ventilation–perfusion mismatch (grade A). In patients with normal lung function, these intraoperative respiratory changes are usually not clinically relevant (grade A). In patients with limited pulmonary reserves, capnoperitoneum carries an increased risk of CO_2 retention, especially in the postoperative period (grade A). In patients with cardiopulmonary diseases, intra- and postoperative arterial blood gas monitoring is recommended (grade A). Lowering intraabdominal pressure and controlling hyperventilation reduce respiratory acidosis during pneumoperitoneum (grade A). Gasless laparoscopy, low-pressure capnoperitoneum, or the use of helium might be alternatives for patients with limited pul-

monary function (grade B). Laparoscopic surgery preserves postoperative pulmonary function better than open surgery (grade A).

The specifics of a capnoperitoneum, the IAP and the used gas, result in hypercapnia, respiratory acidosis, reduced pulmonary compliance, and increased airway resistance (1b [224, 307]). Additional changes in body position have minor influences (2b [68]) but could intensify these effects, especially in the head-down position (2b [114, 116]). Relaxation of the diaphragm caused by anesthesia in combination with increased intraabdominal pressure impairs excursion of the diaphragm and leads to compression of the lower lung lobes. These effects result in a decreased tidal volume, ventilation–perfusion mismatch, a decreased shunt volume, increased dead space, and decreased pulmonary compliance (1b [160], 2b [250]). Pulmonary gas exchange during laparoscopy can be optimized by the choice of the anesthetic procedure (1b [93]) and PEEP (5 [183]). Without hyperventilation P_aCO_2 will increase by 8–10 mmHg and pH will decrease (1b [315]) before a steady state is reached. Intraoperatively, pulmonary changes due to capnoperitoneum are compensated by otherwise healthy adults (1b [197]).

Various laparoscopic procedures have been shown to result in better postoperative pulmonary function when compared to their open-surgery counterparts (1b [38, 42, 48, 51, 74, 112, 149, 167, 197, 206, 275, 307]), but clinically more relevant end points such as postoperative pulmonary complications were rarely evaluated or found unchanged in ASA I and II patients (1b [205, 206]). These data generally prove that laparoscopy rather than conventional surgery should be advised for compromised patients, particularly those with obstructive lung disease. This superiority of laparoscopic surgery during the postoperative period is mostly related to its lesser extent of surgical trauma and pain, but laparoscopy has certain effects on ventilation that deserve special attention.

Capnoperitoneum with an IAP of more than 12 mmHg combined with head-down or Trendelenburg position should be avoided because it reduces pulmonary compliance by more than 30% and there is ventilation–perfusion impairment (1b [155, 159, 224] 2b [188, 250, 296]). Hypercapnia and respiratory acidosis can be avoided by controlled hyperventilation (1b [315]). CO_2 storage during pneumoperitoneum can result in postoperative hypercapnic hangover, which has to be particularly considered in cases, of accidential subcutaneous CO_2 insufflation. To recognize these changes intra- and postoperative arterial blood gas monitoring and continous capnometry are generally recommended for comorbid patients [161], particularly those with cardiopulmonary diseases (2b [314]). These patients may also benefit from prolonged postoperative mechanical ventilation [160]. From a more surgical standpoint, gasless laparoscopy or the use of other gases (e.g., helium and N_2O) may have clinically relevant advantages (1b [28, 155, 159, 224]), but the results of randomized trials are inconsistent (1b [92]) and need to be confirmed. Trocar po-

sitioning also has a relevant influence on pulmonary function, (1a [167]). Overall, most of the discussed randomized trials included only small numbers of patients, leading to an increased chance of type II error.

It should be mentioned that capnothorax can be a serious, albeit rare, complication that has been encountered in patients after capnoperitoneum (4 [7, 233]). Capnothorax occurs more often after laparoscopic esophageal or gastric surgery but has also been observed after lower abdominal procedures or even hernia repair. Because of the high solubility of CO_2, asymptomatic capnothorax diagnosed by postoperative chest X-ray may be treated conservatively. However, tension capnothorax may occur very rarely. Therefore, symptomatic capnothorax requires immediate drainage.

Venous Blood Return

During laparoscopy, both head-up position and elevated intraabdominal pressure independently reduce venous blood return from the lower extremities (grade A). Intraoperative sequential intermittent pneumatic compression of the lower extremities effectively reduces venous stasis during pneumoperitoneum (grade A/B) and is recommended for all prolonged laparoscopic procedures. The incidence of thromboembolic complications after pneumoperitoneum is not known.

Increased intraabdominal pressure together with reverse Trendelenburg position (head-up position) decreases venous return from the lower extremities by more than 40% (1b [273, 274], 2b [12, 99, 123, 204]) with a concomittant increase in femoral venous pressure (2b [12, 139]). However, it has been hypothesized that the systemic coagulation system is activated by laparoscopic surgery (1b [243], 2b [41, 178]), but controversial data exist (2b [67, 119, 192]). Due to the impairment of lower extremity circulation, the increased venous pressure, and the activation of the systemic fibrinolytic system, the potential risk for deep venous thrombosis (DVT) is increased. Although there are alarming reports about a high incidence of DVT after pneumoperitoneum (4 [230]), the rate of clinically evident postoperative thrombembolic complications after laparoscopic surgery remains unclear [10, 31, 184, 189]. The negative effects of elevated IAP and body position on venous blood return from the lower extremities can partly be counteracted by intermittent sequential compression of the lower limbs in laparoscopic cholecystectomy and colorectal surgery (1b [273, 274], 2b [273, 274]). Whether such compression does reduce thromboembolic event remains to be elucidated in larger trials.

The effects of a low-pressure pneumoperitoneum (5–7 mmHg) and abdominal wall lifting on thromboembolic complications have not been studied, although from a pathophysiologic standpoint a positive effect can be reasonably anticipated.

Perfusion of Intraabdominal Organs

Although in healthy subjects (ASA I and II), changes in kidney or liver perfusion (grade A) and also splanchnic perfusion (grade D) due to an intraabdominal pressure of 12–14 mmHg have no clinically relevant effects on organ function, this may not be the case in patients with already impaired perfusion. Especially in patients with impaired hepatic or renal function or atherosclerosis, intraabdominal pressure should be as low as possible to reduce microcirculatory disturbances (grade B). Patients with impaired renal function should be adequately volume loaded before and during elevated intraabdominal pressure (grade A).

Renal Effects

Randomized clinical trials showed a decrease in renal blood flow (RBF), glomerular filtration rate, and urine output in the initial phase of a pneumoperitoneum (1b [155, 221]). With increasing IAP renal function is gradually depressed (5 [146]). Elevated IAP causes renal dysfunction due to direct mechanical compression of renal parenchyma, renal arteries, and veins (5 [247]). The reduction in RBF and urine output is probably caused by a decrease in CO and/or the compression of the renal vein. In experimental studies, renal vein flow remained decreased for at least 2 h postoperatively (5 [195, 247]). Mediated by humoral factors, a sympathetic reaction induces a constriction of the renal artery. Pneumoperitoneum increases plasma renin activity (PRA) and consequently activates the RAAS, which promotes the renal vasoconstriction via angiotensin II. However, one prospective randomized trial found no signs of a clinically relevant impairment of renal function (1b [26]).

Hepatoportal Effects

When measured with laser Doppler, hepatoportal circulation is gradually decreased with increasing IAP (2b [69], 4 [136, 223]). In elderly patients, splanchnic circulation is very sensitive to elevated pressure (4 [261]). Experimental and clinical studies reported elevated liver enzymes after prolonged laparoscopic procedures and elevated intraabdominal pressure (1b [95], 2b [209]). However, in one RCT no signs of clinically relevant postoperative liver dysfunction were detected (1b [26]).

Splanchnic Effects

Elevated IAP mechanically compresses capillary beds, decreases splanchnic microcirculation, and thus impairs oxygen delivery to the intraabdominal organs. During pneumoperitoneum, a 24% reduction of blood flow in the su-

perior mesenteric artery and the hepatic portal vein was reported (5 [125]). In healthy patients, a high vs low IAP (15 vs 10 mmHg) decreased blood flow into the stomach (54%), the jejunum (32%), the colon (4%), the parietal peritoneum (60%), and the duodenum (11%) (4 [266]). Furthermore, clinical and animal studies noted a decrease in gastric intramucosal pH (1b [157], 2b [69]), which may be the earliest indicator of alterated hemodynamic function compared to traditional measurements, such as CO, SVR, and lactate [154], but conflicting findings exist [69, 187, 223]. The clinical implications of these investigations remain unclear.

Otherwise healthy patients seem to compensate changes in intraabdominal organ perfusion without impairment of organ function. However, in patients with cardiovascular comorbidities or preexisting organ disorders, reduced alteration in organ perfusion could have detrimental effects. Therefore, for these patients careful observation and selection of surgical technique are required.

Several studies of different quality reported that in patients with limited hepatic or renal function, postoperative hepatic and renal function were better preserved by keeping IAP under 12 mmHg and by avoiding a prolonged pneumoperitoneum (1b–4 [69, 125, 154, 266]). Recently, one experimental study investigated the influence of different IAP levels on intra- and extraabdominal tissue blood flow by using color-labeled microspheres and reported, a nonimpaired tissue blood flow during capnoperitoneum of 10–12 mmHg (5 [317]). Esmolol inhibits the release of renin and blunts the pressor response to induction and maintenance of pneumoperitoneum. It may protect against renal ischemia during laparoscopy because urine output under, esmolol therapy was found to be higher (1b [162]). Nonsteroidal antiinflammatory drugs (NSAIDs), widely used in laparoscopic surgery, can cause renal medullary vasoconstriction. Because cases of renal failure after laparoscopic surgery and NSAID therapy were reported, NSAIDs should be replaced by other analgetics wherever possible (5; A.-M. Koivusalo, personal communication).

Stress Response and Immunologic Parameters

Changes in systemic inflammatory and antiinflammatory parameters (mainly cytokines) as well as in stress response parameters are less pronounced after laparoscopic surgery than after conventional surgery (grade A). Whether this leads to clinically relevant effects (e.g., less pain, fatigue, and complications) remains to be proven. There is no compelling clinical evidence that specific modifications of the pneumoperitoneum alter the immunological response.

The influence of pneumoperitoneum on the function of the immune system and stress response is poorly evaluated because most studies investigate surrogate parameters of the immunological function, such as cytokines and

other cell products, and not the cell function itself (e.g., account, ratio, concentration, and activity of immunological cells). The essential clinical outcomes after surgery concerning immunological functions are infections (e.g., sepsis, pneumonia, urinary tract infection, and local wound-related infections) and cancer growth (e.g., metastasis and local tumor spread). However, there is no study in the field of laparoscopic surgery demonstrating an association between changes of intra- and postoperative immune function and the occurrence of clinical complications.

Clinical controlled trials of laparoscopic versus conventional surgery have mostly focused on changes of cytokine levels to describe the influence of pneumoperitoneum on systemic immunological functions. These studies showed differences in serum cytokine levels between laparoscopic and conventional surgery for IL-1(1b [174]), IL-6 (1b [36, 135, 165, 176, 254, 320, 322]), CRP (1b [135, 140, 176, 235, 254, 320], CRP (1b [133, 138, 174, 233, 252, 318]) and cell-mediated immunity (1b [224]) that have not been confirmed by other authors (1b [17, 198], 2 b [89]). In RCTs, postoperative immunological functions seemed to be better preserved after laparoscopic compared to conventional procedures (1b [13, 45, 151, 176, 235, 276, 284, 308, 321]); however, some trials found no differences (1b [73, 113, 173, 203, 226, 248, 270, 289, 295]) and one trial even reported a more pronounced immunodepression after laparoscopy (1b [290]). Additional RCTs examined perioperative stress response and found adrenaline (1b [150]), noradrenaline (1b [150]), and cortisol (1b [150, 174, 303]) decreased to a lesser extent after laparoscopic than after conventional procedures, although one study did not confirm this result (1b [112]). By comparisons carbon dioxide insufflation with gasless laparoscopy, similar courses of stress response parameters were found (1b [158, 162]), but conflicting data exist (1b [126]). Since all these studies compared laparoscopic and open surgery, the immunological effects of the pneumoperitoneum and the surgical procedure overlap each other, precluding the quantification of any specific effects.

The influence of the specifics of the pneumoperitoneum (e.g., IAP, gas, and warming and humidified surrounding) on immunological function has only partly been studied in experimental settings. Helium seems to preserve cell-mediated intraperitoneal immunity better than CO_2 (5 [47, 219]) and causes a less pronounced cytokine response and bacterial translocation (5 [194]). In clinical trials, postoperative intraperitoneal cytokine response after warming the insufflation gas was attenuated (1b [244]). Another study suggested a similar stress response (IL-6, CRP, neutrophil elastase, and white cell count) after pneumoperitoneum or abdominal wall lifting (1b [221]). It is questionable whether the specifics of the pneumoperitoneum have clinically relevant effects or even benefits on postoperative immunological function and outcome (e.g., less pain, fatigue, and complications). Thus, additional clinical trials with adequate end points and sample sizes have to be per-

formed to confirm the hypothesis of better preservation of the immune function by minimally invasive surgery.

Peritonitis

Presupposing appropriate perioperative measures (e.g., adequate preoperative volume loading) and hemodynamic stability, there are no contraindications to create a pneumoperitoneum when laparoscopic surgery is applicable in cases of peritonitis (grade B). The results from animal studies on the influence of pneumoperitoneum bacteremia and endotoxemia are controversial.

In experimental studies, a penumoperitoneum seems to increase the risk of bacteremia and endotoxemia [23–25, 77, 101, 214]. Other animal studies demonstrated that the systemic inflammation is higher after laparotomy than after laparoscopy, causing a transient decrease in immunologic defense and possibly leading to sepsis (5 [131, 180]).

With regard to the specifics of a pneumoperitoneum, any increase in IAP seems to further promote bacteraemia (2b [77]), but data are inconsistent. The used gas seems to play only a minor role (5 [105]). A clinical RCT found no difference in the acute phase response and endotoxemia between laparoscopic and conventional gastric surgery in cases of peritonitis (1b [173]). Furthermore, laparoscopic compared to conventional cholecystectomy for acute and gangrenous cholecystitis does not increase the mortality rate (1b [153]), and the morbidity rate seems to be even lower after laparoscopy (1b [153, 182]). Two small conflicting RCTs assessed bacteremia during appendectomy and found 0/11 versus 6/12 and 5/14 versus 5/13 positive blood cultures after open and laparoscopic access, respectively (1b [222, 279]). The hypothesis that in cases of peritonitis laparoscopy leads to a lesser depression of the systemic immune response with better postoperative outcome is unproven.

In conclusion, the decision to perform a laparoscopic procedure in case of peritonitis depends on the extent of peritonitis, the onset of disease, and the general clinical state of the patient. No clinical trials have found any contraindication to perform laparoscopy in case of beginning peritonitis (e.g., perforated appendicitis).

Risk of Tumor Spreading

There is no strong clinical evidence (except case reports) that pneumoperitoneum in patients with intraabdominal malignant disease increases the risk of tumor spread (grade D). The panel considers that there is no reason to contraindicate pneumoperitoneum in these patients, given the fact that an appropriate operative technique is used (grade C). The type of insufflation gas seems to affect intraabdominal tumor growth, whereas intraabdominal pressure is of little im-

portance (grade D). Due to the low level of evidence, patients undergoing laparoscopic surgery for malignant disease should be included in randomized controlled trials or at least in quality registries.

Several animal studies have been conducted to evaluate the pathogenesis of portsite metastasis in laparoscopic surgery, but the experimental models and tumor cell techniques vary considerably (5 [32, 33, 132, 134, 151, 219]). Port-site recurrence is common in small animal models after inoculation of high numbers of tumor cells and more pronounced after capnoperitoneum compared to laparotomy or gasless laparoscopy (5 [132, 134, 219]). IAP has little influence on intraperitoneal tumor growth or the incidence of port-site metastasis, whereas insufflation with helium may decrease subcutaneous tumor growth (5 [132, 134, 219]). In contrast to these findings, intraperitoneal tumor growth is stimulated more by laparotomy than by laparoscopy, gasless laparoscopy, or anesthesia alone without any operative procedure (5[130]).

Port dislocations should be avoided and ports should be irrigated intraperitoneally before they are retracted from the abdominal cavity. Before the tumor is extracted, the incision has to be protected against direct tumor cell contamination. The risk of tumor cell dissemination may be reduced by intraabdominal instillation of cytotoxic solutions at the end of the operation (5 [34]).

Prospective clinical trials failed to show a higher incidence of free intraperitoneal tumor cells (5 [37]) or recurrence in the skin incision (2a [304], 5 [37]) for laparoscopic compared to conventional surgery. A systematic review of clinical trials found no significant differences in overall survival, disease-free survival, cancer-related death, locoregional tumor recurrences, port-site metastasis, or distant metastasis in patients undergoing laparoscopic or conventional colorectal resections (2a [304]). Perioperatively, mobilization of neoplastic cells occurs frequently in patients with colorectal cancer, but the surgical approach does not seem to be a determining factor (16 [18]). Randomized trials with low quality found no wound or port-site metastasis in 91 patients during a mean follow-up of 21.4 months and in 43 patients after long-term 5-year follow-up (2b [57, 169]). Adequately powered RCTs on laparoscopic and conventional resections of colorectal carcinoma are missing, but such trials are currently being performed in Europe, the USA, and Australia. Results of these trials will be available in 2004–2006.

Establishing the Pneumoperitoneum

Creation of a Pneumoperitoneum

For severe complications (vessel perforation) it is impossible to prove a difference between closed- and open-access technique in RCTs; therefore, large outcome studies should be considered. In the RCTs, the rate of major and minor

complications is surprisingly high, which may be due to the definition of a complication or surgical learning curve. Insertion of the first trocar with the open technique is faster as compared to the Veress needle (grade A). The randomized controlled trials comparing closed (Veress plus trocar) versus open approach have inadequate sample sizes to find a difference in serious complications. In large outcome studies there were less complications in the closed group (grade B). Although RCTs found the open approach faster and associated with a lower incidence of minor complications (grade A), the panel cannot favor the use of either access technique. However, the use of either technique may have advantages in specific patient subgroups (grade B).

Among the various techniques for achieving a pneumoperitoneum and introducing the first trocar, two common methods are usually performed. The first, so-called closed technique requires the Veress needle, which is inserted in the abdominal cavity for CO_2 insufflation followed by blind introduction of the first trocar. The second, so-called open technique was first described by Hasson [110]. This technique begins with a small incision at the umbilical site and subsequently all layers of the abdominal wall are incised. The first trocar is then inserted under direct vision followed by gas insuation.

Table 2.2. Randomized clinical trials of Veress needle or open approach

Reference/ year	No. of patients	Procedure	Access time (min)	Complications	Results
Gullà et al. [103]/2000	262	Diagnostic and operative laparoscopy	Not mentioned	Needle: 11/101 Open: 0/161	Open technique is safer
Saunders et al. [262]/ 1998	176	Diagnostic laparoscopy in abdominal trauma	Needle: 2.7 Open: 7.3	Needle: 0/98 Open: 0/78	Veress technique is faster
Cogliandolo et al. [50]/ 1998	150	Laparoscopic cholecystectomy	Needle: 4.5 Open: 3.2	Needle: 5/75 Open: 5/75	Open technique is faster
Peitgen et al. [231]/1997	50	Diagnostic and operative laparoscopy	Needle: 3.8 Open: 1.8	Needle: 0/25 Open: 0/25	Open technique is faster
Byron et al. [39]/1993	252	Diagnostic and operative laparoscopy	Needle: 5.9 Open: 2.2	Needle: 19/141 Open: 4/111	Open technique is safer and faster
Nezhat et al. [219]/1991	200	Diagnostic and operative laparoscopy	Not mentioned	Needle: 22/100 Open: 3/100	Open technique has fewer complications
Borgatta et al. [30]/ 1990	212	Laparoscopic tubal sterilization	Needle: 9.6 Open: 7.5	Needle: 7/110 Open: 4/102	Open technique is safer and faster

The morbidity associated with the establishment of the pneumoperitoneum and the insertion of the first trocar is estimated to be less than 1% (4 [29, 109, 264]), but the true incidence of visceral and vascular injury for both techniques is unknown. However, major vascular injuries occur most often with the Veress needle (2c [44, 236]). Several RCTs found that the open technique on average causes less complications and is cheaper and faster than the Veress needle technique (1b [30, 39, 50, 104, 220, 232]) (Table 2.2). However, one study on the access technique for percutaneous diagnostic peritoneal lavage in blunt trauma patients showed that the Veress needle technique was faster compared to the open technique (1b [263]). A recent three-armed RCT found it easier to establish the pneumoperitoneum with a new access device (TrocDoc) than with the open technique or the Veress needle (1b [14]). The choice between reusable and single-use instruments was outside our scope. In specific patient subgroups, the access technique has to be chosen according to the patients characteristics (e.g., pregnancy, obesity, and trauma).

Gas Embolism and Its Prevention

Clinically relevant gas embolism is very rare, but if it occurs, it may be a fatal complication (grade C). The true incidence of clinically inapparent gas embolism is not known. Most described cases of gas embolism have been caused by accidental vessel punction with a Veress needle at the induction of pneumoperitoneum. Low intraabdominal pressure, low insufflation rates, as well as careful surgical technique may reduce the incidence of gas embolism (grade D). A sudden decrease in end-tidal CO_2 concentration and blood pressure during abdominal insufflation should be considered a sign of gas embolism (grade C). Due to the low incidence of clinically relevant gas embolism, advanced invasive monitoring (transesophageal Doppler sonography) cannot be recommended for clinical routine (grade B).

The incidence of gas embolism during pneumoperitoneum is estimated to be less than 0.6% (2 [282], 4 [122, 144]). Many case reports have detailed fatal or near-fatal coronary, cerebral, or other gas embolism (4 [102, 152, 172, 231, 238]). In more than 60% of cases, gas embolism occurred during the creation of a pneumoperitoneum.

The usual cause leading to gas embolism was the accidental deplacement of a needle or trocar into a blood vessel. Similarly, any injury to the veins of parenchymal organs can result in direct gas flow into systemic circulation. CO_2 bubbles are capable of reaching the right heart (2b–5 [61, 66, 79, 267]). This is best detectable when patients are studied with transesophageal echocardiography (2b–5 [61, 66]. Transcranial Doppler has shown that CO_2 bubbles may even reach the cerebral circulation (4 [267]). Furthermore, gas em-

boli are able to escape from venous to arterial circulation through pulmonary arteriovenous shunts (5 [306]) or an open Foramen ovale (4 [190]).

Experimental animal studies have induced gas embolism by infusing air directly into a vein or by lacerating a large intraabdominal vein during a pneumoperitoneum (5 [66, 145, 147]). Increased IAP of more than 20 mmHg in connection with an insoluble gas (helium or argon) enhanced the risk of gas embolism during pneumoperitoneum (5 [146, 148, 251]), suggesting that caution should be exerted when laparoscopic surgery is performed close to large veins (5 [66]). Furthermore, the use of nitrious oxide for anesthesia may increase the risk of developing gas embolism during laparoscopy (4 [200, 242], 5 [147]).

In clinical practice, there are few technical options available to reduce the risk of gas embolism. It is therefore very important that especially the surgeon who creates the pneumoperitoneum be experienced in laparoscopic access techniques. It can be assumed that blunt trocars reduce the risk of accidental vessel puncture (1b [14]).

The most sensitive method to detect gas embolism is transesophageal Doppler monitoring (TEE) (2b [283, 316]). Simple measures to detect clinically relevant gas embolism are electrocardiogram (ECG) and $EtCO_2$ monitoring, which have low costs and require low personal effort. During surgery, decreasing $EtCO_2$ values of more than 3 mmHg could be related with gas embolism and should be clarified immediately (4 [52], 5 [147]). In case of injury of larger veins during abdominal insufflation, ECG and $EtCO_2$ should be closely monitored, especially when gases with low solubility are used. Because of the low incidence of gas embolism, special perioperative monitoring (e.g., TEE) is not indicated.

Choice of Insufflation Pressure

The panel recommends use of the lowest IAP allowing adequate exposure of the operative field rather than using a routine pressure (grade B). An IAP lower than 14 mmHg is considered safe in a healthy patient (grade A). Abdominal wall-lifting devices have no clinically relevant advantages compared to low-pressure (5–7 mmHg) pneumoperitoneum (grade B).

Normal and low laparoscopic insufflation pressure are defined as 12–15 and 5–7 mmHg, respectively. It is important to differentiate between the pressure at induction of the pneumoperitoneum and that during the operation. Initially, the IAP might be increased up to 15 mmHg to reduce the risk of trocar injuries. As already stated, IAP affects the physiology of heart, lung, and circulation. In order to attenuate these possible side effects of high IAP, the intravascular volume should be adequately filled preoperatively (1b [159]) and the insufflation pressure should be selected according to the planned laparoscopic procedure and the patient characteristics. In ASA I and II patients, a low-pressure pneumoper-

Table 2.3. Randomized clinic trials comparing low- and high-pressure pneumoperitoneum

Refrenence/ year	No. of patients/ASA	Pressures compared	Results	Conclusions
Wallace et al. [308]/1997	40/ASA I–II	7.5 vs 15 mmHg CO_2	CI↓, MAP↑, HR↓, end-tidal CO_2↑, pain scores↓	Cardiac changes in both groups similar; postop pain in low-pressure group reduced
Pier et al. [236]/1994	33/ASA I–II	8 vs 15 vs 19 mmHg CO_2	No differences in pain, analgesic use, FEV_1, or VC	Pressure has little effect on pain
Dexter et al. [63]/1999	20/ASA I–II	7 vs 15 mmHg CO_2	MAP↑, HR↑, SV↓, CO↓	High pressure reduces SV and CO more than low PP

All trials were performed on laparoscopic cholecystectomy
CO cardiac output, *HR* heart rate, *MAP* mean arterial pressure

itoneum reduces adverse effects on physiology without compromising laparoscopic feasibility (1b [63, 237, 309]) (Table 2.3). It remains questionable whether these physiologic changes are associated with clinically relevant side effects.

In older and compromised patients (ASA III and IV), the effects of a high vs low IAP have only been studied in nonrandomized clinical trials (2b [64, 83, 111], 4 [257]). In these studies, an elevated IAP (12–15 mmHg) showed considerable cardiac alterations. With the use of invasive monitoring, adequate volume loading, and vasoactive drug, it was possible to keep the hemodynamic and cardiac function stable. Therefore, in ASA III and IV patients, gasless or low-pressure laparoscopy could be alternatives, which should be further tested.

Warming and Humidifying of Insufflation Gas

Warming and humidifying insufflation gas is intended to decrease heat loss. However, compared to external heating devices, the clinical effects of warmed, humidified insufflation gas are minor (grade B). Data on its influence on postoperative pain are contradictory (grade A).

Perioperative hypothermia is related to increased catecholamine and cortisol levels leading to peripheral vasoconstriction and higher arterial blood pressures (2b [86]). Maintaining normothermia generally decreases postoperative cardiovascular morbidity (1b [84, 85]).

General and regional anesthesia essentially determine body core temperature by downregulation of the internal temperature level. Once vasoconstric-

Table 2.4. Pneumoperitoneum and hypothermia; randomized clinical trials

Reference/year	No. of patients, operations	Treatments	Temperature measurement	Pathophysiological results	Clinical results
Dietterle et al. [323]/ 1998	100 vs 100 operative or diagnostic pelviscopic procedures	Body vs room temperature, pressure and humidifying not mentioned	None	None	Gas warming lowers the intensity of diaphragm and shoulder pain and reduces the use of analgesics
Saad et al. [254]/2000	10 vs 10 lap. CCE	37 vs 21 °C. CO_2 IAP 15 mm Hg, humidifying not mentioned	Esophageal thermotip catheter	No differences in body and intraabdominal temperatures and pain scores	Gas warming has no clinically relevant effect
Slim et al. [284]/1999	Double-blind 49 warm vs 51 cold gas, different upper abdominal lap. procedures	37 vs 21 °C, CO_2, IAP 14 mmHg humidifying not mentioned, 20°RT	Subdiaphramatic thermometric probe	Subdiaphramatic temperature equal VAS score for shoulder tip pain higher in the warm group	Gas warming increases postoperative pain (VAS)
Mouton et al. [209]/ 1999	20 vs 20, lap. CCE	34–37 vs 21–25 °C	Esophagus	No difference in core temperature; pain score less in humidified group	Humidified heated gas reduces pain but preserves no heat loss
Nelskylä et al. [215]/ 1999	18 vs 19 women, lap, HE end point: heart rate variability	37 vs 24 °C, CO_2, IAP 12–14 mmHg , humidifying not mentioned	Tympanic and nasopharyngeal	Body core temperature decreases more in the warming group	Heating of insufflation gas does not prevent decrease of body temperature
Puttick et al. [243]/ 1999	15 vs 15, ASA I–II, lap. CCE	37 vs 21 °C, CO_2, mean duration of surgery 32 min	Esophagus	Body core temperature decreases more in room temperature group	Higher cytokine levels in room temperature group; pain scores and consumption not different

Bäcklund et al. [11]/1998	13 vs 13 prolonged lap. Procedures >90 min	37 vs 21 °C, CO_2, IAP 11–15 mmHg , humidifing not mentioned	Swan–Ganz catheter	Core temperature and urine output higher in warm PP	Warm insufflation increases urine output
Ott et al. [226]/1998	Double-blinded multicenter (7) study, 72 women	36 °C and humidified vs 23 °C, CO_2 IAP?	Endotracheal	Warm insufflation: less intraoperative hypothermia, postoperative stay and pain	Gas warming reduces lap. induced hypothermia
Korell et al. [162]/1996	50 vs 53 women, div. laparoscopic procedures	Heated CO_2 (30–32 °C) vs normal CO_2 (23–24 °C)	Flow therme	VAS scores reduced for shoulder and subdiaphragmatic pain	Warm CO_2 reduces postoperative pain
Semm et al. [277]/1994	30 vs 30 lap. pelviscopy	37 °C PP vs 21 °C PP, CO_2 IAP 12 mmHg, humidifying not mentioned	Intraadbominal and rectal probe	37 °C group shoulder tip pain; pain medication and incidence of tachycardia reduced	Warm insufflation reduces shoulder tip pain; pain medication

IAP intraabdominal pressure

tion has occurred, application of warming systems is less effective in compensating heat loss (1b [245]). Therefore, forced-air warmer systems should be applied before heat loss occurs. In contrast, warming and humidifying of the insufflation gas is less important than application of external warming devices before and during anesthesia.

Warming of the insufflation gas reduces postoperative intraperitoneal cytokine response (1b [243]) and reduces postoperative hospital stay (1b [226]) and pain (1b [226, 277, 323]) (Table 2.4). In contrast, a double-blind RCT found an increase in shoulder tip pain after warming the insufflation gas (1b [284]). Other groups found no clinically relevant effects of warming the insufflation gas (1b [198, 215, 254, 311]). Additional humidifying of warmed insufflation gas seems to reduce postoperative pain but has no heat-preserving effect in brief laparoscopic procedures (1b [209]). Since most of the studies have small sample sizes with possible type II error, no firm conclusions can be drawn. Given their possible small effects, the costs of these devices have also to be considered.

Abdominal Wall-Lifting Devices

Abdominal wall lifting as compared to capnoperitoneum results in less impairment of hemodynamic, pulmonary, and renal function (grade A). In ASA and I and II patients, the magnitude of these benefits is too small to recommend abdominal wall lifting (grade D). In patients with limited cardiac, pulmonary, or renal function, abdominal wall lifting combined with low-pressure pneumoperitoneum might be an alternative (grade C). Nevertheless, surgical handling and operative view were impaired in most surgical procedures (grade A).

Gasless laparoscopy has been developed to avoid the pathophysiological side effects of elevated IAP and CO2 insufflation, especially in patients with comorbities (ASA III and IV). However, most RCTs on gasless laparoscopy vs pneumoperitoneum have been performed in healthy ASA I and II patients (Tables 2.5, 2.6). In these patients, gasless laparoscopy results in a more stable hemodynamic and pulmonary function (1b [155, 220, 223]), a concomitant increase in urine output (1b [156, 223]), reduced hormonal stress reponses (1b, [156, 223]), less postoperative pain (1b [131, 153]), and less drowsiness (1b [155, 178]). Contrarily, other RCTs found no differences in postoperative pain (1b [102]) and cardiorespiratory functions (1b [200]). Many surgeons encountered technical difficulties due to inadequate visualization (1b [136, 184, 200]). This led to high conversion rates in these trials, one of which was even terminated prematurely [136]. Although gasless laparoscopy may have hemodynamic and cardiovascular advantages in ASA III and IV patients, clinical trials in this group of patients have not been per-

Table 2.5. Randomized clinical trials comparing gasless to low- or high-pressure pneumoperitoneum

Reference/ year	No. of patients, ASA	Pressures compared	Results in experimental group	Conclusions
Lubkan et al. [184]/2000	30, single blind	Laparolift vs 15 mmHg	VAS score for visualization less in gasless patients	Conventional PP provides better view
Ogihara et al. [223]/1999	12, ASA I–II	Gasless vs 13 mmHg CO_2 (Trendelenburg position 15–20° in both groups)	CO_2 group: pulmonary compliance↓, epinephrine↑, norepinephrine↑, dopamine↑, ADH↑, urine output↓	Gasless: lesser hormonal stress responses; better pulmonary function; higher urine output
Schulze et al. [271]/1999	17	Gasless vs 12 mmHg CO_2 (thPDA in both groups)	CO_2 group Blood flow↓, HR↑, MAP↑, CVP↑	No clinically relevant differences; CO_2 group less pain and more fatigue
Vezakis et al. [304]/1999	36, ASA I–II	Gasless vs 8 mmHg CO_2	No changes in postop pain and analgesic consumption	Shoulder pain more frequent
Cravello et al. [53]/1999	103	Gasless vs CO_2 PP (IAP unknown) (8 conversions)	No differences in complication pain medication hospital stay	Gasless technique needs further evaluation
Guido et al. [102]/1999	54	Gasless vs 15 mmHg CO_2	No differences in shoulder, pelvic, and periumbilical pain	Similar pain scores compared to conventional PP
Meijer et al. [200]/1997	20, ASA I–II	Gasless (AWL) +5 vs 15 mmHg CO_2	Gasless surgery lasted longer; CO, RR, and HR equal in both groups	AWL is not recommended for laparoscopic cholecystectomy, view impaired
Koivusalo et al. [156]/1997	30, ASA I–II	IAP 12–13 mmHg CO_2 vs gasless	CO_2 group: MAP↑, pulmonary compliance↓, urine output↓, U-NAG↑, intramucosal pH↓	Gasless: more stable in hemodynamics; protects renal and splanchnic ischemia
Koivusalo et al. [155]/1997	25, ASA I–II	IAP 12–15 mmHg CO_2 vs gasless AWL	Drowsiness shorter	Avoiding CO_2 reduces drowsiness
Johnson and Sibert [136]/1997	18	Gasless vs CO_2 PP (IAP not mentioned)	Increased technical difficulty – poor visualization	CO_2 PP is preferable for routine LTC

Table 2.5 (continued)

Reference/ year	No. of patients, ASA	Pressures compared	Results in experimental group	Conclusions
Casati et al. [42]/1997	20	Gasless vs 12 mmHg CO_2	Better pulmonary compliance: oxigenation unchanged	Better lung compliance
Goldberg and Maurser [96]/1997	57	Gasless (laparolift) vs 15 mmHg CO_2; 9/28 converted because of inadequate exposure	Technically difficult; no differences in cardiopulmonary parameters and pain scores	No clinical benefit
Koivusalo et al. [154, 157]/1996	26, ASA I–II	IAP 12–15 mmHg vs laparolift	Maddox–Wing deviation higher in conventional PP group gasless: plasma renin activity↓, diuresis higher	Less right shoulder pain, nausea, and vomiting; smaller neuroendocrine responses; better renal function
Lindgren et al. [178]/1995	25, ASA I–II	PP (IAP 12–15 mmHg + CO_2) vs AWL	CO_2 group MAP↑, HR↑, pulmonary compliance↓	MAP lower; postoperative nausea, vomiting, and right shoulder pain less often

AWL abdominal wall lifting

Table 2.6. Cross-tabulation of current research on the effects of technical modifications of laparoscopy on pathophysiologic and medical outcomes

	Open-acces technique	Smaller trocars (3.5 mm)	Warmed insufflation gas	Helium, argon, or NO_2	Low-pressure laparoscopy	Gasless laparoscopy	Intraperitoneal anaesthetics
Pathophysioloical effects							
Circulatory	(0)	(0)	++ [277]	0 [28]	++ [63, 158, 236, 308]	++ [96, 156, 158, 178, 200, 220, 223]	(0)
Pulmonary	(0)	(0)	?	0 [28]	+ [236]	++ [155, 158, 200, 220, 223]	?
Renal/hepatic/ intestinal	(0)	(0)	++ [11]		+	++ [156, 158, 223]	(0)
Immunological	(0)	?	++ [243]	(0)	(0)	+/0 [220]	?
Hormonal	(0)	?	?	(0)	(0)	++ [156, 223]	?
Body core temperature	(0)	(0)	+/0 [11, 215, 226, 243, 254]	?	(0)	+	(0)
Technical effects	++ [262]	– [276]	(0)	(0)	-/0 [63, 158, 308]	– [96, 136, 184, 200]	(0)
Clinical effects							
Intraoperative surgical incidents	+++ [30, 39, 50, 103, -219, -231]	[276]	+	(0)	(0)	?	(0)
Heart and lung complications	(0)	+ [276]	?	(0)	-10	+/0	?
Kidney and liver complications	(0)	(0)	?	(0)	-10	+/0	?
Pain	(0)	++ [22, 35, 276]	+/0 [162, 243, 254, 277, 284]	0 [236]	++ [258, 308]	+/0 [53, 102, 154, 178, 271, 304]	+++ [3, 40, 49, 55, 69, 70, 93, 211, 214, 227, 228, 293, 297, 309]

Table 2.6 (continued)

	Open-acces technique	Smaller trocars (3.5 mm)	Warmed insufflation gas	Helium, argon, or NO_2	Low-pressure laparoscopy	Gasless laparoscopy	Intraperitoneal anaesthetics
Drowsiness and fatigue	(0)	0 [276]	?	(0)	(0)	++ [155, 178, 271]	?
Cosmetic results	?	++ [276]	(0)	(0)	(0)	(0)	(0)
Incisional hernia	?	++	(0)	(0)	(0)	(0)	(0)
Adhesions	(0)	+	(0)	(0)	+	(0)	(0)
Infections	(0)	?	(0)	(0)	(0)	(0)	(0)

+++strong RCT evidence in favour of intervention; ++, some RCT evidence in favour of intervention; +/0, conflicting RCT evidence in favour of intervention; + non-RCT evidence in favour of intervention; 0 some RCT evidence for no effect of intervention; (0) non-RCT evidence for no effect of intervention; – non-RCT evidence against intervention; -/0 conflicting RCT evidence against intervention; – some RCT evidence against intervention; – strong RCT evidence against intervention; ? no valid research evidence available

formed. Since gasless laparoscopy also requires excellent surgical expertise, its use should be restricted to certain subgroups of surgeons and patients.

Size of Access Devices

Smaller access devices (≤ 5 mm) in laparoscopy are only feasible in selected group of patients. The use of 2–5-mm instead of 5–10-mm access devices improves cosmetic result and postoperative pain marginally in laparoscopic cholecystectomy (grade A).

Although it has been assumed that smaller access devices may markedly improve the patients outcome of laparoscopic surgery, this has not been shown in valid RCTs (1b [22]). Merely modest advantages have been reported concerning a better cosmetic result (1b [276]) and less postoperative pain (1b [22, 35, 46, 276], 4 [192]) after laparoscopic cholecystectomy. Postoperative pulmonary function and fatigue were unchanged (1b [276]). Other clinical trials found a shorter convalescence by using smaller access devices in laparoscopic procedures (4 [192]). The incidence of postlaparoscopic incisional hernia is less than 1% (4 [165, 169]). Whether smaller access devices prevent incisional hernia has not been clarified (4 [165]). To prove a difference would require a large sample size and an extensive postoperative observation period. Currently, the general use of smaller trocars cannot be recommended due to difficulties in handling and reduced optical quality, especially when using smaller laparoscopes (1b [22, 276], 4 [168]). Recently published RCTs reported a reduction in postlaparoscopic pain when a radially expanding access device was compared to the conventional cutting trocar (1b [19, 80, 170, 318]). No data are available on other clinical effects.

Perioperative Aspects

Adhesions

Some laparoscopic procedures may cause less postoperative adhesions compared to their conventional counterparts (grade B). However, the specifics of a pneumoperitoneum (gas, pressure, temperature, and humidity) seem to have no major effect on the development of postsurgical adhesions (grade D).

Two RCTs found less postsurgical adhesions after laparoscopic compared to conventional surgery (2b [61, 62, 185]), but these studies have methodological flaws (small sample size, unclear allocation concealment, no intention-to-treat analysis, and losses to follow-up). Furthermore, since postsurgical adhesions are usually assessed by means of different scoring systems, it is difficult to compare the results of the trials in between or to rule out observer bias in these unblinded trials.

Pathophysiologically, a reduced peritoneal fibrinolytic activity seems to be the main cause for postsurgical adhesions (4 [116]). Experimental studies indicate that adhesion rates also depend on intraabdominal pressure (5 [317]) and the type of gas used (5 [132, 213]). However, one clinical RCT found no difference in peritoneal fibrinolytic activity in elective laparoscopic compared to conventional colorectal resections (1b [216]). It seems that the specifics of a pneumoperitoneum do not influence generally the peritoneal fibrinolytic activity and the development of postoperative adhesions. Therefore, avoiding local peritoneal damage seems to be the most significant factor to prevent postsurgical adhesions.

Pain, Nausea, and Vomiting

Pain after laparoscopic surgery is multifactorial and should be treated with a multimodal approach (grade A). Shape and size of access devices have to be considered (grade A). Low-pressure pneumoperitoneum, heated and humidified insufflation gas, incisional and intraperitoneal instillation of local anesthetics, intraperitoneal instillation of saline, and removal of residual gas all reduce postlaparoscopic pain (grade B). Inconclusive data and small effect sizes of singular approaches make it difficult to recommend these treatments in general (grade D). No evidence exists that the specifics of a pneumoperitoneum have any effect on postoperative nausea and vomiting.

Although pain after laparoscopic surgery is less severe and of shorter duration than that after open surgery, it still causes considerable discomfort and increased stress response. The etiology of postlaparoscopic pain can be classified into at least three aspects: visceral, incisional, and shoulder pain [21, 140, 300]. Although visceral pain may also depend on the extent of intraabdominal surgery, incisional pain is related to the number and size of access devices and also to the technique of incision closure and drainage. The origin of shoulder pain is only partly understood, but it is commonly assumed that the continual stretching of the peritoneum during and after the pneumoperitoneum is responsible. Clinically, incisional and deep abdominal pain dominate over shoulder pain. However, shoulder pain is specific for laparoscopic surgery. After different abdominal laparoscopic procedures, shoulder pain was noted in 30–50% of cases, which is significantly higher than after the corresponding open procedures (1b [43, 55, 174, 297]). It was suggested that shoulder tip pain is caused mechanically by stretching the diaphragmatic ligaments (1b [308]). The hypothesis of a chemical effect of the pneumoperitoneum with a decrease in intraperitoneal pH could not be verified [233].

The incidence of postoperative nausea and vomiting after laparoscopic procedures ranges from 10 to 60% [81, 201, 312]. After laparoscopic cholecystect-

omy, nausea and vomiting persisted up to 14 days in some patients [296]. The pathogenesis of postoperative nausea and vomiting is multifactorial, depending on anesthesia, surgery, gender, and perioperative administration of opioids. Several RCTs examined the influence of antiemetics and analgesics on postoperative nausea and vomiting, but this was beyond the scope of this guideline.

Within the past few years, various modifications of the pneumoperitoneum have been developed and clinically tested in order to reduce peritoneal pain after laparoscopic surgery [21, 310]. Here, we focus on those interventions that are directly related to the pneumoperitoneum, thus excluding oral, intravenous, or epidural drug administration and other nonlocal treatments. The intensity of postoperative pain varies largely among different cultures, settings, and individuals.

The following interventions were all shown in RCTs to effectively reduce pain after laparoscopy:

- Reducing IAP (1b [178, 236, 299, 308])
- Using other insufflation gases, such as N_2O, helium, or argon (1b [2, 180, 206, 236, 280])
- Lowering the insufflation rate (1b [16])
- Warming and humidifying the insufflation gas (1b [162, 209, 210, 226, Removal of residual intraabdominal gas at the end of operation (1b [86, 137, 298], 2b [4, 128], 4 [4, 128])
- Intraperitoneal instillation of fluids (1b [233])
- Intraperitoneal instillation of anesthetics (1b [3, 40, 49, 55, 69, 70, 93, 211, 214, 227, 228, 293, 297, 309])
- Reducing the size of trocars (1b [22, 35, 97, 166])
- Injecting anesthetics into the trocar sites (1b [3, 21, 257, 301])
- Omitting drains (which is beyond the scope of this recommendation, since it depends on the type of operation)

The intraperitoneal instillation of anesthetics is well studied. Most RCTs found a significant decrease in postlaparoscopic pain, including shoulder tip pain (1b [3, 40, 49, 55, 69, 70, 93, 211, 214, 227, 228, 293, 297, 309]), whereas other trials found no effect (1b [21, 87, 140, 244, 264, 270]). Since there is also evidence that postlaparoscopic instillation of normal saline or Ringers lactate reduces pain (1b [233]), it is important to distinguish between trials that used placebo controls from those that did not.

Humidifying the insufflation gas reduced postoperative pain in one trial (1b [211]) but increased it in another (1b [284]). After gasless laparoscopy, one double-blind RCT showed that shoulder tip pain (as primary end point) was more frequent than after conventional pneumoperitoneum (1b [304]), a second RCT with a smaller sample size reported the contrary (1b [154]), and a third found no difference (1b [101]).

On the basis of these contradictory results, the panel is not able to favor one treatment option over another. For the multifactorial pathogenesis of postlaparoscopic pain, we assume that a combined therapeutic approach is most effective ([20, 201]). Surgical awareness of this significant patient problem needs to be improved.

Pregnancy

Presupposing obstetrical consultation, laparoscopic procedures during pregnancy should be performed in the second trimester if possible (grade C). Perioperatively, maternal end-tidal CO_2 concentration and arterial blood gases must be monitored to control maternal hyperventilation and to prevent fetal acidosis (grade C). For the establishment of the pneumoperitoneum the open technique should be preferred (grade C). During laparoscopy intraabdominal pressure should be kept as low as possible and body positioning should be considered in order to avoid inferior vena cava compression by the uterus (grade C). Furthermore, pneumatic compression devices are recommended (grade D).

Surgery during pregnancy always carries an increased risk of fetal loss. Therefore, the indication for surgical intervention during pregnancy is generally limited to urgent situations such as acute appendicitis [268] or acute cholecystitis [99, 287]. The incidence of acute appendicitis and acute cholecystitis during pregnancy is similar to that of nongravid females and is estimated to be less than (0.1% (4 [195, 248]). The treatment of acute cholecystitis in gravid women should consider effective nonsurgical therapeutic options (4 [292]). Today, pregnancy should not be seen as an absolute but a relative contraindication for laparoscopic procedures. Because of increased risk for postoperative abortion in the first trimester and hindrance of operation due to the enlarged uterus, surgery during pregnancy should be performed during the second trimester (4 [190, 286]). During pregnancy laparoscopic compared to conventional surgery is preferred because of possibly less fetal impairment due to less postoperative analgetic requirements (4 [176]) and less postoperative maternal respiratory depression (4 [56]). However, increased intraabdominal pressure may decrease maternal respiratory compliance (5 [9, 58]), uterine blood flow (5 [58]), or preterm labor (5 [58, 96]). Furthermore, the use of carbon dioxide seems to increase fetal acidosis (5 [54, 59, 120]), to enhance the risk for fetal loss (4 [8]), and may lead to detrimental side effects if hyperventilation fails (5 [54]). Most of these concerns are based on experimental studies and case reports and should be confirmed by randomized controlled trials. Due to the low incidence of surgical interventions during pregnancy, these studies have to be performed as multicenter trials.

Intracranial Pressure

Increased IAP and head-down position increase intracranial pressure (ICP) (grade A). Therefore, elevated IAP, head-down position, and hypoventilation should be avoided (grade D). In patients with head injury or neurological disorders, perioperative monitoring of ICP should be considered (grade C). Gasless laparoscopy might be an alternative to prevent ICP peaks (grade D).

During pneumoperitoneum, IAP and head-down position increase ICP (5 [75, 117, 142, 207, 252], 4 [123]), enhance cerebral blood flow velocity (4 [1]), and diminish cerebrospinal fluid absorption (5 [106]). Elevated ICP values during laparoscopic surgery return to baseline after desufflation (5 [75]). There is no evidence that elevated ICP during pneumoperitoneum is clinically relevant.

Pathophysiological studies suggested that an increased intraabdominal pressure hinders venous drainage of the lumbar venous plexus followed by a decline in cerebrospinal fluid absorption during abdominal CO_2 insufflation (5 [105, 106]). Furthermore, it was hypothesized that this mechanical effect leads to an increase in ICP and a central nervous system response causing systemic hypertension (5 [15, 251]). However, the exact pathophysiology of increasing ICP during pneumoperitoneum remains unclear. Experimental and clinical studies showed that hemodynamic changes are directly related to the increase in ICP (4 [89, 123], 5 [142, 251]). Therefore, in patients with severe head injuries or conditions associated with elevated ICP, intraabdominal pressure should be as low as possible, sudden IAP peaks should be avoided, and intraoperative ICP monitoring should be considered (4 [127]). Furthermore, gasless laparoscopy could be an option to avoid the effects of IAP on ICP (5 [75, 117]).

The use of carbon dioxide as insufflation gas leads to hypercarbia and acidosis, which possibly influence the intracerebral circulation by vascular autoregulation. CO_2 increases ICP more than do helium and nitric oxide (5 [267]). Hypoventilation and hypercarbia increase ICP compared to hyperventilation and hypocarbia, but during acute elevations of ICP hyperventilation did not decrease ICP effectively (5 [251]). The insufflation gas has fewer effects on ICP than on IAP (4 [74], 5 [60]).

Abdominal Trauma

There are no prospective studies evaluating the specifics of a pneumoperitoneum (type of gas, IAP, and temperature) in patients with blunt or penetrating abdominal trauma (grade D).

Laparoscopy is used as a diagnostic tool in hemodynamically stable patients after blunt or penetrating trauma in order to detect those injuries that require laparotomy or laparoscopic repair (2 b [71, 77, 285]). In rare cases of penetrating trauma, the establishment of a pneumoperitoneum led to an insufflation of

injured organs or cavities ([119]). Nevertheless, the panel agrees that there is no reason to contraindicate pneumoperitoneum in stable trauma patients.

The use of different intraabdominal pressures, different types of gas, or even gasless laparoscopy has not been evaluated in patients with blunt or penetrating abdominal trauma. Thus, no recommendations are reasonably justifiable. However, one clinical RCT tested which access technique is faster and safer, and found advantages for the closed technique (1b [262]), thus refuting data from nontrauma surgery.

Discussion

After a 2-year break, the EAES has continued its guideline activities, now on an even more evidence-based level and with much more advanced preparation than in the past. We believe that the result of this endeavor can be considered to be a milestone in the societys responsibility of being a bridgetender between primary research and clinical practice and vice versa.

We hope that the reader understands the importance of guideline methodology. In a European survey 2 years ago, many members complained that the EAES consensus panels had always been consisting of the same clique of people. The panel for this guideline still contains many well-known names from the EAES simply because the number of experts in endoscopic surgery is limited, as are resources for guideline development. Wherever interdisciplinary coworking was necessary, experts from other fields were invited to join the panel, although this guideline could have received further benefit from the input of a pediatric surgeon.

The scope of this guideline is broad since the pneumoperitoneum is the key issue in laparoscopic surgery. However, it is impossible for a guideline to answer all relevant points in detail or to discuss the role of the pneumoperitoneum separately for every disease entity. The panel tried to formulate the statements as concise as possible. However, for those issues, for which no strong evidence was found, it was often impossible to recommend any specific option. Those who find such broad statements disappointing should remember that the panel can only judge on the basis of clinical experience and published evidence. Often, a treatment is widely held to be evidence based, although not a single study has ever been performed.

Therefore, one of our aims was to define some implications for future research. A fair amount of RCTs were retrievable to answer the various issues. We consider it unlikely that important studies were missed by our literature searches because we combined various techniques to capture all relevant studies. However, the available studies mostly focused on those questions which can be answered already using a small sample size and short-term observation. Some other statements did not receive grade A because the exist-

ing RCTs had methodological flaws. What is of general concern is that such a large proportion of trials assessed pathophysiological rather than clinical outcomes. These trials, albeit randomized, are usually insufficient to answer the clinical questions we had posed. Therefore, the plea for clinically relevant RCTs cannot be reiterated too often. It is a future task to check whether the recommendations have to be modified on the basis of new data.

Developing guidelines is only worthwhile if they are used clinically. Guideline use hinges upon guideline awareness and knowledge. Therefore, the format and dissemination of the current guideline goes beyond simple publication. Since guidelines created on a European level cannot address the local circumstances in every European country or even hospital, the EAES scientific committee recommends the use of the current guideline as a basis for a locally adapted and translated guideline, which could then be implemented at any given level.

The most important factors that have to be considered before adapting this guideline for local use are individual surgical expertise and health care setting. Some surgical techniques that are discussed or even recommended here are probably not practical or affordable for every European surgeon. This is why we decided not to include cost comparisons in this guideline.

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Pneumoperitoneum – Update 2006

Ann-Cathrin Moberg, Agneta Montgomery

Introduction

The European Association for Endoscopic Surgery (EAES) published guidelines concerning pneumoperitoneum for laparoscopic surgery in 2002 [14]. This extensive documentation concerns evidence-based clinical practice guidelines focussing on the pathophysiological basis for clinical indications, establishing pneumoperitoneum and perioperative aspects. Technique-specific complications are of great concern and most of these are related to the access of the abdominal cavity and the creation of pneumoperitoneum in laparoscopic surgery.

Under the mandate of the EAES Scientific Committee, an update concerning the access technique, insufflation pressure and warming of the insufflation gas has been performed. The pathophysiological bases for the clinical indications and perioperative aspects are not discussed in this update.

Methods

For this update a systematic review was performed by searches (as of March 2006) in Medline, the Cochrane Library and reference lists. The update includes studies published between 1999 and 2006 that have not been referred to in the previous guidelines. The medical subject headings used were laparoscopy, pneumoperitoneum in combination with access, Veress, open, insufflation, warming, humidified and randomised. The primary intention was to identify clinically relevant randomised controlled trials (RCTs). Systematic reviews and large individual cohort studies were also included. No animal studies were included. Only studies written in English were considered. All studies were graded according to the scientific-evidence level described by Sackett et al. [16] also used in the previous EAES guidelines.

The tables of RCTs have been updated from the previous guidelines and summarised in three settings: clinical trials of different access techniques, low- and high-pressure pneumoperitoneum, and hypothermia.

Access Techniques

Consensus 2002: *For severe complications (e.g. vessel perforation) it is impossible to show a difference between closed- and open-access techniques in RCTs; therefore, large-outcome studies should be considered. In the RCTs, the rate of major and minor complications is surprisingly high, which may be due to the surgical learning curve or to how "complication" is defined. Insertion of the first trocar with the open technique is faster compared with that of the Veress needle (grade A). The RCTs comparing closed (Veress/trocar) versus open approaches have sample sizes that are not sufficient to show any difference in major complications. In large-outcome studies there were fewer complications in the closed group (grade B). The committee analysing the RCTs found the open approach faster and it was associated with a lower incidence of minor complications (grade A). The committee could not favour the use of either access technique. However, the use of either technique may have advantages in specific patient subgroups (grade B).*

Update 2006: Meta-analysis of nonrandomised studies comparing open versus closed (Veress/trocar) access concluded a trend towards a reduced risk of major complications, access-site herniation and minor complications in nonobese patients during open access (grade B). Data regarding different closed techniques; direct trocar insertion, Veress/trocar and Veress/radially expanding access (REA) has been added. Major complications in studies of direct trocar versus Veress/trocar were inconclusive (grade B). Minor complications in RCTs were fewer with direct trocar insertion compared with Veress/trocar (grade A). REA versus conventional cutting-tip trocar (second trocar) in a RCT causes less postoperative pain, better patient satisfaction and fewer local wound events (grade A). There is no RTC large enough to address serious complications.

There are four basic techniques used to create pneumoperitoneum: open access technique, blind Veress followed by either a conventional cutting-tip trocar or a REA device, direct trocar insertion with elevation of the rectus sheet and optical trocar insertion.

The true incidence of visceral and vascular injuries of the aforementioned techniques is still unknown but is believed to be less then 1%. Differences that occur by chance would be difficult to discern without exceptionally large sample sizes.

Five randomised clinical trials of different access techniques are described in Table 3.1. Two of these studies included more then 500 patients and both compare direct trocar insertion to Veress/trocar access. It is concluded that the Veress/trocar causes an unacceptably high number of complications, but mostly are minor. The direct trocar insertion is easy and effective (grade A) [1, 8]. The use of the open balloon blunt-tip trocar is described as simple

Table 3.1. Randomised clinical trials of different access techniques

References/ years	No. of patients, and operations	Treatments	Methods	Results	Conclusion
Gunenc et al. [8]/ 2005	578 Randomised method not described, gynaecologic surgery	277–DTI 301–VN[a)]	Emphysema, entry failure and other complications	Emphysema: 0–DTI, 11–VN ($p < 0.05$) Entry failure: 2–DTI, 14–VN ($p < 0.05$) Other complications: 2–DTI, 8–VN (NS)	DTI is easy and effective
Agresta et al. [1]/ 2004	598 Single-blind general surgery	275–DTI 323–VN[a)]	Feasibility, complications in nonobese patients	Feasibility same Minor complications: 0–DTI, 18–VN ($p < 0.01$) Major complications: 0–DTI, 5–VN (NS)	VN unacceptable; high number of complications (7.4%)
Yim et al. [23]/2001	34 Double-masked[b)] adnexal surgery	34–REA 34–CCTT	Severity (VAS) and duration of pain, scar length, patient satisfaction and complications	Reduction in severity and duration of pain, shorter wound length, higher patient satisfaction in REA 4–epigastric bleeding in CCTT	REA had less postoperative pain and better patient satisfaction
Bernik et al. [3]/2001	180 Randomised method not described, chole-cystectomy	118–open BBTT 34–open Hasson 28–VN[a)]	Access time and gas leakage	BBTT faster; gas leakage inconclusive	BBTT simple and rapid
Bhoyrul et al. [4]/ 2000	244 Double-blind general surgery	119–REA 125–VN[a)]	Complications, pain (VAS) and incisional hernias	Fewer port site complications in REA. Pain similar. No hernias	REA results in fewer local wound events

BBTT balloon blunt-tip trocar, *CCTT* conventional cutting tip trocar, *DTI* direct trocar insertion, *NS* not significant, *REA* radially expanding access, *VAS* visual analogue scale, *VN* Veress needle.

a) Veress needle followed by conventional cutting-tip trocar.

b) Self-controlled study not including primary trocar entrance

and rapid (grade A) [3]. The REA is compared with Veress/trocar in two randomised studies and both conclude that the use of REA is associated with fewer local wound events, better patient satisfaction and less pain (gradeA) [4, 23].

Inclusion criteria were met in 40 studies in a meta-analysis that summarised complications according to open access, Veress/trocar and direct trocar insertion. Fifty-six percent of all major complications were visceral injuries. It was concluded in prospective nonrandomised studies comparing open and closed (Veress/trocar) access that there is a trend in open access towards a reduced risk of major complications, access site herniation and in nonobese patients a reduced risk of minor complications. In prospective nonrandomised studies comparing direct trocar and Veress/trocar access major complications were inconclusive. There were fewer minor complications with direct trocar insertion, predominantly owing to a reduction in extraperitoneal insufflation. Three access-related deaths have been reported (grade B) [10].

Another meta-analysis, including 61 studies, described the overall frequency of bowel injuries of 0.7/1,000 and major vascular injuries in 0.4/1,000 patients. The overall incidence of major injuries at the time of entry was 1.1/1,000. Direct trocar insertion is associated with a significantly reduced major injury incidence of 0.5/1,000, when compared with both open and Veress/trocar entry. In older studies the open entry was often used in high-risk patients, which might be the explanation for the increased incidence of bowel injuries in this group. Open entry appears to minimise vascular injury at the time of entry (grade B) [13].

In a large database study including 14,000 patients, different access techniques were used and the incidence of visceral injuries was 0.13%, major vascular injuries 0.007% and mortality 0.007% (grade B) [19]. In a database analysis of 4,600 patients comparing open versus Veress/trocar access in two different consecutive time cohorts, no cases of major vascular injuries were seen in either group. Visceral injuries were seen in 0.17% of patients in the Veress group and in 0.05% of patients in the open group (not significant) (grade B) [12]. In a consecutive series comparing direct trocar insertion versus Veress/trocar there was a significantly higher overall complication rate in the Veress/trocar group, 14 versus 0.9% ($p < 0.01$). Two major complications, one visceral and one vascular, were seen in the Veress group (grade B) [22]. The REA device is compared to an ordinary cutting-tip trocar used as the secondary port regarding abdominal wall events. REA is free of abdominal wall complications in 99.8% of cases. Cutting-tip trocars have demonstrated increased complication rates for the abdominal wall in terms of bleeding and larger fascia defects that would potentially increase the risk of port site hernias (grade B) [7]. Optical trocar insertion was reported in one retrospective study including 650 patients. The time for entrance was short and a total of 0.3% of bowel injuries were described and no major vascular injuries were reported (grade B) [20].

Insufflation Pressure

Consensus 2002: *The committee recommends use of the lowest intraabdominal pressure (IAP) allowing adequate exposure of the operative field rather than using a routine pressure (grade B). An IAP lower than 14 mmHg is considered safe in a healthy patient (grade A).*

Update 2006: The previous recommendations are still valid and are further supported by less pain and higher quality of life postoperatively using a low insufflation pressure (grade A).

In this update another three RCTs, including a total of 288 patients, were analysed (grade A) [2, 11, 17]. All three studies focussed on postoperative discomfort regarding pain, shoulder-tip pain, analgesia consumption or quality of life (Table 3.2). All three compare low-pressure versus high-pressure pneumoperitoneum. The definition of normal and low laparoscopic insufflation pressure was previously defined in the EAES guidelines as 12–15 and 5–7 mmHg, respectively. These definitions are not in accordance with the definitions used in two of the studies [11, 17]. The largest study of 148 cases used the recommended pressure levels of the two groups mentioned before and demonstrated significantly less pain postoperatively for the first 5 days, less analgesia consumption for the first 4 days and better quality of life concerning physical activity 7 days postoperatively [2]. There was less frequency and intensity of shoulder-tip pain together with less analgesia consumption in another study comparing 9 versus 13 mmHg [17]. The last study compared 10 versus 15 mmHg and does not show any difference between the groups concerning pain or quality of life [11].

The results from these studies further support low-pressure pneumoperitoneum being defined as 7 mmHg or lower. The ASA classification was not addressed separately in these studies. No systematic review or large individual cohort study addressing low-pressure versus high-pressure pneumoperitoneum has been identified.

Warming and Humidifying of Insufflation Gas

Consensus 2002: Warming and humidifying insufflation gas is intended to decrease heat loss; however, compared with external heating devices, the clinical effects of warmed, humidified insufflation gas are minor (grade B). Data on its influence on postoperative pain are contradictory (grade A).

Update 2006: Warming and humidifying insufflation gas compared with standard CO_2 is not associated with any clinically relevant increase in body temperature, especially when an external warming blanket is used in parallel (grade A). There is no clinically relevant effect on postoperative pain for the

Table 3.2. Randomised clinical trials comparing low- and high-pressure pneumoperitoneum. All studies were cholecystectomies

References/ years	No. of patients, operations and ASA classification	CO_2 pressures compared	Method	Results	Conclusion
Koc et al. [11]/2005	50 Double-blind ASA I–III	10 vs 15 mmHg	Pain (VAS), analgesic consumption and QoL	No difference between the groups	Low-pressure PP does not reduce postoperative pain
Barczynski et al. [2]/ 2003	148 Single-blind ASA I–II	7 vs 12 mmHg	Pain (VAS), analgesic consumption and QoL	Less pain, analgesic consumption and better QoL (physical) for low pressure	Recommends low pressure PP if adequate exposure is obtained
Sarli et al. [17]/2000	90 Double-blind ASA I–II	9 vs 13 mmHg	Shoulder-tip pain (VAS) and analgesic consumption	Lower frequency and intensity of shoulder-tip pain and less analgesic consumption in low-pressure group	Low-pressure PP reduces the frequency and intensity of shoulder-tip pain

PP pneumoperitoneum, *QoL* quality of life

two methods (grade A). Warming and humidifying insufflation failed to reduce fogging (grade A).

A total of six RCTs included 279 patients (Table 3.3). A significant increase in body temperature was demonstrated using warmed and humidified CO_2 (grade A) [6, 9, 18, 21] and no differences were found in two studies [5, 15]. Pain, analgesic consumption, recovery and hospital stay failed to demonstrate any difference in four studies [5, 6, 15, 18]. Reduced analgesic consumption was demonstrated in one study [9] and increased pain was demonstrated in another study [21] in the warmed, humidified group. Failure to reduce fogging using warmed and humidified CO_2 was demonstrated in three studies [6, 9, 15].

No systematic review or large individual cohort study has been identified addressing the method of warming and humidifying the insufflation gas.

The application of an external warming device before and during anaesthesia is included as routine in most laparoscopic settings and the possible small effect of humidified and warmed insufflation gas is not justified. Spe-

Table 3.3. Pneumoperitoneum and hypothermia; randomised clinical trials

References/ years	No. of patients, and operations	Treatments and no. in groups	Temperature and measurement	Results	Conclusion
Davis et al. [5]/ 2006	44 Single-blind 4 groups Roux-en-Y	11–standard 11–heated (insufflator tube set) 11–humidified (Insuflow) 11–heated and humidified	Urine bladder	No difference in intra-abdominal humidity or temperature. Pain (VAS), recovery and hospital stay similar	Heating or humidifying of CO_2 not justified
Savel et al. [18]/ 2005	30 Double-blind 2 groups Roux-en-Y	15–standard 15–warmed and humidified (Insuflow)	Oesophageal probe	Temperature increased in warmed/ humidified group. Pain (VAS) and analgesic consumption similar	Warmed and humidified CO_2 was not associated with any significant benefit with regards to postoperative pain
Hamza et al. [9]/ 2005	44 Double-blind 2 groups Roux-en-Y	21–standard 23–warmed and humidified (Insuflow)	Oesophageal probe Tympanic thermometer	Temperature increased and less analgesic consumption in warmed/ humidified group	Insuflow modestly reduced heat loss and analgesic consumption. It failed to reduce fogging of lens
Farley et al. [6]/ 2004	101 Double-blind 2 groups CCE	52–standard 49–warmed and humidified (Insuflow)	Oesophageal probe	Temperature increased in warmed/ humidified group. Pain, recovery and hospital stay similar	No major clinically relevant difference between the groups. Failed to reduce fogging
Nguyen et al. [15]/ 2002	20 Single-blind 2 groups Fundoplication	10–standard 10–heated (warming blanket and Insuflow)	Oesophageal probe Tympanic thermometer	No difference in temperature, pain (VAS), analgesic consumption, hemodynamics and lens fogging	Heated and humidified CO_2 with additional external warming did not influence temperature or pain

Table 3.3 (continued)

References/ years	No. of patients, and operations	Treatments and no. in groups	Temperature and measurement	Results	Conclusion
Wills et al. [21]/2001	40 Double-blind 2 groups Fundoplication	21–standard 19–heated		Increased temperature, pain (VAS) and analgesic consumption in heated group	Heated CO_2 provides no benefit but may be associated with increased early pain

CCE cholecystectomy

cial precautions to minimise gas leakage are essential in laparoscopic surgery for the purpose of reducing the risk of hypothermia.

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The EAES Clinical Practice Guidelines on Laparoscopic Antireflux Surgery for Gastroesophagel Reflux Disease (1997)

Ernst Eypasch, Edmund A. M. Neugebauer, F. Fischer, Hans Troidl, A. L. Blum, D. Collet, A. Cuschieri, B. Dallemagne, H. Feussner, K.-H. Fuchs, H. Glise, C. K. Kum, T. Lerut, L. Lundell, H. E. Myrvold, A. Peracchia, H. Petersen, J. J. B. van Lanschot

Introduction

In the last 2 years, growing experience and enormous technical developments have made it possible for almost any abdominal operation to be performed via endoscopic surgery. Laparoscopic cholecystectomy, appendectomy, and hernia repair have been going through the characteristic life cycle of technological innovations, and cholecystectomy, at least, seems to have proven a definitive success. To evaluate this life cycle, consensus conferences on these topics have been organized and performed by the EAES [76 b].

Currently, the interest of endoscopic abdominal surgery is focusing on antireflux operation. This is documented by an increasing number of operations and publications in the literature. The international societies such as the European Association for Endoscopic Surgery (EAES) have the responsibility to provide a forum for discussion of new developments and to provide guidelines on best practice based on the current state of knowledge. Therefore, a consensus development conference on laparoscopic antireflux surgery for gastroesophageal reflux disease (GERD) was held, which included discussion of some pathophysiological aspects of the disease. Based on the experience of previous consensus conferences (Madrid 1994), the process of the consensus development conference was slightly modified. The development process was concentrated on one subject – reflux disease – and during the 4th International Meeting of the EAES, a long public discussion, including all aspects of the consensus document, was incorporated into the process.

The methods and the results of this consensus conference are presented in this comprehensive article.

Methods

At the Annual Meeting in Luxemburg in 1995, the joint session of the Scientific and Educational Committee of the EAES decided to hold a Consensus Development Conference (CDC) on laparoscopic antireflux surgery for gastroesophageal reflux disease. The 4th International Congress of the EAES in June 1996 in Trondheim should be the forum for the public discussion and finalization of the Consensus Development Conference.

The Cologne group (E. Neugebauer, E. Eypasch, F. Fischer, H. Troidl) was authorized to organize the CDC according to general guidelines. The procedure chosen was the following: A small group of 13 internationally known experts was nominated by the Scientific Committee of the EAES The criteria for selection were:

1. Clinical expertise in the field of endoscopic surgery
2. Academic activity
3. Community influence
4. Geographical location.

Internationally well-known gastroenterologists were asked to participate in the conference in the interest of a balanced discussion between internists and surgeons.

Prior to the conference, each panelist received a document containing guidelines on how to estimate the strength of evidence in the literature for specific endoscopical procedures and a document containing descriptions of the levels of technology assessment (TA) according to Mosteller and Troidl [190 a]. Each panelist was asked to indicate what level of development, in his opinion, laparoscopic antireflux surgery has attained generally, and he was given a form containing specific TA parameters relevant to the endoscopic procedure under assessment. In this form, the panelist was asked to indicate the status of the endoscopic procedure in comparison with conventional open procedures and also to make a comparison between surgical and medical treatment of gastroesophageal reflux disease. The panelist's view must have been supported by evidence in the literature, and a reference list was mandatory for each item. Each panelist was given a list of relevant specific questions pertaining to each procedure (indication, technical aspects, training, postoperative evaluation, etc.). The panelists were asked to provide brief answers with references. Guidelines for response were given and the panelists were asked to send their initial evaluation back to the conference organizers 3 months prior to the conference.

In Cologne, the congress organization team analyzed the individual answers and compiled a preconsensus provisional document.

In particular, the input and comments of gastroenterologists were incorporated to modify the preconsensus document.

The preconsensus documents were posted to each panelist prior to the Trondheim meeting. During the Trondheim conference, in a 3-h session, the preconsensus document was scrutinized word by word and a version to be presented in the public session was prepared. The following day, a 2-h public session took place, during which the text and the tables of the consensus document were read and discussed in great detail. A further 2-h postconference session of the panelists incorporated all suggestions made during the

public session. The final postconsensus document was mailed to all expert participants, checked for mistakes and necessary corrections and finalized in September 1996. The full text of the statements is given below.

Consensus Statements on Gastroesophageal Reflux Disease

1. What Are the Epidemiologic Facts in GERD?

In western countries, gastroesophageal reflux has a high prevalence. In the USA and Europe, up to 44% of the adult population describe symptoms characteristic of GERD [124, 127, 242]. Troublesome symptoms characteristic of GERD occur in 10–15% with equal frequency in men and women. Men, however, seem to develop reflux esophagitis and complications of esophagitis more frequently than women [23].

Data from the literature indicate that 10–50% of these subjects will need long-term treatment of some kind for their symptoms and/or esophagitis [34, 195, 225, 242].

The panelists agreed that the natural history of the disease varies widely from very benign and harmless reflux to a disabling stage of the disease with severe symptoms and morphological alterations. There are no good long-term data indicating how the natural history of the disease changes from one stage to the other and when and how complications (esophagitis, stricture, etc.) develop.

Topics which were the subject of considerable debate but which could not be resolved during this conference are listed here [8, 11, 23, 28, 68]:

- The cause of the increasing prevalence of esophagitis
- The cause of the increasing prevalence of Barrett's esophagus and adenocarcinoma
- The discrepancy between clinically and anatomically determined prevalence of Barrett's esophagus
- The problem of ultrashort Barrett's esophagus and its meaning
- The relationship between *Helicobacter pylori* infection and reflux esophagitis
- Gastroesophageal reflux without esophagitis and abnormal sensitivity of the esophagus to acid
- The role of so-called alkaline reflux, which is currently difficult to measure objectively.

2. What Is the Current Pathophysiological Concept of GERD?

GERD is a multifactorial process in which esophageal and gastric changes are involved [27, 65, 98, 251, 283].

Major causes involved in the pathophysiology are incompetence of the lower esophageal sphincter expressed as low sphincter length and pressure, frequent transient lower esophageal sphincter relaxations, insufficient esophageal peristalsis, altered esophageal mucosal resistance, delayed gastric emptying, and antroduodenal motility disorders with pathologic duodenogastroesophageal reflux [27, 65, 92, 95, 134, 251, 283].

Several factors can play an aggravating role: stress, posture, obesity, pregnancy, dietary factors (e.g., fat, chocolate, caffeine, fruit juice, peppermint, alcohol, spicy food), and drugs (e.g., calcium antagonists, anticholinergics, theophylline, (β-blockers, dihydropyridine). All these factors might influence the pressure gradient from the abdomen to the chest either by decreasing the lower esophageal sphincter or by increasing abdominal pressure.

Other parts of the physiological mosaic that might contribute to gastroesophageal reflux include the circadian rhythm of sphincter pressure, gastric and salivary secretion, esophageal clearance mechanisms, as well as hiatal hemia and *H. pylori* infection.

3. What Is a Useful Definition of the Disease?

A universally agreed upon scientific classification of GERD is not yet available. The current model of gastroesophageal reflux disease sees it as an excessive exposure of the mucosa to gastric contents (amount and composition) causing symptoms accompanied and/or caused by different pathophysiological phenomena (sphincter pressure, peristalsis) leading to morphological changes (esophagitis, cell infiltration) [65, 98].

This implies an abnormal exposure to acid and/or other gastric contents like bile and duodenal and pancreatic juice in cases of a combined duodenogastroesophageal reflux.

GERD is frequently classified as a synonym for esophagitis, even though there is considerable evidence that only 60% of patients with reflux disease sustain damage of their mucosa [8, 91, 150, 200, 231, 243]. The MUSE and Savary esophagitis classifications are currently used to stage damage, but they are poor for staging the disease [8].

The modified AFP Score (Anatomy-Function-Pathology) is an attempt to incorporate the presence of hiatus hemia, reflux, and macroscopic and morphologic damage into a classification [83]. However, this classification lacks symptomatology and should be linked to a scoring system for symptoms or quality of life; both scoring systems are extremely important for staging of the disease and for the indication for treatment [195 a, b].

4. What Establishes the Diagnosis of the Disease?

A large variety of different symptoms are described in the context of gastroesophageal reflux disease, such as dysphagia, pharyngeal pain, hoarseness, nausea, belching, epigastric pain, retrostemal pain, acid and food regurgitation, retrostemal burning, heartburn, retrostemal pressure, and coughing. The characteristic symptoms are heartburn (retrosternal buming), regurgitation, pain, and respiratory symptoms [150, 204]. Symptoms are usually related to posture and eating habits.

In addition, typical reflux patients may have symptoms which are not located in the region of the esophagus. Patients with heartbum may or may not have pathological reflux. They may have reflux-type "nonulcer dyspepsia" or other functional disorders.

The diagnostic tests that are needed must follow a certain algorithm. After the history and physical examination of the patients, an upper gastrointestinal endoscopy is performed. A biopsy is taken if any abnormalities (stenosis, strictures, Barrett's, etc.) are found [8].

If no morphologic evidence can be detected, only functional studies, e.g., measuring the acid exposure in the esophageal lumen by 24-h esophageal pH monitoring, are helpful and indicated to detect excessive reflux [65]. It is of vital importance that the pH electrode be accurately positioned in relation to the lower esophageal sphincter (LES). Manometry is the only objective way to assess the location of the LES.

Ordinary esophageal radiologic studies (barium swallow) are considered another mandatory basic imaging study [105 a].

At the next level of investigation there are a number of tests that look for the cause of pathologic reflux using esophageal manometry as a basic investigative tool for this purpose to assess lower esophageal sphincter and esophageal body function [27, 65, 91, 134, 283]. Video esophagography or esophageal emptying scintigraphy may also be helpful.

Optional gastric function studies are 24-h gastric pH monitoring, photooptic bilirubin assessment to assess duodenogastroesophageal reflux, gastric emptying scintigraphy, and antroduodenal manometry [81, 93, 95, 118, 146, 234].

Currently these gastric function studies are of scientific interest but they do not yet play a role in overall clinical patient management, apart from selected patients. The diagnostic test ranking order is displayed in Table 4.1.

Table 4.1. Diagnostic test ranking order for gastroesophageal reflux disease

Basic diagnostic tests	Physiologic/pathologic criteria	References
Endoscopy+ histology	Savary–Miller classification I, II, II, IV, V MUSE classification (M) metaplasia (U) ulcer (S) stricture (E) erosions	Savary and Miller [231], Armstrong et al. [8]
Radiology	Barium swallow	Gelfand [105a]
24-h esophageal pH monitoring	Percentage time below pH 4 DeMeester score	DeMeester et al. [65]
Stationary esophageal manometry[a)]	LES: Overall length Intraabdominal length Pressure (Transient LES relaxations) esophageal body disorders weak peristalsis	DeMeester et al. [65] Dent et al. [69a] Eypasch et al. [78]
Optional tests	Persistent gastric acidity	Barlow et al. [14b]
24-h gastric pH monitoring	Excessive duodenogastric reflux	Fuchs et al. [93, 95] Schwizer et al. [234]
Gastric emptying scintigraphy	Delayed gastric emptying	Clark et al. [40]
Photo-optic bilirubin assessment	Esophageal bile exposure	Kauer et al. [146]
	Gastric bile exposure	Fein et al. [81]

[a)] The concise numerical values for sphincter length, pressure, and relaxation depend on the respective manometric recording system used in the esophagealfunction lab

5. What Is the Indication for Treatment?

Pivotal criteria for the indication to medical treatment in gastroesophageal reflux disease are the patient's symptoms, reduced quality of life, and the general condition of the patient. When symptoms persist or recur after medication, endoscopy is strongly indicated.

Mucosal damage (esophagitis) indicates a strong need for medical treatment. If the symptoms persist, partially persist, or recur after stopping medication, there is a good indication for doing functional studies. Gastrointestinal endoscopy, already mentioned as the basic imaging examination in GERD, should be performed in context with the functional studies.

Indication for surgery is again centrally based on the patient's symptoms, the duration of the symptoms, and the damage that is present.

Even after successful medical acid suppression the patient can have persistent or recurrent symptoms of epigastric pain and retrosternal pressure as well as food regurgitation due to the incompetent cardia, insufficient peristalsis, and/or a large hiatal hemia.

With respect to indication, one important factor in the patient's general condition is age. On the one hand, age plays a role in the risks stratification when the individual risk of an operation is estimated together with the comorbidity of the patient. On the other hand, age is an economic factor with respect to the break-even point between medical and surgical treatment [21 b].

Concerning the indication for surgery, a differentiation in the symptoms between heartburn and regurgitation is considered important. (Medical treatment appears to be more effective for heartburn than for regurgitation.)

Therefore the indication for surgery is based on the following facts:

- Noncompliance of the patient with ongoing effective medical treatment. Reasons for noncompliance are preference, refusal, reduced quality of life, or drug dependency and drug side effects.
- Persistent or recurrent esophagitis in spite of currently optimal medical treatment and in association with symptoms.
- Complications of the disease (stenoses, ulcers, and Barrett's esophagus [11, 68]) have a minor influence on the indication. Neither medical nor surgical treatment has been shown to alter the extent of Barrett's epithelium.

Therefore mainly symptoms and their relation to ongoing medical treatment play the major role in the indication for surgery. However, antireflux surgery may reduce the need for subsequent endoscopic dilatations [21a]. The participants pointed out that patients with symptoms completely resistant to antisecretory treatment with H_2-blockers or proton-pump inhibitors are bad candidates for surgery. In these individuals other diseases have to be investigated carefully. On the contrary, good candidates for surgery should have a good response to antisecretory drugs. Thus, compliance and preference determine which treatment is chosen (conservative or operative).

6. What Are the Essentials of Laparoscopic Surgical Treatment?

The goal of surgical treatment for GERD is to relieve the symptoms and prevent progression and complications of the disease creating a new anatomical high-pressure zone. This must be achieved without dysphagia, which can occur when the outflow resistance of the reconstructed GE junction exceeds the peristaltic power of the body of the esophagus. Achievement of this goal requires an understanding of the natural history of GERD, the status of the patient's esophageal function, and a selection of the appropriate antireflux procedure.

Since the newly created structure is only a substitute for the lower esophageal sphincter, it is a matter of discussion to what extent it can show physiological reactions (normal resting pressure, reaction to pharmacological stimuli, appropriate relaxations during deglutition, etc.). There is no agree-

ment on how surgical procedures work and restore the gastroesophageal reflux barrier.

With respect to the details of the laparoscopic surgical procedures, the following degree of consensus was attained by the panel (11 present participants) (yes/no):

1. Is there a need for mobilization of the gastric fundus by dividing the short gastric vessels? (7/4)
2. Is there a need for dissection of the crura? (11/0)
3. Is there a need for identification of the vagal trunks? (7/4)
4. Is there a need for removal of the esophageal fat pad? (2/9)
5. Is there a need for closure of the crura posteriorly? (11/0)
6. Should nonabsorbable sutures be used (crura, wrap)? (11/0) [1)]
7. Should a large bougie (40–60 French) be used for calibration? (5/6)
8. Should objective assessment be performed (e.g., calibration by a bougie, others) for
   Tightness of the hiatus? (9/0)
   Tightness of the wrap? (9/2)
9. If there is normal peristalsis should one
   routinely use a 360° short floppy fundoplication wrap? (8)
   routinely use a partial fundoplication wrap? (2)
   Use a short wrap equal to or shorter than 2.5 cm? (1)
10. In cases of weak peristalsis, should there be a "tailored approach" (total or partial wrap)? (5/6)[1)]

7. Which Are the Important End Points of Treatment Whether Medical or Surgical?

The important end points for the success of conservative/ medical as well as surgical therapy must be a mosaic of different criteria, since neither clinical symptoms, functional criteria, nor the daily activity and quality-of-life assessment can be used *solely* to assess the therapeutic result in this multifactorial disease process.

Patients show great variety in demonstrating and expressing the severity of clinical symptoms and, therefore, they alone are not a reliable guide. Functional criteria can be assessed objectively, but may not be used in the decisionmaking process without looking at the stage of mucosal damage or morphological abnormalities (hiatus hemia, slipped wrap; AFP Score).

[1)] During the public discussion, Professor Montori (Rome) mentioned the Angelchick prosthesis as a rare alternative – however, this was not discussed in the consensus group

Complete evaluation includes assessment of symptoms, daily activity, and quality of life–ideally, in every single patient.

Instruments: The examples of instruments are listed in [80 a, 195 a, b].

The earliest point at which one ought to collect functional data after the operation is 6 months. The reasonable time of assessment in the postsurgical follow-up phase is probably 1 year followed by 2-year intervals.

Economic assessment is considered to be a significant end point and is dealt with in a later section.

There is no evidence that laparoscopic surgery should be any better than conventional surgery. If laparoscopic surgery is correctly performed, apart from the problems of abdominal wall complications like hernia, infection, and wound rupture, there should be no difference in outcome as compared to the standard obtained in open surgery.

Laparoscopic surgery, however, has the potential to reduce postoperative pain and limitations of daily activity.

8. What is Failure of Treatment?

In gastroesophageal reflux disease, lifelong medication is needed in many patients, because the disease persists but the acid reduction can take away the symptoms during the time the medication is taken. The disease is treated by reducing the acid and not by treating or correcting the causes of the disease. This latter argument can be used by surgeons, since they mechanically restore the sphincter area and, therefore, correct the most frequent defect associated with the disease.

In surgery, failure of a treatment is defined as the persistence or recurrence of symptoms and/or objective pathologic findings once the treatment phase is finished. In GERD, a definite failure is present when symptoms which are severe enough to require at least intermittent therapy (heartburn, regurgitation) recur after treatment or when other serious problems ("slipped Nissen", severe gas bloat syndrome, dumping syndrome, etc.) arise and when functional studies document that symptoms are due to this problem. Recurrence can occur with or without esophageal damage (esophagitis). Professor Blum (Lausanne) suggested that further long-term outcome studies of medical and surgical treatment are needed.

Quality-of-life measurements are able to differentiate whether and to what extent recurrent symptoms are really impairing the patient's quality of life.

It was agreed upon that a distinction is necessary between the two types of failures of the operation: "the unhappy 5–10%" (i.e. slipped Nissen, etc.) and the 10–40% of individuals who only become aware of their dyspeptic symptoms postoperatively while the reflux-related symptoms are treated. Dyspeptic symptoms occur in the normal population in 20–40% [174 b].

Some of the "postfundoplication symptoms" are present already before the operation and are due to the dyspeptic symptomatology associated with GERD.

Patients with failures should be worked up with the available diagnostic tests to detect the underlying cause of the failure. If there is mild recurrent reflux, it usually can be treated by medication as long as the patient is satisfied with this solution and his/her quality of life is good. In the case of severe symptomatic recurrent reflux or other complications, and if endoscopy shows visible esophagitis, the indication for refundoplication after a thorough diagnostic workup must be established. Surgeons very experienced in pathophysiology, diagnosis, and the surgical technique of the disease should perform these redo operations. Expert management of patients undergoing redo surgery for a benign condition is of extreme importance.

9. What Are the Issues in an Economic Evaluation?

With respect to a complete economic evaluation the panelists refer to the available literature [14 a, 76 a].

Cost, cost minimization, and cost-effectiveness analyses of gastroesophageal reflux disease must take into account the following issues (list incomplete):

1. Costs of medications
2. Costs of office visits
3. Costs of routine endoscopies
4. Frequency of sick leaves at work
5. Frequency of restricted family or hobby activity at home
6. Assessment of job performance and restrictions due to the disease
7. Costs of diagnostic workup including functional studies and specialized investigations
8. Costs of surgical intervention
9. Costs for treatment of surgical complications
10. Costs of treatment of complications of maintenance medical therapy, such as emergency hospital admissions, e.g., swallowing discomfort, bolus entrapment in peptic stenoses
11. Perspective of the analysis (patient, hospital, society)
12. Health care system (socialized, private).

A special issue is the so-called break-even point between medical and surgical treatment (duration and cost of medical treatment vs laparoscopic antireflux treatment) [21 b].

Ultimately, the results of medical or surgical treatment, especially with respect to age of the patient, should be translated into quality-adjusted life-years (QALYs) to differentiate which treatment is better for what age, comorbidity, and stage of disease.

Literature List with Ratings of References

All literature submitted by the panelists as supportive evidence for their evaluation was compiled and rated. The ratings of the references are based on the panelists' evaluation. The number of references is incomplete for the case series without controls and anecdotal reports. The result of the panelists' evaluation is given in Table 4.2 for the endoscopic antireflux operations and in Table 4.3 for medical treatments (all options). The consensus statements are based on these published results. A complete list of all references mentioned in Tables 4.2 and 4.3 is included.

Question 1. What Stage of Technological Development is Endoscopic Antireflux Operations at (in June 1996)?

The definitions for the stages in technological development follow the recommendations of the Committee for Evaluating Medical Technologies in Clinical Use [190 a] (Mosteller F, 1985) extended by criteria introduced by Troidl (1995). The panel's evaluation as to the attainment of each technological stage by endoscopic antireflux surgery, together with the strength of evidence in the literature, is presented in Table 4.4.

Technical performance and applicability were demonstrated by several authors as early as 1992/1993. The results on safety, complications, morbidity, and mortality data depend on the leaming phase (more than 50 cases) of the operations. The complication, reoperation, and conversion rates are higher in the first 20 cases of an individual surgeon. It is strongly advocated that experienced supervision be sought by surgeons beginning laparoscopic fund-

Table 4.2. Ratings of published literature on antireflux operations and medical treatment: strength of evidence in the literature-antireflux operations

Study type	Strength of evidence	References
Clinical randomized controlled studies with power and relevant clinical end points	III	[202, 203, 246, 274]
Cohort studies with controls prospective, parallel controls prospective, historical controls	II	[32, 37, 49, 80 87, 110 130 147, 163, 188, 217, 221, 272, 274, 281]
Case-control studies Cohort studies with literature controls Analysis of databases Reports of expert committees	I	[3, 4, 12, 19, 22, 36, 44, 47, 49, 55, 60 61, 63, 72, 73, 95, 89, 107, 113, 126, 132, 159, 162, 163, 177, 184, 187, 190 192, 208, 212, 213, 216, 219, 237, 255, 267]
Case series without controls Anecdotal reports Belief	0	Numerous

Table 4.3. Ratings of published literature on antireflux operations and medical treatment strength of evidence in the literature-medical treatment

Study type	Strength of evidence	References
Clinical randomized controlled studies with power and relevant clinical end points	III	[10 17, 24, 26, 39, 56, 70 112, 115, 116, 120 121, 139, 151, 161, 168, 171, 180 189, 202, 223, 224, 227, 228, 240 244, 246, 263, 265, 268, 270 274, 282, 284]
Cohort studies with controls: ▬ Prospective, parallel controls ▬ Prospective, historical controls	II	[3, 6, 23, 29, 38, 85, 101, 130 135, 139]
Case-control studies Cohort studies with literature controls Analysis of databases Reports of expert committees	I	[16, 23, 50, 72, 117, 123, 135, 152, 157, 172, 174, 200 229, 241, 260, 264]
Case series without controls Anecdotal reports Belief	0	Numerous

Table 4.4. Evaluation of the status of endoscopic antireflux surgery 1996: level attained and strength of evidence

Stages in technology assessment[a]	Level attained/ strength of evidence[b]	Consensus (%)[c]
1. Feasibility Technical performance, applicability, safety, complications, morbidity, mortality	II	64 (7/11)
2. Efficacy ▬ Benefit for the *patient* demonstrated in centers of excellence	II	64 (7/11)
▬ Benefit for the *surgeon* (shorter operating time, easier technique)	0–I	67 (6/9)
3. Effectiveness Benefit for the patient under normal clinical conditions, i.e., good results reproducible with widespread application	II	60 (6/10)
4. Costs Benefit in terms of cost-effectiveness	I–II	70 (7/10)
5. Ethics Issues of concern may be long operation times, frequency of thrombo-embolization, incidence of reoperations, altered indication for surgery, etc.[c]	0	57 (4/7)
6. Recommendation	Yes	100 (11/11)

[a] Mosteller [190a] and Troidl [265a]
[b] Level attained to the definitions of the different grades
[c] Percentage of consensus was calculated by dividing the number of panelists who voted 0, I, II or III by total number of panelists who submitted their evaluation forms

oplication during their first 20 procedures [278 a, b]. Data on *efficacy* (benefit for the patient) demonstrated in centers of excellence were based on type II studies. The benefit for the surgeon in terms of elegance, ease, and speed of the procedure is not yet clear cut. The operation time is the same or longer, and the technique is harder initially – however, the view of the operating field is better. The effectiveness data are still insufficient, long-term results are missing, and the results reported come mainly from interested centers and multicenter studies. It is important to audit continually the results of antireflux operations, especially because different techniques are used. The economic evaluation of laparoscopic antireflux surgery is still premature (few data from small studies only). Future studies are recommended in different health care systems, assessing the relative economic advantages of laparoscopic antireflux surgery in comparison to the available and paid medical treatment.

A major issue of ethical concem is the altered indication for surgery. A change of indication might produce more cost and harm in inappropriately selected patients. Laparoscopic antireflux surgery should be recommended in centers with sufficient experience and an adequate number of individuals with the disease. Randomized controlled studies are recommended to compare medical vs laparoscopic surgical treatment and partial vs total fundoplication wraps.

Question 2. What is the Current Status of Laparoscopic Antireflux Surgery vs Open Conventional Procedures in Terms of Feasibility and Efficacy parameters?

Tables with specific parameters relevant to open and laparoscopic antireflux procedures summarize the current status (Tables 4.5, 4.6). The evaluation is mainly based on type I and type II studies (see list of references).

The results show that safety is comparable and rather favorable compared to the open technique. The incidence for complications, morbidity, and mortality is similar to the open technique once the leaming phase has been surpassed. For specific intraoperative and postoperative adverse events see Tables 4.5 and 4.6.

In terms of *efficacy,* significant advantages of the endoscopic antireflux operations are: less postoperative pain, shorter hospital stay, and earlier retum to normal activities and work.

In general, laparoscopic antireflux surgery has advantages over open conventional procedures if performed by trained surgeons.

Laparoscopic antireflux surgery has the potential to improve reflux treatment provided that appropriate diagnostic facilities for functional esophageal studies and adequately trained and dedicated surgeons are available.

Table 4.5. Antireflux surgery vs open conventional procedures: evaluation of feasibility parameters by all panelists at CDC in Trondheim

Stages of technology assessment	Assessment based on evidence in the literature						
	Definitely better [a)]	Probably better	Similar	Probably worse	Definitely worse	Consensus [b)]	Strength of evidence 0–III [c)]
Safety/intraop. adverse events Gastric or esophageal leaks/ perforations	1		6	4		55% (6/11) similar	I–II
Hiatal entrapments of gastric warp with necrosis	1		9	1		82% (9/11) similar	I–II
Vascular injury, bleeding, splenic injury	2	4	5			55% (6/11) better	I–II
Emphysema	1		3	4	2	60% (6/10) worse	II
Operation time			3	5	1	67% (6/9) worse	II
Postoperative adverse events Bleeding	1	2	8			73% (8/11) similar	I–II
Wound infection	3	6	2			82% (9/11) better	I–II
Reoperation		2	6	3		55% (6/11) similar	I–II
Warp disorders		1	8	2		73% (8/11) similar	I–II
Hemias of abdominal wall	3	6	2			82% (9/11) better	I–II
Thrombosis/pulmonary embolism	1	3	6	1		55% (6/11) similar	I
Mortality		3	7			70% (7/10) similar	I–II

[a)] Comparison: laparoscopic fundoplication techniques vs open conventional procedure
[b)] Percentage of consensus was calculated by dividing the number of panelists who voted better (probably and definitely), similar, or worse (probably and definitely) by the total number of panelist's who submitted their evaluation forms
[c)] Refer to Table 4.1

Table 4.6. Antireflux surgery vs open conventional procedures: evaluation of efficacy parameters by all panelists prior to CDC in Trondheim

Stages of technology assessment	Assessment based on evidence in the literature						
	Definitely better[a)]	Probably better	Similar	Probably worse	Definitely worse	Consensus[b)]	Strength of evidence 0–III[c)]
Postoperative pain	6	4				100% (10/10) better	I–II
Postoperative disorders Bloating			9	1		90% (9/10) similar	I–II
Flatulence			10	1		91% (10/11) similar	I–II
Dysphagia			9	2		82% (9/11) similar	I–II
Recurrent reflux			10			100% (10/10) similar	I–II
Hospital stay	4	7				100% (10/10) better	I–II
Return to normal activities and work	7	3				91% (10/11) better	I–II
Cosmesis	7	2	2			82% (9/11) better	I–II
Effectiveness (overall assessment)	1	5	4			60% (6/10)	I–II

[a)] Comparison: laparoscopic fundoplication techniques vs open conventional procedure
[b)] Percentage of consensus was calculated by dividing the number of panelists who voted better (probably and definitely), similar, or worse (probably and definitely) by the total number of panelists who submitted their evaluation forms
[c)] Refer to Table 4.1

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Gastroesophageal Reflux Disease – Update 2006

Karl-Hermann Fuchs, Ernst Eypasch

Introduction

Gastroesophageal reflux disease (GERD) is one of the most frequent benign functional disorders in humans concerning the gastrointestinal tract. It is a multifactorial process although the majority of patients develop this disease from a failure of the gastroesophageal junction to hold gastric contents in the stomach [20, 23, 36]. The disease presents typically with symptoms such as heartburn and/or regurgitation, but can present with dysphagia, extraesophageal symptoms such as epigastric pain, respiratory symptoms and others. Gastroenterologists and surgeons are the major medical subspecialties that are involved in the diagnosis, treatment and research of this disease. In addition, many other disciplines, such as pulmonologists, ENT physicians, radiologists, pathologists and others must be involved in the management of the disease because of its multifactorial background and its multifactorial problems.

The European Association for Endoscopic Surgery (EAES) has established consensus conferences regarding special medical problems involving minimally invasive surgery and endoscopy. Ten years ago a first consensus development conference was organized, focusing on GERD and the results were subsequently published in *Surgical Endoscopy* [28]. The purpose of this chapter is a critical overview of questions and consensus statements published at the time and a current analysis of important literature and randomized trials on GERD in 2006.

Consensus Subjects in Management of GERD

Epidemiologic Background in GERD

GERD is mainly established and develops predominantly in modern industrial societies such as Europe and the USA [23]. There is a high prevalence of the disease in these societies in 20–40% of the adult population. It was agreed that the natural history of the disease varies in a wide spectrum between a very mild form of the disease with occasional symptoms, and an

advanced stage of GERD with severe symptoms and endoscopic alterations. Many special topics were discussed and could not be resolved within the conference, such as the cause of increasing prevalence, special aspects of Barrett's esophagus and its development to adenocarcinoma, the meaning of ultrashort Barrett's esophagus and the relationship of GERD to *Helicobacter pylori* as well as GERD without the presence of esophagitis, abnormal sensitivity of the esophagus, and the acid and the so-called alkaline reflux.

Currently, the prevalence of GERD including all forms of manifestations can be determined as high as 10–20% in Western societies [5]. An increasing incidence of GERD is highly probable. Epidemiologic studies show a prevalence for at least one episode of heartburn per week in 11–18% of the population [5, 46, 55, 56].

The Pathophysiologic Background of GERD

GERD is a multifactorial process, in which esophageal and gastric changes are involved. The major pathophysiologic causes are the incompetence of the lower esophageal sphincter, transient sphincter relaxations, insufficient esophageal peristaltisis, altered esophageal mucosal resistance, delayed gastric emptying and antroduodenal motility disorders with pathologic duodeno-gastro-esophageal reflux [20, 23, 30, 36, 75, 81]. Several factors, such as stress, obesity, pregnancy and dietary factors as well as drugs, play an aggravating role in this process.

Currently no spectacular new insights into the pathophysiology of GERD have emerged. It is a multifactorial determined disease, in which without any doubt the gastroesophageal junction with its special anatomical and functional components are important. Since there is some evidence that different stages of severity of GERD might have a different background, this leaves us with more questions than evidence-based facts [48, 51, 74].

The Useful Definition of the Disease

A universally agreed scientific definition of GERD was not available at the time; therefore, a model of GERD as increased exposure of the mucosa to gastric contents causing symptoms and morphologic changes was used. This implied an abnormal exposure to acid and/or other gastric contents, like bile, duodenal and pancreatic juice in cases of combined duodeno-gastro-esophageal reflux.

In the past 5–10 years several attempts have been made by both gastroenterologists and surgeons to establish a definition that can be used by both subspecialties to fulfill requirements for research projects and the clinical management of the disease. Often these definitions are characterized by the

individual view of the predominant organizing bodies of these consensus projects such as the GENVAL workshop, the impedance workshop and, for example, the German Society of Gastroenterology workshop guidelines project [26, 35, 51].

In summary, the definition can be established as follows: GERD is present when there is a risk for organic complications by increased gastroesophageal reflux and/or a significant limitation of health-related well-being such as quality of life due to reflux symptoms.

This definition resulting from the GENVAL workshop in 1999 is generally enough to cover all problems [26]; however, in daily clinical practice a more precise definition must be used based on diagnostic findings to determine whether the individual patient has the disease or not. Therefore, it is important to realize that morphologic complications of reflux can develop in the esophagus, such as esophagitis, stricture and Barrett's esophagus as well as extraesophageal symptoms. The presence of GERD is highly probable, when reflux symptoms occur once or twice per week accompanied by the limitation in quality of life [74].

Currently, GERD is differentiated in nonerosive reflux disease (NERD), erosive reflux disease with esophagitis (ERD) and Barrett's esophagus as well as extraesophageal manifestations [48, 74].

The natural course of GERD has not been studied extensively. The initial stages of NERD and ERD are usually not progressive in most patients; therefore, a repetitive endoscopic evaluation to verify the change from one stage into the next is not necessary. On the other hand, the spontaneous disappearance of reflux disease after a long period of time occurs rather seldom. In a minority of patients with GERD, severe forms of the disease can progress over the years; however, this observation is not well documented and evidence is minimal, since these patients are constantly treated by medication and are usually seen in surgical centers after some time.

The Diagnostic Workup of GERD

A large variety of different symptoms were described in the context of GERD, such as dysphagia, odynophagia, hoarseness, nausea, belching, epigastric pain, retrosternal pain, acid and food regurgitation, retrosternal burning, heartburn, retrosternal pressure, coughing and epigastric pressure [7, 16, 49]. The most typical symptoms are heartburn, retrosternal burning, and food and acid regurgitation [48, 49]. Symptoms are usually related to posture and eating habits. If typical symptoms are present, there is already a high probability of the presence of the disease; however, symptoms are not a reliable guide to document the presence of GERD [16]. Therefore, morphologic and functional evaluation is important. Morphologic tests are endoscopy and

radiography. If no morphologic evidence can be found, functional studies such as 24-h esophageal pH monitoring and esophageal manometry are required. In the 1996 consensus conference a certain diagnostic test ranking order for GERD was established: endoscopy, radiology, 24-h esophageal pH monitoring and esophageal manometry as basic diagnostic tests and 24-h gastric pH monitoring and gastric emptying scintigraphy as well as bilirubin monitoring as optional tests [28].

Today, in 2006, true heartburn is considered a very important chief complain in GERD [9, 48]. When this symptom is present, there is a probability of more than 75% that the individual patient suffers from reflux disease [63]. With all other symptoms, this probability is much less and other diseases, especially functional dyspepsia, can be the cause.

Endoscopy is especially important in exclusion of malignant disease and when alarm symptoms such as dysphagia, retrosternal pain and bleeding are present [49, 53]. With endoscopy, it is possible to establish the diagnosis of GERD and its grade of severity, if reflux esophagitis is present. If esophagitis is excluded, the presence of NERD must be established using other techniques [38].

Twenty-four-hour pH monitoring is considered to be the gold standard investigation for the quantitative evaluation of acid exposure in the distal esophagus [34, 54]. Most gastroenterologists prefer pH monitoring only in the absence of esophagitis. Since esophagitis can also be due to ulcers from medication and since many studies and much of the surgical literature show the value of pH monitoring in the detection of the presence of the disease, preoperative workup should include pH monitoring [9, 69].

For diagnostic workup prior to surgery endoscopy, 24-h pH monitoring and manometry are important for the optimal selection for patients. For the surgically relevant pathophysiologic background it is important to determine either the incompetence of the lower esophageal sphincter by esophageal manometry or the increased incidence of transient sphincter relaxations by sleeve manometry [7, 14, 20, 23, 25, 30, 34, 36, 54, 64, 75, 80]. Manometry prior to surgery is important in order to exclude spastic esophageal motility disorders.

The Indication for Treatment of GERD

The indication for medical treatment of GERD should be established in patients with symptoms and reduced quality of life. When these symptoms persist over weeks the indication for medical treatment is useful. If mucosal damage such as esophagitis is present, medical therapy is necessary.

In 1996, the indication for surgery was based on the patient's symptoms, the duration of the symptoms and the presence of damage [28]. Even after

successful medical acid suppression, patients can have persistent or recurrent symptoms of epigastric pain and retrosternal pressure as well as food regurgitation due to an incompetent cardia, insufficient peristaltisis and/or a large hiatal hernia. Concerning the indication for surgery, a differentiation in symptoms between heartburn and regurgitation is important. Medical treatment can resolve heartburn, but usually does not interfere with regurgitation; therefore, the indication for surgery at the time was based on the following facts:

- Noncompliance of the patient with on-going effective medical therapy. The reasons for noncompliance were preference, refusal, reduced quality of life or drug dependency and side effects.
- Persistent or recurrent esophagitis despite adequate medical treatment.
- Complications of the disease such as stenosis, ulcers and Barrett's esophagus have a minor influence on the indication, since neither medical nor surgical treatment has been shown to alter the extent of Barrett's epithelium. At the time the participants pointed out that patients with symptoms completely resistant to antisecretory treatment are bad candidates for surgery. In these individuals other diseases have to be investigated carefully.

Today, in the majority of cases, patients with NERD and ERD need medical therapy with proton pump inhibitors (PPIs). A vast amount of data is available today to show the benefit of PPI therapy in GERD. All patients with acute symptoms of reflux disease should undergo PPI treatment. After stopping this medication, the patient's symptoms will relapse. As a consequence, a long-term maintenance therapy must be established for many patients (ERD and NERD).

The basis for establishing an indication for antireflux surgery is the necessity of long-term treatment with PPI [30, 50]. There is always a controversial discussion between gastroenterologists and surgeons about the precise criteria for surgery and this will continue in the next few years. It is a matter of individual discussion and interpretation of data. Rather unquestionable criteria or indications for surgery are proven PPI side effects in the individual patient, intolerable persisting symptoms despite inadequate PPI dose (usually regurgitation and aspiration and volume reflux). A relative indication is the wish of the patient despite satisfactory quality of life under PPI treatment [26, 28, 33, 37].

Predictive factors for a good postoperative result are a positive response to PPI therapy, a documented pathologic acid exposure of the esophagus by 24-h pH monitoring and the presence of typical reflux symptoms [9].

Technical Essentials of Laparoscopic Antireflux Surgery

In 1996, it was stated, that the goal of surgical treatment for GERD is to relieve the symptoms and to prevent progression and the development of complications of the disease by the creation of a new anatomic high-pressure zone [28]. This must be achieved without dysphagia, which can occur when the outflow resistance of the reconstructed gastroesophageal junction exceeds the peristaltic power of the body of the esophagus. Achievement of this goal requires an understanding of the natural history of GERD, the status of the patient's esophageal function and the selection of the appropriate reflux procedure. Today in 2006, this goal of surgical treatment is still the same; however, the understanding of surgical therapy has changed to some extent.

At the time, 11 participants at the consensus conference discussed in detail the laparoscopic surgical techniques and established a list of ten technical features, which are presented as follows according to the degree of consensus that was attained by the panel (agreement yes/no):

1. Need for mobilization of the gastric fundus (7/4)
2. Need for dissection of the crura (11/0)
3. Need for identification of the vagus truncs (7/4)
4. Need for removal of the esophageal fat pad (2/9)
5. Need for closure of the crura posteriorly (11/0)
6. Use of nonabsorbable sutures for crura and wrap (11/0)
7. Use of large bougie (40–60 French) for calibration (5/6)
8. Objective assessment for tightness of hiatus and tightness of wrap (9/0 or 9/2)
9. Normal peristalsis routinely uses 360° short floppy wrap (8/3)
10. Weak peristalsis tailored approach (total or partial wrap) (5/6)

In the past 10 years a number of randomized trials regarding different techniques have been published. Of special interest are the randomized comparisons between medical and surgical technique, randomized comparison of open versus laparoscopic technique, partial versus total fundoplication and randomized comparisons regarding different technical aspects such as division of short gastric vessels, dissection of the vagus and anterior versus posterior hiatoplasty or crural closure.

It must also be emphasized that there were some controversial aspects regarding the results of randomized trials compared with the results of prospective series from single centers with considerable experience of the disease and its surgical therapy, which should also be kept in mind regarding clinical relevance. Another important issue regarding the value of randomized trials is the selection criteria or definitions that are used for patients to enter these studies in order to reflect the comparability between different

randomized trials. In some randomized trials only symptoms were used as the criterion for the presence of the disease, while in others additional results of objective testing, such as esophageal acid exposure or endoscopic findings, were used as criteria [3, 4, 12, 21, 22, 29, 41, 42].

Reviewing the literature of the past 10 years will show that nonfundoplication techniques such as the Angelchik prothesis, the ligamentum teres plasty or the Hill operation have not been the subject of comparisons or reports in large series and therefore their impact can be neglected.

In many publications from experienced centers with a large case load the results for open antireflux surgery after 5 years were reported with a success rate between 28 and 95%, after 5–10 years between 66 and 96% and with a follow-up for more than 10 years between 56 and 85% [22, 24, 33]. With the application of minimal access technique the success rates after 5 years were in the range 85–95% and in the very few studies with a follow-up time longer than 5 years after a laparoscopic procedure they were between 85 and 91%, where nonspecialized centers show clearly worse results [8, 10, 17, 28, 32, 35, 37, 39, 40, 43–45, 47, 59, 60, 71, 73, 81].

Comparison of Medical Versus Operative Therapy

Table 5.1 demonstrates the current overview of very few studies focusing on this comparison between medical and surgical therapy. The classic paper reporting the use of omeprazole as a PPI versus open surgical therapy from Scandinavia shows in a 5-year follow-up no advantage of either management strategy and a similar rate of failure for PPIs and surgical therapy [58]. Although not published as a full paper, there is a report showing an advantage for surgical therapy after 7 years of follow-up, with this difference just reaching a statistical significance. In a second study, early results already show an advantage regarding acid exposure in the esophagus and quality of life criteria after 6 months of follow-up in favor of laparoscopic fundoplica-

Table 5.1. Randomized comparison between medical proton pump inhibitor therapy and antireflux surgery

Author/year	*N*	Follow-up	Failure rate	Quality of life
Lundell et al. [58]/2001	155 Omeprazole	5 years	75%	
	155 Open ARS	5 years	70%	
Mahon et al. [62]/2005	108 PPI	12 months		Score 136
	104 LARS	12 months		Score 142*
European trial	>500	<3 years		
	PPI versus LARS			

ARS antireflux surgery, *LARS* laparoscopic antireflux surgery, *PPI* proton pump inhibitor
*$p < 0.003$

tion [62]. Currently a large European randomized trial is under way with the recruitment of more than 500 patients; however, follow-up is still too short.

Randomized Comparison of Open Versus Laparoscopic Technique

There are several studies showing an advantage for special parameters such as immunologic factors or respiratory function in favor of the laparoscopic technique compared with the open technique [68, 82] (Table 5.2). The first randomized trial comparing these two techniques was published in 1997 by Laine et al. [52] and shows a longer operation time with laparoscopic technique. Fifty-five patients were compared with 55 patients with a significantly longer hospitalization for the open technique. The functional result was there was no significant different between the two groups.

Another study created a large controversial discussion, since the laparoscopic arm showed after a few months many patients with dysphagia, compared with the conventional technique [4]. Nilsson et al. [66] published the results of their randomized comparison between open and conventional antireflux surgery after 5 years in 2004. This study is of special interest, since owing to the special design, the patients and personal were blind to the choice of technique. In the laparoscopic group, there was significantly less use of analgesia, better postoperative respiratory function and shorter hospitalization. The 5-year follow-up data showed no difference in the functional result regarding the access technique, but a good functional result after 5 years in both groups.

In summary, from the available randomized trials comparing open versus laparoscopic technique it must be emphasized how important the experience of the surgeon is, especially in the laparoscopic group, and that obviously some degree of inexperience can cause excessive dyphagia and other side effects.

Randomized Comparison of Total Versus Partial Fundoplication

The discussion regarding these two procedures has been controversial in the past few years and still is. Several randomized trials have shown that there is no difference in functional outcome regarding reflux persistence or recurrence. In some trials the side effects of the operations are significantly less after partial fundoplication. Table 5.3 demonstrates the overview of this comparison. Even though the randomized trials have not shown any problems in durability after partial fundoplication, several prospective cohort studies from high-volume, very experienced centers have shown the problems with durability after partial fundoplication. The latter fact will cause further controversial discussions within the surgical community, because of its clinical relevance.

Table 5.2. Randomized comparison between open and laparoscopic technique: perioperative data

Author/ recruitment	Randomized groups	Morbidity *N* (%)	Operation time (min)	Hospitalization (days)	Return to work (days)
Laine et al. [52]/1992–1995	Open 55	7 (13)	57	6.4	37
	Laparoscopic 55	3 (8)	88	3.2	15
Heikkinen et al. [42]/1995–1996	Open 20	5 (25)	74	5.5	44
	Laparoscopic 22	3 (14)	98	3.0	21
Bais et al. [4]/1997–1998	Open 46	8 (17)	–	–	–
	Laparoscopic 57	5 (9)			
Luostarinen and Isolauri [61]/1994–1995	Open 15	0	30	5.0	30
	Laparoscopic 13	1 (8)	105	4.0	17
Chrysos et al. [13]/1993–1998	Open 50	38 (76)	83	5.9	–
	Laparoscopic 56	12 (21)	77	2.4	
Nilsson et al. [66]/1995–1997	Open 30	0	109	3.0	32
	Laparoscopic 30	0	148	3.0	27

Table 5.3. Randomized comparison between open and laparoscopic technique: follow-up data

Author/recruitment	Randomized groups	Patients at follow-up	Reflux recurrence *N* (%)	Dysphaga *N* (%)	Bloating *N* (%)	Reoperation *N* (%)
Laine et al. [52]/1992–1995	Open 55	30 (12 months)	3 (10)	4 (13)	2 (7)	0
	Laparoscopic 55	18 (12 months)	0	0	3 (17)	0
Heikkinen et al. [42]/1995–1996	Open 20	19 (24 months))	2 (11)	11 (58)	10 (53)	0
	Laparoscopic 22	19 (24 months))	0	9 (48)	11 (58)	0
Bais et al. [4]/1997–1998	Open 46	46 (3 months)	1 (2)	0	–	0
	Laparoscopic 57	57 (3 months)	2 (4)	7 (12)*	–	4 (7)
Luostarinen and Isolauri [61]/1994–1995	Open 15	13 (17 months)	0	6 (46)	–	0
	Laparoscopic 13	13 (17 months)	0	4 (31)	–	1 (8)
Chrysos et al. [13]/1993–1998	Open 50	50 (12 months)	1 (2)	2 (4)	3 (6)	0
	Laparoscopic 56	56 (12 months)	2 (4)	2 (4)	0	0
Nilsson et al. [66]/1995–1997	Open 30	23 (60 months)	4 (17)	5 (22)	10 (43)	1 (4)
	Laparoscopic 30	17 (60 months)	2 (12)	7 (41)	8 (47)	2 (12)

* $p < 0.05$

Comparison of Mobilization of the Gastric Fundus by Division of the Short Gastric Vessels

A few randomized trials were focused on this question and have shown that the results are rather in favor of leaving the fundic attachments intact rather than mobilizing the fundus totally (Table 5.4). Since the way of wrapping the fundus around the lower esophageal sphincter depends on the method of mobilization of the fundus, this question remains open. The symmetric wrap which is favored by some authors is impossible to perform with a non-mobilized fundus. Also the extent of mobilization might have an influence on the results of the comparative groups, which is another criticism of those who favor the mobilization of the fundus. Table 5.5 demonstrates some of the results of the available randomized trials. In summary, it can be stated that on the basis of these data it is not a mistake to leave the fundic attachments towards the spleen intact.

Management of the Vagus Nerve

There is only one study which has investigated the advantage or disadvantage of the dissection of the vagus and has documented an anatomic position of the vagus. Peillon et al. [72] investigated this issue and did not find any significant difference in outcome between those patients in whom they dissected the vagus and clearly defined its localization and in those patients on whom they did not perform this additional step.

The Value of a Hiatoplasty (Crural Closure) and Cardia Calibration

Twenty years ago, there was a remarkable discussion among surgeons regarding the necessity and benefit of crural closure. Interesting enough, for the participants of the consensus conference of 1996 there wes only one issue that was without controversial discussion [28]. This was the total agreement of the necessity of performing a precise crural dissection and a crural closure. There is one trial showing that anterior closure is as good as posterior closure [78]. The importance of the crural closure has gained even more clinical relevance in patients with large hiatal hernias or redo cases, where the weakness of the hiatal and crural material leads to migration of the wrap. In these cases, there is some new evidence that the use of a mesh in onlay technique will reduce the failures substantially. Two randomized trials have confirmed this view [31, 41].

Another randomized trial focused on the value of the cardia calibration by using a large bougie. Patterson et al. [70] showed an advantage of patients with a cardia calibration by using a bougie during the suture of the fundopli-

cation since those patients with no calibration during the operation had significantly more severe side effects.

Important End Points of Treatment (Medical and Surgical)

In 1996 it was stated that the important end point of the success of conservative medical as well as surgical therapy must be a mosaic of different criteria. Today many gastroenterologists are convinced that symptoms and quality of life are the crucial end points in the treatment of GERD and that it is of less importance whether there is still some degree of esophagitis after treatment. For years in many surgical studies the postoperative presence of esophagitis was still considered as a sign of failure. This controversy is still being discussed at present and more data are needed. This seems to be a reasonable concept in times of financial restrictions and the problematic possibility of repeating expensive investigations for follow-up patients with GERD.

As a consequence, treatment failure is defined in many newly designed studies as the persistence or recurrence of symptoms during the follow-up time [58]. Measures of quality of life must be included in the evaluation of retreatment and posttreatment status in order to have a quantitative assessment. The statement in the 1996 consensus report therefore is still valid: In GERD a definite failure is present when symptoms which are severe enough to require at least intermittent therapy (heartburn and regurgitation) recur after treatment or when other serious problems (like severe gas bloat, dumping syndrome, etc.) arise and when functional studies document that symptoms are due to this problem. Recurrence can occur with or without esophageal damage.

The Issue of an Economic Evaluation

At the time, the judgment over a complete economic evaluation was referred by the panelists to the available literature [28]. It was recognized that these issues have considerable importance. However, today it must also be emphasized that economic considerations depend very heavily on the economic and financial situation as well as the structure of the health insurance system in the individual countries [1, 15, 65]. As a consequence, no general conclusions can be drawn Europe-wide. This question interferes with the establishment of the indication for surgery. Prior to surgery, a long period of adequate PPI treatment is absolutely necessary. The break-even point between the expense of long-term medical treatment (this depends also on the costs of PPIs, which have been decreasing in the past few years) and the expense of one-time surgical therapy are difficult to calculate. One must keep in mind that a failure rate of surgical therapy of 5–10% is a realistic figure and is a very expensive burden that the surgical treatment arm has to carry.

Endoscopic Antireflux Therapy

In the past few years several forms of endoscopic antireflux therapy have been established, such as the Stretta procedure, the Enteryx injection, the gastroplication by Endocinch, the Gate Keeper technique and the Plicator gastroplication [2, 11]. Most of these techniques have been stopped in the last 24 months owing either to their insufficiency and high rate of recurrence and/or severe side effects and complications. Currently, the Stretta procedure still in use is, which is the application of radiofrequency waves in the lower esophageal sphincter in order to cause a scaring and have a mechanical effect on the gastroesophageal junction. It is also speculated that there might be an effect on the number of transient sphincter relaxations. The Plicator technique is currently under clinical investigation and no long-term data are available.

In summary, these endoscopic antireflux therapies, performed by flexible endoscopy, were considered 5 years ago as a tremendous achievement with many possibilities and a great prospect of becoming a third arm of therapy in the management of GERD. After the problems regarding these techniques in the past 24 months it is too early to consider this option of therapy as a major and clinically relevant treatment option at present.

What iss the stage of technological development or endoscopic antireflux operations and what iss the current status of antireflux surgery versus open, conventional procedures in terms of visibility and efficacy parameters?

This issue was basically answered in question 6. Laparoscopic antireflux surgery is a well-established and safe technique 15 years after its first application by Bernard Dallemagne in 1991 [18, 19]. Today, antireflux procedures should be performed laparoscopically because they have a proven advantage and this should be the standard.

Conclusions

GERD is a multifactorial process. In the past 10 years many new insights have been gained owing to the research work and clinical experience with patients with this disease. There is a well-established medical therapy with PPIs for the vast majority of patients. The mainstay of diagnostic workup is endoscopy, 24-h esophageal pH monitoring and esophageal manometry as well as radiography. The minimally invasive technique has become the standard access technique in all specialized centers around the world. The past 10 years has shown a tremendous boom in surgical activity causing a widespread application of this operative technique as well as research activities and randomized trials to establish evidence-based criteria.

Careful selection of patients after adequate PPI therapy for surgery and a precise diagnostic workup with 24-h esophageal pH monitoring, endoscopy

as well as esophageal manometry to exclude motility disorders is important. Two major antireflux procedures that have been used worldwide in most cases are the 360° short floppy Nissen fundoplication and the posterior partial Toupet-hemifundoplication. Randomized trials as well as a few long-term follow-up studies have shown good results in 80–90% of patients.

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The EAES Clinical Practice Guidelines on the Diagnosis and Treatment of Diverticular Disease (1999)

Lothar Köhler, Stefan Sauerland, Edmund A. M. Neugebauer, R. Caprilli, A. Fingerhut, N. Y. Haboubi, L. Hultén, C. G. S. Hüscher, A. Jansen, H.-U. Kauczor, M. R. B. Keighley, F. Köckerling, W. Kruis, A. Lacy, K. Lauterbach, J. Leroy, J. M. Müller, H. E. Myrvold, P. Spinelli

Introduction

Colonic diverticulosis is an increasingly common condition. About a third of the population is affected by the sixth decade and a half by the ninth decade. The estimated incidence of diverticulitis is approximately ten patients/100,000/year [3, 8]. In the USA, approximately 200,000 admissions to hospital annually are due to diverticular disease. Over the preceding century, the sex predilection has changed from a male to a female predominance. It is well documented that the disease is more common in Western societies than in developing countries [55, 61]; this prevalence can be explained by the etiology of the disease [4]. In East Asia, right-side colonic diverticula or bilateral disease has been found to be more common [54, 58].

Owing to the worldwide importance of the disease and the newly emerging possibilities and controversies in diagnosis and therapy, the European Association for Endoscopic Surgery (EAES) decided to hold a consensus development conference (CDC) during the Sixth International Congress of the EAES, held in Rome, Italy, in 1998.

Methods

With the authorization of the EAES, the planning committee together with the Scientific Committee of the EAES nominated 16 experts as panel members. As with previous conferences [69], the criteria for selection were clinical and scientific expertise in the field of diverticular disease, along with geographical location. In addition, all medical specialties involved in diverticular disease were represented on the panel, so that recommendations would derive from a more complete perspective of the disease.

Prior to the conference, all panelists were asked to search the literature, list all relevant articles, and estimate the strength of evidence for every article cited (see footnote to Table 6.1 for categories of evidence) [1]. They were asked to answer 12 questions on subjects ranging from natural history and diagnosis to aspects of therapy. When assessing laparoscopic sigmoid resection, the levels of technology according to Mosteller [60] and Troidl [83] had to be ranked.

Table 6.1. Laparoscopic surgery for diverticular disease

Stages in technology assessment	Definitely better	Probably better	Similar	Probably worse	Definitely worse	Strength of evidence[a]	References
Feasibility							
Safety/ intraoperative adverse events			X			III	[15, 21, 27, 35, 43, 48, 49, 53, 78, 82, 89, 92]
Operation time				X		III	[15, 21, 27, 35, 43, 48, 49, 53, 78, 82, 89, 92]
Postoperative adverse events		X	X			III	[15, 21, 27, 35, 43, 48, 49, 53, 78, 82, 89, 92]
Mortality			X			III	[15, 21, 27, 35, 43, 48, 49, 53, 78, 82, 89, 92]
Efficacy							
Postoperative pain and other disorders		X				III	[21, 49, 53, 82, 89]
Hospital stay		X				III	[15, 21, 35, 43, 49, 53, 78, 82, 89]
Return to normal activities and work		X				IV	No data
Cosmesis	X					IV	82
Effectiveness (overall assessment)		X				III	

Ia evidence from metaanalysis of randomized controlled trials;
Ib evidence from at least one randomized controlled trial;
IIa evidence from at least one controlled study without randomization;
IIb evidence from at least one other type of quasi-experimental study;
III evidence from descriptive studies, such as comparative studies, correlation studies, and case-control studies;
IV evidence from expert committee reports or opinions or clinical experience of respected authorities, or both
[a] Categories of evidence (as defined by AHCPR [1])

All answers received from the panel members were analyzed and subsequently combined into a provisional preconsensus statement. Each member was then informed about the identity of the other members, which had not been disclosed thus far.

In Rome, all panel members met for a first meeting on June 4, 1998. At this time, the provisional statement was scrutinized, word by word, in a 5-h session. The following day, the modified statement was presented to the audience for public discussion (1.5-h session). During a postconsensus meeting on the same day, all suggestions from the audience were discussed again by the panelists, and the statement was further modified. The final statement was mailed to all panelists for a final Delphi process.

Consensus Statements on Diverticular Disease

1. Definition

In the literature, there is as yet no uniform definition of diverticular disease [30, 36, 80]. Consensus on the following terminology was achieved: Colonic diverticular disease is a condition seen mostly in the sigmoid region. It is characterized structurally by mucosal herniation through the colonic wall, generally accompanied by muscular thickening, elastosis of the taenia coli, and mucosal folding [40, 90]. This condition may be asymptomatic (*diverticulosis*) or associated with "symptoms," termed *diverticular disease*, which may be complicated or uncomplicated. The term *diverticulitis* is used to indicate superadded inflammation involving the bowel wall. Other pathologic complications include perforation, fistula, obstruction, and bleeding.

2. Natural History

The *natural history* of this condition has not been very well investigated within prospective studies [8, 29, 68, 79]. No good indicators are available to distinguish patients who will become symptomatic from those who will not.

3. Etiology

The etiology of diverticular disease is generally accepted as being associated with a lifelong *deficiency of dietary fiber* [19, 22]. It is believed that such a diet results in a small stool, the propulsion of which requires a high intracolonic pressure (equivalent to 150 mmHg or more) [84]. At the vulnerable regions where blood vessels enter the colonic wall, herniation is found. Muscular thickening and elastosis of the taenia coli have also been documented.

A high-roughage diet, such as that consumed by vegetarians, protects against diverticular disease [38]. This type of diet offers an opportunity for

primary disease prevention. In Western countries, however, the decline of dietary fiber intake, mainly from cereal grains, has resulted in a high prevalence of disease, in sharp contrast to the data from developing countries.

Aging is associated with decreased tensile strength of both the collagen and the muscle fibers of the colon. In diverticulosis, similar changes occur, but they exceed the effect ascribed to aging alone [87, 88]. Nevertheless, with increasing age, the prevalence of diverticular disease rises steadily. Moderate and vigorous *physical activity* stimulates bowel activity and therefore may have a protective effect, at least in men [2]. Because *obesity* correlates with low physical activity levels and low fiber intake, it is associated with diverticular disease [74], but it plays no causal role.

Some *hereditary diseases*, such as polycystic kidney disease, Marfan's and Ehlers–Danlos syndrome, are associated with an increased incidence of disease, since, these diseases impair the strength of the submucosa.

Smoking may modestly increase the risk of developing diverticular disease. *Alcohol* and *caffeine* consumption do not play major roles in the etiology [3].

Immunosuppressed patients (mainly transplant recipients) have an increased susceptibility to diverticular disease [25].

Acute attacks of diverticulitis may be associated with hard feces becoming trapped in a diverticulum, causing mucosal ulceration and bacterial migration into the surrounding pericolic fat.

4. Classification

Diverticular disease can be classified with regard to the following aspects of the disease: localization, distribution, clinical symptoms and presentation, and pathology [58]. Two classifications are of importance – the *clinical classification and the Hinchey classification.*

Clinical classification: Subjective disease is difficult to grade, but we consider crampy pain, fever, and subjective patient evaluations to be symptomatic. Disease is classified as follows:

- Symptomatic uncomplicated disease
- Recurrent symptomatic disease
- Complicated disease (hemorrhage, abscess, phlegmon, perforation, purulent and fecal peritonitis, stricture, fistula, small-bowel obstruction due to postinflammatory adhesions)

Hinchey classification: The modified *Hinchey classification* [44, 78] should be used to describe the clinical stages of *perforated diverticular disease:*

- Stage I: pericolic abscess
- Stage II a: distant abscess amenable to percutaneous drainage
- Stage II b: complex abscess associated with/without fistula

- Stage III: generalized purulent peritonitis
- Stage IV: fecal peritonitis

However, neither classification is validated according to established criteria [72].

5. Diagnosis

The choice of diagnostic procedure depends on the clinical presentation. Differential diagnosis in coexisting intestinal disease has to be considered. The first step in making the diagnosis is to establish patient history with respect to type, severity, and course of the symptoms. The second step may require barium enema, colonoscopy, laboratory tests, CT, sonography, or radiograph [18]. The order of the procedures depends on the clinical decision and the availability of the methods.

In *uncomplicated cases*, a colonoscopy with biopsy and/or a barium enema [39, 71] is necessary to rule out adenoma, carcinoma, colitis, and Crohn's disease [64]. There is no consensus on which method should be used first, or whether biopsy is mandatory or recommended.

Patients with *recurrent symptomatic disease* who are eligible for surgery, especially if an endoscopic procedure is planned, should undergo CT and/or barium enema to provide information on location of the disease process, extraluminal changes, and coexisting abdominal abnormalities [10].

In *complicated diverticular disease* (except bleeding) cross-sectional imaging such as computed tomography (CT) should be used in addition to radiography [12, 41, 45, 57, 81]. CT has been reported to have more than 90% sensitivity and specificity [6, 23]. Ultrasonography may serve as another good diagnostic tool [77, 86], but its usefulness depends on the experience of the examiner [75, 91]. If CT is unavailable or does not yield a conclusive diagnosis, a low-pressure, water-soluble contrast enema can be considered. Flexible endoscopy is not recommended in suspected perforation or abscess formation, since it may perforate the colonic wall. The value of magnetic resonance imaging (MRI) has not yet been studied in acute diverticular disease and therefore be evaluated by water-soluble contrast enema to confirm the should be considered experimental.

Cases of *acute obstructive diverticular disease* should obstruction. If the patient has a chronic obstructive situation, colonoscopy with biopsy should be performed.

In cases presenting with *massive bleeding*, a number of different approaches have been used successfully, including selective arteriography, endoscopy, and radionuclide scans [24, 67]. However, there is no consensus on which of these diagnostic tools is preferable as a first choice.

6. Criteria for Making the Treatment Decision

There is general consensus that *disease-dependent criteria* for the treatment decision include number of previous attacks, fever, anemia, leukocytosis, intraluminal narrowing, obstruction, fistulas, abscess formation, free air, intraabdominal fluid, and thickening of the wall verified by CT scan [10, 26].

Patient-dependent criteria include age and concomitant disease, functional and emotional status, degree of disability, cognitive function, and subjective well-being of the patient. However, these criteria have not been thoroughly studied in previous trials.

The number of diverticula, their distribution, and manometry data should have no influence on decision making.

7. Indications for Conservative Treatment

There is a consensus that conservative treatment is indicated in cases with a first attack of uncomplicated diverticulitis [51]. The rationale is that approximately 50–70% of patients treated for a first episode of acute diverticulitis will recover and have no further problems. Only approximately 20% of patients with a first attack develop any complications. Those with recurrent attacks are at 60% risk to develop complications [29]. The members agreed that a detailed description of conservative treatment was outside the scope of the consensus conference, and stated that conservative treatment strategies should be followed as suggested in a recent review article [30]. Appropriate conservative therapy in mild cases consists of oral hydration, oral antibiotics (i.e., ciprofloxacin and metronidazol [66]) and antispasmodics. In moderate or severe cases, oral feeding should be stopped to allow bowel rest [11]. Hydration and antibiotics should be given intravenously. Analgesics can be given as required, including narcotics, but morphine should be avoided because of its potential to cause colonic spasm and hypersegmentation [65].

Patients with diverticular disease who are not suffering from an acute attack should be instructed to maintain a diet high in fiber [19]. Patients who continued to experience discomfort (such as mild cramps, meteorism, or stool irregularities) may benefit from the addition of bulking agents (i.e., plantago) or antispasmodics.

8. Indications for Operative Treatment

There is a consensus that prophylactic sigmoid colectomy is not justified in asymptomatic patients who have no history of inflammatory attacks. There is also agreement that prophylactic sigmoid colectomy should not be performed for symptomatic diverticular disease in the belief that complications

would be prevented thereby. Patients should be considered for elective surgery if they have had at least two attacks of symptomatic diverticular disease [7]. There are no available data on symptoms or signs that might predict the occurrence or severity of an attack. The decision should be made by the treating doctor. At the same time, the benefits of resection for recurrent symptoms must be weighed against the risks of surgery in old, fragile patients and those with concurrent disease. This situation must be fully explained to patients (consensus). Surgery may also be indicated after the first attack in patients who require chronic immunosuppression. Chronic complications such as colovesicular or colovaginal fistulas, stenoses, and bleeding are further indications for operation. If a concomitant carcinoma cannot be excluded, surgery is also recommended.

9. Type of Operation

For *symptomatic, uncomplicated disease*, there is a consensus that the diseased segment – usually the sigmoid colon – should be resected. Sigmoid myotomy is nowadays an outmoded procedure. It is not necessary to remove all diverticula [93]. The distal resection line should be just below the level of the rectosigmoid junction, and anastomosis is performed with the proximal rectum to prevent recurrent disease [37]. The extent to which the colon is resected in the oral direction is controversial. Many surgeons claim that the colon should be divided when the bowel is soft, even in the presence of diverticula; whereas others suggest complete proximal resection of macroscopically involved bowel to achieve normal wall thickness without diverticula at the line of resection. There are insufficient data to resolve this issue [14, 93]. The left ureter should always be identified before resection is performed. During resection, the presacral nerves should be identified and preserved from damage.

Hinchey I (abscess confined to mesentery) should first be treated by percutaneous drainage where possible, followed by sigmoid colectomy and primary anastomosis in fit patients (consensus).

Hinchey II (pelvic abscess, whatever the localization) should also be treated by percutaneous drainage, and followed later by sigmoid resection in most cases, but the risk in patients with comorbidity must be considered in the final decision (consensus) [9].

Hinchey III (purulent peritonitis) is a problematical situation: There are no valid data regarding its best treatment. Options include Hartmann resection, or resection with primary anastomosis with or without a covering stoma [28, 42, 50]. There is a need for randomized trials here (consensus).

Hinchey IV (fecal peritonitis) should be treated by the Hartmann procedure after intense preoperative resuscitation measures [13]. Drainage alone by open operation is not viable for Hinchey III and IV (consensus).

Patients should be informed that the chance of restoring intestinal continuity is only 60% at best after a Hartmann procedure [62]. Open surgery to restore continuity after a Hartmann operation is a major undertaking, and it is associated with a high potential for complications (consensus).

If continuous and severe *bleeding* is caused by diverticular disease, the involved segment should be resected [17, 31, 56, 67]. On-table lavage and endoscopy should be considered to localize the bleeding [5]. However, exact localization is often impossible [32]. In these cases, subtotal colectomy with ileorectal anastomosis is indicated. Selective intraarterial infusion of vasopressin and endoscopic injection hemostasis have been shown to be effective [47, 70], but elective surgery should be considered to prevent recurrence in the long term [20].

10. Place of Laparoscopic Procedures

There is a consensus that elective laparoscopic sigmoid resection (for procedures, see Appendix) may be an acceptable alternative to conventional sigmoid resection in patients with recurrent diverticular disease or stenosis [21, 27, 33, 34, 48, 49, 53, 78] (Table 6.1).

In Hinchey I and II patients, the laparoscopic approach is not the first choice, but it may be justified if no gross abnormalities are found during diagnostic laparoscopy [43]. In some patients, peritoneal lavage or drainage of a localized abscess can be undertaken by laparoscopy [52].

There is no place today for laparoscopic resections in Hinchey III (diverticulitis with purulent peritonitis) and Hinchey IV (diverticulitis with fecal peritonitis) patients [35, 46, 59, 63, 76, 85]. Laparoscopic hookup after a Hartmann resection may reduce morbidity [62], but there may be a high conversion rate.

All surgeons engaged in laparoscopic-assisted sigmoid colectomy must have a low threshold for converting to an open operation if difficulties are encountered or if the anatomy of the abdomen and pelvis cannot be clearly defined [92]. The procedures should be restricted to surgeons experienced in laparoscopic techniques.

11. Laparoscopic Technique

The aim of laparoscopic surgery is to minimize surgical trauma. The same principles as those used in conventional surgery must be applied to the laparoscopic technique.

12. Avoiding Recurrent Disease

In uncomplicated nonoperated cases, recurrent attacks can be prevented by bulking agents, such as plantago. During the operation, the proper height of the proximal resection of the diseased bowel is still a controversial topic [16]. The distal resection should be performed to the level of the rectum, where the taenia disappears [14]. A specimen of 20 cm or more should be resected [16].

13. Long-Term Results and Sequelae of Therapeutic Interventions

In *uncomplicated disease*, the data indicate that a high-fiber diet provides symptomatic relief and protects from complications (below 1% per patient year follow-up) [42].

In *complicated disease*, after successful conservative treatment, the risk of further episodes of complications is approximately 2% per patient year [42, 73]. Resection was required in 3% or less of patients in collected series.

Only a few studies have focused on the outcome for the patients. Quality-of-life measurements are missing. Functional data concerning stool frequency, bowel habits, and continence after the operation are scarce. The persistence of intermitted pain in the lower abdomen after sigmoid resection is surprisingly high (1–27%) [93].

14. Economics

Extensive literature reviews have turned up very little in the way of economic data on the treatment of diverticular disease, especially data that would allow a comparison of treatment options. We recommend that choice of treatment not be based on economic data currently, because costs may vary from one locale to another. Further studies in this area are indicated.

Appendix: Operative Technique for Laparoscopic Sigmoidectomy

The patient is positioned in a modified Trendelenburg position. The pneumoperitoneum should not exceed a pressure of more than 12 mmHg.

Usually four trocars are used, but more trocars can be used in cases of difficulties. The optic trocar is inserted above the umbilicus in the midline. Another 5- or 10-mm trocar is positioned in the left lower quadrant, and two further trocars (10 and 12 mm) are placed in the lower right quadrant.

The dissection begins in the basis of the mesosigmoid, where the vessels are located and divided after identification of the left ureter. Some surgeons prefer the primary mobilization of the sigmoid colon after identification of

the left ureter; others prefer to ligate the superior rectal artery or dissect even closer to the bowel. The mesenteric attachments are freed widely. The parietal peritoneum is divided up to the splenic flexure. Mobilizing the splenic flexure may be useful in creating a tension-free suture. After presacral nerves are identified, the rectosigmoid junction is divided by stapler. A mini-laparotomy is performed in the left lower quadrant, or in the right lower quadrant, or a Pfannenstiel incision is done.

The bowel is extracted through the mini-laparotomy, and proximal resection is completed. Some surgeons use a bag to remove the specimen. The anvil of the stapling device is placed after performing a purse-string suture. After reestablishing the pneumoperitoneum, the stapler is introduced perianally, and the anastomosis is completed. The completeness of the resection ring has to be examined. Integrity of the anastomosis is checked either by endoscope, by air, or by methylene blue-colored water. Drainage of the pelvis is facultative.

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Diverticular Disease – Update 2006

M. E. Kreis, K. W. Jauch

Definition, Epidemiology and Clinical Course

A commonly accepted uniform definition of diverticular disease is not available. The mere presence of diverticula which are herniations of the mucosal layer through the colonic wall is referred to as diverticulosis. It is debatable whether diverticulosis on its own without further complications causes symptoms and whether this condition should be named diverticular disease. However, problems secondary to diverticulosis such as diverticulitis, perforation, fistula, obstruction and bleeding definitely justify the use of the term diverticular disease, which, then, may also be classified as complicated diverticular disease.

Diagnostics

The diagnostic workup for diverticular disease has been virtually unchanged throughout recent years. With the high-resolution CT scanners that are available nowadays, most clinicians and radiologists prefer the CT scan to diagnose diverticula compared with the more time-consuming barium enema, although the latter is still a useful examination. Furthermore, imaging of diverticular is also elegantly possible with modern MRI scans [1]. It is of note that colonoscopy, which frequently detects diverticula as an irrelevant finding during screening for colorectal cancer, was found to be a useful procedure even for acute diverticulitis in order to diagnose associated pathology [2]. In this study, the rate of perforation was low so that this risk does not really justify renouncing colonoscopy during an acute attack.

Operative Versus Conservative Treatment

There is still consensus that the patients should not undergo sigmoid colectomy after the first attack of uncomplicated diverticulitis. Elective sigmoid colectomy is recommended for patients who have a second attack. This algorithm is now further supported by a recent study reporting data from a large

database [3]. In this study, 13.3% of the patients who had an initial episode of acute diverticulitis had a recurrence, while this rate went up to 29.3% in those patients that had not been operated on following two episodes. It is debatable whether younger patients should be operated on earlier, i.e., upon initial presentation with acute diverticulitis. Approximately half of the studies that address this issue argue in favor of this approach [4–7], while the other half argue against it [8–11]. This issue, therefore, remains unsettled.

The historic paper by Farmakis et al. [12] that reported lethal complications in almost 10% of patients during recurrent divertiular was recently challenged by a retrospective study published by Müller et al. [13] with 363 patients and a 12-year follow-up. In their study, only two patients died secondary to diverticular disease during follow-up, which supports the concept that patients should be operated on to achieve relief of symptoms rather than to prevent lethal complications.

Choice of Surgical Approach and Procedure

For recurrent diverticulitis, elective sigmoid colectomy with resection below the recto-sigmoid junction and anastomosis to the upper rectum remains the gold standard. The standard for perforated diverticulitis in staged Hinchey III and IV stages was extensively discussed in recent years. Salem [14] performed a meta-analysis including 98 studies that reported on the surgical approach for patients with these stages. While sigmoid colectomy with primary anastomosis (with or without ileostomy) has a lower morbidity (23.5 vs 39.4%) and a lower mortality (9.9 vs 19.6%) compared with the Hartmann operation (including operations for reanastomosis), a prospective randomized trial is still lacking. Thus, although no selection bias was identified in this review, the evidence for the recommendation to perform a sigmoid colectomy with primary anastomosis even in Hinchey III and IV stages remains limited.

Technical Aspects of Surgery

Laparoscopic sigmoid colectomy was shown to be a feasible and an acceptable alternative to open sigmoid colectomy for recurrent diverticulitis in the past. Conversion rates, morbidity and mortality following laparoscopic sigmoid colectomy were shown to be volume-dependent [15]. The laparoscopic technique has the potential result in reduced complications, reduced hospital stay and better cosmetic results compared with the open operation; however, it also carries the potential for increased operative time and increased treatment costs [16]. As the available comparative, nonrandomized

studies have a selection bias, definitive conclusions are not possible at this time; thus, we need to wait for the results of ongoing randomized-controlled trials before the superior technique can be determined.

Peri- and Postoperative Care

Several publications addressing the potential of fast-track surgery following surgery for colorectal cancer were published in recent years [17, 18]. No reports are available addressing specifically the peri- and postoperative care following sigmoid colectomy for recurrent diverticulitis. As care after surgery for cancer of the sigmoid colon is similar, multimodal rehabilitation, i.e. fast-track surgery after sigmoid colectomy for recurrent diverticulitis, is likely to have a comparable advantageous effect on patient recovery. Interestingly, Basse et al. [19] demonstrated in a recent study that the laparoscopic approach does not provide additional advantages regarding patient recovery compared with open surgery, when fast-track principles are strictly followed.

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The EAES Clinical Practice Guidelines on Laparoscopic Resection of Colonic Cancer (2004)

Ruben Veldkamp, M. Gholghesaei, H. Jaap Bonjer, Dirk W. Meijer, M. Buunen, J. Jeekel, B. Anderberg, M. A. Cuesta, Alfred Cuschieri, Abe Fingerhut, J. W. Fleshman, P. J. Guillou, E. Haglind, J. Himpens, Christoph A. Jacobi, J. J. Jakimowicz, Ferdinand Koeckerling, Antonio M. Lacy, Emilio Lezoche, John R. T. Monson, Mario Morino, Edmund A. M. Neugebauer, S. D. Wexner, R. L. Whelan

Introduction

Laparoscopic surgery for colon cancer remains controversial. Because of early reports of port site metastases, many surgeons refrained from following the laparoscopic approach to colon cancer, despite evidence from experimental tumor biology studies that have indicated clear oncological benefit of laparoscopic surgery.

Multi-center clinical trials randomizing patients with colon cancer to either laparoscopic or open resection were initiated in the mid-1990s to assess the oncological safety of laparoscopic surgery. Because a minimum follow-up period of 3 years is required to establish cancer-free survival rates, none of these ongoing randomized trials has yet accumulated sufficient data that would enable reliable and definitive assessment of laparoscopic colectomy for cancer.

This consensus conference (CC) addresses only colon cancer. Rectal cancer has been excluded because the available experience with laparoscopic surgery for rectal cancer is limited and because the treatment of rectal cancer differs from that of colon cancer in many respects.

The objectives of the consensus conference were:

1. To establish the preferred diagnostic procedures, selection of patients, and surgical technique of laparoscopic resection of colon cancer
2. To assess the radicality, morbidity, hospital stay, costs, and recovery from laparoscopic resection of colon cancer
3. To define standards and optimal practice in laparoscopic colon cancer surgery and provide recommendations/statements that reflect what is known and what constitutes good practice.

Methods

The consensus recommendations and statements are based on a systematic review of the literature and a consensus development conference (CDC) held in Lisbon, Portugal, during the 2002 congress of the EAES. They are summarized in the "Appendix."

A panel of experts in both open and laparoscopic surgery were recruited for the CDC and to assist in the formulation of the consensus. Each expert had to complete independently a detailed questionnaire on laparoscopic resection of colon cancer, participate in the CDC, and review the consensus document. A reference list with accompanying abstracts was provided to the experts, who were asked to provide details of published articles not included in the bibliography that had been sent to them. The questionnaire covered key aspects of laparoscopic resections of colon cancer. The personal experience of the experts, their opinions, or references drawn from the literature search formed the basis for completion of the questionnaire. In parallel, the questions were also addressed by performing a systematic review of the relevant literature.

The systematic review was based on a comprehensive literature search of Medline, Embase, and the Cochrane Library. The following query was used to identify relevant articles: (colectom* OR hemicolectom* OR colon resection) AND (laparoscop* OR endoscop* OR minimal* invasive) AND (colorect* OR colon OR intestine, large) AND (malignanc* OR cancer OR adenocarcinoma* OR carcinoma* OR tumor* OR tumour* OR metastas* OR neoplas*) NOT (FAP OR familial adenomatous polyposis OR HNPCC OR hereditary nonpolyposis OR inflammatory bowel disease OR ulcerative colitis OR Crohn* OR diverticulitis). Only the terms colon cancer and laparoscopy were used in the Cochrane search because the previous query was too restricted and hence inappropriate for the Cochrane database. Relevant articles were first selected by title; their relevance to the objectives of the consensus conference was then confirmed by reading the corresponding abstracts. Missing articles were identified by hand searches of the reference lists of the leading articles and from articles brought to the attention of the organizing group by the experts. The primary objective of the search was to identify all clinically relevant randomized controlled trials (RCT). However, other reports (e.g., using concurrent cohort, external, or historical control), population-based outcomes studies, case series, and case reports were also included. All articles were categorized by two reviewers (R. Veldkamp and H. J. Bonjer) according to the quality of data and evidence they provided (Table 8.1).

The systematic review of the literature provided evidence on extent of the resection, morbidity, mortality, hospital stay, recovery, and costs of laparoscopic colon cancer surgery. Regrettably, the level of evidence of articles on

Table 8.1. A method for grading recommendations according to scientific evidence

Grade of recommendation	Level of evidence	Possible study designs for the evaluation of therapeutic interventions
A	1 a	Systematic review (with homogeneity) of RCT
	1 b	Individual RCT (with narrow confidence interval)
	1 c	All or none case series
B	2 a	Systematic review (with homogeneity) of cohort studies
	2 b	Individual cohort study (including low-quality RCT)
	2 c	"Outcomes" research
	3 a	Systematic review (with homogeneity) of case-control studies
	3 b	Individual case-control study
C	4	Case series (and poor-quality cohort and case-control studies)
D	5	Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles," animal studies

From Sackett DL, Straus SE, Richardson WS, Rosenberg W, Haynes RB (2000) Evidence-based medicine: how to practice and teach EBM. 2nd ed. Churchill Livingstone, London
RCT randomized controlled trial(s)

surgical technique is low according to the Cochrane classification, indicating that surgical techniques are difficult to evaluate scientifically because many important aspects – e.g., multilimb coordination, dexterity, tactile and visual appreciation of anatomical structures, and surgical experience – cannot be measured objectively.

Analysis of the completed questionnaires and the information culled from the systematic review as outlined above formed the basis for the formulation of the draft consensus document, which was reviewed by the experts 3 weeks before the CDC in Lisbon, when all the panelists met for the first time on 2 June 2002. All statements, recommendations, and clinical implications with grades of recommendation were discussed during a 6-h session in terms of the prevailing internal (expert opinion) and external evidence. The following day, the consensus document with its clinical implications was presented to the conference audience by all panelists for public discussion. All suggestions from the audience were discussed, and the consensus document was modified where appropriate. In the following months, the consensus proceedings were published online on the Internet page of the EAES. All members of the EAES were invited to comment on the consensus proceedings on a forum Web page. Sixteen surgeons commented on the consensus proceedings through the Internet forum. The modified final consensus document was approved by all the panelists before publication.

Preoperative Evaluation and Selection of Patients

Preoperative Imaging

In current practice, the same preoperative workup is done prior to both laparoscopic and conventional colectomies. Metastatic spread of colonic cancer is commonly investigated by ultrasonography of the liver and plain radiography of the chest. Colonoscopic biopsy specimens from the tumor are taken in most patients to confirm the presence of cancer. However, colonoscopy does not accurately localize the lesion [1]. Abdominal CT imaging to assess the size of the tumor and possible invasion of adjacent tissues is performed selectively at some European centers and more extensively in the USA.

The size of the colonic tumor is one of the important criteria for establishing the suitability of laparoscopic resection. The atraumatic and protected removal of a tumor that has been mobilized laparoscopically requires an incision of the abdominal wall. The laparoscopic approach is not indicated when the size of this incision for extraction approximates the size of a conventional laparotomy. Hence, preoperative knowledge about the size of the tumor improves selection and reduces the need for conversion.

Barium enema studies provide reliable data on the localization of colon cancer but do not show invasion of the tumor in the colonic wall or surrounding structures [2]. Conventional CT of the colon can also provide information about the localization of the tumor. In the near future, more advanced radiologic techniques, such as virtual colonoscopy, may be able to assess the site of the tumor more precisely [3, 4].

Cancerous invasion of organs adjacent to the colon can be detected by CT. However, the accuracy of preoperative staging of colon cancer by CT varies from 40 to 77% [3] because of the limited soft tissue contrast of CT, which impairs assessment of mural invasion by the tumor. The importance of tumor size and infiltration of surrounding structures is documented by a review of the causes of conversion during laparoscopic colonic surgery which indicated that almost 40% of conversions were due to a bulky or adherent tumor (see “Conversion Rate”).

Laparoscopy has the potential to assess tumor invasion of adjacent organs, but there are no published reports on the value of laparoscopic staging in the workup and selection of patients for open or laparoscopic resection of colon cancer as distinct from its established use in gastric, pancreatic, and esophageal tumors.

Recommendation 1: Preoperative imaging

Preoperative imaging studies of colon cancer to assess the size of the tumor, possible invasion of adjacent structures, and localization of the tumor are recommended in laparoscopic surgery for colon cancer (level of evidence: 5, recommendation: grade D).

Contraindications

Age

The experts agreed that age is not a contraindication. This view is supported by a subanalysis of a case series by Delgado et al. [5], who reported significantly lower morbidity after laparoscopic resection compared to open colectomy in patients over 70 years old. Schwandner et al. [6] performed a subanalysis of 298 patients undergoing laparoscopic or laparoscopic-assisted colorectal procedures. There were no statistically significant differences among the younger, middle aged, and older patients in terms of conversion rate (3.1 vs 9.4 vs 7.4%, respectively), major complications (4.6 vs 10.1 vs 9.5%, respectively), and minor complications (12.3 vs 15.% vs 12.6%, respectively). However, duration of surgery, stay in the intensive care unit, and postoperative hospitalization were significantly longer in patients older than 70 years ($p < 0.05$). Complications reported in case series involving elderly patients after laparoscopic cholecystectomy seem to compare favorably with open cholecystectomy studies [7, 8].

Statement 2: Contraindications: age

Age only is not a contraindication for laparoscopic resection of colon cancer (level of evidence: 2b).

Cardiopulmonary Condition

Cardiopulmonary consequences of the pneumoperitoneum were thoroughly reviewed in the EAES consensus statement of 2002 [9]. Relevant parts of this consensus have been enclosed in the current consensus. Decreased Cardiopulmonary function is not regarded a contraindication to laparoscopic resection of colon cancer.

Cardiovascular effects of pneumoperitoneum occur most often during its induction, and this should be considered when the initial pressure is raised for the introduction of access devices. In ASA I–II patients, the hemodynamic and circulatory effects of a 12–14 mmHg capnoperitoneum are gener-

ally not clinically relevant (grade A). Due to the hemodynamic changes in ASA III–IV patients, however, invasive measurement of blood pressure or circulating volume should be considered (grade A). These patients also should receive adequate preoperative volume loading (grade A), beta-blockers (grade A), and intermittent sequential pneumatic compression of the lower limbs, especially in prolonged laparoscopic procedures (grade C). If technically feasible, gasless or low-pressure laparoscopy might be an alternative for patients with limited cardiac function (grade B). The use of other gases (e.g., helium) showed no clinically relevant hemodynamic advantages (grade A).

Carbon dioxide (CO_2) pneumoperitoneum causes hypercapnia and respiratory acidosis. During laparoscopy, monitoring of end-tidal CO_2 concentration is mandatory (grade A), and minute volume of ventilation should be increased in order to maintain normocapnia. Increased intraabdominal pressure and head-down position reduce pulmonary compliance and lead to ventilation–perfusion mismatch (grade A). In patients with normal lung function, these intraoperative respiratory changes are usually not clinically relevant (grade A). In patients with limited pulmonary reserves, capnoperitoneum carries an increased risk of CO_2 retention, especially in the postoperative period (grade A). In patients with cardiopulmonary diseases, intra- and postoperative arterial blood gas monitoring is recommended (grade A). Lowering intraabdominal pressure and controlling hyperventilation reduce respiratory acidosis during pneumoperitoneum (grade A). Gasless laparoscopy, low-pressure capnoperitoneum, or the use of helium might be an alternative for patients with limited pulmonary function (grade B). Laparoscopic surgery preserves postoperative pulmonary function better than open surgery (grade A).

Recommendation 3: Contraindications: cardiopulmonary status

Invasive monitoring of blood pressure and blood gases is mandatory in ASA III–IV patients (recommendation: grade A, no consensus: 91% agreement among experts). Low-pressure (less than 12 mm Hg) pneumoperitoneum is advocated in ASA III–IV patients (recommendation: grade B).

Obesity

Intraoperative ventilation of obese patients is more often problematic than in normal-weight patients, largely because the static pulmonary compliance of obese patients is 30% lower and their inspiratory resistance is 68% higher than normal [10]. The respiratory reserve of obese patients is thus reduced, with a tendency to hypercarbia and respiratory acidosis.

Obesity also reduces the technical feasibility of the laparoscopic approach. In obese patients, anatomical planes are less clear. This increases the level of difficulty of the dissection and prolongs operation time. Retraction of the small intestine and fatty omentum are more difficult and prevent easy exposure of the vascular pedicle at the base of the colonic mesentery in all parts of the colon. The routine use of hand-assisted laparoscopy may facilitate this.

Pandya et al. [11] have shown that the conversion rate is higher in patients with a body mass index (BMI) above 29 due to increased technical difficulties. A similar conclusion was reached by Pikarsky et al. who reported a higher conversion rate in patients with a BMI above 30 [12].

There is insufficient evidence in the literature to indicate which method should be preferred. Also, in conventionally operated patients, complication rates rise with increasing BMI. In particular, ventilatory complications and wound infections are encountered in these patients. We found no study comparing laparoscopic to open colon-cancer surgery in the obese. For laparoscopic cholecystectomy, many studies have demonstrated similar complication rates after open and laparoscopic surgery [13–15, 17, 18].

Statement 4: Contraindications: obesity

Obesity is not an absolute contraindication, but the rates of complication and conversion are higher at a BMI above 30 (level of evidence: 2c, no consensus: 93% agreement among experts).

Characteristics of the Tumor

Radical resection of colonic cancer is essential for cure. Atraumatic manipulation of the tumor and wide resection margins (longitudinal and circumferential) are the basic elements of curative surgery [19]. Laparoscopic radical resection of locally advanced colorectal tumors is problematic because adequate laparoscopic atraumatic dissection of bulky tumors is difficult. Furthermore, laparoscopic resection of adjacent involved organs or the abdominal wall compounds the technical problem. Hence, the role of laparoscopic surgery in patients with T4 cancers remains controversial. The majority of the experts consider T4 colonic cancer an absolute contraindication to laparoscopic resection; en bloc laparoscopic resection is possible only in a limited number of patients. The routine use of hand-assisted laparoscopy may change this in the future.

The laparoscopic approach is useful for palliative resections of colonic cancer. Most experts do not consider peritoneal carcinomatosis to be a contraindication for laparoscopic surgery.

Recommendation 5: Contraindications: tumor characteristics

Potentially curative resections of colon cancer suspected of invading the abdominal wall or adjacent structures should be undertaken by open surgery (level of evidence: 5, recommendation: grade D, no consensus: 83% agreement among experts).

Adhesions

Adhesions account for 17% of all conversions. However, prior abdominal operation appears to play a less important role in the completion rate of laparoscopic colon resection, as reported by Pandya et al. [11]. In this study, conversion rates did not differ between patients who had previous abdominal operation and those who did not. In this series of 200 patients, 52% of whom had had a previous laparotomy, only five required conversion to laparotomy because of extensive intraabdominal adhesions. Hamel et al. [20] compared the morbidity rate following right hemicolectomy between patients with and without prior abdominal operation. The complication rates for the two groups were similar despite the presence of more adhesions in the previously operated group.

To our knowledge, no studies have been published comparing laparoscopic to open surgery for patients with previous abdominal operation.

Statement 6: Contraindications: adhesions

Adhesions do not appear to be a contraindication to laparoscopic colectomy (level of evidence: 4).

Localization

Half the experts do not recommend laparoscopic resections of the transverse colon and the splenic flexure. The omentum, which is adherent to the transverse colon, renders dissection of the transverse colon difficult. Mobilization of a tumor at the splenic flexure can be very demanding.

Operative Technique

Anesthesia

Nitrous oxide, when employed as inhalational anesthetic, does not cause intestinal distention assessed by girth of transverse colon and terminal ileum at the beginning and end of the procedure [21]. The first study investigating

the usefulness of nitrous oxide during laparoscopic surgery was completed by Taylor et al. [22]. In one group, isoflurane with 70% N_2O in oxygen (O_2) was used, in the other; isoflurane in an air/O_2 mixture was used during laparoscopic cholecystectomy. No significant intraoperative differences were found between the two groups with respect to operating conditions or bowel distension. However, the consequences of the use of nitrous oxide during longer laparoscopic procedures have not been investigated.

Most experts employ general anesthesia without epidural analgesia.

Pneumoperitoneum

Recommendations regarding the creation of a pneumoperitoneum are given in the EAES consensus statement of 2002 [9].

Trocar Positions

Positioning of the trocars is based on the experience and preference of the individual surgeon. For right hemicolectomies, 50% of experts use four trocars, 30% use three trocars, and 20% use five trocars. Most of them extract the specimen through an incision made at the site of the umbilical trocar. At the umbilicus, a 10–12-mm trocar is placed. A 10-mm trocar is placed suprapubically and another trocar in the epigastric region by 70% of authors. Some experts place a 5-mm trocar at the left iliac fossa or at the right subcostal space.

For left hemicolectomy and for sigmoid resection, trocars are positioned at almost the same sites. Thirty percent of experts perform these procedures using a hand-assisted technique. Five trocars are used by more than 70% of experts. A 10–12-mm trocar is placed at the umbilicus; two 10-mm trocars are placed by 80% of experts in the right iliac fossa and in the right suprapubic region. The incision for specimen extraction is made at the left iliac fossa, or, if the hand-assisted technique is used, the specimen is extracted through the hand port incision, usually in the upper lateral abdomen. For left hemicolectomy, the specimen is extracted through a suprapubic incision or through an incision at the left iliac fossa.

Statement 7: Placement of trocars

Placement of trocars is based on the experience and the preference of the individual surgeon (level of evidence: 5).

Camera

There is unanimous agreement about the use of a threechip camera, because of its better resolution. The laparoscope can be 30° or 0°, depending on the surgeon's preference. Two experts use a flexible videolaparoscope. The camera is hand-held by most experts. Mechanical and robotic devices are available, but they are used by less than 10% of experts.

Recommendation 8: Videoscopic Image

High-quality videoscopic imaging is strongly recommended (level of evidence: 5, recommendation: grade D).

Prevention of Port Site Metastasis

Port site metastases after laparoscopic resection of colon cancer have caused great concern in the surgical community. Therefore, the causative mechanisms in the occurrence of port site metastases has become an important subject for experimental research. Many mechanisms have been proposed and have been subject of extensive research [23]. However, so far no conclusive pathogenesis of port site metastases has been established. We will discuss the most common preventive measures for port site metastases and their pathogenesis. No levels of evidence and grades of recommendation are given for each individual measure because most evidence is derived from experimental research and there is no consensus among the experts on which measures to use.

Surgical Experience

The incidence of port site metastases has decreased dramatically with growing experience. The initial incidence of port site metastases of 21% has dropped to less than 1% (see "Port Site Metastases After Laparoscopic Colectomy"). Surgical experience thus appears the main determinant for the occurrence of port site metastases.

Wound Protectors

Experimental studies have shown that tumor growth is increased at the site of extraction of a malignant tumor [24]. All experts protect the abdominal wall or place the specimen in a plastic bag prior to extraction to prevent tumor cell implantation and growth. However, port site recurrences have been reported after extraction of a right colonic cancer that was placed in a plastic bag [25]. Therefore, wound protection is considered safer.

Gasless Laparoscopy

In view of the possibility that a positive pressure pneumoperitoneum may be responsible for wound tumor deposits, some surgeons have suggested the use of gasless laparoscopy. In this respect, experimental findings on gasless laparoscopy are controversial. Bouvy et al. [24] and Watson et al. [26] reported a significant decrease in the occurrence of port site metastasis when gasless laparoscopy was used in an animal model. Gutt et al. [27] and Iwanaka et al. [28] could not confirm these observations. Wittich et al. [29] reported in an experimental study that tumor growth was proportional to the insufflation pressure. Hence, low insufflation pressures may reduce the risk of dissemination.

Different Types of Gas

Carbon dioxide attenuates the local peritoneal immune response, which might enhance the risk of tumour cell implantation and tumor growth in the traumatized tissues [28, 30–34]. Neuhaus et al. [35], Jacobi et al. [36], and Bouvy et al. [37] assessed tumor growth in animals after abdominal insufflation with different gases. Only helium significantly reduced the rate of wound metastasis. However, the clinical implications of the use of helium in humans have not been explored fully.

Wound Excision

Because cancer cells can implant in wounds during surgery, it might be expected that excision of the wound edges would reduce the rate of neoplastic wound recurrences. This has not been confirmed in animal studies. Wu et al. [38] reported a reduction in port site metastases rates from 89 to 78% after wound excision, whereas Watson et al. reported that wound excision was followed by a significant increase of wound recurrence [39].

Irrigation of Peritoneal Space and Port Site

Irrigation of the peritoneal cavity with various solutions to reduce the incidence of peritoneal and port site metastases has been studied mostly in animal models. These studies have shown that peritoneal irrigation with povidone-iodine [40, 41], heparin [42], methotrexate [40], and cyclophosphamide [28] all reduced the rate of port site metastasis. Intraperitoneal tumor growth and trocar metastases were suppressed by the use of taurolidine in a rat model [36, 43, 44]. Eshraghi et al. [45] irrigated the port sites with distilled water, saline, heparin, and 5-FU. They found that 5-FU reduced the recur-

rence rate. Half of the experts irrigate the port sites with either betadine, distilled water, or tauroline.

Trocar Fixation

Tseng et al. [46] showed in an experimental study that gas leakage along a trocar ("chimney effect") and tissue trauma at the trocar site predisposed to tumor growth. However, the chimney effect has never been validated clinically.

Aerosolization

In experimental studies [47, 48], aerosolization occurs only when very large numbers of tumor cells are present in the abdominal cavity. The clinical significance of the aerosolization of tumor cells has not been proven. Some experts advocate desufflation of the pneumoperitoneum at the end of the operation before removal of the ports.

No-Touch Technique

The no-touch technique is based on the risk of dislodging tumor emboli during manipulation of the colorectal carcinoma. The value of the no-touch technique in colon surgery remains controversial. An improvement in the 5-year survival was reported by Turnbull et al. [49] in a retrospective analysis. In the only prospective randomized trial, which evaluated 236 patients, Wiggers et al. [50] showed that the no-touch technique did not impart a significant 5-year survival advantage. The absolute 5-year survival rates were 56.3 and 59.8% in the conventional arm and no-touch surgical groups, respectively. In the conventional group, more patients had liver metastases and the time to metastasis was shorter, but differences in survival were not statistically significant.

Bowel Washout

Studies have shown that viable tumor cells exist in the lumen of the colon and rectum. Rectal washout may thus reduce risk of recurrence, but the potential benefit remains unproven [19]. Exfoliated tumor cells have been detected in resection margins, rectal stumps, and circular stapling devices [51–53]. Furthermore, the viability and proliferative and metastatic potential of exfoliated malignant colorectal cells have been confirmed [52, 53]. Several washout solutions, including normal saline, have been shown to eliminate exfoliated malignant cells in the doughnut of rectal tissue from circular staplers [54]. Despite these observations, there is no conclusive evidence that bowel washouts reduce local recurrence and hence no data to support their use in surgery for colon cancer.

Statement 9: Preventive measures for port site metastasis

Proper surgical technique and practice reduce the likelihood of port site metastasis (level of evidence: 5).

Tumor Localization

Preoperative tumor localization is important in the laparoscopic resection of colonic cancer because intraoperative localization by palpation of the colon for tumors that are not visible on the serosal side is not possible unless the hand-assisted laparoscopic surgery (HALS) technique is used. The risk of incorrect tumor localization includes resection of the wrong bowel segment or less than radical resection because of insufficient proximal or distal margins [55–57].

Many colonoscopic techniques are used for marking the site of a tumor. Two of these, metal clip placement [58, 59] and tattooing [60, 61], are most commonly used. Tumor localization is advisable except for tumors located near the ileo-cecal valve, which forms a clear landmark during colonoscopy [62]. Special equipment is needed for clip placement. Before surgery, plain abdominal radiography is performed to exclude the migration of clips. During surgery, the clips are identified by intraoperative ultrasound or fluoroscopy. Hence, this is an expensive and time-consuming technique [63], although it is very reliable [59, 64].

Intra-operative colonoscopy is an alternative modality to localize the colonic lesion. However, this technique can induce distention of the colon and small bowel, particularly in right-sided lesions [65]. The colonoscopic tattooing technique with india ink or methylene blue is efficient. Tattoo injection with ink can be carried out at the time of the first colonoscopy because ink remains in place for several weeks. It is important to inject the dye in all quadrants, at an angle of 45°, and to mark the oral and aboral margins of the lesion. Athick omentum or tattooing along the mesocolic margin can mask a tattoo such that localization fails. Reported success rates for detection of the tumor after tattooing vary between 78.6 and 98% [61, 66]. The reported morbidity rate for tattooing is 0.22% [67]. In this review, only one patient was found in whom overt clinical complications developed. Injection into the peritoneal space has been reported in 0.5–8% [63, 68].

Recommendation 10: Intraoperative localization of tumor

Preoperative tattooing of small colonic tumors is advised. The alternatives are intraoperative colonoscopy, or pre-operative colonoscopic clipping followed by peroperative fluoroscopy, or ultrasonography (level of evidence: 5, recommendation: grade D).

Hand-Assisted or Laparoscopic-Assisted Approach

Basically, three different techniques are described for laparoscopic colon resection: totally laparoscopic, laparoscopic-assisted, and hand-assisted colectomy.

During totally laparoscopic procedures, the resected specimen is removed through the anus. It can be performed during low anterior resection or sigmoidectomy. The anastomosis is done laparoscopically using a circular stapler introduced through the anus. Totally laparoscopic procedures have been abandoned, largely because early experience indicated a high recurrence rate at the extraction site and no apparent advantage [69].

In laparoscopic-assisted colon resection, part of the procedure is performed in an open fashion through an incision of the abdominal wall made for the extraction of the resected specimen. This is the most common procedure for all colectomies.

Hand-assisted laparoscopic surgery (HALS) is an alternative to laparoscopically assisted colectomy. This procedure enables the surgeon to use his or her hand, with the dual benefit of magnified view and restoration of the tactile sense by the internal hand, which also provides atraumatic retraction and effective control of sudden bleeding. In addition, the internal hand is able to locate small tumors that are not visible from the serosal aspect.

With the early hand access devices, maintenance of the pneumoperitoneum was difficult, but this problem has been resolved with the second generation of hand access devices [70]. HALS appears to be at least as effective as the laparoscopically assisted technique in terms of operative time, conversion rate, and postoperative outcome [71]. Only two experts use HALS for laparoscopic colectomy.

Dissection of Mesocolon

Most experts dissect the mesocolon before taking down the lateral attachments of the colon. Fifty-four percent of experts use a vascular stapling device, 27% employ an external knotting technique, and 18% use clips to ligate the large-caliber mesocolic vessels. Most experts dissect the mesocolon from medially to laterally over Toldt's fascia. All agree that the surgeon must know both approaches to be able to deal with a difficult problem during the procedure.

For right hemicolectomy, the mobilization of the bowel is always performed laparoscopically. Dissection of the mesocolon and bowel transection can both be performed laparoscopically or after the colon has been exteriorized. Transection of the ileum is performed laparoscopically by 71% of experts. Aboral transection of the colon, as well as the anastomosis, is per-

formed after exteriorization. In left hemicolectomy, dissection of the mesocolon, mobilization of the colon, and transection of the aboral colon are done laparoscopically. The anastomosis is performed using a circular stapler introduced through the anus by 66% of experts. Others perform a stapled or hand-sewn anastomosis after exteriorization of the colon. No preference exists for either end-to-end, end-to-side, or side-to-side anastomosis.

Sigmoidectomy involves the same steps as left hemicolectomy, but all experts use a circular stapler for the anastomosis.

Recommendation 11: Dissection of mesocolon

Dissection of the mesocolon from medial to lateral is the preferred approach in laparoscopic colon surgery (level of evidence: 5, recommendation: grade D).

Learning Curve

"Learning curve" can be defined in various ways. Simons et al. considered the learning curve completed when the operative time stabilizes and does not vary by more than 20 min [72]. Schlachta et al. [73] demonstrated that operating time, intraoperative complications, and conversion rates decline after the performance of 30 colorectal resections. Bennett et al. [74] reported that experience plays an important role in reducing complication rates and has less impact on reducing the operating time. Lezoche et al. reported that the conversion rate dropped from 17 to 2% after 30 laparoscopic colectomies [75]. Many surgeons consider the learning curve for laparoscopic colonic resection to be longer than that for laparoscopic cholecystectomy.

Intraoperative Results of Laparoscopic Resection of Colon Cancer

Conversion Rate

Reported conversion rates in laparoscopic surgery depend on the definition of conversion, the selection of patients, and the experience of the surgeon. Conversion rates between 4 and 28% have been reported in comparative studies (Table 8.2).

There is currently no standardized definition of conversion. In most studies, an operation is considered to be converted when a laparoscopic procedure was commenced but could not be completed by this approach. In two studies, a diagnostic laparoscopy was performed before every operation to establish the feasibility of a laparoscopic resection [76, 77]. If laparoscopy in-

dicated that resection would not be possible, open surgical resection was performed. These operations were not considered as converted. In two case series, high conversion rates of 41 and 48% were reported [78, 79]. Both studies reflected a very early experience with laparoscopic surgery, and no attempt was made to select patients according to weight, tumor stage, or number of previous abdominal operations. None of the other case series that have been reviewed reported higher conversion rates [56, 76, 80–83].

In a study by Lezoche et al. [84], conversion rates were calculated for the first 30 patients operated laparoscopically and for the consecutive 26 patients. The conversion rate in the early experience group was 16.8%, whereas in the subsequent group it was 1.8%; this finding underscores the importance of experience in reducing the conversion rate. This finding was confirmed by several other reports analyzing early and later experiences with laparoscopic colon surgery [11, 56, 81, 85]. All found a clear decrease in the number of conversions as more operations were performed.

Laparoscopic colectomies are converted for a variety of reasons. Locally advanced bulky or invasive tumors, adhesions, and technical problems account for most conversions (Table 8.2). Because many conversions are for invasive or bulky tumors, improved preoperative selection of patients based on more accurate clinical staging may decrease conversion rates. Preoperative CT or MRI scanning can provide more information on the localization of the tumor and the invasion of surrounding structures.

Statement 12: Conversions

Laparoscopic colectomy is converted to open surgery in 14% (0–42%) of cases. The most common causes of conversion are tumor invasion of adjacent structures or bulky tumor, adhesions, and technical failure (level of evidence: 3 a).

Duration of Surgery

In general, laparoscopic resection of colonic cancer takes longer to perform than open resection. Although operating time decreases with increasing experience [75, 78, 81, 84, 86], it is difficult to compare operating times between open and laparoscopic resections for colon cancer because most studies include a wide variety of procedures and do not specify per type of resection performed. Studies that included rectal procedures reported longer operating times [77, 87, 88].

Reported operating times vary between 140 and 251 min for laparoscopic colorectal resections and 120 and 175 min for open surgery (Table 8.3). In some studies, benign lesions were also included [77], and rectal procedures

Table 8.2. Reported conversion rates in studies on laparoscopic resection of colorectal cancer

Study	*n*	Conversion rate	Cause
1			
Weeks et al. [115]	58/228	25	1 advanced disease, 3 positive margins, 10 inability to visualize structures, 4 inability to mobilize colon, 12 adhesions, 4 intraoperative complications, 2 associated complicating disease, 12 other
Schwenk et al. [111]	0/30	0	After diagnostic laparoscopy
Milsom et al. [77]	4/59	7	2 bowel distension, 2 tumor too low, 1 adhesions
Delgado et al. [5]	18/129	14	15 invasion of adjacent organs, 1 adherence, 2 NS
Curet et al. [87]	7/25	28	3 tumor fixation to adjacent organs, 3 extensive adhesions, 1 abscess around ureter
Stage et al. [94]	3/18	17	3 extensive tumor growth
Lacy et al. [93]	4/25	16	4 invasion of small bowel
3			
Lezoche et al. [84]	6/140	4	2 hemorrhage, 2 anastomotic defects, 1 obesity, 1 inadequate splenic flexure mobilization
Feliciotti et al. [126]	5/104	4.8	2 anastomotic defects, 1 obesity, 1 inadequate splenic flexure mobilization, hemorrhage
Bouvet et al. [88]	38/91	42	12 adhesions, 8 poor exposure, 5 extensive tumor growth, 3 excessive procedure time, 2 bleeding, 2 inability to identify the ureter, 1 inadequate distal margin, 1 equipment failure, 4 combination of factors
Hong et al. [112]	12/98	12	5 adherence, 5 size of tumor, 2 adhesions
Psaila et al. [117]	3/25	12	NS
Khalili et al. [90]	6/80	8	3 extensive tumor, 2 adhesions, 1 intraoperative bleed
Pandya et al. [11]	47/200	23.5	6 hypercarbia, 2 unclear anatomy, 2 stapler misfiring, 5 too ambitious, 6 bleeding, 7 cystotomy, 2 enterotomy, 5 adhesions, 3 obesity, 10 size/invasion tumor, 5 phlegmon
Bokey et al. [95]	6/34	18	1 injury cecum, 1 adhherence, 1 adhesions, 1 hypercapnia, 2 lack of progress
Franklin et al. [116]	8/192	4.2	7 large invasive tumor, 1 bleed
Santoro et al. [114]	0/50	0	–
Leung et al. [92]	8/50	4	2 adhesions, 2 bleeding, 3 large/invasive tumors, 1 low tumor
Van Ye et al. [99] Leung et al. [104]	1/15	6.7	1 adhesions

Table 8.2 (continued)

Study	*n*	Conversion rate	Cause
4			
Schiedeck et al. [152]	25/399	6.3	NS
Bokey et al. [103]	9/66	14	2 lack of progress, 2 adherence, 1 adhesions, 1 cecal injury, 1 hypercapnia, 1 ureter not identifined, 1 bleed
Fleshman et al. [163]	58/372	15.6	NS
Franklin et al. [154]	3/50	6	3 bulky/invasive tumor
Poulin et al. [155]	12/131	9	6 fixed tumor, 3 adhesions, 1 oncologic resection impossible, 1 hemorrhage, 1 perforation of small bowel
Leung et al. [108]	54/201	26.9	22 conversions after diagnostic laparoscopy (not further specified) Invaisve or bulky tumor: 36% Adhesions: 18% Technical problem: 22% (12 lack of progress, 18 poor exposure, 8 hypercarbia, 6 anastomotic problem, 2 bowel distension, 6 inadequate mobilization, one equipment failure)
Total	395/2812	14%	Bleed: 7% Safe oncologic resection impossible: 2% Visceral injury: 3% Obesity: 2% Others: 10%

NS not specified

were excluded in only one RCT [89]. In two RCT [77, 87] and in five nonrandomized comparative studies, the intention-to-treat principle was violated [75, 88, 90–92], resulting in selection bias, possibly favoring the laparoscopic group.

Statement 13: Duration of surgery

Laparoscopic colectomy requires more operating time than open colectomy (level of evidence: 2a).

Statement 14: Extent of resection

For a laparoscopic oncological resection to be as safe as an open resection, the extent of resection of colonic and lymphatic tissue should not differ from that of open colectomy. All RCT report similar numbers of lymph nodes harvested in laparoscopic and open surgical specimens. Also, the length of

Table 8.3. Duration of surgery

Study	Laparoscopic	Open	*p* value
2			
Lacy et al. [89]	142 ± 52	118 ± 45	0.001
Hewitt et al. [102]	165 (130–300)	107.5 (90–150)	0.02
Milsom et al. [77]	200 ± 40	125 ± 51	< 0.0001
Delgado et al. [5]	< 70 years: 144 ± 40	122 ± 45	0.005
	> 70 years: 150 ± 60	119 ± 51	0.001
Curet et al. [87]	210 (128–275)	138 (95–240)	< 0.05
Stage et al. [94]	150 (60–275)	95 (40–195)	0.05
Lacy et al. [93]	148.8 ± 45.5	110.6 ± 49.3	0.006
Schwenk et al. [156]	219 ± 64	146 ± 41	< 0.01
3			
Lezoche et al. [84]	RHC 190 (90–330)	140 (90–280)	0.03
	First 30: 226 (140–330)		
	Last 20: 153 (90–240)	190 (130–340)	0.04
	LHC 240 (150–480)		
	First 30: 260 (150–480)		
	Last 20: 210 (150–320)		
Bouvet et al. [88]	240 (150–516)	150 (60–376)	< 0.01
Fukushima et al. [150]	231 ± 23	169 ± 20	NS
Hong et al. [112]	140 ± 49.5	129 ± 53.5	NS
Psaila et al. [117]	179 ± 41	123 ± 41	< 0.05
Khalili et al. [90]	161 ± 7	163 ± 8	NS
Lezoche et al. [75]	Overall 251 (90–480)	175 (90–340)	< 0.001
	RHC 203 (90–330)	140 (90–280)	< 0.001
	LHC 282 (150–480)	190 (130–340)	< 0.001
Marubashi et al. [91]	RHC 211.9 (134–330)	148.7 (104–173)	< 0.05
Leung et al. [92]	196 ± 44.4	150 ± 61.1	< 0.001

Results given as mean ± standard deviation (*SD*) or median (range).
NS not significant, *RHC* right hemicolectomy, *LHC* left hemicolectomy

the retrieved bowel segments and tumor-free margins were comparable [5, 77, 87, 93, 94] (Table 8.4).

In nonrandomized comparative studies, no differences between open and laparoscopic groups were found for number of lymph nodes, length of the retrieved specimen, tumor-free proximal and distal margins, and total length of specimen. In two studies, a smaller distal resection margin was recorded [88, 95]. However, in these studies, the mean distal tumor-free resection margins were still 6 and 10 cm, respectively, which is oncologically acceptable.

There are reports of laparoscopic colon resections not containing the primary tumor or missing a synchronous second colonic carcinoma [55–57]. This type of result underscores the importance of tumor localization by either tattooing the tumor with ink or intraoperative colonoscopy.

The extent of laparoscopic lymphadenectomy and bowel resection is similar to those obtained by open colectomy (level of evidence: 2 b).

Table 8.4. Number of lymph nodes and extent of resection

Study	No. of lymph nodes Laparoscopic	Resection margins (cm) Open	*p* value	Laparoscopic	Open	*p* value
2						
Milsom et al. [77]	19 [a)]	25	–	Clear in all	Clear in all	
Delgado et al. [5]	< 70 years 9.6	10.5	NS			
	> 70 years 12.2	10.5	NS			
Curet et al. [87]	11	10	NS	Length 26	25	–
Stage et al. [94]	7	8	–	Margins 4	4	
Lacy et al. [93]	13	12.5	NS			
3						
Lezoche et al. [84]	RHC 14.2	13.8	NS	Length 28.3	29.1	NS
	LHC 9.1	8.6	NS	Length 22.9	24.1	NS
				LHC TFM 5.2	5.3	NS
Bouvet et al. [88]	8	10	NS	Prox 10	10	NS
				Dist 6	9	0.03
Hong et al. [112]	7	7	NS	Dist 7.9	7.2	NS
Koehler et al. [113]	14	11	–	Length 24.1	22.6	–
				Prox 13.2	10.1	–
				Dist 7.9	8.6	–
Psaila et al. [117]	7.0	7.7	NS			
Khalili et al. [90]	12	16	–			
Lezoche et al. [75]	10.7	11	NS	Length 26.8	29.4	NS
				LHC TFM 5.2	5.3	NS
Marubashi et al. [91]				LoD 1.7	2.25	< 0.01
Bokey et al. [95]	17	16	NS	Prox 10.1	11.0	NS
				Dist 10.0	13.4	0.03
Franklin et al. [116] Santoro et al. [114]	NA	NA	NS	NA	NA	NS
Leung et al. [92]	9 [a)]	8 [a)]		Dist 3 [a)]	3.5 [a)]	

Results are given as the mean
NS not significant, *NA* not available, *Length* length of resected specimen, *Prox* proximal resection margin, *Dist* distal resection margin, *TFM* tumor-free margin, *LoD* level of dissection
[a)] Median

Clinical Outcome

Short-Term Outcome

Morbidity

The reported morbidity and mortality rates for open conventional colorectal surgery range from 8 to 15% and from 1 to 2%, respectively [96]. Serious complications include anastomotic leakage, bowel obstruction, and abdominal and pulmonary infection.

Table 8.5 summarizes the studies describing morbidity following laparoscopic colectomy. Data from the RCT indicated a significantly lower overall complication rate after laparoscopic surgery [5, 89, 93]. In a subset analysis comparing laparoscopic to open resection, reduction of postoperative morbidity after laparoscopic resection was more pronounced than in patients under 70 years of age [5].

Table 8.5. Morbidity

Study	Laparoscopic (%)	Open (%)	*p* value
2			
Lacy et al. [89]	11	29	0.001
Milsom et al. [77]	15	15	NS
Delgado et al. [5]	10.9	25.6	0.001
	<70 years 11.4	20.3	NS
	>70 years 10.2	31.3	0.0038
Curet et al. [87]	1.5	5.28	NS
Stage et al. [94]	11	0	–
Lacy et al. [93]	8	30.8	0.04
Schwenk et al. [111]	7	27	0.08
3			
Lezoche et al. [84]	RHC 1.9	2.3	NS
	LHC 7.5	6.3	NS
Bouvet et al. [88]	24	25	NS
Hong et al. [112]	Major 15.3	14.6	NS
	Minor 11.2	21.5	0.029
Khalili et al. [90]	19	22	NS
Lezoche et al. [75]	13	14.3	NS
	Minor 3.6	7.5	NS
	Major 9.4	6.8	NS
Marubashi et al. [91]	27.5	25	–
Bokey et al. [95]	NA	NA	NS
Franklin et al. [116]	Early 17	23.8	NA
	Late 5.2	8.9	
Santoro et al. [114]	Early 28	28	–
	Late 12	0	
Leung et al. [92]	26	30	NS

NS not significant

Table 8.6. Complication rates in an analysis of 11 studies

Complication	*n*	Percentage
Wound infections	30	5.7
Respiratory	16	3.1
Cardiac	15	2.9
Hemorrhage	10	1.9
Anastomotic leaks	8	1.5
Urinary tract infections	3	0.6
Small bowel perforations	3	0.6
Port site herniation	2	0.4
Hematoma	2	0.4
Septicemia	1	0.2
Peritonitis	1	0.2
Anastomotic stricture	1	0.2
Anastomotic edema	1	0.2
Hypoxia	1	0.2
Acute renal failure	1	0.2
Uncompensated renal insufficiency	1	0.2
Urinary retention	1	0.2
Deep vein thrombosis	1	0.2
Small bowel obstructions	1	0.2
Phlebitis	1	0.2
Intraabdominal abscesses	1	0.2

Morbidity of laparoscopic resection of colonic cancer has not been reported in sufficient detail by most authors [97]. Specific complications of laparoscopic surgery involve vascular and visceral injuries, trocar site hernias [98, 99], and transection of the ureter [79]. Vascular injuries may be caused by blind introduction of the Veress needle or first trocar [78, 79, 97, 100]. Winslow et al. reported incisional hernias at the extraction site in 19% after laparoscopic colectomy, whereas incisional hernias occurred in almost 18% after open colectomy [101].

Experience is an important factor in preventing complications, as shown in three studies that reported lower morbidity with increasing experience [56, 74, 85]. Arecent systematic review [96] analyzed morbidity as reported in 11 studies [92–94, 102–109] (Table 8.6). The infectious complications of laparoscopic colectomy have not been assessed by large-scale prospective randomized studies. Wound infection at the extraction site was encountered in 14% of patients after laparoscopic colectomy vs 11% of patients after open colectomy [101].

Statement 15: Morbidity

Morbidity after laparoscopic colectomy does not differ from that after open colectomy (level of evidence: 2b).

Mortality

Mortality rates, defined as death within 30 days after surgery, are similar for both open and laparoscopic colectomy. However, no randomized controlled trials on laparoscopic vs open colectomy have yet been conducted with sufficient numbers to distinguish small differences. In two RCT, a 0% mortality rate was reported for both open and laparoscopic procedures [102, 110]. In the RCT by Schwenk et al. [111], one death occurred in the conventional group and none in the laparoscopic group. In another RCT, three deaths occurred, but this study failed to report to which group these patients were assigned to and the causes of death [94].

In nonrandomized reports, mortality was reported in only five studies [95, 104, 112–114]. None of these studies showed any significant differences between the open and laparoscopic groups, although the cohorts were too small to detect small differences.

Statement 16: Mortality

Mortality of laparoscopic colectomy appears similar to that of open colectomy (level of evidence: 2b).

Recovery

Length of Hospital Stay

Many factors determine length of hospital stay after surgery, and length of stay differs by country and hospital. Clinical condition of the patient is only one such factor. Type of insurance, social and economic status, and perception of postoperative recovery by both surgeon and patient are also important factors. Table 8.7 summarizes all studies comparing length of hospital stay after laparoscopic and open colectomy for cancer. The COST trial reported by Weeks et al. [115] is currently the multicenter RCT with the highest power and most published data. In this trial, a highly significant shorter hospital stay was found after laparoscopic colectomy (5.6 ± 0.26 vs 6.4 ± 0.23 days, $p < 0.001$), even though the analysis was performed on an intention-to-treat basis and patients converted to open operation were included in the laparoscopic group.

Six other RCT reported on length of hospital stay [5, 77, 87, 93, 94, 102]. In four RCT, a significant earlier hospital discharge was reported for the laparoscopic group [5, 87, 93, 94]. In one RCT with a sample size of 16, no statistical analysis was performed [102]. Median and range of length of hospital stay did not differ in this study (6 days [5–7] vs 7 days [4–9]). In one RCT, the difference was not significant [77].

Table 8.7. Length of hosipital stay (in days)

Study	Laparoscopic	Open	*p* value
1			
Weeks et al. [115]	5.6 ± 0.26	6.4 ± 0.23	< 0.001
2			
Hewitt et al. [102]	6 (57)	7 (4–9)	–
Milsom et al. [77]	6.0 (3–37)	7.0 (524)	NS
Delgado et al. [5]	< 70 years 5	7	0.0001
	> 70 years 6	7	0.0009
Curet et al. [87]	5.2	7.3	< 0.05
Stage et al. [94]	5 (3–12)	8 (5–30)	0.01
Lacy et al. [93]	5.2 ± 1.2	8.1 ± 3.8	0.0012
3			
Lezoche et al. [84]	RHC 9.2	13.2	0.001
	LHC 10.0	13.2	0.001
Bouvet et al. [88]	6 (2–35)	7 (4–52)	< 0.01
Hong et al. [112]	6.9 ± 5.4	10.9 ± 9.3	0.003
Koehler et al. [113]	8.1 (6–14)	15.3 (9–23)	–
Psaila et al. [117]	10.7 ± 4.7	17.8 ± 9.5	0.001
Khalili et al. [90]	7.7 ± 0.5	8.2 ± 0.2	NS
Lezoche et al. [75]	10.5	13.3	0.027
Marubashi et al. [91]	18.7	35.8	< 0.0001
Franklin et al. [116]	< 50 years 5.2 (2.0–9.2)	9.35 (517)	–
		12.85 (941)	
	> 50 years 7.84 (448)		
Leung et al. [92]	6 (3–22)	8 (3–28)	< 0.001

Results given as mean ± SD or median (range)
NS not significant

In the nonrandomized comparative studies, hospital stay after laparoscopic surgery varies from 5.7 to 18.7 days and between 8 and 35.8 days after open surgery [75, 84, 88, 90–92, 112, 113, 116, 117]. In all these studies, hospital stay was shorter in the laparoscopic group, although in three studies the differences were not significant [90, 113, 118]. Differences in hospital stay between laparoscopic and open colectomy groups vary from 1 to 7 days.

A recent article by Wilmore et al. [119] reviewed fast-track surgery for open procedure. Fast-track surgery is a multimodal approach that combines various techniques used in the perioperative care of patients to achieve a faster recovery and discharge after surgery. Methods include epidural or regional anesthesia, optimal pain control, early enteral feeding, and early mobilization. This Danish research group managed to shorten the postoperative hospital stay to 2 days after conventional open colectomy. So far, this approach has not been studied for patients undergoing the laparoscopic resection of colon cancer.

Statement 17: Length of hospital stay

Hospital stay after laparoscopic resection of colon cancer is shorter than after open colectomy (level of evidence: 1a).

Postoperative Pain

Postoperative pain is an endpoint that impacts on the perceived health status, quality of life, hospital stay, and resumption of normal activities. In general, less postoperative pain is perceived after endoscopic surgery than after open surgery. In one RCT, statistically significantly less pain at rest after laparoscopic resection of colonic cancer was observed for 30 days or fewer postoperatively, when compared to open colectomy [94]. Also pain during mobilization was reported to be less severe. The number of patients included in this trial, however, was limited and the methodology used was flawed because the intention-to-treat principle was violated. Similar results were obtained by another RCT [113]. This study showed differences in pain at rest and during mobilization for 12 days or fewer, but these differences were not significant. In a recent RCT, postoperative pain was analyzed using the Symptoms Distress Scale, which includes self-reported symptoms such as pain, along with the duration of use of analgesics [115]. In this study, only a shorter duration of use of analgesics was observed in the laparoscopic arm.

Statement 18: Pain

Pain is less severe after laparoscopic colectomy (level of evidence: 2a).

Postoperative Analgesia

The need for analgesics after surgery can be measured in several ways. Table 8.8 summarizes all studies comparing postoperative analgesia after laparoscopic or open resection of colon cancer. Some authors assessed the number of pills or injections per day [75, 77, 92], whereas others recorded the number of days the patient needed analgesics [91, 95, 112]. In the COST trial, patients in the laparoscopic arm required parenteral and oral analgesics for a shorter period of time [115]. In another RCT, significantly less morphine was used in the laparoscopic groups only on the 1st postoperative day [77]. In all other studies, the laparoscopic group used fewer analgesics, although the difference was not always significant [75, 91, 92, 95, 102, 112, 120].

Table 8.8. Postoperative analgesia

Study			Laparoscopic	Open	*p* value
1					
Weeks et al. [115]	Oral (days)		2.2 ± 0.15	1.9 ± 0.15	0.03
	Parenteral (days)		4.0 ± 0.16	3.2 ± 0.17	< 0.001
2					
Milsom et al. [77]	Morphine	Day 1	0.78 ± 0.32	0.92 ± 0.34	0.02
		Day 2	0.4 ± 0.29	0.50 ± 0.31	NS
		Day 3	0.39 ± 0.32	0.36 ± 0.24	NS
Schwenk et al. [120]	PCA (morphine)	Cumulative dose until day 4	0.78 (0.24–2.38)	1.37 (0.71–2.46)	< 0.01
Hewitt et al. [102]	Morphine	Cumulative dose until day 2	27 (0–60)	62 (28–88)	0.04
3					
Hong et al. [112]	Days till stop iv or im analgesia		2.7 ± 1.5	3.2 ± 2.0	0.021
Lezoche et al. [75]	Analgesics in percentage of patients	Day 1	75%	98%	< 0.001
		Day 2	49%	91%	0.001
		Day 3	10%	71%	< 0.001
		Day 4	0.7%	49%	< 0.001
		Day 5		21%	
Marubash et al. [91]	Days till stop epidural		2.98	4.04	< 0.05
	No. of pills		1.49	2.68	NS
Bokey et al. [95]	Days till stop (parental analgesia)		4.4	4.9	NS
Leung et al. [92]	No. of injections		3 (0–16)	6 (0–32)	< 0.001

NS not significant
Results given as mean ± SD or median (range)

Statement 19: Postoperative use of analgesics

Less analgesia is needed after laparoscopic colectomy than after open colectomy (level of evidence: 1b).

Gastrointestinal Function

Resumption of intestinal function can be measured by several parameters: time to first bowel movement, first passage of flatus or defecation (Table 8.9), and time to resume intake of liquid or solid foods (Table 8.10). In the RCT, data on passage of first flatus and defecation are consistent with a faster re-

Table 8.9. Gastrointestinal function

Study	Flatus/defecation (days)			Bowel movement		
	Laparo-scopic	Open	*p* value	Laparo-scopic	Open	*p* value
2						
Lacy et al. [89]				36 ± 31	55 ± 40 h	0.001
Milsom et al. [77]	3 (0.8–8)	4 (0.8–14)	0.006	4.8 (1.5–8)	4.8 (1.5–14.5)	NS
Delgado et al. [5]				< 70 years 35 ± 36 > 70 years 37 ± 19	53 ± 26 57 ± 33	0.0007 0.0005
Lacy et al. [93]	35.5 ± 15.7 h	71.1 ± 33.6 h	0.0001			
Schwenk et al. [156]	50 ± 19	79 ± 21	< 0.01	70 ± 32	91 ± 22	< 0.01
3						
Lezoche et al. [84]	Flatus					
	RHC 2.9	3.0	NS			
	LHC 2.7	3.5	< 0.0001			
	Defecation					
	3.5	4.0	< 0.0001			
	3.8	5.2	< 0.0001			
Hong et al. [112]	3 ± 1.7	4.1 ± 1.8	< 0.0001	3.5 ± 2	4.9 ± 2.1	< 0.0001
Koehler et al. [113]	3.4 (2–5)	5.8 (3–7)	–			
Lezoche et al. [75]	3.0	3.7	NS	3.4	4.5	0.036
Marubashi et al. [91]	2.1	3.75	< 0.0001			
Bokey et al. [95]	4.5	4.4	NS	4.9	5.5	NS

Results given as mean ± SD or median (range)
NS not significant

covery in the laparoscopic group. In two studies, the differences were not significant [75, 103]. In all RCT, first bowel movement and resumption of diet were earlier after laparoscopic colorectal surgery.

Statement 20: Gastrointestinal function and start of postoperative oral intake

Gastrointestinal function recovers earlier after laparoscopic colectomy (level of evidence: 2b).

Pulmonary Function

Laparoscopic surgery causes less impairment of pulmonary function, enabling faster recovery. Postoperative pulmonary function after laparoscopic cholecystectomy, as compared to the open counterpart, is improved [121].

Table 8.10. Start of postoperative oral intake

Study	Parameter	Laparoscopic	Open	*p* value
2				
Lacy et al. [89]	Oral intake	54 ± 42	85 ± 67	0.001
Delgado et al. [5]	Oral intake	< 70 years 50 ± 45 > 70 years 59 ± 33	59 ± 33 81 ± 48	0.0001 0.002
Curet et al. [87]	Clear liquids	2.7	4.4	< 0.05
	Regular diet	4.1	5.8	< 0.05
Lacy et al. [93]	Oral intake	50.9 ± 20	98.8 ± 48.6	0.0001
Schwenk et al. [156]	Regular diet	3.3 ± 0.7	5.0 ± 1.5	< 0.01
3				
Hong et al. [112]	Fluids	2.1 ± 1.8	4.0 ± 2.0	< 0.0001
	Solid food	5.2 ± 3.1	7.1 ± 2.8	< 0.0001
Koehler et al. [113]	Regular diet	3.2 (2–6)	6.2 (4–10)	–
Khalili et al. [90]	Oral intake	3.9 ± 0.1	4.9 ± 0.1	0.001
Lezoche et al. [75]				
Marubashi et al. [91]	Oral intake	5.13	10.04	< 0.0001
Bokey et al. [95]	Fluids	4.3	4.2	NS
	Full diet	6.9	7.6	NS
Leung et al. [92]	Normal diet	4 (2–20)	4 (3–17)	NS
Van Ye et al. [99]	Normal diet	4.8	7.2	0.001

Results given as mean ± SD at median (range)
NS not significant

Postoperative pulmonary function after colorectal resection has been investigated in an RCT by Schwenk et al. [111]. Parameters shown in Table 8.11 were measured preoperatively and at different time points postoperatively. Forced vital capacity and forced expiratory volume were more profoundly impaired in patients who underwent conventional resections than in the laparoscopic group. Similar results were found for the peak expiratory flow and the midexpiratory phase of the forced expiratory flow. Also, the postoperative oxygen saturation was lower in the conventional group than in the laparoscopic group. Two pneumonias occurred in the conventional group vs none in the laparoscopic group. The difference was not significant, but the sample size of the study was only 30 patients.

Postoperative pulmonary function was investigated in two other RCT. Milsom et al. [122] found a significantly earlier postoperative recovery of pulmonary function after laparoscopic surgery. The RCT conducted by Stage et al. [94] showed no significant differences between the two groups in pulmonary function.

Table 8.11. Postoperative pulmonary function

Study	Parameter	Laparoscopic	Open	*p* value
1				
Schwenk et al. [111]	FVC (p.o. day 1)	2.59 ± 1.11	1.73 ± 0.60	< 0.01
	FEV1 (p.o. day 1)	1.80 ± 0.80	1.19 ± 0.51	< 0.01
	PEF (p.o. day 1)	3.60 ± 2.22	2.51 ± 1.37	< 0.05
	FEF 25–75% (p.o. day 1)	2.67 ± 1.76	1.87 ± 1.12	< 0.05
	SaO2 (%) (p.o. day 1)	93.8 ± 1.9	92.1 ± 3.3	
2				
Milsom et al. [77]	FEV1 and FVC (days till 80% recovery of pre-operative values)	3.0	6.0	0.01
Stage et al. [94]	FEV1	NA	NA	NS
	FVC	NA	NA	
	PEF	NA	NA	

Results given as mean ± SD or median (range)
p.o. postoperative, *NS* not significant, *FVC* forced vital capacity, *FEV1* forced expiratory volume in 1, *PEF* peak expiratory flow, *FEF 25–75%* forced expiratory flow at 25–75% of forced vital capacity, SaO_2 arterial oxygen saturation

Statement 21: Postoperative pulmonary function

Postoperative pulmonary function is less impaired after laparoscopic resection of colon cancer (level of evidence: 1b).

Return to Work and Daily Activities

The parameters of early recovery are strongly influenced by societal and economic organization of health care within a community. This may explain the wide variability between studies. Only in randomized trials can one assume that these factors are evenly distributed in both groups. None of the available randomized trials addressed this topic.

Long-Term Outcome of Laparoscopic Colectomy

Recently, Lacy et al. [89] published the results of their single-center randomized controlled trial on laparoscopic curative resection of colon cancer. In this study of 219 patients, 111 underwent laparoscopic colectomy. A significantly better 3-year cancer-related survival was found in the laparoscopically operated patients than in the open group (91 vs 79%, respectively). This difference in survival could be attributed mainly to the markedly better survival

Table 8.12. Overall survival rates

Study	Follow-up	Laparoscopic (%)	Open (%)	*p* value
2				
Lacy et al. [89]	43 months	82	74	NS
3				
Leung et al. [104]	21.4 months (median)	90.9 (*n*=28)	55.6 (*n*=56)	NS
Leung et al. [92]	32.8 months (median)	67.2 (*n*=50)	64.1 (*n*=50)	NS
Khalili et al. [90]	19.6 months	87.5 (*n*=80)	85 (*n*=90)	NS
Santoro et al. [114]	5 years	72.3 (*n*=50)	68.8 (*n*=50)	NS
Hong et al. [112]	Lap 30.6 months Open 21.6 months	NA (*n*=98)	NA (*n*=219)	NS
4				
Delgado et al. [157]	42 months	AR 83, SR 87 (*n*=31)		
Cook and Dehn [158]	Until patient's death	20 (*n*=5)		
Hoffman et al. [159]	2 years	Node–: 92 (*n*=89) Node +: 80%		
Molenaar et al. [160]	3 years	All: 59, by Dukes' stage (*n*=35): A=86, B=66, C=68, D=0		
Quattlebaum et al. [161]	8 months	90 (*n*=10)		
Poulin et al. [155]	Stages I–III: 24 months Stage IV: 9 months	81		

NS not significant, *AR* anterior resection, *SR* sigmoid resection

in stage III colon cancer patients. Follow-up data of large multicenter randomized controlled trials the (CLASICC [123], COST [124], and COLOR [125] trials) will provide a more definitive assessment of survival after laparoscopic vs open colon resections.

In smaller nonrandomized comparative studies, no significant differences in disease-free and overall survival have been observed between open and laparoscopic patient groups (Tables 8.12, 8.13). No significant differences were found between open and laparoscopically operated patients in a nonrandomized matched control study with 5-year follow-up [104]. Another study using historical controls also showed no difference in long-term survival, with survival rates of 64.1 and 67.2% in the open and laparoscopic arms, respectively [92]. In a further six comparative studies, no differences of overall survival were found between laparoscopic and open resections of colon cancer [84, 88, 112, 114, 116, 126].

Table 8.13. Disease-free survival rates

Study	Follow-up	Laparoscopic (%)	Open (%)	*p* value
2				
Lacy et al. [89]	43 months	91	79	0.03
3				
Leung et al. [104]	5 years	95.2	74.7	NS
Leung et al. [92]	4 years	80.5	72.9	NS
Feliciotti et al. [126]	48.9 months	86.5	86.7	NS
Lezoche et al. [84]	42.2 months 42.3 months	RHC 78.3 LHC 94.1	75.8 86.8	NS
Bouvet et al. [88]	26 months	93	88	NS
Santoro et al. [114]	NA	73.2	70.1	NS
Hong et al. [112]	Lap 30.6 months Open 21.6 months	NA	NA	NS
Franklin et al. [116]	5 years	87	80.9	NS
4				
Delgado et al. [157]	42 months	AR: 78 SR: 70		
Hoffman et al. [159]	2 years	Node–: 96 Node +: 79		

NS not significant

Statement 22: Overall and cancer-related disease-free survival

Cancer-related survival after laparoscopic resection appears to be at least equal to open resection (level of evidence: 2a).

Port Site Metastases After Laparoscopic Colectomy

Early reports of port site metastases after laparoscopic resection of colonic cancer generated considerable concern in the surgical community in the early 1990s. Initial enthusiasm for the laparoscopic approach to colon cancer was replaced by skepticism. Abdominal wall recurrence after open colectomy was considered to be rare – approximately 0.7% according to a retrospective study by Hughes et al. [127]. However, Cass et al. reported abdominal wall recurrence in 2.5% of patients after open resection of colon cancer [128], and Gunderson et al. showed that two-thirds of abdominal wall recurrences are missed by physical examination of the abdominal wall [129]. At second-look laparotomy 3 months after the open curative resection of colon cancer, 3.3% of patients suffered a recurrence in the abdominal wall.

In the literature on laparoscopic resection of colon cancer published before 1995, high incidences of port site metastasis were reported, ranging

from 0.6 to 21% [130–133]. In a review of data from reports on laparoscopic resection of colon cancer published later, a much lower rate of 0.85% was recorded in an analysis of 1,769 operation [23]. Wittich et al. [134] analyzed data from 16 studies, including a total of 3,547 patients, 30 of whom (0.85%) developed port site metastases. In a recent systematic review, 11 port site metastases were found in 1,114 operations, translating to an incidence of 1% [96]. The high incidences of port site metastasis in early reports on laparoscopic surgery appear to reflect inexperience with the technique, such that an oncologically appropriate operation was not performed. The details of the published port site metastases are shown in Tables 8.14 and 8.15.

Table 8.14. Port site metastasis after resection of colorectal carcinoma

Study	Design	*n*	Follow-up	PSM
Lacy et al. [89]	RCT	111	Median 43	1
Milsom et al. [77]	RCT	42	Median 18	0
Lacy et al. [110]	RCT	31	21	40
Ballantyne [162]	Registry	498	NA	3
Fleshman et al. [163]	Registry	372	NA	4 (1.3%)
Rosato et al. [164]	Registry	1071	NA	10 (0.93%)
Vukasin et al. [165]	Registry	480	>12	5 (1.1%)
Schledeck et al. [152]	Registry	399	Mean 30	1 (0.25%)
Leung et al. [108]	Prospective	217	Mean 19.8	1 (0.65%)
Poulin et al. [155]	Prospective	172	Mean 24	0
Franklin et al. [116]	Prospective	191	>30	0
Bouvet et al. [88]	Prospective	91	26	0
Feliciotti et al. [126]	Prospective	158	Mean 48.9	2
Bokey et al. [103]	Retrospective	66	Median 26	1 (0.6%)
Fielding et al. [86]	Retrospective	149	NA	2 (1.5%)
Gellman et al. [166]	Retrospective	58	NA	1 (1.7%)
Hoffman et al. [159]	Retrospective	39	24	0
Huscher et al. [80]	Retrospective	146	Mean 15	0
Leung et al. [92]	Retrospective	50	>32	1
Khalili et al. [90]	Retrospective	80	Mean 21	0
Kwok [167]	Retrospective	83	NA	2 (2.5%)
Leung et al. [108]	Retrospective	179	Mean 19.8	1 (0.65%)
Lord et al. [98]	Retrospective	71	Mean 16.7	0
Lumley et al. [82]	Retrospective	103	NA	1 (1.0%)
Khalili et al. [90]	Retrospective	80	Mean 19.6	0
Guillou et al. [168]	Retrospective	59	NA	1 (1.7%)
Larach et al. [56]	Retrospective	108	Mean 12.6	0
Croce et al. [169]	Retrospective	134	NA	1 (0.9%)
Kawamura et al. [170]	Retrospective	67 (gasless)	NA	0
		5305		38 (0.72%)

PSM port site metastases

Table 8.15. Case reports on port site metastasis

Study	Year	Duke's stage	Months to recurrence
Alexander et al. [171]	1993	C	3
O'Rourke et al. [172]	1993	B	10
Walsh et al. [173]	1993	C	6
Fusco et al. [174]	1993	C	10
Cirocco et al. [175]	1994	C	9
Nduka et al. [176]	1994	C	3
Prasad [176]	1994	B	6
		A	26
Berends et al. [130]	1994	B	NA
		C	NA
		D	NA
Lauroy [177]	1994	A	9
Ramos et al. [178]	1994	C	NA
		C	NA
		C	NA
Cohen et al. [179]	1994	B	3
		B	6
		C	6
		C	9
		C	12
Jacquet et al. [180]	1995	B	10
		B	9
Montorsi et al. [25]	1995	B	2

Statement 23: Port site metastasis

The incidence of port site metastases after laparoscopic colectomy is below 1% (level of evidence: 2c).

Quality of Life

Health-related quality of life associated with laparoscopic colon resection for malignancy has been addressed only by Weeks et al. [115]. The investigators used the Symptoms Distress Scale, Quality of Life Index (QLI), and a global rating scale. The only statistically significant difference reported was the global rating scale score 2 weeks postoperatively (p=0.009). In this study, both the global rating scale and the QLI were not employed during the first two postoperative weeks, despite the probability that differences in quality of life are likely to be most evident and most pronounced in the early days after surgery.

Costs

The issue of costs associated with the implementation of health care technologies is of increasing importance. Not only are financial demands on health care increasing, but at the same time health budgets are limited. Currently, there are no prospective cost-effectiveness evaluations available for laparoscopic colon resection. Some evaluations are currently being conducted alongside large multicenter RCT. In the CLASICC [123], COST [124], and COLOR [125] trials, cost-effectiveness of the two approaches is being evaluated. Such analyses include both direct costs (costs primarily associated with treatment) and indirect costs (costs secondarily related to disease or treatment).

Direct Costs

In-hospital costs need to be carefully evaluated. In a retrospective review, the in-hospital costs of laparoscopically assisted right hemicolectomy were compared to the costs of open colectomy [135]. Costs were collected only from the time of operation until the time of discharge and thus reflected only hospital costs. This study reported higher direct costs for laparoscopic hemicolectomy than for open hemicolectomy due to increased operating time and the use of disposables (AUD 9,064 vs AUD 7,881, respectively). A review of the hospital costs of laparoscopic colectomy concluded that the shorter hospital stay in the laparoscopy arm more than compensated for the increased operating room costs, resulting in lower total hospital costs for laparoscopic colectomy (USD 9,811 vs USD 11,207) [136]. This evaluation included operations for both benign and malignant disease of the colon. In a prospective study, direct in-hospital costs for laparoscopic colectomy were also lower than those for open surgery (DEM 5,400 vs DEM 7,500) [113]. However, this large study included operations for both benign and malignant colorectal disease and violated the intention-to-treat principle.

Out-of-Hospital Costs

Out-of-hospital costs, such as visits to outpatient clinics, home care, and visits to family doctors, have not yet been estimated for laparoscopic colectomy.

Indirect Costs

The preferred method of cost analysis is to evaluate cost-effectiveness from a societal perspective. This implies the measurement of indirect costs. The most important indirect costs are incurred from patients who are employed but are unable to work, causing loss of productivity. One might argue

that a faster recovery would lead to patients returning to work earlier. Koehler et al. reported that such costs were lower for laparoscopic colectomy (DEM 1,600) than for open colectomy (DEM 2,200).

Cost-Effectiveness

For policy making and the implementation of new techniques, one must assess both the costs associated with this technique as well as the effects of this technique and its widespread safe applicability. Survival is the most important endpoint after the resection of colon cancer. The differences in costs between laparoscopic and open colorectal surgery have to be assessed in the context of survival rates obtained by the two approaches. The next endpoint in order of importance is quality of life. The calculation of quality-adjusted life years combines both. No cost-effectiveness studies have been reported.

Statement 24: Costs

The operative costs for the laparoscopic resection of colon cancer are higher because of a longer operating time and the use of more expensive (disposable) devices (level of evidence: 3b).

Postoperative Stress Response

Stress Response After Laparoscopy

Laparoscopic surgery induces less trauma than conventional surgery and is thus likely to depress the immune response to a lesser extent. The preservation of the peritoneal and systemic immune system is important to prevent infections, sepsis, and the implantation of tumor cells to the traumatized tissues. In general, open surgery appears to inflict a greater nonspecific depression of the immune response than the laparoscopic approach.

Carbon dioxide pneumoperitoneum may impair the local immunity of the peritoneal lining. Peritoneal macrophages produce less cytokines [31, 32], and their intrinsic function (phagocytosis) [137, 138] diminishes on exposure to carbon dioxide insufflation.

Systemic immunity is depressed to a lesser extent by laparoscopic surgery than conventional open surgery. Both experimental and clinical studies on delayed-type hypersensitivity (DTH) response [139, 140], production of cytokines [141], and expression of HLA-DR receptors [139, 142] have confirmed this.

Stress Response During Colectomy

It has been suggested that survival may be improved if immunosupression induced by surgery could be reduced or eliminated [143]. The acute-phase response is a good index of the immune status of patients. Production of acute-phase proteins by hepatocytes often increases 1,000-fold, as does C-reactive protein (CRP) after tissue injury. This reaction of liver cells is induced by corticoids and cytokines, of which interleukin-6 (IL-6) is the main activator. During recovery, the levels of acute-phase proteins normalize. This acute-phase reaction has been measured in most studies by monitoring the levels of IL-6 and CRP (Tables 8.16, 8.17).

Most studies demonstrated lower IL-6 levels after laparoscopic colorectal resection compared with open conventional surgery [102, 142, 144–149]. Only one study reported a significant raise in IL-6 serum level after laparoscopic sigmoidectomy [150]. Although IL-6 was lower after laparoscopic colectomy, studies have shown conflicting CRP data (Table 8.17).

In addition to cytokines, other cell-related parameters, such as DTH and CD4/CD8 markers, have been assessed after laparoscopic colectomy, with no significant changes reported between laparoscopic and open colorectal surgery [102, 151].

Table 8.16. Measurements of plasma interleukin-6 (IL-6) levels (pg/ml)

Study	Preoperative	Laparoscopic	Open	*p* value
1–2				
Ordemann et al. [142]	NA	Significantly lower after laparoscopy		< 0.01
Schwenk et al. [144]	4.25 (3.4–7.7)	34.0 (25.6–48.7)	50.5 (39.8–75.7)	0.03
Hewitt et al. [102]	NA	173 ± 156	313 ± 294	0.25
Wu et al. [145]	NA	83 ± 7	105 ± 33	< 0.05
3				
Sietses et al. [146]	1.75 ± 1.64	85.6 ± 82.3	132.1 ± 143.8	NS
Fukushima et al. [150]	NA	Significantly higher after laparoscopy		< 0.05
Delgado et al. [149]	NA	239.5 (49.1–645.7)	372.7 (31.4–3.226)	< 0.05
Nishiguchi et al. [147]	NA	Significantly lower after laparoscopy		< 0.05

Results given as mean ± SD or median (range)
NS not significant

Table 8.17. Measurements of plasma C-reactive protein (mg/dl)

Study	Preoperative	Laparoscopic	Open	*p* value
1–2				
Schwenk et al. [144]	NA	40 (33.0–49.4)	61.2 (52.0–77.9)	0.002
Wu et al. [145]	6.4	NA	NA	NS
3				
Fukushima et al. [150]	NA	NA	NA	NS
Delgado et al. [149]	NA	6.9 ± 4.5	9.1 ± 4.8	0.01
Nishiguchi et al. [147]	NA	Significantly lower after laparoscopy		0.05

Results given as mean ± SD or mean (range)
NS not significant

Statement 25: Stress response

Stress response after laparoscopic colectomy is lower (level of evidence: 1b).

Table 8.18. Summary of all statements and recommendations

	No.	Statements and recommendations	Level of evidence	Grade of recommendation
Preoperative evaluation and selection of patients				
Recommendation	1	Preoperative imaging studies of colon cancer to assess the size of the tumor, possible invasion of adjacent structures, and localization of the tumor are recommended in laparoscopic surgery for colon cancer	5	D
Statement	2	Age only is not a contraindication for laparoscopic resection of colon cancer	2b	–
Recommendation	3	Invasive monitoring of blood pressure and blood gases is mandatory in ASA II–IV patients (no consensus: 91% agreement among experts). Low-pressure (< 12 mmHg) pneumoperitoneum is advocated in ASA II–IV patients		A B

Table 8.18 (continued)

	No.	Statements and recommendations	Level of evidence	Grade of recommendation
Statement	4	Obesity is not an absolute contraindication, but the rates of complications and conversions are higher at BMI > 30 (no consensus: 93% agreement among experts)	2c	–
Recommendation	5	Potentially curative resections of colonic cancer suspected of invading the abdominal wall or adjacent structures should be undertaken by open surgery (no consensus: 83% agreement among experts)	5	D
Statement	6	Adhesions do not appear to be a contraindication to laparoscopic colectomy	4	–
Operative technique				
Statement	7	Placement of trocars is based on the experience and the preference of the individual surgeon	5	–
Recommendation	8	High-quality videoscopic imaging is strongly recommended	5	D
Statement	9	Proper surgical technique and practice reduces the likelihood of port site metastasis	5	–
Recommendation	10	Preoperative tattooing of small colon tumors is advised. The alternatives are intra-operative colonoscopy or preoperative colonoscopic clipping followed by pre-operative fluoroscopy or ultrasonography	5	D
Recommendation	11	Dissection of the mesocolon from medial to lateral is the preferred approach in laparo-scopic colonic surgery. Intra-operative results of laparo scopic resection of colon cancer	5	D

Table 8.18 (continued)

	No.	Statements and recommendations	Level of evidence	Grade of recommendation
Statement	12	Laparoscopic colectomy is converted to open surgery in 14% of cases (0–42%). The most common causes of conversion are tumor invasion of adjacent structures or bulky tumor, adhesions, and technical failure	3a	–
Statement	13	Laparoscopic colectomy requires more operating time than open colectomy	2a	–
Statement	14	The extent of laparoscopic lymphadenectomy and bowel resection is similar to those obtained by open colectomy	2b	–
Clinical outcome				
Statement	15	Morbidity after laparoscopic colectomy does not differ from that after open colectomy	2b	–
Statement	16	Mortality of laparoscopic colectomy appears to be similar to that of open colectomy	2b	–
Statement	17	Hospital stay is shorter after laparoscopic resection of colon cancer than after open colectomy	1a	–
Statement	18	Pain is less severe after laparoscopic colectomy	2a	–
Statement	19	Less analgesia is needed after laparoscopic colectomy compared to open colectomy	1b	–
Statement	20	Gastrointestinal function recovers earlier after laparoscopic colectomy	2b	–
Statement	21	Postoperative pulmonary function is less impaired after laparoscopic is open resection of colon cancer	1b	–
Statement	22	Cancer-related survival after laparoscopic resection appears to be at least equal to open resection	2a	–
Statement	23	The incidence of port site metastases after laparoscopic colectomy is $<1\%$	2c	–

Table 8.18 (continued)

	No.	Statements and recommendations	Level of evidence	Grade of recommendation
Costs				
Statement	24	The operative costs for the laparoscopic resection of colon cancer are higher because of a longer operating time and the use of more expensive (disposable) devices	3b	–
Postoperative stress response				
Statement	25	Stress response after laparoscopic colectomy is lower	1b	–

BMI body mass index

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Colonic Cancer – Update 2006

Ruben Veldkamp, M. Gholghesaei, H. Jaap Bonjer, Dirk W. Meijer, M. Buunen, J. Jeekel, B. Anderberg, M. A. Cuesta, Alfred Cuschieri, Abe Fingerhut, J. W. Fleshman, P. J. Guillou, E. Haglind, J. Himpens, Christoph A. Jacobi, J. J. Jakimowicz, Ferdinand Koeckerling, Antonio M. Lacy, Emilio Lezoche, John R. T. Monson, Mario Morino, Edmund A. M. Neugebauer, S. D. Wexner, R. L. Whelan

Definition

No new data available.

Epidemiology and Clinical Course

No new data available.

Diagnostics

No new data available.

Operative Versus Conservative Treatment

No new data available.

Choice of Surgical Approach and Procedure

The choice of surgical approach, laparoscopic or open, in colon cancer is dependent on both short- and long-term results. Since publication of the consensus on laparoscopic resection of colon cancer, one single center and three multicenter randomized controlled trials published their results following laparoscopic versus open surgery for colon cancer. The Clinical Outcomes of Surgical Therapy Study Group (COST) trial [1] and the trial by Leung et al. [2] (Hong Kong) reported the long-term outcome. The Conventional Versus Laparoscopic Assisted Surgery in Patients with Colorectal Cancer (CLASICC) trial [3] and the Colon Cancer Laparoscopic or Open Resection (COLOR) trial [4] published the short-term results. In this update, we will discuss these studies.

Intraoperative and Immediate Postoperative Results

In the COLOR trial [4], a European multicenter randomized study, 1,248 patients with colon cancer were included. The duration of surgery was 32 min longer in the laparoscopic group (202 vs. 170 min, $p < 0.0001$), while blood loss was 75 ml less (100 vs. 175 ml, $p < 0.0001$). Similar differences in intraoperative results between laparoscopic and open colon resection were reported in the Hong Kong trial. The laparoscopic procedure took 45 min longer (189 vs. 144 min, $p < 0.001$), but was associated with less blood loss (169 vs. 238 ml, $p = 0.06$).

After surgery, the recovery of patients was faster following laparoscopic surgery in the COLOR trial: 1 day earlier recovery of bowel movements (3.6 vs. 4.6 days, $p < 0.0001$) and fluid intake (2.9 vs. 3.8 days, $p < 0.0001$) and fewer analgesics requirements. This resulted in a shorter hospital stay (8.2 vs. 9.3 days, $p < 0.0001$). The Hong Kong and CLASICC trials also documented faster postoperative recovery of bowel function, less need for analgesics and shorter hospital stay. The COST [1], COLOR [4], CLASICC [3] and Hong Kong [2] trials did not report a difference in postoperative in-hospital morbidity, mortality, resection margins or number of harvested lymph nodes.

The costs of laparoscopic and open surgery for colon cancer were investigated by Janson et al. [5] in a subset of Swedish patients randomized in the COLOR trial. Costs were calculated up to 12 weeks after surgery. All relevant costs to society were included. Two hundred and ten patients were included in the primary analysis, 98 of whom were operated on laparoscopically and 112 with open surgery. The cost of surgery was significantly higher for the laparoscopic group than for the open group (difference in means € 1,171, $p < 0.001$), as was the cost of the first admission (difference in means € 1,556, $p = 0.015$) and the total costs to the healthcare system (difference in means € 2,244, $p = 0.018$). The total costs to society did not differ significantly between groups (difference in means for laparoscopic versus open surgery € 1,846, $p = 0.104$). Janson et al. [5] concluded that within 12 weeks of surgery for colon cancer, there was no difference in the total costs to society; however, the laparoscopic procedure was more costly to the healthcare system.

The results of the aforementioned large randomized trials confirm the conclusions from the original consensus statement regarding intraoperative and immediate postoperative results of laparoscopic resection of colon cancer compared with those for the open procedure. Laparoscopic surgery for colon cancer is a safe and feasible procedure, improving short-term outcome.

Long-Term Results

Since publication of the consensus on laparoscopic versus open surgery for colon cancer, all major randomized controlled trials no longer include patients and two trials published their results. Results of the trial by Lacy et al. [6] have already been discussed in the consensus.

The COST trial is so far the only large multicenter trial to have published long-term outcome results comparing laparoscopic with open surgery for colon cancer. In this study, 3-year overall and cancer-free survival were not different; however, this trial did not achieve its accrual goal and stopped randomization after 872 patients. Tinmouth and Tomlinson [7] stated that "We can conclude with 95 percent certainty that patients who are treated laparoscopically have at most a 16 percent increase in the risk of death and 11 percent increase in the risk of recurrence." The number of patients treated per center was low, which may have led to learning-curve effects in this trial; therefore, this trial did not close the debate on long-term safety of laparoscopic colon cancer surgery.

Leung et al. [2] included 403 patients with rectosigmoid cancer in a single-center randomized trial. Survival after laparoscopic and open colectomy was similar. The long-term outcomes of the CLASICC and COLOR trials have not yet been published.

It can be concluded that patients with colon cancer who are operated on laparoscopically have similar long-term survival to patients operated on with open surgery. However, a meta-analysis of all major randomized trials is to be performed to achieve the highest level of evidence for this subject. Given the advantages of laparoscopic surgery in the immediate postoperative period, laparoscopy should be implemented in the treatment of colon cancer with curative intent.

Technical Aspects of Surgery

No new data available.

Peri- and Postoperative Care

No new data available.

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The EAES Clinical Practice Guidelines on Obesity Surgery (2005)

Stefan Sauerland, Luigi Angrisani, Mituku Belachew, J.M. Chevallier, Franco Favretti, Nicholas Finer, Abe Fingerhut, Manuel García Caballero, J.A. Guisado Macias, R. Mittermair, Mario Morino, Simon Msika, Francesco Rubino, Roberto Tacchino, Rudolf Weiner, Edmund A.M. Neugebauer

Introduction

Obesity is an increasingly serious health problem in nearly all Western countries [76, 108, 320]. Although various preventive and conservative treatment options are available, it has been estimated that obesity-related illnesses, such as diabetes mellitus, knee osteoarthritis, systemic hypertension and heart failure, are responsible for an estimated 3–6% of total health care costs [6, 230, 279]. A recent study on the association between different grades of obesity and the number of life-years lost indicated that life expectancy can be up to 20 years shorter in severe obesity [104]. The consequences of obesity are by far more severe than those of smoking or alcohol [319].

Definition and classification of obesity is based primarily on the body mass index (BMI), calculated as weight divided by the square of height with kilograms per square meter as the unit of measurement [17]. For Caucasians, a BMI of 30–35 is considered as class 1 obesity, 35–40 as class 2, and over 40 as class 3. Morbid obesity is usually defined as a BMI of over 40 or a BMI over 35 in combination with comorbidities [238]. In addition, some surgeons speak of super- and mega-obesity, if a patient's BMI exceeds 50 or 70, respectively. Alternatively, absolute or relative increases in body weight may be used to define obesity.

Given the enormous importance of morbid obesity and the limited efficacy of dietetic and pharmacological treatments, surgical treatment has become increasingly popular. The number of procedures performed has more than doubled within a few years [64, 78, 289]. This dramatic growth can be attributed in part also to the introduction of new surgical techniques, e.g. the adjustable silicone gastric band (AGB), and the rise of laparoscopic surgery. Traditionally, there are two types of operations for morbid obesity: Gastric restrictive operations (where food intake is restricted) and malabsorptive operations (where aliments are diverted from absorption via a gastrointestinal shortcut). Both types of obesity surgery are now being performed laparoscopically [38]. The aim of these guidelines is to systematically review the clini-

cal effectiveness of the various surgical procedures and to support surgeons and other physicians in the provision of high-quality care for morbidly obese patients.

Methods

Selection of Topics and Experts

Considering the current controversy regarding the best surgical treatment for morbid obesity, the Scientific Committee and the Executive Board of the EAES decided to provide the surgical community with evidence-based guidelines. The aim and focus of these guidelines cover key questions regarding effective and efficient surgical treatment of obesity, including patient selection, choice of surgical technique, management of complications and follow-up.

A panel was appointed to develop clinical practice guidelines and consisted of representatives from key disciplines, i.e. surgeons specialized in obesity treatment, general surgeons, nutritionists, and epidemiologists from across Europe. Experts were selected according to scientific and clinical expertise, geographical localisation, and membership in societies pertaining to laparoscopic obesity surgery. The Obesity Management Task Force of the European Association for the Study of Obesity (EASO) was represented at the complete process by one nominated delegate (N.F.).

Guideline development started with a list of key questions, which all experts were asked to answer. In May 2004, the panel convened to review and discuss the range of answers on the basis of the scientific evidence. The nominal group process was used to develop statements that were agreeable for all or at least the majority of panel members. A preliminary position paper was compiled and presented to the audience at the EAES congress in June 2004. All comments from the audience were discussed and a final version of the guidelines was agreed on consensually. The project was funded by the EAES. All panelists had to document and sign their relationships to commercial stakeholders in order to rule out possible conflicts of interest.

Literature Searches and Appraisal

According to the hierarchy of research evidence, we tried to locate randomized controlled trials (RCTs, i.e. level 1b evidence) dealing with the key questions. When RCTs were of low quality or completely lacking, non-randomized controlled clinical trials (CCTs, i.e. level 1b evidence) were included. Whenever level 1 and 2 evidence was scarce, case series with comparison of pre- and postoperative status (i.e. level 4 evidence) were used. However, it should be noted that for some studies our grading of evidence led to differ-

ent opinions of levels than in other similar assessments [55]. Studies were downgraded whenever the intention-to-treat principle was heavily violated or randomization was obviously unconcealed and biased. For each intervention, we considered the validity and homogeneity of study results, effect sizes, safety, and economic consequences. It should be noted that not all studies can be categorized, since studies presenting epidemiologic incidences or prevalences, or proposing ideas or definitions are not amenable to evidence grading. Furthermore, one study could be assigned different levels of evidence, whenever two or more comparisons were performed within one study, some of which may be randomized while other are not.

To identify relevant studies in all languages [5], the electronic databases of Medline (PubMed) and the Cochrane Library (Issue 2, 2004) were used. Searches in Medline spanned from 1966 to May 2004 and used the following wording: "obesity/surgery" [MeSH] OR "obesity, morbid/surgery" [MeSH] OR "gastric bypass" [MeSH] OR "biliopancreatic diversion" [MeSH] OR "anastomosis, Roux en Y" [MeSH] OR "jejunoileal bypass" [MeSH] OR "biliopancreatic bypass" OR "duodenal switch" OR '"gastroplasty" OR gastric band*. Restricting this search to the publication type "clinical trial" yielded 312 articles. In addition, the references of previous evidence-based guidelines on obesity therapy were screened [42, 117, 153]. Recently published systematic reviews of RCTs, CCTs, or case series (levels of evidence 1a, 2a or 4, respectively) and their reference lists were also studied in detail [55, 61–63, 78, 120, 152, 220, 262]. Of note, we considered three abstracts (by Agren, van Rij, and van Woert) to be insufficient sources of information, although the Cochrane review treated them as independent RCTs [63].

All recommendations were graded according to the quality and quantity of the underlying scientific evidence, the risk-benefit balance, and the values expressed by the panelists. We attempted to respect the views of patients, although no patient directly participated in guideline formulation. The grades of recommendations ranged from A (high-quality evidence, usually from RCTs, demonstrating clear benefits) over B (medium quality evidence and/or a disputable risk-benefit ratio) to C (low quality evidence and/or unclear risks and benefits).

Results

Multidisciplinary Evaluation

Before making a decision for obesity surgery, the patient must be seen by surgeon and anaesthesiologist (GoR A), and should also be seen by an expert in dietary/nutritional support (GoR B). The consultation of further specialities depends on the patient's comorbidity (GoR B).

It is beyond any doubt that all patients must be seen by a surgeon and an anaesthesiologist before surgery. While the anaesthesiologists will usually be consulted only a few days before surgery, the surgeon should see the patient at least twice prior to the decision for surgery. Alternatively, a visit with a bariatric primary care physician has been proposed (EL 5 [94]). Since obesity surgery often introduces a durable change of the gastrointestinal tract, the decision for or against surgery requires a well-informed patient. Therefore, a few weeks' time interval between the first visit and the eventual operation are desirable (EL 4 [367]). The role of other specialities in examining and preparing the patient for surgery has evolved over many years [94].

The association between psychologic health and the success of obesity surgery reinforces the role of a psychiatrist or psychologist in assessing possible candidates for surgery. The patient's preoperative motivation has been found to be a predictor of weight loss after gastric bypass (EL 2b [21, 271]), while other psychological factors have little influence on the long-term effectiveness of surgery in other studies (EL 2b [47, 82]). A few authors suggested the need of psychiatric evaluation of all morbidly obese who seek surgical treatment (EL 5 [56, 121]), because some patients were found postoperatively to develop anorexia-like syndromes, post-traumatic stress disorders, or other psychological problems leading to treatment failure (EL 4 [121, 128, 315]). A recent review by Dixon and O'Brien did recommend routine psychologic assessment, although they noted that such an assessment is common, but not standard, practice in the USA (EL 5 [82, 94]) and Europe (EL 4 [231]). This panel therefore agreed with Brolin's position that psychological evaluation is necessary only for selected patients (EL 5 [38]). It is beyond the scope of these guidelines to differentiate here between psychologists, psychiatrists, and other qualified persons.

Nutrition also is a crucial aspect of obesity, both preand postoperatively. Therefore, most surgeons in the field believe that all patients must be evaluated, instructed, and guided by an expert in nutrition. This person may either be a physician with nutritional medicine qualification or a registered dietitian. Similarly, physical exercise should be initiated preoperatively under the guidance of a physical therapy specialist. Although there are no comparative studies on the impact of nutrition and physical exercise therapy, both are considered standard (EL 5 [94]). In addition to the nutritionist, other groups have reported routine consultation of a pneumologist or an endocrinologist (EL 4 [231, 356]).

Indications for Surgery

Obesity surgery should be considered in adult patients with a documented BMI greater than or equal to 35 and related comorbidity, or a BMI of at least 40 (GoR A). All patients must fully understand and agree with postoperative

care (GoR A), and must be free of general contraindications (GoR A). Adults with a BMI between 30 and 35 accompanied by substantial obesity-related comorbidity or after prolonged medical treatment should undergo obesity surgery only in the context of controlled clinical trials (GoR C). No consensus was reached on the usefulness of obesity surgery in adolescent patients.

Many studies and committees have pointed out that in morbidly obese patients "no current [conservative] treatments appear capable of producing permanent weight loss" (EL 5 [125]). So far, only one randomized trial has compared obesity surgery versus non-surgical therapy: In this trial by Andersen et al. [13, 14] (EL 1b), horizontal gastroplasty produced significantly more weight loss and maintenance of weight loss than very low calorie diet (32 versus 9 kg after 2 years). After more than 5 years, 16% of surgical patients had successfully reduced weight as compared to only 2% of diet patients.

The very large, but non-randomized Swedish Obese Subjects (SOS) study (EL 2b) compared different types of obesity surgery versus conservative treatment in a matched-pair design [158, 159]. Women and men with a BMI greater than 38 or 34, respectively, were studied over 2 years. They lost significantly more weight after surgical than after non-surgical treatment and this weight loss resulted in significant improvements of comorbidities, such as diabetes (from a prevalence at baseline of 19–10% after 2 years), hypertension (from 53 to 31%), sleep apnea (from 23 to 8%), dyspnea when climbing stairs (from 87 to 19%), and chest pain when climbing stairs (from 28 to 4%). The SOS study also found health-related quality-of-life (QoL) to be directly correlated with weight loss [159]. As there was a significant difference in QoL even between women with 30–40-kg weight loss and those with more than 40-kg weight loss, it seems as if obesity surgery should aim at the largest possible excess weight loss (EWL). If long-term EWL is less than 50%, a procedure is generally considered a treatment failure.

Traditionally, obesity surgery is considered appropriate for adult patients with either a BMI of 40 or more, or a BMI between 35 and 40 with obesity-related comorbidity. These selection criteria have been laid down in March 1991 by the National Institutes of Health Consensus Development Panel [236–238] and have subsequently been adopted by all major surgical and non-surgical societies [9, 11, 88, 148, 178, 226, 235, 313]. Even though the BMI threshold values of 40 and 35 were arbitrarily chosen, it appears wise to stick to these criteria, because the majority of surgical experience and scientific evidence relates to patients who were selected by such criteria. Off course, the risk-benefit ratio needs to be assessed critically in each individual patient (EL 2b [260]). As the short-term risks of obesity surgery clearly exceed that of conservative treatment (EL 1c [93]), it is advisable that all patients should have tried other ways of weight loss prior to surgery. In costef-

fectiveness analyses, all major obesity procedures were found to give better results than conservative treatment in morbidly obese patients (EL 2b [62, 235]).

Recent reports have shown that surgical treatment is similarly effective in patients with a BMI between 25 and 35 (EL 4 [15]). According to Dixon and O'Brien [82], the "cut-off of BMI > 35 is due for review" also in the USA, where it is currently been evaluated in a RCT. Although no study so far has compared surgical and non-surgical management in patients with a BMI between 30 and 35, obesity surgery is increasingly being performed in this subgroup. Given the strength of the existing evidence, it seems too early to recommend obesity surgery even in cases with a BMI of at least 30 who suffer from substantial obesity-related comorbidity. The majority of the panel favored surgical treatment in well-selected patients with a BMI between 30 and 35 only in the context of controlled clinical trials.

A complex issue in the NIH selection criteria is the proper definition of comorbidities, which warrant obesity surgery due to their seriousness and potential alleviation through weight loss. Comorbidities may be divided in medical, physical and psychological categories. In this respect, medical conditions such as sleep apnea and other hypoventilation syndromes (EL 4 [57, 114]), type II diabetes mellitus (EL 4 [190, 251, 261, 263, 265, 282, 328]), obesity-related cardiomyopathy and hypertension [31, 53, 103, 273, 318, 328], hyperlipidemia (EL 4 [231, 251]), asthma (EL 4 [251]), pseudotumor cerebri (EL 4 [216, 324]), knee osteoarthritis (EL 4 [114]), low back pain (EL 4 [215]), female urinary incontinence (EL 4 [45, 114]) and infertility (EL 4 [113, 204, 360]) are well-documented indications for obesity surgery, because clinical evidence has convincingly proven that weight-loss allows prevention, relevant improvement, or even remission of these conditions. The metabolic effect of obesity surgery in diabetic patients is especially noteworthy, since it goes beyond weight reduction alone (EL 4 [161, 263, 282]; EL 5 [283]). Gastroesophageal reflux, however, was found unresponsive to obesity surgery in some studies (EL 2b [107, 255]), whereas others found an association (EL 4 [81, 114, 149, 251, 311]). Of course, these results varied with the type of surgery.

Physical, social, and psychological problems are important factors in the quality-of-life of obese persons. Although such problems are difficult to communicate and to quantify, they play a leading role in deciding on conservative or surgical treatment of obesity. Various validated instruments are available to assess quality-of-life (QoL) in obese patients [171], but it should be added that most of these QoL questionnaires were validated by their responsiveness to weight loss, so by definition a procedure that produces weight loss will produce improved QoL. The literature is replete with before-and-after-studies (EL 4) about the positive changes in patients' quality-of-life

(QoL) caused by bariatric surgery [135, 347]. This allows us to focus here exclusively on studies with a non-surgical control group. Arcila et al., for example, demonstrated significant improvements in various QoL domains after VBG and RYGB as compared to conservative therapy (EL 2b [19]). In a recent study from Switzerland (EL 2b), obesity surgery proved better than conservative treatment in patients with and without severe psychosocial stress [43]. It can be concluded that deliberation on obesity treatment options must incorporate an assessment of the patient's current physical, social, and psychological status as well as the expected effects of therapy on this status. Therefore, psychological counseling, even superficial, as a screening tool is desirable in all patients before surgery.

Various contraindications must also be taken into account, although most have not been derived from firm clinical evidence. As patients' non-compliance with follow-up schedules can lead to potentially life-threatening complications [26], all candidates for obesity surgery must hold a realistic view of the operation and the necessity for lifelong aftercare (EL 1c). Severe mental or cognitive retardation and malignant hyperphagia are therefore generally considered absolute contraindications, because such patients will be unable to eat and exercise as required postoperatively (EL 5 [82, 121]). On the other hand, minor arid major mental and personality disorders are highly prevalent in morbidly obese patients, but they were not found to be valid predictors of successful therapy (EL 2b [34, 291]). Eating disorders are no general contraindication, even if they are not amenable to psychological and dietary counseling (EL 4 [203]). Nevertheless, such disorders must be known when selecting the type of surgery.

Psychiatric disorders (psychotic, personality, or affective disorders, alcoholism and/or drug abuse, mental retardation, and eating disorders, especially bulimia nervosa, and binge eating disorder), lack of social support, persistent ambivalence to surgery, and marital dysfunction are factors which must be evaluated in particular before surgery. A substantial percentage of bariatric surgery patients suffer from binge eating disorders or binge eating symptoms. The effect of bariatric surgery on the outcome of binge eating symptoms largely depends on the type of operation. In general, the indication for surgery depends on the severity of the mental disorder and its response to psychopharmacological treatment. Repeated assessment of the patient may end in a postponement or cancelling of the operation. Surgery is contraindicated only in the cases of severe mental disease not responding to treatment (EL 4 [56, 203, 336]).

Women of reproductive age, who wish to have children after surgery, should not be denied an operation, because the course of pregnancy and the health of the baby are usually unaffected by previous obesity surgery (EL 2b [79, 113, 202, 205, 309, 350]). Still, postoperative contraception is recom-

mended for about 12 months, after which weight should usually be stabilized. In patients with LABG (laparoscopic adjustable gastric banding), the band can be deflated in case of pregnancy (EL 4 [344]). Finally, liver cirrhosis should not hinder elegibility for obesity surgery (EL 4 [26, 65]).

Before reaching skeletal maturity children should definitely not be offered obesity surgery, but recent pilot studies (EL 4) on adolescents (12–19 years old) suggested that surgery in this age group is as effective as it is in adults [32, 52, 85, 146, 317, 327]. Since about 80% of obese adolescents will remain obese into adulthood, some surgeons have offered surgery to well selected nonadult patients. However, the total number of patients aged between 12 and 18 is small, thus precluding any recommendation on performing surgery in adolescents. Recently, a threshold BMI of 40 (with severe comorbidities) or 50 (with less severe comorbidities) has been proposed for consideration of obesity surgery in adolescents (EL 5 [147]). In this panel, however, there was no consensus on the selection of adolescents for surgery. The balance of the risks and benefits of surgery must be also considered critically at the other end of the age scale. Findings in patients aged between 55 and 70 documented beneficial effects of surgery on weight and some comorbidities (EL 4 [193, 229]). In patients over 60 or 65 years, however, obesity-related comorbidity has usually become more complicated and less reversible (EL 5 [32, 82, 231]). In consequence, the risks of surgery may be no worthwhile (EL 2b [93, 339]), although a fixed age limit can not be recommended.

Preoperative Diagnostics

As for any other major abdominal surgical procedures, all patients should be evalated for their medical history (GoR A) and undergo laboratory tests (GoR B). Despite the lack of sound evidence in the obese, chest radiography, electrocardiography, spirometry, and abdominal ultrasonography may be recommended for the evaluation of obesity-related comorbidity (GoR C). Polysomnography (GoR C) should be done in patients with high risk of sleep apnea. In centers where psychiatric consultation or psychological assessment is not routine, psychological screening should be performed (GoR C). Upper gastrointestinal endoscopy or upper GI series is advisable for all bariatric procedures (GoR C), but is strongly recommended for gastric bypass patients (GoR B).

In the preoperative work-up, as outlined above, patients with apparent psychosocial problems should be seen also by a psychologist or psychiatrist. In the morbidly obese, psychosocial problems are usually associated with an increased motivation for weight loss, which in turn is predictive of the success of surgery (EL 2b [253, 271, 336]). Socioeconomic problems are also highly prevalent [188]. To assess these connections, all patients should be

evaluated for psychologic health, quality-of-life, possible personality disorders, social relationships, motivation, expectations and compliance. Many centers use self-developed questionnaires for this purpose (EL 4 [271, 291, 315]). The psychiatric assessment of morbid obesity should include a brief explanation and description of the assessment process, a clinical interview (ideally at least 3 months before surgery), and psychological testing of eating behaviour, quality of life, psychopathology, and personality (EL 5 [95]). The clinical interview should cover the patient's previous weight loss attempts and treatments, eating patterns, eating disorders symptoms, physical activity, attitudes and expectation regarding treatment, psychiatric history, mental and marital status.

Published evidence on the technical preoperative evaluation of obese patients stems largely from case series and general gastrointestinal surgery standards, which were adopted to obesity surgery. Standard investigations are electrocardiography, chest radiography and laboratory tests (EL5 [94, 312]). According to Naef et al. [231] (EL 4), laboratory testing should include a full blood count, liver, kidney (EL 4 [162]), coagulation and thyroid parameters, thyroid hormone stimulating test, a lipid profile, a oral glucose screening test (only in patients not known to be diabetic), and an analysis of arterial blood gas. Urinalysis is also a standard procedure [94].

Ultrasonography of the abdomen is usually done to detect cholecysto- or choledocholithiasis. Being a noninvasive and cheap procedure, abdominal sonography seems to be advisable as a part of the routine preoperative work-up. Even those centers where intraoperative ultrasound is performed, use preoperative ultrasonography as a screening tool.

Specifically important to obese patients is the evaluation of pulmonary function and obstructive sleep apnea. Sugerman and colleagues first described the high prevalence of pulmonary obstructive diseases in morbidly obese patients (EL 4 [322, 323]). To prevent postoperative hypoventilation, it has been recommended that all patients be assessed spirometrically as part of the preoperative work-up and supplied with the necessary therapy (EL 4 [217, 231]; EL 5 [312]). In multivariate analysis, a forced expiratory volume (FEV1) under 80% and an abnormal electrocardiogram were predictive of postoperative intensive care admission (EL 2b [124]). Hypoventilation syndromes were also found to be predictive of thrombembolic complications and anastomotic leakage (EL 2b [93, 285]). American obesity clinics recently recommended routine polysomnography, because sleep apnea was detected in 77–88% of their patients (EL 4 [109, 252]) and was predictive of postoperative complications in other studies. Other groups use the Epworth sleepiness scale or similar instruments to screen for patients who will require polysomnography (EL 4 [299]). Various studies have found a higher preoperative prevalence of pulmonary problems with increasing BMI (EL 2b [214]). One study, however, failed to confirm the

predictive value of both, BMI and Epworth sleepiness scale, in the prediction of obstructive breathing disorders (EL 2b [109]). In summary, the threshold for ordering polysomnography should be low and all superobese patients should probably be tested routinely (EL 5 [94]).

Disputable is the evaluation of the upper gastrointestinal (GI) tract by endoscopy, barium meal, both, or none of the two technologies. In the study by Sharaf et al., routine radiologic assessment of the upper GI tract before bariatric surgery led to clinically important findings in only 5.3% of patients (EL 4 [302]). In only six of 814 patients (0.9%), as reported by Ghassemian et al., X-ray examination of the GI tract demonstrated relevant abnormality, and not a single operation had to be delayed due to the results of the GI tract series (EL 4 [122]). Using esophageal manometry, two recent case series found abnormalities in only 13–20% of patients and being without clinical consequences (EL 4 [169, 186]). Jaffin et al., however, described that esophageal disorders were highly prevalent (61%) and associated with postoperative results (EL 4 [150]). Other groups also have advocated routine upper GI tract series before gastric banding, because hiatal hernia may cause band slippage (EL 4 [115, 127]). Endoscopy, however, offers the advantage of visualizing esophageal and gastric mucosa (EL 4 [115, 337]), thus detecting gastritis, reflux, or ulcerations. This may be of special value before any operation with exclusion of the stomach (EL 5 [312]). To make a compromise, this panel advises to perform either upper GI series or endoscopy in all patients. Given the higher prevalence of reflux after VBG (EL 4 [24, 164, 259, 301]), preoperative GI evaluation seems to be of special importance in VBG patients.

Choice of Procedure

Adjustable gastric banding (AGB), vertical banded gastroplasty (VBG), Roux-en-Y gastric bypass (RYGB) and biliopancreatic diversion (BPD) are all effective in the treatment of morbid obesity (GoR B). All four types of procedures should be explained to the patient (GoR C). In terms of weight loss, BPD is superior to RYGB (GoR B), RYGB is superior to VBG (GoR A), and VBG is superior to AGB (GoR A). There is an increased risk of perioperative complications in procedures requiring stapling and anastomoses (GoR A). The reoperation rate is higher for adjustable gastric banding and Mason (but not MacLean) VBG (GoR A). As positive and negative effects differ among the procedures, the choice of procedure should be tailored to the patient's BMI, perioperative risk, metabolic situation, comorbidities and preference as well as to the surgeon's expertise (GoR C). Intragastric balloon, sleeve gastrectomy, and gastric pacemaker are options (GoR C), which require further evaluation.

Since obesity surgery has various competing aims, such as weight loss, adjustability, reversibility, and safety, it is difficult to draw universally valid conclusions about the optimal bariatric procedure. For all types of surgery, there is overwhelming evidence from case series on safety, efficacy, and effectiveness in terms of weight loss, but much less data are available on the comparative evaluation of different bariatric procedures. Therefore, the decision must be taken with the patient's individual situation and the surgeon's expertise in mind. A profound knowledge of the different malabsorptive and gastric restrictive procedures and their pathophysiologic consequences is indispensable.

Biliopancreatic diversion (BPD) was invented by Scopinaro (EL 5 [294, 296]; EL 4 [295]) and later modified by Marceau et al., who added a duodenal switch (EL 4 [136, 200, 201]). BPD with duodenal switch and sleeve gastrectomy was found to be superior (EL 2b [267]), which allows us to leave the original BPD procedure unmentioned in the following considerations. In the long-term after BPD, patients typically lose between 65 and 75% of their excess body weight (EL 4 [267, 293]).

Roux-en-Y gastric bypass (RYGB) was first described by Mason and Ito [207, 208]. Numerous technical modifications have been proposed relating to gastric pouch construction, gastro-jejunal anastomosis, and length of alimentary and biliopancreatic limbs. RYGB usually results in 60–70% EWL [75, 101, 138, 173, 222, 273], but the procedure is much better accepted in the USA (about 70% of all procedures) as compared to Europe [332].

Gastroplasty was first performed horizontally ("gastric partition"), but in 1982 Mason [206] introduced the vertical banded gastroplasty (VBG), which was quickly adopted by surgeons. In this procedure a gastric pouch of about 10–20 ml is created. By using a mesh band or a silastic ring, the gastric pouch outlet can be calibrated and reinforced. Postoperative weight reductions range between 55 and 65% nadir EWL (EL 4 [199, 224, 232, 277, 325]).

In gastric banding, a ring is placed around the gastric cardia. A small pouch is created, thus limiting food intake. Modern gastric bands have an inflatable reservoir to adjust the size of the remaining passage [30, 175]. With the introduction of laparoscopic adjustable gastric banding (LAGB), the procedure has gained worldwide popularity. Being a gastric restrictive procedure, weight loss is less in gastric banding compared to other procedures and usually reaches only 45–55% (EL 4 [49, 67, 83, 249, 250, 330, 342, 367]). Technical details of all four procedures will be discussed in a separate chapter below.

The randomized studies in this field are summarized in Fig. 10.1. In the following, we will discuss key findings of these studies comparing biliopancreatic diversion, gastric bypass, gastroplasty, and gastric banding.

Several randomized studies have compared gastric bypass versus horizontal or vertical gastroplasties. As horizontal gastroplasty has been abandoned

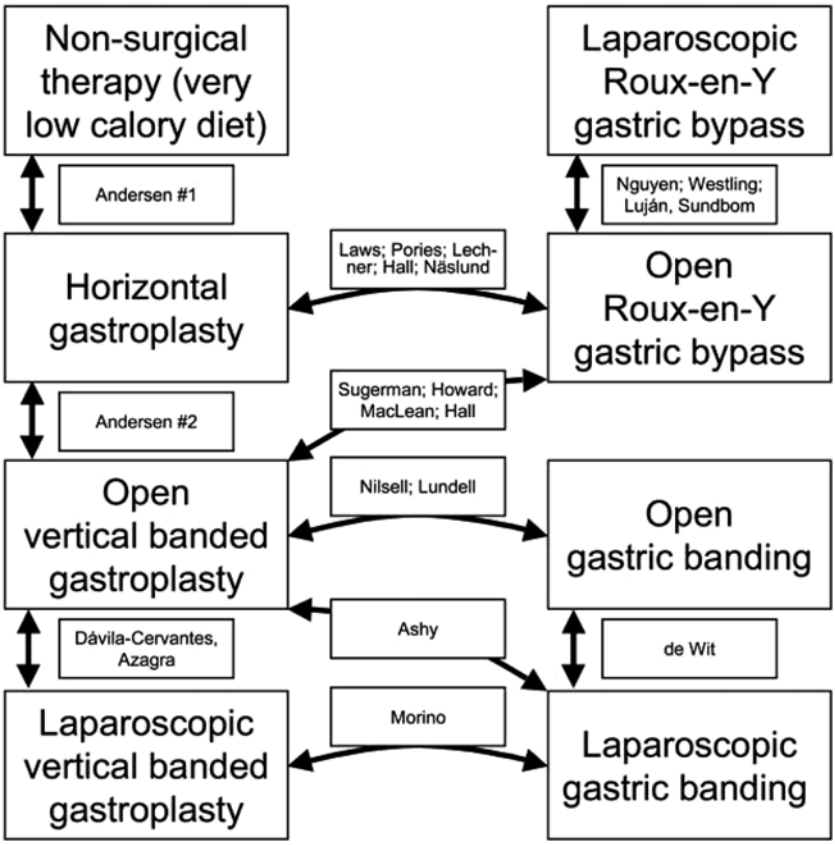

Fig. 10.1. Randomised controlled trials comparing different obesity surgery procedures among each other or versus medical treatment. Please note that the trial by Hall et al. [129] had three arms and therefore appears twice. The trial by Sundbom evaluated hand-assisted laparoscopic Roux-en-Y gastric bypass

since the 1980 s, we will only briefly discuss the four RCTs evaluating this technique. Laws first showed that gastric partitioning produces less weight loss than RYGB (EL 1 b [179]). Other groups (Pories et al. [264], Lechner et al. [181, 182], and Hall et al. [129]) have confirmed this finding (EL 1 b). Finally, Naslund et al. (EL 1 b [233, 234]) found that nearly all of their gastric bypass patients lost more than 25 kg within the first postoperative year, compared to only 18 of 28 gastroplasty patients ($p < 0.01$). The 1987 publication by Andersen et al. [12] (EL 1 b) finally brought horizontal gastroplasty to an end.

Four RCTs compared open RYGB and open vertical banded gastroplasty. In an often-quoted study (EL 1 b), Sugerman et al. [326] compared 3-year results between 20 RYGB and 20 VBG patients. In terms of EWL after 1 year,

RYGB was found to be superior over VBG (68 versus 43%), but postoperative complications, for instance vitamine B_{12} deficiency and vomiting due to stoma stenosis, were more common after RYGB. In the three-armed study from Adelaide, which was already cited above, Hall et al. [129] compared the 3-year success rates defined as more than 50% EWL. Successful treatment was observed in 67% of patients after RYGB, 48% after vertical gastroplasty, and 17% after gastric partition. The RCT by Howard et al. [143] was able to report long-term data. Again, EWL was clearly better in the RYGB than in the VBG cohort. MacLean et al. [196, 198] confirmed these results.

VBG and gastric banding have been compared in three trials (all EL 1b), but the trials used different surgical approaches (Fig. 10.1). One trial compared both procedures in open access surgery [247], one trial compared open VBG versus LAGB [20], and the third trial compared both procedures in laparoscopic surgery [223]. In the study by Nilsell et al., weight reduction tended to be larger and quicker after VBG, but after 5 years gastric banding patients reached the same level of weight loss. Reoperations were performed more often in the VBG group (11/30 versus 3/29), a finding which contradicts non-randomized data (EL 2b [29, 333]). In their study of 60 patients, Ashy et al. [20] found greater EWL half a year after VBG as well, but failed to report long-term data. Due to shorter hospital stay, less complications, and adjustability Ashy et al. preferred LAGB over open VBG. In comparing LAGB and laparoscopic VBG, Morino et al. described shorter hospital stay after LAGB, but found fewer complications and reoperations after laparoscopic VBG. Weight loss was also better after VBG. Consequently, this group firmly favored the latter technique and commented that the high complication rates after VBG in the Nilsell study might have been due to not dividing the stomach between the staple lines.

It is difficult to draw summary conclusions from these three trials, because they represent a mixture of surgical procedures and approaches. One common result of the three trials is the better weight reduction after VBG. Data on complication rates, however, are conflicting. A very detailed assessment of comparative and non-comparative studies (EL 2a) recently concluded that "laparoscopic gastric banding is safer than VBG and RYGB" [55], because short-term mortality and morbidity were found to be lower after LAGB. Still, the ranges of complication rates were wide, thus suggesting a strong effect of surgical expertise. In a large study on laparoscopic RYGB and gastric banding, Biertho et al. concluded that the balance between weight loss and complications favored LAGB in patients with BMI under 40, whereas RYGB might be preferable in case of a BMI between 40 and 50 (EL 3b, downgraded due to large unadjusted baseline differences [33]).

Of note, no randomized trial so far has compared BPD to other procedures. This is in part a consequence of the 1991 NIH consensus development

conference, which simply failed to mention BPD as one of the standard procedures [72]. Two-year follow-up data presented by Rabkin [267] (EL 2b) showed marginally greater EWL after BPD (78%) than after RYGB (74%). In 2004, Deveney et al. [77] confirmed this comparability of EWL after BPD and RYGB (EL 2b). In a small study by Murr et al. [228] (EL 2b), EWL within 4 years was greater after BPD (71%) than after long-limb RYGB (57%), but some cases of liver failure and metabolic bone disease developed in the BPD group. Similarly, EWL after 2 years was 60% following BPD versus 48% following non-adjustable gastric banding (EL 2b [23]), but longer hospital stay and higher major complications rates were also found. In a matched-pair analysis (EL 2b), BPD also resulted in greater EWL (64 versus 48%) when compared to LAGB [86]. In summary, the degree of weight loss caused by BPD is greater, but this is at the expense of other outcomes.

When making a choice between gastric banding, VBG, RYGB and BPD, it is well documented (EL 1b as outlined above, except for BPD) and generally accepted that weight loss is more pronounced after the latter procedures. In fact, weight loss decreased according to the procedures performed in following decreasing order: BPD, RYGB, VBG, and gastric banding. Therefore, in patients with milder degrees of obesity, procedures that produce greater absolute weight loss may not be advantageous, although this can only regarded as a recommendation by rule of thumb. However, the reverse conclusion, that gastric banding and VBG should not be used in massive obesity, does not seem to fully apply, because recent reports showed that LAGB is associated with sufficient EWL also in patients with a BMI of 60–100 (EL 2b [86]; EL 4 [96]).

A remarkable proposal for operative selection among the various procedures was published in 2002 by Buchwald [42], who first reviewed a large number of case series (EL 4) and then constructed a clinical algorithm based on BMI, age, gender, race, body habitus, and comorbidity. For example, according to the algorithm a patient with a BMI of 48 should not receive gastric banding irrespective of other factors. Likewise, a patient with a BMI greater than 55 should receive either BPD or long-limb RYGB. This panel agrees to the relative importance of these parameters for choosing a procedure, but is reluctant to propose any strict criteria. BMI, comorbidity, and age should play a key role in selecting the procedure. Data on other criteria are largely missing, except for psychological parameters as described above.

The concept of selecting the procedure according to eating habits was initially proposed by Sugerman et al. [326]. Although this was a RCT, the study's comparison between sweet eaters and non-sweat eaters was nonrandomized and possibly data-driven (EL 2b). More recent studies have failed to confirm this finding (EL 2b [144]). Notwithstanding, eating habits should influence the choice of the procedure to some degree. Most surgeons require LAGB and VBG patients to accept restrictive dietetic rules, and perform

RYGB or BPD if this criterion is not fulfilled. Comorbidity also plays some role in decision-making. As some, but not all, studies showed that esophageal reflux may get worse after gastric banding (EL 4 [16, 80, 352]), RYGB might be preferable in such cases (EL 4 [24, 36, 110, 164]). The only RCT on this issue, however, failed to find a difference between LAGB and VBG with regard to reflux symptoms (EL 1b [192]).

The intragastric balloon was introduced in 1982 as an as adjunct to non-operative treatment of obesity [116, 246]. A series of small studies compared intragastric balloons against sham control (EL 1b [141, 172, 187, 210, 270, 278]) or no additional intervention (EL 1b [119]). Both, experimental and control groups lost weight due to low-calorie diet, but no additional effect of the balloon was found in five of the seven trials. With newer smooth-surface balloon, mean EWL after 6 months of intragastric balloon treatment was between 20 and 50% (EL 4 [87, 90, 140]) depending on patient compliance and balloon volume (EL 2b [281]). Since the balloon carries a non-negligible risk of prolonged vomiting, pain, gastric ulcers, and spontaneous deflation with intestinal obstruction, the device has not yet become standard (EL 4 [41]; EL 5 [100, 185]). Especially in comparison to obesity surgery, the balloon was found to produce insufficient and non-durable weight loss (EL 2b [166]). Nowadays, however, some centers still use the gastric balloon in selected patients with a BMI between 30 and 35 (EL 4 [281, 335]). It also is being used as a weight-reducing adjuvant therapy before bariatric surgery (EL 4 [87, 209, 345]). Loffredo et al. [189] proposed that the amount of weight reduction obtained with the balloon could serve as a guidance in selecting the type of bariatric procedure (EL 2b) and has started a RCT testing this hypothesis.

Although sleeve (or longitudinal) gastrectomy is a specific step within the BPD operation, some surgeons have used it also as a first-stage procedure in patients with BMI above 60 to reduce surgical risks, followed about a year later either by RYGB or BPD. EWL within the first year after sleeve gastrectomy as the sole procedure has been reported to range between 33 and 45% (EL 4 [7, 272]), but the limited experience with sleeve gastrectomy prohibits any statement about its clinical value. Still, sleeve gastrectomy may be used as an interim procedure in high-risk morbidly obese patients, especially in case of intraoperative hemodynamic instability (EL 4 [7, 272]). Beyond the traditional surgical concepts of gastrorestriction and malabsorption is the gastric pacemaker, a completely new device, which is currently being evaluated in a randomized, placebo-controlled trial [362]. Preliminary data showed an EWL of about 30% after 15 months (EL 4 [69, 217, 219]). Although the technique is minimally invasive with apparently little surgical complications, longer term results are awaited before this device should be used outside trials.

Surgical Access: Open Versus Laparoscopic

All procedures have been proven to be technically feasible via laparoscopy. There is evidence that the laparoscopic approach is advantageous for gastric banding, VBG, and gastric bypass (GoR B). Preliminary data suggest that the laparoscopic approach may be also preferable for BPD, if surgical expertise is available (GoR C), but further studies are needed.

In 1994, laparoscopic Roux-en-Y gastric bypass (RYGB) was described by Wittgrove et al. [357–359] (EL 4), who found it to give superior results as compared to open surgery. Later, laparoscopic Roux-en-Y gastric bypass (RYGB) was compared to open RYGB in three similarly designed RCTs. In the first study by Nguyen et al. [241–243] (EL 1b) EWL was similar after both procedures, whereas reductions in postoperative complications and hospital stay favored the laparoscopic approach. Late anastomotic strictures, however, were seen more frequently after laparoscopic RYGB. Westling and Gustavsson found that weight loss was unaffected by the surgical approach, but postoperative hospital stay was 2 days shorter after laparoscopic surgery (EL 1b [355]). Most recently, laparoscopic and open gastric bypass were compared by Lujan et al. [191] in a well-performed study (EL 1b). The duration of surgery and hospital stay were shorter in the laparoscopic group. Both groups experienced similar degrees of EWL, but the high rate of incisional hernia in the open group (10/51) led to a significant long-term advantage for the laparoscopic technique (0/53). In addition to these three RCTs, a small, but rigidly designed trial by Sundbom and Gustavsson [329] compared hand-assisted laparoscopic versus open RYGB (EL 1b). Weight loss was similar in both groups, as were postoperative complications. DeMaria et al. [74] confirmed these results in a nonrandomised study (EL 2b).

Until now, two RCTs have compared laparoscopic versus open vertical banded gastroplasty. The quality of one trial was good because of properly concealed allocation and blinded outcome assessment (EL 1b [70]), but the second trial should certainly not be classified as level 1 evidence, since all four converted cases were shifted from the laparoscopic into the open group for analysis (EL 2b [22]). Both trials clearly documented a longer duration of surgery in the laparoscopic group. Hospital stay was 4 days in both groups in both trials. Respiratory and physical function was restored quicker after laparoscopic surgery [70]. As EWL was similar, laparoscopic surgery seems to be favorable, although more data are needed.

In adjustable gastric banding, one RCT dealt with the comparative effectiveness of laparoscopic versus open approach in 50 patients (EL 1b [71]). LAGB was found to be advantageous due to a 1-day reduction in hospital stay and fewer readmissions, while reduction of BMI was similar. However, the laparoscopic operation took twice as long as its open counterpart. For

non-adjustable gastric banding, level II evidence indicates that laparoscopic surgery produces similar weight loss but quicker reconvalescence as compared to open surgery [112].

As the first laparoscopic biliopancreatic diversion (BPD) was performed only in 1999 (EL 4 [25, 275]), scientific evaluation of this technique has not advanced as for the other procedures. Early results were published by a few centers (EL 4 [25, 256, 275, 297, 346]) and showed promising results in terms of technical feasibility and postoperative morbidity, but long-term data are lacking so far. The only comparative study (performed in superobese patients) found similar weight loss and reconvalescence after laparoscopic and open BPD, but better improvement of comorbidities in the laparoscopic group [165]. This finding, however, should be attributed to different durations of follow-up in the two groups (EL 3b, downgraded accordingly).

In summary, laparoscopic surgery has had a major impact on obesity surgery [55, 287]. According to surveys of American Society of Bariatric Surgery members, the percentage of laparoscopic procedures in relation to all bariatric procedures has increased from about 10% in 1999 to nearly 90% in 2004 [32]. These dramatic changes have been fuelled by affirmative trial data but also commercial interests. A second and equally important effect is the lowered threshold in considering patients for surgery [289].

Training and Qualification

All surgeons performing obesity surgery should have an adequate technical expertise (GoR A). He or she should be a qualified and certified general or gastrointestinal surgeon with additional training in obesity surgery (GoR B). Technical expertise in laparoscopic surgery alone is insufficient to start a bariatric surgery program (GoR B).

According to the Cancun statement of the IFSO (EL 5 [126]), every obesity surgeon should be a "fully trained, qualified, certified general or gastrointestinal surgeon, who has completed a recognized general/gastrointestinal surgery program" with additional training in "bariatric surgery including patient education, support groups, operative techniques, and postoperative follow-up". In addition, the IFSO recommends certain written approvals of expertise, course attendance, membership in an obesity surgery society, continuing medical education, and other criteria. Similar guidelines have been issued for US hospitals (EL 5 [314]), where board-certified training of surgeons and standard hospital infrastructure are formally required. Surgical experience should be documented by "an appropriate volume of cases (open and/or laparoscopic)".

Many published series on different bariatric operations have reported learning curve effects, but there is no clear threshold for the distinction between an unexperienced and an experienced surgeon. Consequently, the

American guidelines recommended that "priviliges should not be granted or denied based on the number of procedures performed". The IFSO statement, however, declared that obesity surgery should be learned from an experienced surgeon, defined as "one who has performed at least 200 bariatric surgical procedures and has 5 or more years experience".

So far, only two clinical studies have explored the volume-outcome relationship in bariatric surgery. Courcoulas et al. found that surgeons with fewer than ten procedures per year had significantly higher morbidity (28 vs 14%) and mortality (5 vs 0.3%) than high-volume surgeons (EL 2b [64]), but this result was partly attributable to better patient selection and overall hospital volume. As medium volume surgeons (with 10–50 cases per year) had also worse results when compared to high-volume surgeons, the authors were unable to recommend a minimum caseload for obesity surgery, although there was a significant trend toward higher mortality among patients in the lower activity group. The second, larger, study looked at hospital volumes and noted a nearly three-fold increase in comorbidityadjusted complication rates in hospitals with less than 100 cases per year. Given the large proportion of lowvolume hospitals and surgeons in Europe, this panel warns against starting a bariatric surgery program without having the necessary prerequisites in terms of staff, infrastructure, and volume requirements.

General Perioperative Aspects

Antibiotic (GoR A) and antithromboembolic (GoR B) prophylaxis should be administered to all obesity surgery patients.

Antibiotic administration was first studied by Pories et al. [266], who gave cefazolin or placebo over two postoperative days to gastric bypass patients (EL 1b). Wound infections were significantly reduced, thus making infection prophylaxis a standard. Antibiotics should always be given in an appropriate dose (EL 1b [105]), but there are no data available to specifically recommend certain groups or dosage regimens of drugs.

Prophylaxis of thromboembolic complications has also been an essential part of bariatric procedures. The incidence of fatal pulmonary embolism has been described to be 0.2% (EL 4 [285, 354]). More recent series, however, have shown that anticoagulation may not be necessary in patients with short operative times, use of postoperative pneumatic compression stockings, and quick mobilisation (EL 4 [123]). The current standard consists of low-dose heparin in combination with intermittent pneumatic compression stockings (EL 5 [363]). Most data in this field have to be extrapolated from other types of surgery, as until today only one small RCT has been performed in obesity surgery (EL 1b [157]). In this study, no difference between daily doses of 5,700 IU vs 9,500 lU nadroparin was detected.

Specific Technical Aspects of the Procedures

Key aspects of surgical technique in LAGB are the pars flaccida approach (GoR B), correct positioning (GoR A) and fixation (GoR A) of the band. In VBG, pouch volume should be less than 30 ml (GoR C) and the staple line should be completely transsected (GoR B). There is variability in many technical aspects of RYGB without clear data to justify clear-cut recommendations. The standard GB includes a pouch volume of about 20 or 30 ml (GoR C), an alimentary limb length of at least 75 cm (GoR C), and a biliary limb of at least 50 cm (GoR C). Long limb distal GB seems to be preferable in superobese patients, as this induces greater weight loss (GoR B). In BPD, the length of common canal should always be greater than 50 cm (GoR C). In BPD with duodenal switch and sleeve gastrectomy, the length should be between 50 and 100 cm (GoR C). There are preliminary data suggesting that closing mesenteric defects may prevent internal hernia (GoR C).

Laparoscopic Adjustable Gastric Banding

Nowadays, adjustable bands are generally preferred to non-adjustable ones, as this avoids postoperative food intolerance, vomiting, and other complications (EL 2b [112]). The selection of banding devices is influenced by clinical but also cost-related data. Most commonly used are the Lap-Band and the Swedish Adjustable Gastric Band [106], which have yielded similar results (EL 2a [111]). All new bands should be compared against these standard devices (EL 4 [366]). One randomized trial showed that the Lap-Band resulted in less complications as compared to the Heliogast band (EL 1b [35]).

The pars flaccida technique is generally preferred in the preparation of the path for the band (EL 2b [68]; EL 4 [274]). In respect to band position, gastric banding was found to be superior over esophagogastric banding (EL 1b [351]). A further study described more dysphagia after esophagogastric banding (EL 2b [177]). Weiner et al. [343], however, favored esophagogastric over retrogastric placement due to a lower risk of band slippage (EL 1b). In a Czech language article, Kasalicky et al. [160] described that cuff fixation is a worthwhile option to prevent band slippage (EL 1b). It is common practice to secure the band by a few non-resorbable gastro-gastric sutures on the anterior gastric wall. Furthermore, fixation of the port to the surface of the anterior rectus sheath is necessary to avoid turning and inaccessibility of the port (EL 2b [348]). The routine use of early postoperative barium swallows to detect gastroin testinal perforations is usually unnecessary (EL 4 [239]). Most authors refrain from inflating the band during the first postoperative weeks (EL 2b [46]).

One interesting study examined whether complete resection of the greater omentum performed together with adjustable gastric banding offers metabolic advantages (EL 1b [334]). Two years after surgery, glucose metabolism (i.e. oral glucose tolerance, fasting plasma glucose, insulin, and insulin sensitivity) was significantly more improved in omentectomized patients, although weight loss was similar in both groups.

Vertical Banded Gastroplasty

There are no randomized trials available to define the technical aspects of the procedure. Nevertheless, the following points are standard in laparoscopic surgery. Dissection at the lesser curvature should preserve vagal nerve branches. A circular stapler (usually 21 mm) should be used to create the transgastric window. The pouch volume should be less than 30 ml, which generally requires calibration with a 34 Fr nasogastric tube.

The pouch outlet should be banded with a polypropylene or polytetrafluoroethylene mesh collar, so that outer circumference and inner lumen are about 5 cm and 1 cm respectively in diameter. In one study, less complications were encountered with polypropylene than with Gore-Tex bands (EL 2b [340]). This panel also discourages the use of silastic rings. According to MacLean et al. [195] (EL 4), the gastric pouch needs to be separated at the vertical staple line and sutured in order to avoid staple line disruption. A small trial by Fobi et al. [102] confirmed a lower complication rate after transsection of the staple line (EL 1b). This holds true also for laparoscopic VBG (EL 4 [137]).

Roux-en-Y Gastric Bypass

Similar to other procedures, pouch volume is believed to be a key aspect in RYGB. Usually, a tube with a balloon is passed into the stomach and inflated with 15–30 ml saline before the gastric pouch is stapled. However, it should be noted that no clinical data so far back up a specific pouch volume. Small staples (3.5 mm) are recommended for creating the pouch, and the dissection at the lesser curvature requires careful management to prevent postoperative distension of the gastric remnant. Measuring pouch size is not the standard (EL 5 [332]).

The Roux limb should be created so that it measures 75–100 cm in patients with BMI under 50, but between 100 and 250 cm in case of a higher BMI. These lengths can be derived from several comparative studies (EL 1b [39, 60]; EL 2b [40, 197]). Brolin et al. [39] compared Roux limb lengths of 75 vs 150 cm in superobese patients and found a difference in BMI of 10 kg/m^2 after 2 years follow-up (EL 1b). Ten years later, Choban and Flancbaum

[60] went even further in their trial when they found greater EWL in those superobese patients, who received a 250 cm as opposed to a 150 cm Roux limb. The length of the biliopancreatic limb was kept similar in all patients. In the second part of this trial, 67 patients with a BMI between 40 and 50 were randomized to Roux limb lengths of either 75 or 150 cm, but here no apparent advantages were noted with one or the other technique [60]. Roux limb length therefore should be adapted to match initial BMI, in patients with BMI over 50. In 2004, a similar recommendation was given by SAGES (Society of American Gastrointestinal Endoscopic Surgeons; EL 4 [152]). The retrocolic-retrogastric, retrocolic-antegastric, and antecolic-antegastric routes all seem acceptable for the Roux limb (EL 4 [4]). Papasavas et al. [257, 258] found slightly less stenoses after retrocolic-retrogastric positioning (EL 2b), while others reported less hernias for the antecolic route (EL 2b [163]).

The creation of the gastrojejunostomy is a further critical aspect of RYGB, because 3–5% of patients may develop stenosis [292]. When reviewing the case series on stenoses (EL 4 [292]), stapled anastomoses appear to give better results than the hand-sewn type. This corresponds well to RCT data in gastric cancer patients (EL 1b [142, 300, 307, 353]). In obese patients there is only a trial with pseudorandomization by alternation (EL 2b [1]), where stenosis occurred in ten of 30 handsewn anastomoses and eight of 60 mechanical anastomoses ($p = 0.047$ by Fisher's exact test). Laterolateral anastomoses are currently standard and can be created by circular or linear stapling, although the latter seems perferable. A preliminary comparison between 21 and 25 mm stapled end-to-end anastomoses found no differences (EL 1b [331]). Different devices with similar effectiveness are currently in use (EL 1b [54]). The mesentery defect should be closed in order to avoid internal hernia (EL 4 [97, 154, 258]). A surgical drain should be place at the gastrojejunostomy site (EL 4 [298]), but the nasogastric tube may be removed at the end of the procedure (EL 2b [145]).

Biliopancreatic Diversion

As described above, when speaking of BPD our article refers to biliopancreatic diversion with duodenal switch and sleeve gastrectomy. The vertical subtotal gastrectomy (sleeve gastrectomy) should be performed on a 34–60-Fr bougie along the lesser curvature so that the gastric tube consists of about 10–30% of the original stomach (100–200 ml).

Little data have been published on limb length, but the common limb should measure over 50 cm, but less than 100 cm. Correspondingly, the alimentary canal should be between 200 and 300-cm long. Duodenoileostorny can be created by circular stapling, linear stapling with hand sutures, or a completely hand-sewn technique (EL 2b [346]). The integrity of all staple

lines needs to be confirmed by methylene blue testing. To shorten the duration of surgery in high-risk patients, some authors have proposed to perform BPD either as a two-stage procedure with gastrectomy first (EL 4 [7, 272]) or without gastrectomy (EL 4 [276]).

General Aspects

Other simultaneous procedures may be carried out in obesity surgery patients. First, ventral hernia should be repaired by mesh implantation under the same anaesthesia, as this reduces the risk of bowel ischemia (EL 2b [89, 286]). Second, cholecystectomy has been proposed for all patients (with or without gallstones) at the time of surgery (EL 4 [3, 8, 50, 99, 290]), because obesity surgery furthers postoperative gallstone formation and necessitates cholecystectomy in about 10% of patients following RYGB (EL 4 [3, 8, 73, 305, 306]). Other, more recent studies, however, have shown that simultaneous cholecystectomy can be safely restricted to those patients with asymptomatic gallstones detected on intraoperative ultrasound (EL 4 [134, 155, 338]) or with symptomatic cholecystolithiasis (EL 4 [151]). The postoperative use of ursodeoxycholic acid was shown to reduce the risk of subsequent cholecystolithiasis (EL 1b [218, 321, 364]). A daily dose of 500–600 mg of ursodeoxycholic acid for 6 months was shown to be an effective prophylaxis for gallstone formation.

Long-Term Aftercare

A multidisciplinary approach to aftercare is needed in all patients regardless of the operation (GoR B). Patients should be seen three to eight times during the first postoperative year, one to four times during the second year and once or twice a year thereafter (GoR B). Specific procedures may require specific follow-up schedules (GoR B). Further visits and specialist consultation by surgeon, dietician, psychiatrist, psychologist or other specialists should be done whenever required (GoR C). Outcome assessment after surgery should include weight loss and maintainance, nutritional status, comorbidities, and quality-of-life (GoR C).

Obesity is a “chronic disorder that requires a continuous care model of treatment” [125]. Although there are only a few comparative studies on the frequency, intensity or mode of follow-up, close regular follow-up visits have become routine in most centres (EL 4 [217]). Baltasar et al. highlighted several cases of serious complications and even death which were due to metabolic derangement caused by inadequate follow-up (EL 4 [26]). This is why patients who do not understand or comply with strict follow-up schedules should be denied surgery, as recommended above.

Postop. Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	thereafter
LAGB (minimal)	X		X			X						X												X	once a year
LAGB (intensive)	X	X	X	X		X		X		X		X			X			X			X			X	twice a year
VBG (minimal)	X					X						X												X	once a year
VBG (intensive)	X		X			X			X			X						X						X	once a year
RYGB (minimal)	X					X						X												X	once a year
RYGB (intensive)	X	X	X			X			X			X						X						X	once a year
BPD (minimal)	X		X			X						X												X	once a year
BPD (intensive)	X	X	X			X			X			X						X						X	once a year

Fig. 10.2. Suggested timing of postoperative follow-up visits

The frequency of the visits should be adapted to the procedure, the patient's weight loss over time and the overall probability of complications. Therefore, closer follow-up visits are generally required during the first postoperative year. Shen et al. [304] (EL 3b) examined the association between the number of postoperative visits during the first year and EWL. A significant difference favoring more than six visits per year was found for gastric banding but not for gastric bypass patients. In consequence, many obesity surgeons favor closer follow-up visits after LAGB than after VBG or BPD (EL 4 [46, 217]). Based on current practice patterns (EL 4 [92, 217]), this panel unanimously recommended a follow-up protocol as shown in Fig. 10.2. No data are available to indicate that follow-up should be different after open and laparoscopic surgery. It has been recommended to sonographically exclude gallstones at the 6 and 12 months visit. Follow-up should always be continued lifelong, as long as the surgical procedure or device has not been reverted or removed.

For optimal continuity of care, it seems recommendable to have one physician as the primarily responsible person for follow-up. It is therefore usually the surgeon or the nutritionist, who oversees the patient's course, circulates information to other colleagues and coordinates multidisciplinary consultations. Postoperatively, all patients should be seen several times by the dietician and the psychologist (EL 4 [217, 268]). In addition, it may be necessary to consult the gastroenterologist (for upper gastrointestinal endoscopy), the pneumologist (for sleep apnea), the radiologist or other disciplines. Again, communication and collaboration is essential, since many different comorbidities may be affected by weight reduction.

The importance of psychological counseling is difficult to quantify. Comparisons of patients who attended or quitted postoperative group meeting or psychotherapy (EL 3b, downgraded due to noncomparability of groups) found that attenders had slightly more weight loss and better quality-of-life when compared to nonattenders [139, 245, 269]. Although this panels supports the idea of an intensified postoperative counseling, current data does not justify a firm recommendation.

Nutritional treatment aims to ensure that patients consume a diet that meets normally accepted nutritional recommendations for macro-, micro-nutrients and vitamins in-take, but at a reduced energy intake commensurate with maintaining a reduced body weight. Many patients have pre-existing nutritionally inadequate diets [EL 4 [44, 98, 133]), and deficiencies are commoner in the older and more overweight (EL 2b [183, 184]) and may be exacerbated by drugs commonly used to treat obesity comorbidities (EL 4 [180, 280]). Such deficiencies are more likely to be exacerbated rather than improved by bariatric surgery, especially malabsorptive procedures (EL 4 [27, 91, 130, 194, 268]). For this reason individual nutritional (diet) assessment and advice is necessary both pre- and postoperatively in order to ensure that nutritional status is optimised. It is likely that most patients will require nutritional supplements of vitamins and minerals (EL 2b [37, 51, 131, 308, 310]).

Clinical and scientific documentation of patients' postoperative course should not only focus on weight. Additionally, the clinical course of comorbidities should be closely monitored, and all patients should be questioned about their quality-of-life (QoL), as it recommended by the 1991 NIH conference (EL 5 [238]). For the assessment of QoL, validated instruments are freely available and should be used [221, 254, 361]. In 1997, the ASBS issued guidelines on scientific reporting, which ideally should include the course of BMI and EWL over at least two postoperative years (EL 5 [10]).

Band adjustments are a specific part in the follow-up of LAGB patients. First band filling should be performed between 2 and 8 weeks after band implantationusually after 4 weeks (EL 2b [46]). For this first filling, 1–1.5 ml saline are injected. Band adjustments thereafter should be carried out as required in an individualised manner according to weight loss, satiety and eating behaviour, and gastric problems (e.g. vomiting). Four-, six- or eight-week intervals between adjustments are widely accepted. A much simpler approach for band filling was recently found to produce similar EWL, while reducing workload immensely. Twenty patients treated by Kirchmayr et al. [167] received a bolus-filling 4 weeks after surgery thus obviating the need for subsequent stepwise re-calibration (EL 1b). This panel awaits further studies confirming the safety of this or similar concept. The volume of the pouch should be examined radiographically after 12 months and (as an option) also after 6 months.

Dealing with Complications

Surgeons should be aware that postoperative complications may have an atypical presentation in the obese, and early detection and timely management are necessary to prevent deleterious outcomes (GoR C).

Common to all procedures which employ gastrointestinal suture or anastomoses is the possibility of anastomotic leakage and bleeding [48]. Clinical signs, such as fever, tachycardia, and tachypnea, were found to be highly predictive of anastomotic leaks after RYGB (EL 4 [168]). Generally, anastomotic leakage can be treated by drainage with or without oversewing (EL 4 [298]). Revisional surgery for suspected anastomotic leakage can be done via open or laparoscopic approach (EL 5 [346]). Staple line bleeding with minor or major blood loss can often be treated conservatively (EL 4 [212, 244]; EL 5 [275]). Splenectomy is seldomly required.

Laparoscopic Adjustable Gastric Banding

Complications after LAGB include gastric erosion, band slippage, pouch dilation, occlusion of the stoma, and port-related complications. Gastric erosion usually causes mild pain, various types of infections and prevents further weight loss (EL 4 [2]). When gastric erosion is confirmed on gastroscopy, the band needs to be removed urgently, but not immediately. Patients may be converted to RYGB (EL 4 [156, 341]), VBG, or BPD (EL 4 [84]), or rebanding (EL 4 [118]). However, rebanding should be avoided if further weight reduction is the principal aim (EL 2b [341]).

The incidence of band slippage essentially depends on band positioning (EL 2 [68]). Patients usually complain of burning sensations and discontinuation of weight loss. Initial management consists of band deflation. If the pars flaccida technique was not used in the primary operation, therapy consists of laparoscopic revision (EL 4 [59]). Other alternatives are band repositioning, rebanding, or conversion to other procedures (EL 4 [349]).

Pouch dilatation can occur in the early or late followup. Early dilatation is mostly caused by a wrong position of the band (EL 4 [58]). Patients do not get a feeling of satiety, stop to loose weight, and suffer from vomiting. A contrast meal verifies the diagnosis, but minor degrees of dilatation can be considered not clinically relevant (EL 4 [174]). Therapy consists of immediate gastric tube placement and band deflation followed by reinflation after a few months. In case pouch dilatation persists, band repositioning or conversion to other procedures should be tried (EL 4 [248]).

Access ports can twist or become infected. While port rotation can be corrected by revisional surgical fixation (EL 4 [170, 225, 349]), infection requires port removal. First, the tube is placed in the abdominal cavity. When infection has settled down, the tube is reconnected, and a new port is place at a different position. A spontaneous disconnection between tube and port should be suspected in patients who report an acute abdominal pain (EL 4 [365]). Laparoscopic grasping of the tube with reattachment is a feasible treatment option (EL 4 [365]).

Vertical Banded Gastroplasty

After VBG, the range of complications includes stoma stenosis, pouch dilatation, band erosion and staple line disruption. Erosion or infection of the band at the pouch outlet should be treated by band removal (EL 4 [340]). In severe cases, conversion to LAGB or other procedures may be necessary (EL 4 [66, 176]). As described above, staple line disruption should be prevented intraoperatively by the use of MacLean's technique with complete transsection of the vertical staple line with oversewing (EL 1b [102]; EL 2b [195]). The advantage of not transsecting the staple line, however, is that small disruptions can be accepted without major effects on weight loss (EL 4 [213]). Severe cases of esophageal reflux after VBG may require conversion RYGB (EL 4 [24]).

Roux-en-Y Gastric Bypass

Stoma stenosis, gastric distension, anastomotic leakage, gastrojejunal ulcers and nutritional deficiencies may occur after RYGB. Stoma stenosis due to anastomotic strictures usually occurs during the first postoperative months (EL 4 [284, 292]). Most cases of stoma stenosis are amenable to endoscopic dilatation, but some require conversion for persistence of stenosis or perforation caused by dilatation (EL 4 [28, 288, 292]). On the opposite site, an unwanted dilatation of the gastrojejunostomy may respond to sclerotherapy (EL 4 [316]). Stomal ulceration can usually be treated conservatively with an H2 blocker and sucralfacte (EL 4 [284]).

Biliopancreatic Diversion

The spectrum of complications after BPD is similar to RYGB. Complications have been found to be more likely in patients converted from other procedures to BPD (EL 3b [26]). According to the report by Anthone et al. [18], a lengthening of the common canal can be necessary to treat hypalbuminaemia or persistent diarrhea (EL 4). In that study, the initial length of the common canal was 100 cm.

Discussion

During the last years, the rapidly growing and often lucrative field of obesity surgery has attracted many laparoscopic surgeons. As also the prevalence of obesity has increased steadily, the number of bariatric operations has increased dramatically. Although obesity surgery represents the only therapeutic opportunity for strong and long-term weight loss, balancing between treatment benefits and side effects is often difficult, because many morbidly obese patients present with severe comorbidity. Furthermore, also the less than morbidly ob-

ese population is seeking help of bariatric surgeons. This led to the decision to summarize the state of the art in the field of obesity surgery. The EAES guidelines developed here were also necessary to update previous guidelines of other societies.

Since the results of this consensus conference have been derived directly from the relevant literature by an interdisciplinary panel, it can be hoped that they find widespread acceptance [132]. However, the recommendations are no "cookbook", because national and local circumstances will often necessitate modifications. This European consensus represents a common ground, which can be transferred to all obesity surgery centres. Still, any scientific recommendation represents a compromise between practically orientated firmness of language and its underlying scientific basis. Often, the scarceness of reliable evidence precluded the panel from formulating important decisions. On the other hand, it would have been of no practical value to come up with only bland generalities. Therefore, some recommendations were agreed upon, although only weak evidence had been found to support them, whereas other crucial points, like the choice of surgical procedure, were left unresolved, although some medium-quality, but not convincing evidence was available.

Among the possible shortcomings of these guidelines is the absence of an anesthesiologist, an internist, and a patient in the panel, since the paragraphs on preoperative and postoperative care cover also important aspects of general medicine. As most of the panel members are working in multidisciplinary teams, it can be expected that the most common non-surgical aspects of obesity surgery have been adequately addressed. The input of the nutritionist and the psychiatrist was very valuable. A patient representative often acts as a safeguard against recommending a procedure with unpleasant non-medical side effects and related problems with compliance. However, due to the difficulties in finding a competent person, patients are usually not participating in clinical guideline development. Furthermore, the inclusion of additional persons would have led to a panel size that makes group discussions difficult to moderate [211, 227, 240].

Owing to the lack of published data on various aspects of obesity surgery these recommendations also highlight the need for future studies. Especially the relative effectiveness of the different laparoscopic procedures is worth a number of controlled trials. Some technical modifications and newer devices also require scientific evaluation. Future studies should pay closer attention to the different subgroups of obese and morbidly obese patients, because different risk-benefit ratios are likely in these heterogeneous groups of patients. Since some ongoing studies were already identified during the guideline development process, it should be noted that the present recommendations need to be updated after about 5 years in order to take advantage of this new knowledge [303].

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Morbid Obesity – Update 2006

Mario Morino, Gitana Scozzari

Definition, Epidemiology and Clinical Course

No new data available.

Diagnostics

No new data available.

Operative Versus Conservative Treatment

Two important studies comparing bariatric surgery versus conservative treatment were published in 2004 [6, 20].

The 10-year results of the prospective controlled Swedish Obese Subjects Study were reported in the by Sjöström et al. [20] (EL 2b). This trial compared 641 patients who were submitted to surgery (156 bandings, 451 vertical banded gastroplasties, VGBs, and 34 gastric bypasses) with 627 obese patients of the control group. At 10 years, the body weight had increased by 1.6% in the control group and had decreased by 16.1% in the surgery group ($p < 0.001$). The surgery group had lower 2- and 10-year incidence rates of diabetes, hypertrygliceridemia and hyperuricemia than the control group, whereas differences between the two groups in the incidence of hypercholesterolemia and hypertension were undetectable.

Christou et al. [6] (EL 2b) reported an observational study using a combination of hospital and provincial insurance administrative databases to assess the effectiveness of bariatric surgery and to compare the mortality, morbidity and healthcare use in morbidly obese patients treated with bariatric surgery with a cohort of matched morbidly obese patients who were not treated surgically. Bariatric surgery resulted in a significant reduction in the mean percentage excess weight loss (EWL) (67.1%, $p < 0.001$). Bariatric surgery patients had significant risk reductions for developing cardiovascular, cancer, endocrine, infectious, psychiatric and mental disorders compared with controls, with the exception of haematologic (no difference) and digestive diseases (increased rates in the bariatric cohort). The mortality rate in the bariatric surgery cohort was

0.68% compared with 6.17% in controls, which translates to a reduction in the relative risk of death by 89%. This is a significant observation because it not only suggest the role of morbidity as a risk factor for early mortality but also provides evidence that surgical treatment of obesity produces a significant reduction in mortality. It is important to note that weight loss in the series by Christou et al. [6] was significantly higher that in the study by Sjöström et al. [20] (67 vs 25%) presumably as a consequence of the higher percentage of Roux-en-Y gastric bypasses (RYGBs) (80 vs 5%). In the Swedish study, 95% of surgical procedures were VBG and adjustable gastric banding; both procedures are associated with less weight loss compared with RYGB.

Therefore, compared with conventional therapy, bariatric surgery results in better long-term weight loss, improved lifestyle, amelioration of risk factors and decreased overall mortality (EL 2b).

Choice of Surgical Approach and Procedure

The laparoscopic approach is considered the gold standard for bariatric procedures and no papers comparing the laparoscopic with the open approach were published between 2004 and 2005.

Two randomized controlled trials (RCTs) comparing laparoscopic RYGB (LRYGB) and laparoscopic VBG (LVBG) [12, 17] (EL 1b) confirmed the results obtained from similar trials in open surgery: LRYGB is a time-consuming, demanding technique with a higher early complication rate compared with LVBG (17.8 vs 2.5%), but LRYGB results in a higher 2-year EWL (71.4 vs 53.1% in the study by Lee et al. [12] and 84.4 vs 59.8% in the study by Olbers et al. [17]).

A further RCT compared LRYGB with the mini-gastric bypass [13] (EL 1b) and showed similar results for resolution of metabolic syndrome, improvement of quality of life (QOL) and EWL at 2 years; nevertheless, the operative morbidity rate was higher for LRYGB (20 vs 7.5%).

VBG and RYGB were also compared in terms of oesophageal function in a prospective nonrandomized series by Ortega et al. [18]: on the basis of manometric and pH-metric results at 3 and 12 months postoperatively, the authors concluded that RYGB is significantly better than VBG as an antireflux procedure (EL 3).

These data were confirmed by Di Francesco et al. [10], who demonstrated that VBG reduced weight but not gastro-oesophageal reflux in obese patient at 1-year follow-up. The authors concluded that VBG should not be proposed for obese patients with reflux symptoms and positive functional tests (EL 3). It is important to note that no comparative data on long-term results of different bariatric procedures are available.

The results of a new bariatric procedure, the Implantable Gastric Stimulator (IGS), a pacemaker-like device that induces satiety, have been presented

in a multicentric prospective series of 69 patients with a mean body mass index (BMI) of 41 [8]. Postoperative morbidity was limited to one case, while the mean EWL was 17% at 6 months and 21% at 10 months. It is not possible to draw any conclusion from this article owing to the reduced number of patients, the limited follow-up and the limited quality of data presented (EL 5). Furthermore, the authors stated that "the exact mechanism of action of electrical stimulation therapy for obesity remains to be defined".

Technical Aspects of Surgery

A review article on the physiologic effects of pneumoperitoneum by Nguyen and Wolfe [14] showed that morbidly obese patients have a higher intra-abdominal pressure of 2–3 times that of nonobese patients. The increased intra-abdominal pressure enhances venous stasis, reduces intraoperative portal venous blood flow, decreases intraoperative urinary output, lowers respiratory compliance, increases airway pressure and impairs cardiac function. Intraoperative management to minimize the adverse changes includes appropriate ventilatory adjustment to avoid hypercapnia and acidosis, the use of sequential compression devices to minimize venous stasis, and optimization of intravascular volume to minimize the effects of increased intra-abdominal pressure on renal and cardiac function.

Laparoscopic adjustable gastric banding is the most frequently applied bariatric technique in Europe and Australia. Different techniques and different bands have been proposed but comparative data are lacking.

O'Brien et al. [16] published a RCT comparing the so-called perigastric with the pars flaccida techniques (EL 1b). Patients operated by the pars flaccida technique had a reduced number of long-term complications (16 vs 42%) and a reduced number of revisional procedures; at 2 years, weight loss, correction of comorbidities and QOL were similar in the two groups.

In a second study, the two more frequently used bands, the LapBand and the Swedish Band, were compared in a RCT by Suter et al. [21] (EL 1b); it is important to note that the LapBand was placed using the perigastric technique, while the Swedish Band was placed using the pars flaccida technique. The two main findings were that early band-related morbidity was higher with the Swedish Band and that weight loss was initially faster with the LapBand. No differences could be found between the two groups regarding late morbidity, late reoperations (10% in each group), and EWL at 2 and 3 years. The two studies present contrasting results concerning the perigastric and the pars flaccida techniques; therefore, existing data are insufficient to define which should be the preferred technique.

The technique of RYGB has not been standardized, a fact which results in a tremendous degree of variation from medical centre to medical centre. It

has been shown that increasing the Roux limb length may improve weight loss after RYGB, especially in patients with preoperative BMI > 50 [3, 4].

A RCT by Inabnet et al. [11] addressed this issue comparing 25 RYGBs with a biliopancreatic limb of 50 cm and an alimentary limb of 100 cm with 23 RYGBs with a biliopancreatic limb of 100 cm and an alimentary limb of 150 cm. The BMI decreased equally in both groups with no differences at 3, 6 and 12 months follow-up (EL 1 b).

Different technical devices have been recently proposed to facilitate or improve laparoscopic bariatric surgery, including robot-assisted procedures [1] and different staple-line reinforcement materials [2, 7, 15]. In a short series, Ali et al. [1] (EL 4) showed the feasibility of robot-assisted LRYGB using the Zeus robotic surgical system and addressed the problem of the learning curve defined as "significant but manageable".

Different materials have been tested in order to reduce staple-line bleeding and/or leaks during LRYGB or laparoscopic sleeve gastrectomy. Angrisani et al. [2] using bovine pericardial strips obtained a reduction of intraoperative leaks (methylene blue test) during LRYGB from 12.5 to 0%, but no differences in terms of bleeding or overall complications were found (EL 1 b). Nguyen et al. [15] obtained a significant reduction in staple-line bleeding sites diagnosed intraoperatively (0.4 vs 2.5) and in mean blood loss (84 vs 129 ml) during LRYGB using a glycolic copolymer sleeve to reinforce the staple line (EL 1 b). Furthermore, a significant reduction in peroperative blood loss was found by Consten et al. [7] comparing ten laparoscopic sleeve gastrectomies using a stapled buttressed absorbable polymer membrane to reinforce staple lines with ten cases using a conventional staple line (EL 2 b).

In conclusion, although on a limited number of patients, the use of some form of reinforcement of the staple line during bariatric surgery seems to be effective in improving intraoperative results, but no differences in postoperative complications have been detected by these studies and no data on costs have been reported.

Peri- and Postoperative Care

De Waele et al. [9], in a series of ten patients with a mean BMI of 38 and a mean age of 36 years, showed that laparoscopic adjustable gastric banding may be performed on an ambulatory basis without readmissions or complications (EL 4). The mean time interval between the end of the operation and discharge was 9.6 h (range 8–13 h). A strict selection of patients was advocated.

Factors influencing the outcome of bariatric surgery were evaluated in two different studies.

Poulose [19] reviewed 54,878 patients undergoing bariatric surgery in the USA in 2001 identified using the 2001 Healthcare Cost and Utilization Project

NIS. Risk factors for increased postoperative mortality included male gender, age above 39 years, Medicaid insured, and need for reoperation.

Very similar results were presented in the study by Carbonell et al. [5], who analysed year 2000 data from the Nationwide Inpatient Database for 5,876 RYGBs: male gender and postoperative complications increased mortality; male gender, increasing age and surgery performed in large hospitals were predictors of morbidity (EL 2b).

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The EAES Clinical Practice Guidelines on Laparoscopic Cholecystectomy, Appendectomy, and Hernia Repair (1994)

Edmund A.M. Neugebauer, Hans Troidl, C.K. Kum, Ernst Eypasch, Marc Miserez, Andreas Paul

Introduction

In the history of surgery, probably no other surgical development had such a dramatic and pivotal impact on surgery worldwide as endoscopic surgery. There is indeed no field in surgery which is not affected by endoscopic surgery. However, experience with this "new" tool has shown serious limitations and dangers of endoscopic surgical procedures, especially in less-experienced hands. Furthermore, it is not sufficient to demonstrate that an endoscopic surgical approach is feasible and safe; it must also be ascertained that the specific technique has a real benefit for the patients.

Large international societies such as the European Association for Endoscopic Surgery (EAES) have the responsibility to provide a forum for discussion of new developments and to provide guidelines on the best practice in the different fields based on the current state of knowledge. For this reason, the Educational Committee of the EAES decided to perform consensus development conferences (CDCs) to assess the current status of endoscopic surgical approaches for treatment of cholelithiasis, appendicitis, and inguinal hernia. These topics were chosen because of: (1) importance in terms of prevalence and economy, (2) multidisciplinary interest, (3) scientific controversy, and (4) the existence of sufficient research data for evaluation. The second international European Congress of the EAES, in Madrid, September 15–17, 1994, was chosen as a forum for these consensus development conferences. The method, the same for all three CDCs, and the specific results given as answers to previously posed questions are presented in this comprehensive article.

Methods

At their annual meeting in November 1993, the Educational Committee of the EAES decided to perform three consensus development conferences (CDCs) on the topics mentioned. The second European Congress of the EAES in September in Madrid should be the forum for a public session to discuss the final consensus statements. The Cologne group (chairmen H. Troidl, E.

Neugebauer) was authorized to organize the CDCs according to general guidelines in format and conduct. The procedure chosen was the following: A small group of panelists (10–13 members for each conference) was nominated by the Educational Committee of the E.A.E.S. Criteria for selection were (1) clinical expertise in the field of endoscopic surgery, (2) academic activity, (3) community influence, and (4) geographical location. Two chairpersons were determined and all of them (panelists and chairpersons) were asked to provide written agreements to participate. Four months prior to the conferences, each panelist got (1) a table with guidelines to use to estimate the strength of evidence in the literature for the specific endoscopical procedure, and (2) a table with the description of the levels of technology assessment (TA) according to Mosteller (1985). Each panelist was asked to indicate what level of development, in his opinion, the endoscopic procedure had attained in general and was given (3) a table with specific parameters of TA, relevant to the endoscopic procedure under assessment. In this table, the panelists were asked to indicate the status of the endoscopic procedure in comparison with conventional open procedures. The panelists' view must have been supported by evidence in the literature – a reference list was mandatory for each item in this table (always Table 12.1 in the results section of each CDC). Each panelist was given (4) a list of relevant specific questions pertaining to each procedure (questions on indication, technical aspects, training, etc.). The panelists were asked to provide brief answers with references. Guidelines for response were given and the panelists were asked to send their initial evaluations back to the conference organizers 2 months prior to the conference.

The next step was to compile and to analyze the initial evaluation of the panelists and to prepare provisional consensus statements and tables for each topic by the conference organizers. These drafts were then posted to each panelist prior to the Madrid panel meetings. At this time point, a complete list of the whole panel group was released to each panelist. In a 2-h session of each panel in Madrid, all statements and tables were discussed and modified if necessary under the leadership of the chairperson selected. When full agreement could not be obtained, the consensus was formulated on majority agreement. The consensus results of each panel were presented at the same day to the participants of the second European Congress of the EAES in topic-related plenary sessions by one of the chairpersons. Following discussion final consensus statements were formulated by the panel. The full text of the statements is given below.[1])

[1)] Mosteller F (1985) Assessing medical technologies. National Academic Press, Washington, DC

Table 12.1. Evaluation of feasibility and efficacy parameters for laparoscopic cholecystectomy by the panelists before the final discussion

Stages of technology assessment	Definitely better	Probably better	Similar	Probably worse	Definitely worse	Percentage of consensus [a)]	Strength evidence 0–III [b)]
Feasibility							
Safety (intra-op)			2	5	1	75	II
Operation time			4	4		50	II
Postop complications	1	3	4			50	II
Mortality	1	1	6			75	II
Efficacy							
Postoperative pain	8					100	II
Hospital stay	8					100	III
Return to normal activities	8					100	III
Cosmesis	8					100	II
Overall assessment	5	3				100	II

[a)] Percentage of consensus was calculated by dividing the number of panelists who voted better (probably and definitely), similar, or worse (probably and definitely) by the total number of panelists who submitted their evaluation forms (8)

[b)] Refer to Table 2 for definitions of the grading system

1. Results of EAES Consensus Development Conference on Laparoscopic Cholecystectomy

Chairmen: J. Perissat, Centre de Chirurgie, Université de Bordeaux, Bordeaux, France; W. Wayand, 2nd Department of Surgery, General Hospital, Linz, Austria.

Panelists: A. Cuschieri, Department of Surgery, University of Dundee, Ninewells Hospital 1 Dundee, UK; T.C. Dupont, Jefe del Opto de Cirugia, Hospital Universitario Virgen del Rocio, Seville, Spain; M. Garcia-Caballero, Department of Surgery, Medical Faculty, Malaga, Spain; J. F. Gigot, Department de Chirurgie Digestive, St. Luc Hospital, Bruxelles, Belgium; H. Glise, Department of Surgery, Norra Alsborgs, Lanssjukhus-NAL, Trollhattan, Sweden; C. Liguory, CMC Alma, Paris, France; M. Morino, Surgical Clinic, University of Torino, Turin, Italy; M. Rothmund, Department of Surgery, University of Marburg, Marburg, Germany.

Literature List with Rating

All literature submitted by the panelists as supportive evidence for their evaluation was compiled and rated (Table 12.2). Only papers of grade I and above were considered. The consensus statements were based on these published results.

Table 12.2. Ratings of published literature on laparoscopic cholecystectomy

Study type	Strength of evidence	References
Clinical randomized controlled studies with power and relevant clinical endpoints	III	[5, 26, 30, 37]
Cohort studies with controls: – Prospective, parallel controls – Prospective, historical controls Case-control studies	II	[6, 16, 19, 23, 25, 27, 29, 34, 36, 43, 44, 49, 53, 54, 57, 59]
Cohort studies with literature controls Analysis of databases Reports of expert committees	I	[1–4, 7–15, 17, 18, 20–22, 24, 28, 31–33, 35, 38–42, 45–48, 50–52, 55, 56, 58, 60–65]
Case series without controls Anecdotal reports Belief	0	Not evaluated

Table 12.3. Evaluation of stage of technology attained and strength of evidence

Stages in technology assessment [a]	Level attained/strength of evidence [b]
1. Feasibility Technical performance, applicability, safety, complications, morbidity, mortality	III
2. Efficacy Benefit for the patient demonstrated in centers of excellence	III
3. Effectiveness Benefit for the patient under normal clinical conditions, i.e., good results reproducible with widespread application	II
4. Costs Benefit in terms of cost-effectiveness	I
5. Gold standard	Yes

[a] Mosteller F (1985) Assessing medical technologies. National Academy Press, Washington, DC
[b] Level attained, and if so the strength of evidence in the literature as agreed upon by the panelists

Question 1. What Stage of Technological Development is Laparoscopic Cholecystectomy (LC) at (in Sept. 1994)?

The definitions for the stages in technological development follow the recommendations of the Committee for Evaluating Medical Technologies in Clinical Use. The panel's evaluation as to the attainment of each technological stage by laparoscopic cholecystectomy, together with the strength of evidence in the literature, is presented in Table 12.3. LC is the procedure of choice for symptomatic uncomplicated cholelithiasis. As it is not possible to conduct randomized trials on LC vs open surgery anymore, it is important for all surgeons to audit continually the results of LC. Results of analyses on its cost effectiveness and cost benefits are dependent on the health-care system. Open cholecystectomy remains the standard for comparison.

Question 2: Who Should Undergo LC?

1. The indications for cholecystectomy remain unchanged. LC is indicated for patients who are able to tolerate general anesthesia without undue risk. It is also indicated in patients with calcified (porcelain) gallbladders.
2. Asymptomatic cholelithiases, in general, do not warrant cholecystectomy. Most of the patients remain asymptomatic. It is also rare for complications to occur without symptoms appearing first. Patients with symptomless gallstones that should be followed up closely include:
   i. Diabetics
   ii. Those with sickle cell disease

iii. Children
iv. Those on long-term somatostatin
v. Those on immunosuppressive drugs

3. In the following conditions, LC is usually contraindicated.
   i. Generalized peritonitis
   ii. Septic shock from cholangitis
   iii. Severe acute pancreatitis
   iv. Cirrhosis with portal hypertension
   v. Severe coagulopathy that is not corrected
   vi. Cholecysto-enteric fistula
4. Extreme caution should be taken in the following groups of patients,
   i. Severe associated cardiorespiratory diseases
   ii. Previous upper abdominal surgery
   iii. Acute cholecystitis
   iv. Symptomatic cholecystitis in the second trimester of pregnancy

These cases should be performed only by an experienced team.

Question 3: Is LC Safe and Feasible?

1. The incidence of common bile duct injury is still slightly higher than open surgery. Vascular injury and bowel injury are specific to LC. This is due to surgeon inexperience, limitations of the two-dimensional view, lack of tactile sensation, and extension of indication to more difficult cases. Adequate training with close supervision and strict accreditation is required.
2. Operation time is similar or longer than the open procedure.
3. Morbidity from wound complications and postoperative recovery period are reduced with LC.
4. Mortality risk is similar.
5. In pregnant women, the risk of CO_2 pneumoperitoneum on the fetus in the first trimester is not fully known. LC in the third trimester should be avoided as it is technically difficult and carries a risk of injuring the uterus. Only in the second trimester is LC relatively safe, but it should only be performed by experienced operators in severely symptomatic or complicated cholelithiasis.
6. For acute cholecystitis, publications of data on small numbers of patients by keen endoscopic surgeons have reported complication rates not more than routine LC, even when performed in the same admission. However, the true safety cannot be known until more data are available. The threshold for conversion should be low. Indications for conversion include:
   i. Unclear anatomy
   ii. Gangrenous, friable gallbladder that is difficult to handle

iii. Bleeding
iv. technical problems
v. Unduly long operation time with no progress

Please refer to Table 12.2 for the definitions of the different grades.

Question 4: Is It Beneficial to the Patients?

1. LC leads to markedly less postoperative pain, shorter hospital stay, earlier return to normal activities, and better cosmesis.
2. In general, LC has a distinct advantage over open cholecystectomy.

Question 5: How Should Common Bile Stones Be Managed?

1. The optimal management of common bile duct stones (CBDS), which are present in 10–15% of patients, is not well defined. The common bile duct should be imaged in patients with a previous or present history of jaundice or pancreatitis, or abnormal liver function tests, or when ultrasonography reveals a dilated CBD. Either preoperative endoscopic retrograde cholangiopancreatography (ERCP) or preoperative IV cholangiography (IVC) or intraoperative cholangiography (IOC) can be used to image the duct.
2. ERCP is the most reliable modality for confirming the presence of CBDS preoperatively in patients with abnormal biochemical or ultrasound findings. Endoscopic sphincterotomy (ES) and stone clearance is currently the established treatment for these patients, and is followed by LC. Studies are needed to compare the two-stage treatment (ERCP, ES + LC) with the single-stage laparaoscopic intervention (LC+laparoscopic removal of CBDS).
3. CBDS found on IOC can be treated by (1) open exploration, (2) laparoscopic exploration, (3) intra-operative ERCP, (4) postoperative ERCP, (5) careful observation, depending on the expertise available. Open exploration remains the standard technique. Laparoscopic techniques of exploration are under evaluation. Postoperative ERCP has the risk, albeit low, of failure.

Question 6. What Are the Special Technical Aspects to Be Considered During LC?

1. If problems are encountered during CO_2 insufflation with the Veress needle, the open technique should be used.
2. The junction between the cystic duct and the gall-bladder must always be clearly defined. Dissection of the junction between the cystic duct and the CBD is not necessary. Dissection in this area, principally done to identify the CBD, is, however, associated with the risk of inadverent damage to the CBD itself.

3. Coagulation in Calot's triangle should be kept to aminimum. If needed, either bipolar or soft monopolar (less than 200 mV) coagulation is preferred.
4. Either metal clips (at least two) or locking clips are safe for securing the cystic artery and duct. In event of a large cystic duct, a ligature is safer.
5. The prevention of CBD damage by routine intraoperative cholangiogram (IOC) is not proven. However, IOC allows immediate detection of the injury and thus primary repair with better prognosis. IOC should be done when (1) anatomy is not well seen; (2) duct injury is suspected; (3) common bile duct stones are suspected. All surgeons should be trained to perform IOC.
6. To avoid injury to the CBD, the following principles should be adhered to:
7. Unambiguously identify the structures in Calot's triangle
8. Avoid unnecessary coagulation
9. Dissect starting from the gallbladder-cystic duct junction
10. Perform IOC when the anatomy is not clear
11. Convert to open surgery when in doubt
12. Drainage is usually not required
13. Suturing of trocar sites 10 mm or more is recommended especially when such a site has been dilated or extended for extraction of the gallbladder.

Question 7. What Are the Training Recommendations for LC?

Refer to EAES guidelines published in *Surgical Endoscopy* 1994; 5:721–722

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(Grading of references is given in Table 12.2)

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2. Results of EAES Consensus Development Conference on Laparoscopic Appendectomy

Chairman: E. Eypasch, 2nd Department of Surgery, University of Cologne, Germany; C.K. Kum, Department of Surgery, National University Hospital, Singapore.

Panelists: O.J. McAnenna, Surgical Unit, University College Hospital, Galway, Ireland; M. McMahon, Leeds Institute for Minimally Invasive Therapy, The General Infirmary, Leeds, UK; S. Attwood, Meath Hospital, Dublin, Ireland; E. Schippers, Department of Surgery, Clinic RWTH, Aachen, Germany; J. Jakimowicz, Department of Surgery, Catharina Hospital, Eindhoven, The Netherlands; W. van Erp, Department of Surgery, Diaconessenhuis, Eindho-

Table 12.4. Evaluation of feasibility and efficacy parameters for laparoscopic appendectomy by the panelists before the final discussion

Stages of technology assessment	Definitely better	Probably better	Similar	Probably worse	Definitely worse	Percentage of consensus [a]	Strength of evidence 0–III [b]
Feasibility							
Safety		1	8	2		73	II
Operation time			3	7	1	73	III
Postop complications	1	6	4			64	III
Mortality			9	1 [c]		82	I
Efficacy							
Diagnostic accuracy	7	4				100	II
Wound infection	8	3				100	III
Postoperative pain	4	6	1			91	II
Hospital stay	2	6	3			73	II
Return to normal activities	5	5	1			91	III
Postoperative adhesions	1	7	2 [c]			73	I
Cosmesis	4	4	2 [c]			73	0
Overall assessment	3	6	1	1		7	II

[a] Percentage of consensus was calculated by dividing the number of panelists who voted better (probably and definitely), similar, or worse (probably and definitely) by the total number of panelists [11]

[b] Refer to Table 2 for definitions of the grading system

[c] One panelist wrote "unknown" or left it blank. He is presumed to have voted with this minority group when the percentage of agreement was calculated.

Table 12.5. Ratings of published literature on laparoscopic appendectomy

Study type	Strength of evidence	References
Clinical randomized controlled studies with power, and relevant clinical end points	III	[2, 6, 10, 12, 23, 33]
Cohort studies with controls – Prospective, parallel controls – Prospective, historical controls Case-control studies	II	[3, 4, 8, 13, 18, 19, 25, 27, 29, 32, 34, 36, 38]
Cohort studies with literature controls Analysis of databases Reports of expert committees	I	[1, 5, 7, 9, 14, 16, 20–22, 24, 26, 30, 37]
Case series without controls Anecdotal reports Belief	0	[15, 17, 28, 31, 35, 39]

ven, The Netherlands. P. Testas, Service de Chirurgie Generate, Centre Hospitalier Bicetre, Le Kremlin-Bicetre Cedex, France; J. A. Lujan Mompean, Department of General Surgery, University Hospital "Virgen de la Arrixac", El Palmar, Murcia, Spain; J. S. Valla, Hopital pour Enfants, Nice, France.

Literature List with Rating

All literature submitted by the panelists as supportive evidence for their evaluation was compiled and rated (Table 12.5). The consensus statements were based on these published results.

Question 1. What Stage of Technological Development is Laparoscopic Appendectomy (LA) at (in Sept. 1994)?

The definitions for the stages in technological development follow the recommendations of the Committee for Evaluating Medical Technologies in Clinical Use. The panel's evaluation as to the attainment of each technological stage by laparoscopic appendectomy, together with the strength of evidence in the literature, is presented in Table 12.6. LA is presently at the efficacy stage of development because most of the data on feasibility and safety originate from centers with a special interest in endoscopic surgery. More data on its use in general and district hospitals are needed to ascertain its effectiveness. Detailed analysis on its cost-effectiveness and cost benefits is also lacking. Although a very promising procedure, it is not yet the gold standard for acute appendicitis.

Table 12.6. Evaluation of stage of technology attained and strength of evidence

Stages in technology assessment[a)]	Level attained/strength of evidence[b)]
1. Feasibility Technical performance, applicability, safety, complications, morbidity, mortality	III
2. Efficacy Benefit for the patient demonstrated in centers of excellence	III
3. Effectiveness Benefit for the patient under normal clinical conditions, i.e., good results reproducible with widespread application	I
4. Costs Benefit in terms of cost-effectiveness	Unknown
5. Gold standard	No

[a)] Mosteller F (1985) Assessing Medical Technologies. National Academy Press, Washington, DC

[b)] Level attained, and if so, the strength of evidence in the literature as agreed upon by the panelists. Please refer to Table 12.5 for the definitions of the different grades

Question 2: Is LA Safe and Feasible?

1. There is no evidence in published literature that LA is any less safe than open appendectomy (OA).
2. Operation time, depending on the experience of the surgeon, is similar or longer than the open procedure.
3. Postoperative complications – e.g., bleeding, intraabdominal abscess, re-operation – are not more frequent than OA in the published literature. However, the morbidity associated with widespread application is not yet known.
4. LA is not contraindicated for perforated appendicitis. However, more data for this subgroup of patients is needed.
5. LA may be attempted for an appendiceal abscess by an experienced surgeon if the abscess is to be treated early. Conversion to open surgery should be undertaken when difficulties are encountered. Alternatively, delayed elective LA can be performed after resolution of the abscess with antibiotic therapy.
6. LA can be used in children. It should be performed only by surgeons with ample experience in adult LA. Smaller instruments should be available to improve safety and ergonomy.
7. The safety of LA during pregnancy is not established.
8. The indication for elective LA is the same as for open elective appendectomy.

Question 3: Is It Beneficial to the Patients?

1. Laparascopy improves the diagnostic accuracy of acute right iliac fossa pain, especially in children and young women.
2. LA reduces wound infection rate.
3. There is less postoperative pain in adults. There are no data in children.
4. Hospital stay is similar or less than OA.
5. LA allows earlier return to normal activities.
6. The laparoscopic approach may lead to less post-operative adhesions.
7. Cosmesis may be better than OA.
8. All in all, LA has advantages over OA. However, the potential for serious injuries must be appreciated and avoided in order to make the postoperative advantages worthwhile.

Question 4. What Are the Special Technical Aspects to Be Considered During LA?

The statements here are meant to be guidelines. The surgeon at the operating table has to be the ultimate judge as to what is safe to do.

1. Convert to open surgery if the appendix cannot be found.
2. At diagnostic laparoscopy, there is no obligation to remove the appendix.
3. Bipolar coagulation is a perferred mode of coagulating the artery. Monopolar diathermy may be safe if the appropriate precautions are taken. Use of clips alone or in combination with coagulation is the alternative. Suture ligation of the artery is usually unnecessary. Lasers and staples are not cost-effective.
4. When the base of the appendix is healthy and un-inflamed, one properly applied preformed ligature is probably enough. If in doubt, use two loops. Metal clips alone are not recommended; staples are too expensive and not required in most cases.
5. The appendix should be transected at about 5 mm from the last preformed ligature. It is unnecessary to bury the stump.
6. To avoid wound infection, the appendix should be removed through the port or if too big, within a pouch.
7. Peritoneal toilet is recommended in cases of intraabdominal contamination.
8. The antibiotic policy should be the same as for open appendectomy.

Question 5. What Are the Training Recommendations for LA?

1. LA should be part of the resident's curriculum.
2. At least 20 cases of LA are needed for accredition in general surgery.

Summary

Laparoscopic appendectomy is an efficacious new technology. Its safety and feasibility have been shown in the published literature, mainly from centers with a special interest in endoscopic surgery. However, a few cases of serious complications have been reported. Surgeons should be aware of the potential dangers.

Benefits for the patients, especially in terms of more accurate diagnosis, reduction of wound infection, and earlier return to work, have also been shown in controlled trials, albeit with small numbers of patients. Its effectiveness, compared to open appendectomy, when applied generally to all grades of hospitals, remains to be seen. The cost-effectiveness of LA is not known. Although promising, it is not yet the gold standard for acute appendicitis.

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(Grading of references is given in Table 12.5)

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3. Results of EAES Consensus Development Conference on Laparoscopic Hernia Repair

Chairmen: A. Fingerhut, Department de Chirurgie, Centre Hospitaller Intercommunale, Poissy, France; A. Paul, 2nd Department of Surgery, University of Cologne, Germany

Panelists: J.-H. Alexandre, Department de Chirurgie, Hopital Broussais, Paris, France; M. Biichler, University Hospital for Visceral and Transplantation Surgery, Bern, Switzerland; J.L. Dulucq, Department de Chirurgie, M.S.P. Bagatelle, Talence-Bordeaux, France; P. Go, Department of Surgery, University Hospital Maastricht, Maastricht, The Netherlands; J. Himpens Hopital Universitaire St. Pierre, Department de Chirurgie, Bruxelles, Belgium: C. Klaiber, Department of Surgery, General Hospital, Aarberg, Switzerland; E. Laporte, Department of Surgery, Policlinica Teknon, Barcelona, Spain; B. Millat, Department de Chirurgie, Centre Hospitalier Universitaire, Montpellier, France; J. Mouiel, Department de Chirurgie Digestive, Hopital Saint Roche, Nice, France; L. Nyhus, Department of Surgery, College of Medicine, The University of Illinois at Chicago, Chicago, USA; V. Schumpelick, Department of Surgery, Clinic RWTH, Aachen, Germany

Literature List with Rating

All literature submitted by the panelists as supportive evidence for their evaluation was compiled and rated (Table 12.8). The consensus statements were based on these published results.

Question 1. Is There a Need for the Classification of Groin Hernias, and If So, Which Classification Should Be Used?

Several classifications for groin hernias have been proposed (Alexandre, Bendavid, Gilbert, Nyhus, Schumpelick). The majority of the panelists refer to Nyhus's classification (Table 12.9). It is suggested that this classification be applied in future trials. However, the accuracy and reproducibility of any classification in laparoscopic hernia repair still must be demonstrated.

In any case, the minimal requirements for future studies are classifications which accurately describe the defects:

- The type: direct, indirect, femoral or combined
- State of the internal ring (dilated or not)
- Presence and size of the posterior wall defect
- Size and contents of the sac
- Whether primary or recurrent

Table 12.7. Evaluation of feasibility and efficacy for laparoscopic herniorrhaphy by the panelists before the final discussion

Stages of technology assessment	Definitely better	Probably better	Similar	Probably worse	Definitely worse	Strength of evidence 0–III [b]
Feasibility						
Safety of intraabdominal techniques			6	5	1	I
Safety of extraabdominal techniques (54%) [a]	1	4	7	1		I
Operation time (77%)		2	1	8	2	II
Adverse events						
Spermatic cord injury (54%)	1	4	7	1		I
Testicular vessel injury (62%)	1	7	4	1		I
Nerve injury (50%)		3	6	3		I
Ileus (intraabdominal methods) (70%)		1	2	4	3	I
Bleeding (73%)	1	7	2	1		I
Wound infection (70%)	1	6	3			I
Reoperation (50%)	1	4	3	2		I
Disability (75%)	1	8	2	1		I
Mortality (92%)			11		1	I
Efficacy						
Postoperative pain (85%)	4	7		1	1	II
Hospital stay (58%)	3	4	4		1	II
Return to normal activities (75%)	4	5	2		1	II
Cosmesis	2	3	4			I
Recurrence	1	4	5		1	I
Overall assessment (64%)		7	2	2		II

[a] Percentage of agreement calculated by dividing the number of panelists who voted better (probably and definitely), similar, or worse (probably and definitely) by the total number of panelists [9]

[b] Refer to Table 12.8 for definitions of the grading system

Question 2. In What Stage of Technological Development is Endoscopic Hernia Repair (in Sept. 1994)?

Endoscopic hernia repair is presently a feasible alternative for conventional hernia repair if performed by experienced endoscopic surgeons. It appears to be efficacious in the short term. It has not yet reached the effectiveness stage in general practice. Detailed analysis on cost-effectiveness and cost benefits are lacking. Although some aspects of endoscopic hernia repair are

Table 12.8. Ratings of published literature on laparoscopic hernia repair

Study type	Strength of evidence	References
Clinical randomized controlled studies with power and relevant clinical endpoints	III	[42, 43,54]
Cohort studies with controls – Prospective, parallel controls – Prospective, historical controls Case-control studies	II	[7, 15, 36]
Cohort studies with literature controls Analysis of databases Reports of expert committees	I	[2, 3, 5, 6, 8–10, 13, 14, 16–21, 23–35, 38–41, 44–51, 55–61]
Case series without controls Anecdotal reports Belief	0	[1, 4, 11, 12, 22, 37, 52, 53]

Table 12.9. Nyhus classification for groin hernia

Type of hernia	Anatomical defect
I	Indirect hernia-normal internal ring
II	Indirect hernia-dilated internal ring
III A	Direct hernia-posterior wall defect
III B	Large indirect hernia-posterior wall defect
III C	Femoral hernia
IV	Recurrent hernia

See [40]

very promising (e.g., recurrence and bilateral hernia), it cannot be considered the standard treatment. (Table 12.10.)

Question 3. Is Endoscopic Hernia Repair Safe?

Endoscopic hernia repair may be as safe as the open procedure. However, up until now, safety aspects have not been sufficiently evaluated. Most panellists agreed that it has the same potential for serious complications as in open surgery–such as postoperative ileus, nerve injury, and injuries to large vessels. Reporting all complications, fatal or not, is encouraged and necessary for further evaluation.

Table 12.10. Stages of technology assessment in endoscopic hernia repair

Stages in technology assessment [a]	Level attained/strength of evidence [b]
1. Feasibility Technical performance, applicability, safety, complications, morbidity, mortality	I
2. Efficacy Benefit for the patient demonstrated in centers of excellence	II
3. Effectiveness Benefit for the patient under normal clinical conditions, i.e., good results reproducible with widespread application	0
4. Costs Benefit in terms of cost-effectiveness	0
5. Gold standard	No

[a] Mosteller F (1985) Assessing medical technologies. National Academy Press, Washington, DC

[b] Level attained, and if so the strength of evidence in the literature as agreed upon the panelists. Refer to Table 2 for the definitions of the different grades.

Question 4. Is Endoscopic Hernia Repair Beneficial to the Patient?

The potential reduction in the incidence of hematoma and clinically relevant wound infections has yet to be proven. Postoperative pain seems to be diminished. Although it seems to allow earlier return to normal activities, postoperative disability and hospital stay are highly dependent on activity, motivation, and social status of the patient as well as the structure of the health-care system.

Objective measurement (e.g., standardized exercise tests) should be developed and used to evaluate return to normal activity.

As in other endoscopic procedures, there is a potential for better cosmetic results. The long-term recurrence rate for endoscopic hernia repair is not known.

Question 5. Who Is a Potential Candidate for Endoscopic Hernia Repair?

Candidates:

- Type III A–C
- Recurrences (type IV), bilateral hernia
- Type II?

Contraindications:

Absolute:

- High-risk patients for general anesthesia or conventional surgery
- Unconnected bleeding disorders

- Proven adverse reaction to foreign material
- Major intraabdominal disease (e.g., ascites)

Relative:

- Incarcerated or scrota! (sliding) hernia
- Young age (sac resection only)
- Prior major abdominal operations

Question 6. What Concepts Should Be Used in the Future Evaluation of Endoscopic Hernia Repair?

There is a definite need for classification and randomized controlled (multicenter) trials with clear end points:

- Complication and recurrence rates (over 5 years, with less than 5% lost to follow-up)
- Pain and physical activity resumption
- Size, type, and route of mesh placement

Endoscopic techniques should be compared to conventional hernia or open preperitoneal prosthetic mesh repair techniques vs laparoscopic transabdominal preperitoneal (TAPP) and/or extraperitoneal or totally preperitoneal repair (TPP).

Question 7. Should Endoscopic Hernia Repair Be Performed Outside Clinical Trials?

In 1994, we recommend that endoscopic hernia repair should only be performed after appropriate training and with some sort of quality control.

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(Grading of references is given in Table 12.8)

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Cholecystolithiasis – Update 2006

Jörg Zehetner, Andreas Shamiyeh, Wolfgang Wayand

Definition, Epidemiology and Clinical Course

Cholecystolithiasis is gallstone formation in the gallbladder. Gallstone disease has a great impact on a surgeon's daily routine. The prevalence of cholecystolithiasis is 10–12% in the western world and about 3–4% in Asian populations [10]. The costs for the treatment of biliary stone disease in the prelaparoscopic aera were estimated at US $ 16 billion in the USA in 1987 [34], about one million people are newly diagnosed annually in the USA, and approximately 600,000 operations are performed a year.

Diagnostics

Abdominal ultrasound is the primary tool for the diagnosis of cholecystolithiasis. In combination with laboratory findings and patient history, the correct diagnosis should be made. In the first years of laparoscopic cholecystectomy (LC), intravenous cholangiography (IVC) was used as a valuable tool for the imaging of the bile duct's anatomy in order to prevent common bile duct injuries and to diagnose possible bile duct stones. IVC is entailed with possible adverse reactions [19] and after initial experience of LC, IVC was considered not to be used as a routine screening modality preoperatively [3]. Spiral CT cholangiography is not suitable for routine diagnosis before LC [28] as well as endoscopic retrograde cholangiopancreatography [18]. Details on the management of common bile duct stones can be found in the appropriate chapter of this book.

Routine gastroscopy prior to LC is still discussed controversially. While some authors claim it as a standard examination before LC, others do not [27, 30, 32]. Endoscopy prior to cholecystectomy should be performed only in patients with a history of upper abdominal pain or discomfort [1, 5, 33].

Operative Versus Conservative Treatment

Operative treatment is indicated for symptomatic gallstones. Conservative treatment is appropriate for asymptomatic gallstones as well as in patients with high operative risk according to the EAES Consensus statements (1994), and this still holds true.

Choice of Surgical Approach and Procedure

The 1994 EAES statement remained unchanged in the updating comments (2000) as well as in 2006: LC is the procedure of choice for symptomatic uncomplicated cholecystolithiasis. The overall rate of cholecystectomy by laparoscopy is about 75% in the western world: In the USA the rate of LC for chronic cholecystitis is 78% with a conversion rate of 6.1% [13]. In Germany, the overall rate is 72% [14] and in Australia 75% [6].

Excluding the randomised controlled trials (RCTs) on acute cholecystitis, timing of surgery or ambulatory surgery, over 40 RCTs are available comparing LC versus open cholecystectomy or minicholecystectomy (MC). MC is defined as open cholecystectomy through a laparotomy smaller than 8 cm [15]. In the first years of LC, the longer operation time was the most significant disadvantage of the minimally invasive approach. Most of the trials found shorter hospital stay, less pain and faster return to normal activity, resulting in less postoperative risk for pulmonary complications not only in healthy patients but also in patients with cirrhotic portal hypertension [7, 9, 21]. However, the main advantages can only be detected during the first days postoperatively. McMahon et al. [17] demonstrated that the benefits of LC diminish beginning after the first week to an equal state 3 months postoperatively.

Majeed et al. [15, 31] concluded in a blinded RCT that LC takes longer to do than small-incision cholecystectomy and does not have any advantages in terms of hospital stay, analgesic consumption or postoperative recovery. Finally there is a blinded multicenter RCT from Sweden comparing LC with MC including 724 randomised patients [24, 25]. The conclusion was shorter sick leave and faster return to work after LC, an equal postoperative complication rate and fewer intraoperative complications in the MC group. The operation time was longer for LC.

Technical Aspects of Surgery

For patient positioning, two possibilities are established: The “French technique”, with the surgeon between the patient’s legs [4], or the “American technique”, with the patient in a supine position with the surgeon standing on the left side. One RCT found better pulmonary function with the French

technique [11]. LC is performed by creating a CO_2 pneumoperitoneum. The technical aspects of the pneumoperitoneum (access technique, insufflation gas, etc.) are described in a separate chapter of this book.

The dissection in Callot's triangle should be performed using the "critical view" technique: the two identified structures entering the gallbladder (the duct and the artery) have to be identified clearly before cutting them. These structures might be secured either by metallic or by resorbable clips [23]. Bipolar electrocautery is not safe in the closure of the cystic duct as shown by experimental studies [16, 29]. The dissection is usually done retrograde from the infundibulum to the fundus. In difficult situations, the "fundus" first technique seems to be safe [8, 22, 26].

There is no evidence recommending drainage routinely [12]. One RCT could not prove any advantage of a subphrenic-placed drain in order to evacuate the residual CO_2 gas [20]. Similarly, there is no need for routine antibiotics [2].

Peri- and Postoperative Care

There are no new data available to update the comments from 2000.

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Inguinal Hernia Repair – Update 2006

Abe Fingerhut, Bertrand Millat, Nicolas Veyrie, Elie Chouillard, Chadli Dziri

Introduction

An update on laparoscopic inguinal hernia repair leads one to realize that while approximately 60 controlled randomized trials have already been performed in this arena, and that at least 15 systematic reviews and meta-analyses [1–15] have analytically summed up these results, there is still controversy as to whether laparoscopic inguinal hernia should be performed or not [16]. The conclusions of all these studies, however, as already alluded to in our previous update [17], have been that laparoscopic mesh repair has similar recurrence rates to open mesh repair (both being better than rraphy techniques), costs more (in operative time and in direct costs) than open mesh or nonmesh repair, with clinically marginal benefits as concerns immediate postoperative pain. After a brief summary of these issues, further discussion will be centered on (1) the practical consequences that arise from the results of these studies and (2) the future directions that must be sought.

Material and Methods

A systematic research of the electronic literature was made using the Cochrane and Medline databases to gain access to all controlled randomized trials, systematic reviews, and meta-analyses involving laparoscopic versus open inguinal hernia repair. The search strategy was that described by Dickersin et al. [18, 19] with the appropriate specific search terms for inguinal hernia repair and controlled trials [clinical trial (PT) and randomized controlled trial (PT), and controlled clinical trial (PT)]. More recent individual studies, either not included in the meta-analyses, or outstanding or highly controversial, were also analyzed.

Results

Of over 60 studies found, our analysis concerns 41.

Overall recurrence rates were 2.3% in meta-analyses [6] and 3% in individual studies; rates were as high as 10.1% [20] for laparoscopic and 3.1–4.9% [20]

for open repairs in multicenter studies. In the study by Schmedt et al. [13] comparing the Lichtenstein technique with laparoscopic hernia repair, recurrence was twice as likely to occur after laparoscopic repair (odds ratio, OR, 2.00; 95% confidence interval, CI, [1.46, 2.74]). The duration of the operation was consistently and statistically significantly longer for laparoscopic repair (approximately 16 min whether in individual studies or in the meta-analyses [6, 10]. Complication rates varied in individual studies from 25 to 39% [20] for laparoscopic repair and from 30 to 33% [20] for the open repair, whereas in one meta-analysis [13] the laparoscopic technique was better than the Lichtenstein technique as concerned the incidence of wound infection (0.39 [0.26, 0.61]), hematoma formation (0.69 [0.54, 0.90]), and chronic pain syndrome (0.56 [0.44, 0.70]). The Lichtenstein technique was associated with less seroma (1.42 [1.13, 1.79]). Control of pain, as expressed either as visual analog scores or as analgesic consumption, was marginally in favor of the laparoscopic repair, but these differences were no longer significant 2 weeks after operation [6].

No difference was found in total morbidity or in the incidence of iatrogenic intestinal lesions, urinary bladder lesions, major vascular lesions, urinary retention, and testicular problems.

Discussion

We will not discuss the feasibility of the techniques nor the classic end points for which, in our opinion, discussion is no longer needed and is somewhat futile.

Mesh or Rraphy?

The results of several meta-analyses suggest that mesh, whether inserted laparoscopically or through a traditional, open incision, is associated with less recurrence than the techniques of rrhaphy [4, 6–9, 12]. Slight variations in outcomes have been noted, however, but these are related to the studies included or not included in the different meta-analyses rather than to the type of approach. Stengel et al. [21] recently abstracted all publications of randomized trials of laparoscopic versus open inguinal hernia repair included in the EU Hernia Trialists meta-analyses. Applying meta-regression to identify variables that were likely to alter the relative risk of hernia recurrence with either route, the authors analyzed 41 randomized trials (7,446 patients). They noted significant statistical heterogeneity across studies (χ^2 test, P=0.029), scarce information provided in the original papers, and small sample sizes. The results varied internationally, with trials from the UK, southern Europe, and Australia favoring open hernioplasty (analysis of variance, P=0.0047). The number of surgeons participating in each arm influenced

outcomes as large numbers of surgeons contributing to the open hernioplasty group predicted better results with endoscopic hernia repair [risk ratio 0.99 with any additional surgeon, 95% CI 0.98–1.00, P=0.005]. Because of the diversity in the size of the effect, however, it is doubtful whether data from the available hernia trials should be compiled into a single summary measure. As well, efficacy estimates in hernia surgery are susceptible to technical issues, which need further scientific appraisal on a larger scale.

Laparoscopic or Traditional Open

There has been and continues to be much debate about the benefits of laparoscopic repair of inguinal hernia. The results of laparoscopic hernia repair in large controlled studies [20] reported in the UK [22], and more recently in the USA, although severely criticized by some [16], have clearly shown that laparoscopic hernia repair is not an operation that can be integrated into the general surgeon's armamentarium without raising several important issues. Unquestionably, the results from expert surgeons and centers [23] continue to demonstrate that excellent short-term and long-term outcomes can be achieved, even in the teaching arena. However, the learning curve (i.e., the time necessary to stabilize the duration of operation or reach a stable level or recurrence) for laparoscopic hernia repair has not yet been described in detail [24]. The number of operations to obtain this has been reported to range from 200 to 250 [20, 24] in the overall general population of surgeons who are not claimed experts. The average-to-poor results observed during this long learning curve for all the young surgeons eager to add this technique to their armamentarium require further discussion, concerning ethical and economics issues which will be dealt with later.

Recurrence Rates

Recurrence has been the main end point for several studies and should continue to be the principal criterion for hernia repair [25]. The reasons are several: (1) a bulge in the groin is usually the principal cause for seeking medical advice (far more frequently than any complication); (2) a recurrence is the main reason for reoperation.

The true recurrence rate is very difficult to evaluate in most series and above all in the meta-analyses, essentially because of the variable case-mix in these studies [21]. Moreover, recurrence can be difficult to ascertain, especially when the patient is not seen or examined by a specialist [25]. Moreover, correct evaluation can be plagued by the absence of follow-up, sometimes related to the death of the patient, otherwise to the fact that, not satisfied with the initial attending surgeon, the patient consults another surgeon

[25]. This may explain why the percentage of recurrent hernias operated on in most series is much higher than the actual outcome of the same series, as concerns the recurrence rate.

Complication Rates

Complications rates have been the center of several studies; however, it is important to distinguish between the types of complication rates reported in the literature (overall morbidity, wound complications, deep or intraabdominal complications) and their severity, (i.e., a hematoma at the trocar site insertion resulting from the puncture of the epigastric artery is not comparable with puncture of the iliac artery or vein by a Veress needle or a trocar). Several meta-analyses [3–6, 8, 9] have stated that while there were fewer overall complications with the laparoscopic technique, their severity was greater.

Pain

While it is generally admitted that laparoscopic hernia repair results in less postoperative pain [8, 9], the differences are often minimal and the benefits marginal in terms of analgesic consumption [26, 27]. One reason might be that procedures for measuring pain magnitude, timing of the evaluation of pain, and definitions differ from one study to another, making comparison difficult or even senseless [28]. In any case, these differences hardly exist longer than 2 weeks, usually less than the normal layoff from work, so the criterion of less pain can hardly be expected to contribute to a quicker return to normal activities or to work.

Persistent pain has been reported in up to 54% of patients undergoing operation for hernia repair [28]. Here again, the definition of persistent pain varies greatly across studies for inguinal hernia repair. The presence of foreign material has been suggested to play a major role (plug ?).

Before any reasonable conclusions can be drawn as concerns the question of chronic pain, this issue should now be addressed prospectively using standard definitions and allowing for assessment of the degree of pain [29, 30]. The use of lightweight meshes has recently been advanced to potentially decrease this side effect of mesh [31]. More evidence is required on the loss of utility caused by persisting pain and numbness.

Costs

Costs are a matter of great concern in our budget-constrained health care systems, wherever we look.

Even if the use of reusable instruments (trocars and the associated laparoscopic instruments) has been said to reduce costs [32], sterilization

costs, maintenance, and setup times have a price, which has not yet been calculated with precision.

The meshes used for laparoscopic hernia repair are, on average, more expensive than those inserted through a classic inguinal incision.

The question of fixation of the mesh has been debated ever since the start of the laparoscopic hernia repair era. While several authors have said that fixation is necessary and reduces the risk of slippage of the mesh, and consequently, the risk of recurrence, others [32] maintain that fixation is not necessary: at least four controlled trials have found that there was no difference in the recurrence rate when the mesh was not fixated with staples [33–36]. The costs of staples and the firing machine can then be subtracted from the overall costs.

To overcome the purported disadvantages of fixation (costs, chronic neuralgia), the initial study by Katkhouda et al. [37] has led several authors who still believe that fixation is necessary to now use fibrin glue as a method of fixation [38]. More studies are necessary, however, before any coherent policy can be set.

With the goal of determining whether laparoscopic methods are more effective and cost-effective than open mesh methods of inguinal hernia repair, and then whether laparoscopic transabdominal preperitoneal (TAPP) or laparoscopic totally extraperitoneal (TEP) repair is more effective and cost-effective, a review of economic evaluations undertaken by NICE in 2001 [39] was updated and an economic evaluation was performed in 2005 [9]. Laparoscopic repair was more costly to the health service than open repair (extra cost of about £ 300–350 per patient). From the review of economic evaluations, the estimates of incremental cost per additional day at usual activities were between £ 86 and £ 130. When productivity costs were included, they eliminated the cost differential between laparoscopic and open repair. Additional analysis incorporating new trial evidence suggested that TEP repair was associated with significantly more recurrences than open mesh repair, but these data did not greatly influence cost-effectiveness. The authors concluded that for the management of unilateral hernias, the base-case analysis and most of the sensitivity analysis suggest that open flat mesh repair is the least costly option but provides fewer quality-adjusted life years (QALYs) than TEP or TAPP repair. TEP repair is likely to dominate TAPP repair (on average TEP repair is estimated to be less costly and more effective). McCormack et al. [9] and Vale et al. [40] added that laparoscopic repair would be more cost-effective for management of symptomatic bilateral hernias, and possibly also for contralateral occult hernias (see later). The increased adoption of laparoscopic techniques may allow patients to return to usual activities faster. This may, for some people, reduce any loss of income. On the other hand, for the NHS, increased use of laparoscopic repair would lead to

an increased requirement for training and the risk of serious complications may be higher.

According to the utility analysis of Vale et al. [40], laparoscopic hernia repair with mesh is not cost-effective compared with open mesh repair in terms of cost per recurrence avoided. As well, it appears unlikely that the extra costs will be offset by the short-term benefits (reduced pain and earlier return to normal activities) [40].

Duration of Operation

The consequences of this time difference, while seemingly minimal, are in fact enormous: if every laparoscopic operation took an average of 16 min longer than the traditional repair, this means that overall all hernia repairs in the USA and France would take an average of 1,792,000 and 600,000 min longer, i.e., 29,867 and 10,000 h longer, respectively. The corresponding costs amount to an average increased cost of US $ 29,867,000 [41] and 7,200,000 (Straetmans, personal communication, EAES 2005), respectively for the year 2003. The increased time necessary to assist a younger colleague with inguinal hernia repair has not been evaluated with precision, but is also important to consider. However, when performed by a resident in training [42] a laparoscopic hernia repair takes on average 120 min compared with 75 min for open repair: a difference of 45 min. Kingsnorth [43] has said that the time that should be allocated to perform a hernia repair by a junior is probably twofold. When compared with those of senior surgeons, incremental costs for the hospital provider were US $ 153 and 106 per open hernia repair when carried out by junior consultants and residents, respectively. The overall incremental costs per year for these procedures were € 8,370 for residents and € 22,922 for junior consultants [42]. Evaluated according to whether the operating surgeon was a junior or a senior resident [44], the extra costs were € 2,907 and 1,855.

The reasons why laparoscopic hernia repair requires more time to perform than open repair, on average, warrant discussion.

Possible reasons might include the time necessary for the peroperative preparation and setup for laparoscopic surgery, frustration because of the small space within which the surgeon has to work, unfamiliarity with (laparoscopic) anatomy, and difficulties arising from a suboptimal trocar setup [45, 46].

The solutions to overcome these time differences may be obtained by several routes: one such direction is to increase operating room efficiency by changing patient flow rather than simply working to streamline existing steps [47]. Another is to have a dedicated laparoscopic surgery suite [48], leading to large and statistically significant differences in setup and put-away times for laparoscopic procedures.

Frustration is a frequently encountered feeling that characterizes many surgeons battling with laparoscopic techniques. Hernia repair is certainly no exception, and at least one article recently dealt with this specific problem [49]. In that paper, frustration, as rated on a scale from 1 (no frustration) to 5 (very frustrated), was reported less often by the surgeons performing the open hernia repair than with the laparoscopic technique ($P = 0.0001$) and was associated with a higher rate of hernia recurrence at 2 years (adjusted OR 2.01, 95% CI 1.15–3.51) in open repair: the level of surgeon frustration correlated with hernia recurrence. However, no such association was found in the laparoscopic group. Frustration level was associated with a higher rate of postoperative complications in both the laparoscopic and the open groups. Procedures in which surgeons expressed frustration were 2.9 times more likely to be accompanied by an intraoperative complication than those in which the surgeon experienced no frustration [49].

Time may also be gained by optimizing the trocar setup in such a way that minimizes the efforts and the stress of laparoscopic surgery, including strict ergonomic principles [46, 50].

Unanswered Questions and Future Directions

When finally even the stoutest proponent admits that the benefits of laparoscopic surgery may not be as thought, the following argument arises: laparoscopic treatment of hernia is best for recurrent hernia and for bilateral hernia – this was the conclusion of a very influential paper published in 2003 [51].

Recurrent Hernia

The argument put forth is that hernia repair would be easier if the incision and dissection of tissues did not have to traverse cicatricial or scarred tissues. The idea behind such a recommendation is that recurrence after a traditional hernia repair by rrhaphy or the Liechtenstein technique would be easier if approached through the transperitoneal or the extraperitoneal routes. If this were true, the Stoppa or Rives operation performed through a midline incision should have allowed the same performance: however, nothing has ever been published to support this. Recurrence after a mesh interposition, whether inserted through a previous Stoppa or Rives operation, or the laparoscopic extraperitoneal or transperitoneal routes, all consisting of a preperitoneal mesh interposition, has been thought to due to too small a mesh, nonfixation, or technical errors.

What about the hernia repair that has already been operated on through both the laparoscopic and the anterior route?

Bilateral Hernia

At a time when the question is arising of whether asymptomatic hernia should be dealt with prophylactly [52], the principle of looking for and then repairing an asymptomatic bilateral hernia warrants serious reflection. Few data, once again, exist in favor of doing so, or not. In a meta-analysis of all published pediatric series (hernia repair from birth to 16 years) of unilateral inguinal hernia repair [11], the incidence of metachronous hernia was 1,062 in 15,310 patients (7%). Gender and age were not risk factors. The risk of metachronous inguinal hernia was 50% greater when the initial hernia was on the left side. Of patients who developed a metachronous hernia, 90% did so within 5 years. The complication rate of metachronous hernia was 0.5%. These authors concluded that there is no role for routine contralateral groin exploration in a patient under 16 years old, except perhaps for left inguinal herniorrhaphy. Patients who do not undergo contralateral groin exploration should be followed up for 5 years.

In a prospective nationwide analysis of laparoscopic versus Lichtenstein repair of inguinal hernia in Denmark, Wara et al. [53] looked at results of hernia repair when nonspecialist surgeons were involved, as recorded in a nationwide registry between 1998 and 2003. The outcome measure was the reoperation rates after laparoscopic ($n = 3{,}606$) and Lichtenstein ($n = 39{,}537$) repair, adjusting for factors predisposing to recurrence. The overall reoperation rates after laparoscopic and Lichtenstein repair of unilateral primary indirect hernia (0 vs 1.0%), primary direct hernia (1.1 vs 3.1%), unilateral recurrent hernia (4.6 vs 4.8%), and bilateral recurrent hernia (2.6 vs 7.6%) did not differ significantly. On the other hand, laparoscopic repair of a bilateral primary hernia was associated with a higher reoperation rate than Lichtenstein repair (4·8 vs 3·0%) ($P = 0{\cdot}017$).

When economic considerations are concerned, McCormack et al. [9] and Vale et al. [40] stated that for management of symptomatic bilateral hernias, laparoscopic repair would be more cost-effective as differences in operation time (a key cost driver) may be reduced and differences in convalescence time are more marked (hence QALYs will increase) for laparoscopic compared with (double) open mesh repair. When possible repair of contralateral occult hernias is taken into account, TEP repair is most likely to be considered cost-effective at threshold values for the cost per additional QALY above £ 20,000. Further research relating to whether the balance of advantages and disadvantages changes when hernias are recurrent or bilateral is also required as current data are limited.

Prosthetic Repair and Other Surgery in the Bogros Space

The consequences of prosthetic hernia repair relative to future surgery for prostate cancer and/or vascular surgery in the Bogros space have been the subject of several publications [54–56]. In summary, there seems to be concern that prosthetic inguinal hernia repair may induce fibrotic changes that make ulterior surgery very difficult, dangerous, or impossible [54]. For the moment, however, there are only case or small-series reports on this subject, the results are contradictory [55], and no formal guidelines have emerged.

Learning Curve and Consequences

The influence of surgeon age and other factors on proficiency in laparoscopic or open hernia repair was studied from data originating in a multicenter, randomized trial comparing open and laparoscopic herniorrhaphies, conducted in Veterans Administration hospitals (CSP 456) [24]. Significant differences in recurrence rates for the laparoscopic procedure as well as for the open procedure related to resident postgraduate year (PGY) level were reported according to the surgeons' experience. On the basis of 1,629 unilateral laparoscopic and open herniorrhaphies in this study, the surgeon's experience (experienced 250 procedures or more; inexperienced fewer than 250 procedures) and the surgeon's age (45 years old or older vs younger than 45) were significant predictors of recurrence in laparoscopic herniorrhaphy. The odds of recurrence for an inexperienced surgeon aged 45 years or older were 1.72 times that of a younger, inexperienced surgeon. For open repairs, although surgeon age and operation time appeared to be related to recurrence, only a median PGY level of less than 3 was a significant independent predictor [24].

As stated in several papers, the learning curve for laparoscopic hernia (i.e., the time necessary to stabilize the duration of operation or to reach a stable level of recurrence) has been reported to be long. For recurrence, the learning curve has been estimated at 200–250 [20, 24]. One must not forget that every surgeon has and will have a learning curve during which the patients operated on will have a greater risk of complications, including recurrence, and the operations will take longer to perform and will have inherent increased costs. Prospective population-based registries of new surgical procedures may be the best way to address this, as a complement to randomized trials assessing effectiveness. Methodologically sound randomized controlled trials are needed to consider the relative merits and risks of TAPP and TEP repair in this respect. Further methodological research is required into the complexity of laparoscopic groin hernia repair and the improvement of performance that accompanies experience.

On the other hand, it is of note that the same learning curve can be as short as five operations for the Lichtenstein technique [57]. While the authors are aware of the necessity to allow time and leniency regarding the question of teaching and learning, especially as concerns laparoscopic technique, the reader has to realize that the line has to be drawn somewhere and sometime to know whether, for laparoscopic hernia repair, the debate on the learning curve should not now be ended.

Conclusions

If good, reproducible, short- and long-term results can be proven, and there are no or few cost-containment arguments, certainly those surgeons who are proficient may want to continue to perform inguinal hernia repair laparoscopically. However, what is in the black zone are the unacceptable complication rates, including a higher recurrence rate, while on the learning curve, when satisfactory results can be obtained easily, quickly, and with few complications [57] using time-proven techniques such as the Lichtenstein and plug methods. Moreover, the time necessary to teach the younger generation might be better used to instruct incoming surgeons to learn easier techniques, that will provide equally efficacious outcomes. In accordance with O'Dwyer [22], for patients with a primary inguinal hernia, laparoscopic repair can no longer be recommended as the repair of choice unless it is undertaken in an expert center in minimal access surgery. As to the role of laparoscopy in recurrent and bilateral inguinal hernia, further clinical trials are needed.

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The EAES Clinical Practice Guidelines on Diagnosis and Treatment of Common Bile Duct Stones (1998)

Andreas Paul, Bertrand Millat, Ulla Holthausen, Stefan Sauerland, Edmund A.M. Neugebauer, J.C. Berthou, H.-J. Brambs, J.E. Dominguez-Muñoz, P. Goh, L.E. Hammerström, E. Lezoche, J. Périssat, P. Rossi, M.A. Röthlin, R.C.G. Russell, P. Spinelli, Y. Tekant

Introduction

During the last decade, laparoscopic techniques for abdominal surgery have changed the options for the diagnosis and treatment of many abdominal pathologies. Laparoscopic cholecystectomy has now become the standard procedure for removing symptomatic gallbladder stones. New techniques have also been developed for the removal of common bile duct stones (CBDS), which accompany symptomatic gallbladder stones in 10–15% of patients.

A number of different strategies have emerged that combine laparoscopic cholecystectomy with bile duct clearance. There has been a proliferation of publications in this search for a superior or ideal technique. The European Association for Endoscopic Surgery (EAES) recognizes the need to discuss and summarize these controversial developments and to provide practical guidelines based on the current state of knowledge. Bearing in mind the experience of previous consensus development conferences, we decided to use the joint meeting of the EAES and the ELSA (Endoscopic and Laparoscopic Surgeons of Asia) to bring together an international panel of experts in Istanbul.

Methods

In 1996 the EAES decided to hold a consensus development conference (CDC) on CBDS. The Cologne group was authorized by the EAES to organize the CDC according to general guidelines. Twelve internationally known experts were nominated by the Scientific Committee of the EAES. The criteria for selection were clinical and scientific expertise and activity in the diagnosis and/or treatment of CBDS. In order to balance the interests of experts in the areas of surgery, internal medicine, and radiology, panelists from all three specialities were selected.

Prior to the conference, all panelists were asked to survey the literature, list all relevant articles, and estimate the strength of evidence for every article cited. Referring to these articles, the panelists were asked to address the major open questions concerning the management of CBDS. For the five

most relevant therapeutic options, they were also asked to comment on the status of each therapy. In regard to the question of laparoscopic common bile duct revision versus endoscopic retrograde cholangiopancreaticography (ERCP) with stone extraction, each panel member was instructed to indicate which technique is superior for several specific situations. All panelists received detailed information on how to answer each section, including a basic description of the CDC process, a scale for ranking the strength of the evidence of medical articles, and a description of levels of technology according to Mosteller [105] and Troidl [164].

In Cologne, all answers were analyzed and subsequently combined into a provisional preconsensus statement. This text was mailed to all panelists a month prior to the Istanbul meeting. The panel members were also informed about the identity of the other members, which had not been previously disclosed.

In Istanbul, all panel members convened for a first meeting on June 18, 1997. Here the provisional statement was scrutinized word by word. The following day, the modified statement was presented to the conference audience for public discussion. During a postconference meeting on the same day, all suggestions made by the audience were discussed by the panelists. Because not all of these questions could be resolved at this time, the chairmen were asked to provide additional literature that would address some of the critical issues. When these points had been cleared and altered in the text, the whole statement was mailed to all the panelists for agreement (Delphi process). In October 1997, the following statement was finalized.

Consensus Statement on the Diagnosis and Treatment of Common Bile Duct Stones

General Comment

Options for the management of common bile duct stones (CBDS) are increasing with the development of new technologies for diagnosis and treatment. While intraoperative cholangiography and open CBD exploration have comprised the applied technology for decades, the introduction of ERCP with endoscopic stone extraction in the 1970s and the more recent introduction of laparoscopic cholecystectomy led to a reappraisal of the situation. For each management policy, numerous publications – from case reports to prospective controlled clinical trials – are available, but evidence-based conclusions an rarely be achieved yet.

In terms of predictors for CBDS, the crucial issue is perhaps not which indicators should best be applied to detect CBDS, but whether we should favor a high rate of negative examinations or a high rate of retained stones,

with all their sequelae. The consequences of either strategy are currently not well understood and are often dependent on the local medical and nonmedical conditions.

Nowadays, new imaging techniques in medicine (e.g., magnetic resonance cholangiopancreaticography, MRCP) have opened up new options for the diagnosis of CBDS. Furthermore, any debate about procedure and timing of diagnosis of CBDS leads to this question: Should they all be diagnosed?

Any discussion of an optimal therapy for common bile duct stones must take into account the rare but grave complications that each treatment option, may entail.

In general, the optimal diagnostic and therapeutic strategy seems to be dependent on local circumstances and the experience and expertise of the medical team, since there is still no evidence-based gold standard. In addition, ethical and socioeconomic considerations have an important impact on the controversy. For example, the costs of several techniques are prohibitive in some parts of the world.

Question 1. The Diagnosis of CBDS

What are Good Indicators or Predictive Symptoms/Signs for CBDS?

At the time of cholecystectomy for symptomatic cholelithiasis, 8–15% of patients under the age of 60 years and 15–60% of patients over the age of 60 years have CBDS. This prevalence reflects the prior probability of any patient harboring CBDS before any discriminating test. The prevalence of CBDS has a decisive influence on the predictive value of any indicator. The prevalence of CBDS and the threshold for investigating CBDS vary among individual clinicians.

Among the many parameters investigated, no single indicator is completely accurate in predicting CBDS before cholecystectomy. The indicators can be grouped as follows: symptoms and signs, biochemical parameters, and imaging techniques. Although acute pancreatitis or cholecystitis are associated with a higher prevalence of CBDS, there is no good evidence that a history of pancreatitis is an indicator for CBDS.

Table 15.1 lists the predictive values for the main indicators of CBDS. These data were combined from several primary studies with a meta-analysis [1]. For each individual indicator, the lowest abnormal value is considered to be the threshold. Within a hypothetical population with symptomatic cholelithiasis, a 10% probability (prevalence) of harboring CBDS is assumed. As shown in the example in the table footnote, an individual patient's risk factors can be established by multiplying the relevant positive or negative likelihood ratios.

Table 15.1. Predictive values of preoperative indicators of common bile duct stones (*CBDS*)

Indicator	Sensitivity (95% CI)	Specificity (95% CI)	LR+	LR–
Cholangitis	0.11 (0.02–0.19)	0.99 (0.99–1.00)	18.3	0.93
Preop jaundice	0.36 (0.26–0.45)	0.97 (0.95–0.99)	10.1	0.69
Cholecystitis	0.50 (0.11–0.89)	0.76 (0.45–1.00)	1.6	0.94
Bilirubine ↑	0.69 (0.48–0.90)	0.88 (0.84–0.92)	4.8	0.54
Alkaline phosph ↑	0.57 (0.46–0.69)	0.86 (0.78–0.94)	2.6	0.65
Amylase ↑	0.11 (0.02–0.20)	0.95 (0.93–0.98)	1.5	0.99
CBDS on US	0.38 (0.27–0.49)	1.00 (0.99–1.00)	13.6	0.70
Dilated CBD on US	0.42 (0.28–0.56)	0.96 (0.94–0.98)	6.9	0.77

Data from Abboud et al. [1], reprinted with permission. Data can be read as follows (line 1, cholangitis): from 2 to 19% of patients *with* CBDS have cholangitis (defined as the triad pain–fever–jaundice). Nearly all patients who do *not* have CBDS also do *not* have cholangitis (column 2). A patient with CBDS is 18.3 times more likely to have cholangitis. If we assume prior odds to be 1:9 (i.e., 10% prevalence), we multiply 1/9 by 18.3 to get 2.03. So the posttest odds are about 2:1, which is a 66% probability. However, on the other hand, in a patient without CBDS (column 5), cholangitis is still not unlikely. We receive 1:9.67 posterior odds, or a 9.4% probability.
CI confidence interval, *LR+* positive likelihood ratio, *LR–* negative likelihood ratio, *US* ultrasonography

A cystic duct found to have a diameter of more than 4–5 mm at operation was associated with an increased probability of CBDS (sensitivity, 0.34; PPV, 0.52) in a population of 319 patients with a CBDS prevalence of 12% [59, 61].

In the clinical setting, several groups of patients can be identified, as follows: (a) a *high-risk* group, which fulfills a series of predictive factors resulting in a global probability of CBDS of more than 90% based on the data in Table 15.1; (b) a *medium-risk* group, or group of uncertainty, which fulfills one or several prognostic factors listed in Table 15.1 but for whom the resulting posttest probability (although higher than the pretest probability of 10%) does not reach 90%; (c) a *low-risk* group, which has no signs or symptoms. Although their probability of harboring CBDS is below average, in clinical practice unsuspected CBDS are found in 5% of patients of fewer with symptomatic gallbladder stones.

Question 2. Diagnostic Procedures

Which Diagnostic Tools are Useful in the Detection of CBDS? In What Order Should They Be Applied?

Preoperative ultrasonography (US) misses two of three patients with common bile duct stones. However, it is a useful screening tool for the diagnosis of CBDS because of its noninvasiveness, easy availability, and low costs. Of all tools it should be applied as first. It has a reasonable predictive value if the CBD diameter is dilated as an indirect sign for CBDS. According to the

literature, the sensitivity of preoperative US is 0.14–0.40, depending on the investigator's experience, the defined threshold value, and the general prevalence. The diagnosis of CBDS is more frequently achieved exclusively in patients with dilated CBD (diameter more than 8–10 mm). Furthermore, liver or pancreas pathologies are also detectable by this means.

Preoperative intravenous cholangiography (PIC) does not play a major role in the diagnosis of CBDS anymore. PIC has been reevaluated in patients without jaundice, using a new contrast reagent (meglumine iotroxate) with a reported risk of less than 1% of adverse reactions. Infusion yields a satisfactory bile duct opacification in 90–95% of patients. The negative predictive value (NPV) of a normal PIC is 0.98–1. The positive predictive value (PPV) of PIC for CBDS diagnosis was 0.94 for stones demonstrated at PIC but only 0.31 for stones suspected at PIC [16, 57]. Previous studies showed that PIC missed CBDS in an average of 40% of cases (range, 22–90% sensitivity). Therefore, it is not recommended as a routine procedure. It may be an option based on the local circumstances of a center.

Endoscopic retrograde cholangiopancreatography (ERCP) is a valid diagnostic tool (high sensitivity, specificity, accuracy in experienced hands). It should only be applied with the intention to treat in patients with a high probability of CBDS who are eligible for ES. It has to be recognized that the procedure is invasive and inconvenient for the patient. It requires sedation and has defined morbidity (5–10%) and mortality (less than 1% for diagnostic purpose) rates. The success rate for ERCP is 95%. The sensitivity is 0.84–0.89. Specificity is 0.97–1. PPV is 1 and NPV is 0.88.

Endoscopic ultrasonography (EUS) is another exclusively diagnostic procedure with a high accuracy rate, but currently there is no indication for its routine use in diagnosing CBDS. The sensitivity of endoscopic ultrasound is 93%; specificity is 97%. PPV is 98% and NPV is 88%.

Intraoperative cholangiography (IOC) and *laparoscopic ultrasound* are reliable diagnostic tools (more than 90% accuracy). Modern equipment and the use of fluoroscopy is required and may increase the accuracy in general practice. However, routine performance for the detection of symptomatic CBDS is questionable, although some of our panelists did recommend it. No final consensus was achieved regarding this point. The decision to perform routine or selective IOC during cholecystectomy depends both on the physician's personal beliefs regarding asymptomatic CBDS and his or her individual strategy for treatment. Reasons other than detection of CBDS for performing IOC, such as clarification of biliary anatomy, were considered outside the scope of the consensus. Invasive preoperative diagnostic tests should be avoided in patients scheduled for elective cholecystectomy.

Magnetic resonance cholangiopancreaticography (MRCP) seems to be an excellent diagnostic tool with high accuracy rates, so it might supersede

other invasive diagnostic procedures such as ERCP. Disadvantages include inconvenience for the patient, low availability, and high costs. Furthermore, it is not applicable in every case (morbid obesity, pacemaker, etc.). In a first study from Italy [89], MRCP showed 91.6% sensitivity, 100% specificity, and an overall diagnostic accuracy of 96.8%.

Computer tomography (CT) has been evaluated only in biased populations. It plays no role in routine management. All patients with symptomatic gallbladder stones need to be assessed for CBDS, and the treatment of all diagnosed CBDS is mandatory (eight of 12 panelists were in favor of it). There are three options:

- Routine IOC requires no preoperative screening for CBDS. The rate of useless examinations is in correspondence with the prevalence of CBDS in the population scheduled for cholecystectomy.
- Selective contraindication for IOC is based on the negative predictive value of indicators for CBDS. It allows a 30–50% reduction in the number of IOC and yields a 2–3% rate of missed CBDS [61, 70]. Selective indication for IOC is based on the positive predictive value of preoperative indicators for CBDS. It limits diagnosis and treatment to preoperatively symptomatic CBDS. Limitations are related to the information provided by the predictors and uncertainty regarding the natural history of asymptomatic CBDS.

Question 3. Timing of Diagnostics

When Should CBDS Be Diagnosed?

The timing of diagnostics should be dependent on the status of the patient and the preferred treatment modality of the center – pre- or intraoperatively. A routine policy of postoperative diagnoses of patients with preoperative suspicion for CBDS is not advisable, since it entails the risk of a second operative intervention.

Question 4. Timing of Treatment

Should CBDS Be Treated Before, During, or After Cholecystectomy?

Depending on the clinical status of the patient, treatment can be performed before or during surgery. The policy of the specific center, as well as the experience and expertise of the medical team, may affect the choice of treatment modalities yet yield similar results (Table 15.2). Postoperative treatment of CBDS is only necessary if intraoperative clearance of the common bile duct fails or if patients develop symptoms of retained stones.

Table 15.2. Results of six prospective randomized trials comparing preoperative endoscopic retrograde cholangiography(*ERC*)/endoscopic sphincterotomy (*ES*) with open surgery alone for CBDS

	Surgery	Preop ERC/ES
Total number of patients	302	283
Endoscopic failures		15 (5%)
Successful primary extraction	275 (91%)	233 (82%)
Complications (range)		
Major	8% (4–15%)	8% (4–10)
Minor	15% (8–15%)	10% (6–17)
Total	23% (18–31%)	19% (12–26)
Deaths	4 (1.3%)	8 (2.8%)
Residual stones (range)	4.9% (2–12)	3.4% (0–12)

See Neoptolemos et al. [107], Stain et al. [151], Stiegmann et al. [154], Hammarström et al. [56], Targarona et al. [160], and Association universitaire de recherche en chirurgie [6]

Table 15.3. Evaluation of the status of CBDS therapy in 1997: strength of evidence

Stages in technology assessment[a)]	ERCP	Open surgery	Laparoscopic surgery	ESWL	Transhepatic approach
Feasibility	III	III	III	III	0–I
Benefit for patient	III	III	III	III	0
Benefit for	III	III	I–III	0–III	0
surgeon	II	III	II	0–I	0–I
Effectivenes	III	0–I	0–II	0–I	0
Costs	III	III	III	I–III	0
Ethics	Yes	Yes	Yes	No	No
recommendations					

Grading of scientific evidence was done using the scale explained in Table 15.4 (III is strong evidence, 0 is no evidence)
ESWL extracorporeal shockwave lithotripsy
a) See Mosteller [105] and Troidl [164]

Question 5. Standard Treatment

Which Is the Best Treatment for CBDS and What Is the Appropriate Surgical Procedure for CBDS with Gallbladder in Situ?

There is no standard treatment today. In principle, three treatment regimens are available: endoscopic stone extraction during ERCP, laparoscopic bile duct exploration, and open bile duct exploration (Table 15.3). There is no strong evidence from controlled trials that one procedure is superior to another in experienced hands (Table 15.4). The majority of panel members saw no advantages to laparoscopic surgery over ERCP in terms of intraopera-

Table 15.4. Ratings of the literature on CBDS: strength of evidence

Study design	Strength of evidence	References
Clinical randomized controlled trial with power and relevant end points	III	[5, 6, 14, 24, 28, 35, 37, 44, 49, 52, 56, 60, 61, 77, 79, 81, 83, 86, 91, 103, 106–110, 112, 113, 118, 127, 134, 135, 141, 143, 146, 149–152, 154, 157, 159, 160, 168]
Prospective studies with parallel or historical controls Case-control studies	II	[2–4, 7, 8, 10, 11, 13, 15–21, 23, 25–27, 29, 30–34, 36, 38–43, 45–48, 50, 51, 53–55, 57–59, 62–69, 71–76, 79, 80, 84, 85, 87–89, 92–102, 104, 114–117, 119–126, 128–134, 136, 137, 139, 140, 142–145, 147, 148, 153, 155, 156, 158, 161–163, 165–167, 169–175]
Cohort studies with literature controls Database analyses Reports of expert committees	1	Numerous, not evaluated
Uncontrolled trials Case reports, case series Belief	0	Numerous, not evaluated

tive safety, postoperative complications, mortality, pain, hospital stay, return to work, or cosmesis.

Laparoscopic bile duct exploration or a combination of endoscopic stone removal and laparoscopic cholecystectomy might be better than open surgery in terms of such aspects as less pain and faster recovery.

The laparoscopic transcystic approach and laparoscopic choledochotomy are feasible. For ASA I/II patients, they might be preferable to preoperative ERCP and endoscopic sphincterotomy (ES) followed by laparoscopic cholecystectomy, since they shorten the duration of hospital stay.

Question 6. Treatment in Special Situations

Should Asymptomatic CBDS Be Treated?

Because of the impredictibility of the occurrence of symptoms or complications, diagnosed stones should be treated in all cases. It is additionally an ethical problem to knowingly leave stones behind. However, an expectant management for CBDS is acceptable in high-risk patients (ASA III/IV) and patients unfit for surgery. These patients may benefit from endoscopic treatment alone.

What Is the Appropriate Treatment for Large and/or Impacted CBDS?

Large and/or impacted stones are a rare and ill-defined condition. Their treatment is usually difficult and depends on individual expertise. Options include:

- Endoscopic treatment (with the adjunct of lithotripsy)
- Primary surgery (laparoscopic or open approach with the adjunct of intraoperative lithotripsy and/or hepaticojejunostomy)
- Extracorporeal shockwave lithotripsy (ESWL) with or without ES

How Should CBDS in Cholecystectomized Patients Be Managed?

All such patients should be first treated by endoscopy, if feasible, including lithotripsy as required. There is as yet no evidence that endoscopic sphincterotomy or dilation of the sphincter performed in younger patients has a long-term negative outcome with higher rates of cholangitis, papillary stenosis, or other sequelae.

Question 7. Cholecystectomy

Is Cholecystectomy Always Compulsory in Patients with CBDS?

Available data suggest that cholecystectomy should be recommended in patients with CBDS. In patients with major risk factors for surgery or in elderly patients, an individual management policy – e.g., leaving the gallbladder in situ – can be justified. In Oriental cholangitis and in patients without gallbladder stones, cholecystectomy is usually not indicated after clearance of the common bile duct.

Question 8. Consequences of Therapy

What Are the Long-Term Results and Sequelae of Therapeutic Interventions?

For both endoscopic sphincterotomy and open surgical common bile duct exploration, the long-term complication rates are reported to be in the same range (below 10%), and the procedures have a high success rate in experienced hands. There are no data on the long-term complication rate of laparoscopic bile duct exploration.

Closing Remarks

The closing remarks were delivered by J. Périssat, of France:

- The emerging success of MR cholangiopancreaticography, which has provided an excellent roadmap for the surgeon, should help to stem the debate over the diagnostic purpose of ERCP.
- The general population of surgeons should be brought up to date about the technology of laparoscopic bile duct exploration; furthermore, additional research is urgently needed.
- There should be a follow-up on the results of this conference in the year 2000.

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Common Bile Duct Stones – Update 2006

Jürgen Treckmann, Stefan Sauerland, Andreja Frilling, Andreas Paul

Definition, Epidemiology and Clinical Course

There are no obvious changes in epidemiology of common bile duct stones (CBDS). As less invasive treatment options for CBDS are now well established, even older patients with significant comorbidities and pediatric patients who present with symptomatic cholecystolithiasis and CBDS are reported to be treated with increasing success [3, 25, 34]. In contrast, some prospective data suggest that in selected patients older than 80 years of age an expectant attitude can be justified, because symptoms are rare (below 15%) and in over one third of patients spontaneous passages of calculi were observed [4, 25].

Diagnosis of Common Bile Duct Stones

The ongoing unsolved crucial issue in diagnosis and treatment of CBDS is whether one should favour a high rate of negative examinations or a higher rate of retained stones. The benefit or harm of either strategy short and long term remains to be settled. Further studies [1, 32] underlined that cholangitis, dilated common bile duct with evidence of stones by ultrasound, elevated conjugated bilirubin, and less likely elevated asparate transaminase were predictive as individual factors and jointly excellent indicators (positive predictive value 99%) for CBDS. No new predictive factors for CBDS have been described in the literature and the 1997 statement is still valid for the identification of high-, medium- and low-risk groups for CBDS.

No new diagnostic tools have been established, but some of the existing diagnostic tools have been improved. Conventional percutaneous ultrasound continues to be useful, but still serves just as a screening tool. Intravenous cholangiography is of very limited value and the routine use of intravenous cholangiography cannot be advocated [14, 21]. Besides the technical advances, for example in evaluation of living related liver transplantation (“all-in-one” CT), CT continues to play a major role in routine diagnosis and management of CBDS [16]. Intraoperative ultrasound has a high accuracy (above 95%), but requires sufficient expertise and normally has its place only in centres performing one-stage procedures either by an open approach or by laparoscopy [2, 28].

Endoscopic ultrasound is an excellent diagnostic tool for CBDS with a sensitivity of more than 95% and a specificity of more than 90%, but is an invasive procedure and no controlled trials were published in the last 5 years, indicating that there is no widespread acceptance of endoscopic ultrasound in diagnosis of CBDS in general practice [24, 30]. The technology of magnetic resonance cholangiopancreatography (MRCP) is evolving rapidly and is increasingly gaining acceptance. Sensitivities and specificities for diagnosis of CBDS are reported to be 97 and 95%, respectively. Furthermore, there are data available showing that differentiated use of short and long-sequence MRI and half-Fourier acquired single-shot turbo spin echo (HASTE) vs rapid acquisition with relaxation enhancement (RARE) can increase diagnostic accuracy and decrease costs [6, 7, 13, 19, 20, 27, 36]. Currently, MRC(P), whenever available, should be the standard diagnostic test for patients with medium or high risk for CBDS. Endoscopic retrograde cholangiopancreatography (ERCP) provides an accuracy of at least more than 90% but owing to its invasiveness and complication rate ERCP is only indicated for confirming diagnosis of CBDS and whenever there is an intention to treat CBDS by endoscopic papillotomy (EPT) and stone extraction in the same session, or when magnetic resonance cholangiography (MRC) or endoscopic ultrasound are not available. Alternatively, CBDS are diagnosed by intraoperative cholangiography, whenever preoperative diagnosis is uncertain, or when there is an intention to treat CBDS intraoperatively [2, 21, 28].

Operative vs Conservative (Interventional) Treatment

According to published (external) evidence there is no option which can be identified as a “gold standard”. Endoscopic stone extraction via endoscopic retrograde cholangiography/papillotomy, laparoscopic transcystic or laparoscopic common bile duct revision, and open duct exploration are applied. All three treatment options can be very effective and safe in experienced hands; however, all three treatment principles have their specific disadvantages [5]. Results of three randomized controlled trials comparing therapeutic splitting with one-stage procedures including laparoscopic common bile duct exploration (LCBDE) are available. Depending on the study design, some arguments in favour of laparoscopic bile duct revision [5, 26, 29] can be derived from these studies. Furthermore, in some published series, single-stage procedures including LCBDE are safe and effective, and can result in shorter hospital stay and less frequent procedures, although a clear advantage could not be shown [8, 23]. However, preoperative ERCP and clearance of the common bile duct followed by laparoscopic cholecystectomy is the most frequently applied technique, at least in surveys in Scotland (96.2%) and Germany (94.2%) [12, 17].

CBDS following cholecystectomy should be primarily treated by endoscopy. In the absence of cholangitis, indication for “routine” cholecystectomy after en-

doscopic duct clearance can be individualized in high-risk patients. In order to potentially reduce long-term complications of endoscopic sphincterotomy, endoscopic dilatation for stone clearance showed similar clearance rates, less bleeding, and preservation of sphincter function in controlled trials [15, 22, 33].

Choice of Surgical Approach and Procedure

If single-stage procedures are performed or operative bile duct exploration is otherwise indicated, there is no clear recommendation whether to perform open or laparoscopic common bile duct revision. LCBDE has possible advantages concerning hospital stay and postoperative pain, while being equally safe in experienced hands. Concerning technical aspects of LCBDE, descriptions of various techniques exist. Especially, concerning closure of the common bile duct over T-tubes, an endoprothesis, or no drainage at all, no recommendations can be given [9, 10, 35].

General Comments

In general, it remains uncertain what are the exclusively best diagnostic and therapeutic strategies for CBDS. Personal expertise and experience of the surgical, medical, and radiology team and costs or socioeconomics still seem to be dominating factors in general practice. Nevertheless the currently existing diagnostic tools have a high accuracy and the existing treatment options are effective concerning clearance of CBDS, while usually being safe.

In patients who have a medium risk for the presence of CBDS they are best diagnosed by MRC. Although there has been a continuous trend in the last decade from large incisions towards “closed-cavity” treatment options, up to now, only a minority of surgeons prefer the LCBDE. Most frequently, the also minimally invasive treatment option of combining laparoscopy and conventional interventional endoscopy is applied. Possible reasons are that laparoscopic bile duct surgery requires demanding technical skills, has a longer learning curve, and new methods of adequate training in advanced endoscopic surgery still have to be developed, evaluated, and introduced in general practice [11, 31]. Additionally specialization is already high and increasing, and for example, ERCP and EPT are rather performed by physicians and percutaneous transhepatic cholangiography with drainage by interventional radiologists and not by surgeons. Therefore, an interdisciplinary team approach is usually necessary and overall success may depend on the strength of the team. Training and continuous education should be intensified, especially in academic institutions. Surgeons should be preferably trained in academic institutions which are independent.

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The EAES Clinical Practice Guidelines on Laparoscopy for Abdominal Emergencies (2006)

Stefan Sauerland, Ferdinando Agresta, Roberto Bergamaschi, Guiseppe Borzellino, Andrzej Budzynski, Gerard Champault, Abe Fingerhut, Alberto Isla, Mikael Johansson, Per Lundorff, Benoit Navez, Stefano Saad, Edmund A.M. Neugebauer

Introduction

Acute complaints referable to the abdomen are common presentations in surgical emergency departments. Abdominal pain is the leading symptom in this context. In the context of these guidelines, we define acute abdominal pain as any medium or severe abdominal pain with a duration of less than 7 days. Some of the conditions that cause abdominal pain prove to be self-limiting and benign, whereas others are potentially life-threatening. Since it is often difficult to identify patients who have critical problems early in the course of their disease, laparoscopy offers a superior overview of the abdominal cavity with minimal trauma to the patient. On the other hand, the risks of applying laparoscopy to emergency patients include delay to definitive open surgical treatment, missed diagnoses, and procedure-related complications.

Principally, two different clinical scenarios have to be considered. Either a specific condition can be assumed after diagnostic workup or the reason for the abdominal pain has remained uncertain. Therefore, laparoscopy has a diagnostic but also a therapeutic role. The history of diagnostic laparoscopy covers several decades. In an early study from 1975, Sugarbaker et al. [256] showed that in more than 90% of patients a diagnosis can be established by laparoscopy, thereby avoiding non-therapeutic laparotomy in the majority of cases. Table 17.1 summarizes several cohort studies of diagnostic laparoscopy, which show that over the years increasingly more patients could be successfully managed exclusively by means of laparoscopic surgery. In parallel, specific laparoscopic procedures were evaluated with regard to their effectiveness in the elective and emergency setting. Today, it is possible to hypothesize that all patients with acute abdominal pain would benefit from laparoscopic surgery. It is the aim of these guidelines to define which subgroups of patients should undergo laparoscopic instead of open surgery for abdominal pain.

Table 17.1. Observational studies on the routine use of laparoscopy in unselected patient cohorts

Study year[a)]	No. of patients	Percentages of appendicitis/ gynecological disorders	Definitive diagnosis possible (%)	Percentage of laparoscopic/ open surgical/ conservative therapy	Avoidance of open surgery (%)
Reiertsen et al. [225] 1985	81	23/0/23	86	0/35/38	38
Paterson-Brown et al. [211] 1986	125	NA	91	0/30/70	9
Nagy and James [193] 1989	31	29/3/23	90	6/45/48	55
Graham et al. [99] 1991	79	32/NA/35	99	NA/34/NA	66
Schrenk et al. [236] 1994	15	67/7/7	93	80/20/0	80
Geis and Kim [94] 1995	155	66/5/1	99	96/4/0	80
Navez et al. [198] 1995	255	18/48/5	93	73/27/0	73
Waclawiczek et al. [282] 1997	172	17/28/NA	NA	65/28/7	72
Chung et al. [57] 1998	55	22/15/11	100	62/38/0	62
Salky and Edye [231] 1998	121	50/0/13	98	43/19/38	91
Sözüer et al. [252] 2000	56	38/4/32	95	64/13/23	87
Ou and Rowbotham [207] 2000	77	7/1/52	NA	87/12/1	88
Ahmad et al. [4] 2001	100	37/23/29	NA	81/19/0	81
Lee and Wong [157] 2002	137	25/9/39	91	41/16/43	84
Kirshtein et al. [130] 2003	277	23/1/9	99	75/25/0	75
Sanna et al. [232] 2003	94	20/6/26	98	88/12/0	88
Agresta et al. [2] 2004	602	NA/27/61	96	94/16/0	94
Golash and Willson [98] 2005	1320	69/1/19	90	83/7/10	93
Majewski [176] 2005	108	41/11/15	100	87/13/0	87

NA not assessed.
[a)] Studies are ordered according to year of publication

Methods

Consensus Development

In their meeting on September 11, 2004, the Scientific and Educational Committee of the European Association for Endoscopic Surgery (EAES) decided to focus new clinical guidelines for the role of laparoscopy in abdominal emergencies. These guidelines were primarily intended to supplement the existing guidelines on specific diseases (e.g., appendicitis and diverticulitis) and secondly to define the role of laparoscopy for other, more rare conditions. Based on a review of the current literature, European experts were invited to participate in the development of the guidelines. All members of the expert panel were asked to define the role of laparoscopy in the various diseases that may underlie abdominal emergencies. For each disease, two experts summarized independently the current state of the art. From these papers and the results of the literature review, a preliminary document with recommendations was compiled.

In April 2005, the expert panel met for 1 day to discuss the text of the guideline recommendations. All key statements were reformulated until a 100% consensus within the group was achieved [190]. Next, these statements were presented to the audience of the annual congress of EAES in June 2005. Comments from the audience were collected and partly included in the manuscript. The final version of the guidelines was approved by all experts in the panel. Each "chapter" consists of a key statement with a grade of recommendation (GoR) followed by a commentary to explain the rationale and evidence behind the statement.

Literature Searches and Appraisal

We used the Oxford hierarchy for grading clinical studies according to levels of evidence. Literature searches were aimed at finding randomized (i.e., level 1b evidence) or nonrandomized controlled clinical trials (i.e., level 2b evidence). Alternatively, low-level evidence (mainly case series and case reports; i.e., level 4 evidence) was reviewed. Studies containing severe methodological flaws were downgraded. For each intervention, we considered the validity and homogeneity of study results, effect sizes, safety, and economic consequences.

Systematic literature searches were conducted on Medline and the Cochrane Library until June 2005. There were no restrictions regarding the language of publication. Database searches combined the key word laparoscopy (or laparosc* as title word) with a condition-specific keyword (e.g., diverticulitis). We also paid attention to studies that were referenced in systematic reviews or previous guidelines [35, 134, 214, 275].

Results

General Remark

The wide variability in experience with laparoscopy makes it necessary to state that the following recommendations are valid only for surgeons or surgical teams with sufficient expertise in laparoscopic surgery.

Gastroduodenal Ulcer

If symptoms and diagnostic findings are suggestive of perforated peptic ulcer, diagnostic laparoscopy and laparoscopic repair are recommended (GoR A).

Perforation is the most dangerous complication of gastroduodenal ulcer disease and accounts for approximately 5% of all abdominal emergencies [208, 298]. In perforated peptic ulcer, surgery is generally superior to conservative treatment evidence level (EL) 1b [27, 61]), also because surgical procedures have improved considerably (EL 1a [184]).

Laparoscopic repair of perforated ulcer was first reported in 1990 by Mouret et al. [188].

In two randomized trials, laparoscopic surgery was found to be superior to open surgery for perforated ulcers (EL 1b [153, 246]), and other nonrandomized comparison studies are in accordance with these two trials (Table 17.2). Complication rates in these studies are strongly influenced by the selection of patients for surgery. Contradictory results were found on postoperative pain levels because there appears to be no difference in pain immediately after surgery (when pain is mainly caused by peritoneal inflammation), but laparoscopic patients seemingly experienced less pain later on (when pain is mainly caused by the incision) (EL 2 b [21, 135, 185, 191]). Decreased pain may also account for shorter hospital stay and earlier return to normal activities. Long-term results of both procedures showed no major differences in complication or recurrence rates. Mortality was marginally higher after open surgery, although revisional surgery was more frequently required after laparoscopic surgery (EL 2 a [152]).

Many patients in these studies received omental patch repair rather than simple suture, but there is nearly no comparative evidence available to decide which repair technique is superior (EL 2 b [155]; EL 4 [44, 137, 178, 194, 247]). One trial by Lau et al. [153] compared patch repair with fibrin sealing without finding any differences (El 1 b). Conversion to an upper midline incision may be necessary in approximately 10–20% of operations, usually for multiple, large, or rear side perforations and for advanced peritonitis (EL 4 [60, 62, 66, 110, 244]), Nevertheless, conversion does not seem to worsen the clinical outcome compared to open surgery (EL 2b [57]). The treatment of bleeding gastroduodenal ulcers was considered to fall outside the field of the current guidelines.

Table 17.2. Randomized and nonrandomized controlled trials comparing laparoscopic and open repair for perforated gastroduodenal ulcers

Study year	LoE	No. of patients	Leak agerates (%)	Total complication rates (%)	Difference in hospital stay (days)
Lau et al. [153] 1996	1b	48/45	2/2	23/22	±0 NS [a]
Siu et al. [246] 2002	1b	63/58	2/2	25/50	–1 sign [b]
Johansson et al. [119] 1996	2b	10/17	10/7	30/20	–1 NS [a]
Sø et al. [250] 1996	2b	15/38	0/0	7/24	–2 NS [a]
Miserez et al. [74, 185] 1996	2b	18/16	NA	50/9	–1 NS [a]
Chung et al. [57] 1998	2b	3/3	NA	NA	–4 sign [b]
Kok et al. [135] 1999	2b	13/20	NA	8/15	–1 NS [a]
Næsgaard et al. [191] 1999	2b	25/49	4/0	28/14	±0 NS [a]
Bergamaschi et al. [21] 1999	2b	17/62	0/0	29/34	–2 NS [a]
Mehendale et al. [180] 2002	2b	34/33	0/0	3/6	–5 sign [b]
Lee et al. [155] 2001	3b [c]	155/219	13/2	NA	–1 NS [a]
Nicolau et al. [202] 2002	3b [c]	51/105	0/0	6/7	–2 sign [b]
Seelig et al. [240] 2003	3b [c]	24/31	4/3	13/26	–2 NS [a]
Tsamura et al. [272] 2004	3b [c]	58/13	NA	5/23	–12 sign [b]
Lam et al. [148] 2005	3b [c]	523/1737	NA	3/13	–3 sign [b]

Data are shown for laparoscopic/open group. Studies are ordered according to level of evidence (*LoE*) and year of publication
NS not significant, *sign* significant
[a] Data are difference of medians
[b] Data are difference of means
[c] Study was downgraded because type of surgery was selected according to the patient's status or because converted cases were not analyzed within the laparoscopic group

Acute Cholecystitis

Patients with acute cholecystitis should undergo laparoscojoic cholecystectomy (GoR A). Surgery should be carried out as early as possible after admission (GoR A). In patients unsuitable for early surgery, conservative treatment or percutaneous cholecystostomy should be considered (GoR B).

Laparoscopy is of minor importance in terms of diagnosis of acute cholecystitis. Studies have shown that the following diagnostic criteria define cholecystistis with nearly 100% specificity: (1) acute right upper quadrant tenderness for more than 6 h and ultrasound evidence of acute cholecystitis (the presence of gallstones with a thickened and edematous gallbladder wall, positive Murphy's sign on ultrasound examination, and pericholecystic fluid collections) or (2) acute right upper quadrant tenderness for more than 6 h, an ultrasound image showing the presence of gallstones, and one or more of the following: temperature above 38°C, leukocytosis greater than 10×10/L, and/or C-reactive protein level greater than 10 mg/L (EL 1a [270]).

Traditional treatment consisted of open cholecystectomy, which was performed several weeks after an attack or in the acute setting. With the introduction of laparoscopy for the surgical approach to gallstone disease acute, cholecystitis was initially considered a contraindication. However, with increasing experience, a number of reports became available demonstrating the feasibility of the laparoscopic approach with an acceptable morbidity [143, 144, 286]. Today, there is sufficient evidence to state that laparoscopy is a safe approach, but the question to ask is if it is clearly superior to an open approach. There are several published studies comparing laparoscopic and open cholecystectomy for acute cholecystitis (Table 17.3). Only two of them are randomized trials (EL 1b [122, 131]). Nearly all comparative studies demonstrated faster recovery and shorter hospital stay in favor of laparoscopy (EL 1a [152]). Similarly, a minilaparotomic cholecystectomy was studied by Assalia et al. (EL 1b [14]), who were able to reduce hospital stay from 4.7 days with open surgery to 3.1 days with minilaparotomy. However, in the most recently published study, the outcome was very similar in the laparoscopic and conventional groups (EL 1b [122]).

The question remains whether the favorable outcome for laparoscopy is a result of altered pathophysiological response to the operation or whether this is due to concomitant changes in postoperative care due to the expected faster recovery from laparoscopic surgery. There is a clear possibility that trials comparing open and laparoscopic procedures contain traditional care regimens that have not been revised in the open treatment groups but have been modified in the laparoscopic groups, thereby favoring, the expected improved outcome after minimally invasive surgery. Several studies in which hospital stay and convalescence were utilized as endpoints may merely reflect traditions of

Table 17.3. Randomized and nonrandomized controlled trials comparing laparoscopic and open cholecystectomy for acute cholecystitis

Study year	LoE	No. of patients	Preoperative duration of symptoms	Total complication rates (%)	Difference in hospital stay (days)
Kiviluoto et al. [131] 1998	1b	32/31	4 days (mean)	3/42	–2 sign [a]
Johansson et al. [122] 2005	1b	35/35	72 h (mean)	2/3	–0 sign [a]
Kum et al. [144] 1994	2b	66/43	24–96 h	10/9	–0 sign [a]
Rau et al. [224] 1994	2b	102/114	NA	9/11	–2 sign [b]
Carbajo Caballero et al. [41] 1998	2b	30/30	NA	NA	–7 sign [b]
Lujan et al. [170] 1998	2b	114/110	<72 h	14/23	–5 sign [b]
Araujo-Teixeira et al. [12] 1999	2b	100/100	Variable	10/32	–7 sign [b]
Pessaux et al. [218] 2001	2b	50/89	NA	18/21	–5 sign [b]
Chau et al. [48] 2002	2b	31/42	Surgery performed 2 days (mean) after admission	13/40	–3 sign [b]
Eldar et al. [71] 1997	3b [c]	97/146	72 h (median)	17/26	–4 sign [a]
Glavic et al. [97] 2001	3b [c]	94/115	72 h (mean)	10/17	–4 sign [b]
Bove et al. [33] 2004	3b [c]	87/153	NA	14/NA	NA
Lam et al. [148] 2005	3b [c]	1223/1408	NA	1/5	–4 sign [b]

Data are shown for laparoscopic/open group. Studies are ordered according to LoE and year of publication

[a] Data are difference of medians

[b] Data are difference of means

[c] Study was downgraded because type of surgery was selected according to the patient's status or because converted cases were not analyzed within the laparoscopic group

postoperative care and patient expectations associated with open procedures rather than differences between open and laparoscopic surgical techniques. However, even after the advent of fast-track surgery, the existing evidence supports the use of laparoscopy in terms of earlier postoperative recovery. The basic recommendation should therefore be to offer all patients a laparoscopic approach. If there is no laparoscopically trained surgeon available, the patient should be treated with an open operation in the acute phase of the disease.

The optimal timing of the operation, regardless of whether performed laparoscopically or conventionally, is of major importance. In fact, timing of surgery seems more important than choice of surgical approach. A large number of studies have compared early versus late cholecystectomy for acute cholecystitis (EL 1a [23, 210]; EL 1b [45, 120, 121, 136, 146, 169], EL 2b [24, 25, 49, 69, 93, 102, 133, 139, 173, 199, 215, 220, 242, 258, 273, 285, 295]). However, the time intervals for early, delayed, or interval surgery were inconsistently defined in these studies. It can be concluded from these studies that conversion rates, complication rates, convalescence times, and hospital costs rise in parallel with an increasing delay between admission and operation (EL 5 [96]). Unfortunately, it is impossible to define the exact time limit until which surgery should be performed, but the majority of studies considered a delay of more than 48 or 72 h to be suboptimal. Delaying surgery is considered potentially harmful, especially in patients with a clinical presentation of gangrenous or hemorrhagic cholecystitis (EL 2b [105, 181]), but laparoscopic surgery in these advanced stages of cholecystitis is technically very demanding.

When performing laparoscopic cholecystectomy, the threshold for conversion should be quite low (EL 4 [168]). In many patient series, conversion rates were between 5 and 40% (EL 4 [15, 33, 36, 48, 70, 80, 95, 105, 140, 168, 199, 215, 230, 242, 258, 268, 295]) – much higher than in elective cholecystectomy for uncomplicated cholecystolithiasis. A set of prognostic variables have been identified that predict the need for conversion, such as degree of inflammation, number of previous gallbladder colics, gallstone size, higher age, male gender, obesity, and surgical, expertise (EL 4 [12, 102, 156, 168, 241]). However, these variables do not allow a completely reliable identification of patients in whom laparoscopic cholecystectomy is impossible. Therefore, every surgical procedure for acute cholecystitis should be started laparoscopically, except for patients with general contraindications.

Despite its general superiority, early laparoscopic cholecystectomy may not be possible in all patients. In elderly patients, comorbidities often render early surgery too risky or they simply preclude anesthesia (EL 5 [39]). These cases can only undergo delayed or interval cholecystectomy, although a small study (EL 1b [280]) suggested that a fully conservative treatment can be tried. In the acute phase, precutaneous cholecystostomy has been proposed as a means of alleviating symptoms until definitive treatment can take place (EL 1b [115]; EL 4 [20, 28, 31, 40, 47, 100, 126, 145, 213, 217, 288]). However, one randomized trial from Greece (EL 1b [109]) found that cholecystostomy and conservative treatment performed similarly well, thus justifying the use of both approaches in an individually tailored manner. On the other hand, the benefits of early surgery should not be generally denied to elderly or comorbid patients. With careful anesthesiologic and surgical management, satisfactory results can be achieved in these difficult subgroups (EL 2b [48]; EL 4 [219]).

Acute Pancreatitis

Patients with acute biliary pancreatitis should undergo definitive management of gallstones during the same admission (GoR B). After assessment of severity, mild cases should be done within 2 weeks, whereas severe cases should be done when the general condition has significantly improved (GoR C). The bile duct should be imaged to ensure it is clear of stones (intraoperative cholangiography, magnetic resonance cholangiopancreatography, (MRCP), or endoscopic ultrasound) (GoR B).

Acute pancreatitis is a disease entity with manifold etiologies and large differences in clinical appearance but with high morbidity and mortality in more severe cases. Therefore, classification of acute pancreatitis according to severity is crucial for clinical management. Severe disease requires intensive care and CT imaging (EL 5 [195]). Laparoscopy for diagnostic reasons is unnecessary since diagnosis and classification can be based on other criteria and imaging results (EL 5 [34, 65]).

Early pancreatic necrosectomy compared to late or no surgery has been found to be detrimental in various studies (EL 1b [125, 182]; EL 2b [6, 19, 75, 108, 274]). Whenever possible, necrotic tissue should be allowed to demarcate over a few weeks before necrosectomy takes place. Although some situations (e.g. hemorrhage or compartment syndrome) render surgical exploration inevitable, the majority of cases with severe pancreatitis can and should be spared early surgery (EL 1b [167, 237]). If surgery is necessary, minimally invasive techniques can be chosen for exploration, irrigation, necrosectomy, and drainage (EL 2b [91]; EL 4 [107, 209, 297]), but the open approach is still considered the gold standard (EL 4 [195]).

In biliary pancreatitis, two different approaches may be chosen depending on disease severity. In mild biliary pancreatitis, early laparoscopic cholecystectomy with intraoperative cholangiography is the preferred approach (EL 1b [46, 227, 255]; EL 4 [114, 263]; EL 5 [30, 214]). Bile duct clearance is essential to prevent recurrent disease.

Therefore, all patients with biliary pancreatitis should undergo definitive treatment at the next best opportunity, preferably during the same hospital admission. There are no studies available to compare a wait-and-see policy versus early removal of bile duct stones, but the risk of a potentially life-threatening recurrent pancreatitis when delaying bile duct clearance is generally considered to be unwarrantable.

There are three different options available to clear the bile duct: endoscopic stone extraction during endoscopic retrograde cholangiopancreatography (ERCP), laparoscopic exploration, and open exploration. Neither the 1998 EAES guidelines on common bile duct stones nor the 2005 UK guidelines on acute pancreatitis, favored one approach over the others (EL 5 [214,

275]). Because the scientific basis for these recommendations is unchanged, all three strategies are still equally recommendable. In general, surgery should only be started after the bile duct has been cleared, unless there is expertise available for intraoperative duct clearance (EL 2b [276]). If MRCP is available for imaging, it allows detection of choledocholithiasis with sensitivity and specificity both over 90% (EL 2a [124]), although the performance of MRCP may be inferior in acute pancreatitis. In most patients, a negative MRCP is sufficient to exclude bile duct stones, thus obviating the necessity of intraoperative clearance (EL 1b [106]). In conclusion, the optimal strategy in most hospitals will depend on the availability of imaging modalities, on the one hand, and surgical expertise with laparoscopic bile duct exploration, on the other hand.

Severe cases of biliary pancreatitis have a high risk of organ failure and death, which usually contraindicates early surgery. Again, bile duct clearance is necessary, but the timing and methods of definitive therapy are different than in mild disease forms. In severe cases, ERCP with or without endoscopic sphincterotomy followed by interval laparoscopic cholecystectomy is common (EL 1a [16]; EL 1b [76, 87, 200, 269], EL 4 [228]; EL 5 [1, 59]). After the publication of several diagnostic accuracy studies with good results (EL 1b [5, 42, 166, 221, 234]), the role of endoscopic ultrasonography (EUS) increased, but the advantage of EUS depends on the prior probability of bile duct stones (EL 2b [13, 229]). As already mentioned, disease classification is the cornerstone of successful therapy (EL 2b [201]). Several different systems have been proposed for defining a presumably severe case of pancreatitis and for describing the clinical course (Ranson score, APACHE II score, inflammatory markers, etc.), but the difficult choice of an optimal system is beyond the scope of these recommendations. The UK guidelines recommend delaying surgery "until signs of lung injury and systemic disturbance have resolved," which aptly describes the subjective nature of this decision on timing.

Acute Appendicitis

Patients with symptoms and diagnostic findings suggestive of acute appendicitis should undergo diagnostic laparoscopy (GoR A) and, if the diagnosis is confirmed, laparoscopic appendectomy (GoR A). If diagnostic laparoscopy shows that symptoms cannot be ascribed to appendicitis, the appendix may be left in situ (GoR B).

Appendicitis is a very common disease, but its symptoms are often equivocal and many other causative pathologies can be responsible. Despite improved imaging with sonography or CT, the rates of false-negative appendectomy are still high, especially in women (El 4 [29, 86]). Among the 56 randomized trials that have compared laparoscopic and conventional approaches

for suspected appendicitis (EL 1 a [233]; EL 1 b [186]), only a few studies have explicitly used the findings of diagnostic laparoscopy to guide further surgical therapy. Most of these studies included only female patients of fertile age and documented a large reduction in the rate of negative appendectomy (EL 1 b [37, 117, 147, 151, 205, 277]). However, the diagnostic advantages in men and children seem to be smaller and less consistent since appendicitis is much easier to diagnose in these subgroups.

The relative advantage of laparoscopic over conventional appendectomy has been under under debate for more than a decade. According to the most recent Cochrane Review (EL 1 a [233]), laparoscopic appendectomy offers certain advantages, although the difference compared to open appendectomy is not major. The EAES guidelines on appendectomy clearly favor the laparoscopic approach (EL 5 [72]), mainly because of the significantly reduced risk of wound infection and the faster postoperative recovery. This recommendation also pertains to perforated cases.

If the appendix looks normal on laparoscopy but another pathology is found to be the cause of the patient's symptom, then the appendix should be left in situ (EL 4 [278]). The 10-year follow-up by van Dalen et al. [277] (EL 1 b) demonstrated the safety of this approach in women. The situation is more complicated when the appendix shows no signs of inflammation and no other pathology can be found. Different groups have provided contradictory data on the reliability of macroscopic diagnosis of appendicitis (EL 4 [51, 103, 141, 266]). Weighing the disadvantage of a negative appendectomy against the risk of overlooking a case of appendicitis is difficult. If symptoms and signs are severe and typical for appendicitis, most surgeons will consider appendectomy to be indicated because in early appendicitis inflammation may be limited to intramural layers.

Acute Diverticulitis

Patients with presumed acute uncomplicated diverticulitis should not undergo emergency laparoscopic surgery (GoR C). Although colonic resection remains standard treatment for perforated diverticulitis, laparoscopic lavage and drainage may be considered in some selected patients (GoR C).

After physical examination and a blood count, CT is especially useful to diagnose diverticulitis. If complicated disease is likely, CT is able to visualize inflammation of the pericolic fat, thickening of the bowel wall, or peridiverticular abscess. Diagnostic laparoscopy is therefore unnecessary. Resection of the diseased segment should be performed in an elective rather than an emergency setting since the risk of conversion and the rate of primary reanastomosis strongly depend on the presence and severity of acute inflamma-

tion. The value of elective laparoscopic sigmoid resection has been addressed in guidelines issued by the EAES in 1999 [134].

Complicated cases of diverticular disease are classified according to the modified Hinchey classification. Stage I indicates the presence of a pericolic abscess, stage II a indicates distant abscess amenable to percutaneous drainage, and stage II b Indicates complex abscess associated with or without fistula. Diffuse peritonitis is classified as stage III (purulent) or IV (fecal). Peritonitis or pneumoperitoneum usually require emergency surgical exploration (EL 1 b [142, 294]; EL 5 (10, 212]). In Hinchey stages III and IV, laparoscopic abdominal exploration and peritoneal lavage have been successfully used, but there are only limited data available (EL 2 b [77]; EL 4 [88, 206, 223, 235]). A laparoscopic approach may be especially advantageous in high-risk patients, who would probably not survive Hartmann's procedure. In such patients, perforation may be closed by an omental patch (EL 4 [88]). In stage II b, abscesses can be drained and fistula can be closed laparoscopically (EL 4 [88, 223, 238]), but it must be taken into account that only very few surgeons are experienced enough to perform these operations. It is therefore too early to generally recommend laparoscopic emergency surgery for complicated diverticular disease, despite promising results.

Small Bowel Obstruction due to Adhesions

In the case of clinical and radiological evidence of small bowel obstruction nonresponding to conservative management, laparoscopy may be performed using an open access technique (GoR C). If adhesions are found at laparoscopy, cautious laparoscopic adhesiolysis can be attempted for release of small bowel obstruction (GoR C).

The clinical value and the potential complications of adhesiolysis are highly debated. A blinded trial by Swank et al. [262] found similar levels of pain after diagnostic laparoscopy with or without adhesiolysis (El 1 b). Although this trial was performed in patients with chronic recurrent abdominal pain, it also has implications for the acute pain situation. On the other hand, laparoscopic adhesiolysis is sometimes performed at diagnostic laparoscopy for acute abdominal pain, to enable complete visualization of the abdominal content. Therefore, the term adhesiolysis covers a wide spectrum of invasiveness. Furthermore, the natural variability of adhesions and their sequelae determines possible success and failure rates of adhesiolysis. Therefore, the decision for adhesiolysis in the acute setting is a balance of these factors (EL 2 b [284]). As a rule, adhesiolysis in an abdomen without intestinal obstruction should be kept to a minimum.

Radiographically confirmed small bowel obstruction requires emergency surgery (EL 2 b [82–84] when nonoperative therapy is unsucessful. Laparo-

scopic treatment of acute small bowel obstruction was first described by Bastug et al. [18] (EL 4) and has since been reported by others (EL 4 [3, 8, 17, 32, 55, 56, 89, 90, 111, 129, 160, 163, 197, 243, 254, 259, 261]). Studies comparing the results of laparoscopic and conventional treatment of this condition are nearly lacking, except for the matched-pair analysis by Wullstein and Gross [289] (EL 2b). The benefits of the laparoscopic approach that have been reported consist of a more rapid postoperative recovery with faster return of bowel movements, lower morbidity, and shorter hospital stay. However, there is concern that laparoscopic treatment of small bowel obstruction may lead to a higher rate of bowel injury than conventional surgery. In the single comparative study (EL 2b [289]), the risk of perforation was clearly higher in the laparoscopic group (27%). The high conversion rate is also an issue. Complete laparoscopic treatment seems to be possible in only 50–60% of patients (EL 4 [3, 8, 17, 32, 55, 56, 89, 111, 129, 160, 163, 197, 243, 254, 259, 261]). The remaining patients have to be converted to open surgery for malignant disease, iatrogenic bowel perforation, or other reasons. Some studies have examined predictive factors for successful laparoscopy (EL 2b [163, 259]). A history of two or more surgical abdominal operations, late operation (after 24 h), and bowel diameter exceeding 4 cm have been reported to be predictors of conversion. An isolated scar from a previous appendicectomy seems to be favorable in terms of avoiding a conversion. To avoid the possibility of intraabdominal injuries during laparoscopic access, open rather than laparoscopic surgery should be performed if scars or other findings indicate the presence of severe or extended adhesions (EL 4 [85, 192]).

Incarcerated Hernia

Although the open approach remains standard treatment for incarcerated hernia, laparoscopic surgery may be considered in carefully selected patients (GoR C).

The available evidence for the use of laparoscopic surgery in inguinal, incisonal, and other hernias is very good, but all these studies have excluded symptomatic and emergency surgery cases. It seems unjustified to adopt the principle of transferable evidence to delineate the treatment of incarcerated hernia from the results obtained in the elective setting. With regard to the laparoscopic treatment of incarcerated hernias, so far only case reports (EL 4 [38, 58, 78, 123, 150, 164, 271, 283, 290]) and small case series (EL 4 [81, 113, 149, 154, 165, 239]) have been published. The largest series is from Leibl et al. [158] (EL 4) and reports on 220 patients. The authors – highly experienced laparoscopic surgeons – found their results in incarcerated groin hernias to be similar to those elective for hernia repair. Because there are no comparative studies available to compare open and laparoscopic surgery, one

should be very reluctant to choose a laparoscopic approach to hernia sac, abdominal wall, or peritoneum. Although early clinical results are promising, these techniques should be restricted to surgeons with maximum expertise in laparoscopic hernia surgery.

Mesenteric Ischemia

If mesenteric ischemia is clinically suspected, conventional imaging is preferable over diagnostic laparoscopy in defining therapeutic management (GoR C).

Acute mesenteric ischemia is caused by arterial occlusion (approxiamately 50% of cases), nonocclusive arterial ischemia (20–30%), or venous occlusion (5–15%) [253]. A clinical diagnosis of mesenteric ischemia is usually confirmed by the use of conventional angiography, CT scanning, or duplex sonography [132, 204, 216]. Traditional surgical therapy consists of resection of infarcted bowel segments or embolectomy, depending on duration and extent of ischemia. The benefit of surgery needs to be considered on a case-by-case basis since there is no good evidence available to compare surgical and medical treatment for those patients with a salvageable condition (EL 2b [26, 68, 296]).

The potential value of emergency laparoscopy in these patients relates to its diagnostic rather than its therapeutic opportunities. However, the rate of mesenteric ischemia among patients with acute abdomen is only approximately 1% [112]. Furthermore, laparoscopic viewing does not guarantee correct recognition of ischemia. Since radiographic imaging accurately identifies most cases of mesenteric ischemia, it is very unlikely that diagnostic laparoscopy will prevent a negative laparotomy in these patients. In the literature, only a few cases have been published (EL 4 [52, 54, 73, 292]; EL 5 [159]), although there are more reports concerning second-look laparoscopies.

Gynecologic Disorders

If gynecologic disorders are the suspected cause of abdominal pain, diagnostic laparoscopy should follow conventional diagnostic investigations (GoR A), and, if needed, a laparoscopic therapy for the disease should be performed (GoR A). A close cooperation with the gynecologist is strongly recommended.

Many acute gynecologic disorders can be approached safely and effectively by laparoscopy with the intent not only to correctly diagnose the patient but also to render treatment (EL 4 [138, 174, 196, 207]). The most common diagnoses encountered in women with acute pelvic pain are ectopic pregnancy (approximately 20% of cases), salpingo-oophoritis (20%), pelvic adhesions (20%), endometriosis (15%), and ovarian cysts (15%). In gynecological emergencies, CT scans are very seldom helpful. After a pregnancy test,

transvaginal and conventional ultrasound can aid in formulating a differential diagnosis. However, diagnostic laparoscopy is superior to other diagnostic tools (EL 2b [183]) and may lead to the correction of an erroneous preoperative diagnosis in up to 40% of patients (EL 4 [7, 67, 138, 264]).

Ectopic pregnancy (EP) is a life-threatening condition. In early pregnant women presenting with acute pelvic pain and/or vaginal bleeding, a diagnostic laparoscopy should always be considered to exclude EP. In the vast majority of cases, a pregnancy test can exclude the diagnosis in cases with only minor symptoms. When serum human chorionic gonadotropin (hCG) levels reach 1,000 IU/L, transvaginal ultrasonography can differentiate between an EP or an intrauterine pregnancy (IUP) because all IUPs can clearly be seen in cases with hCG > 1,000 IU/L. A normal IUP will have a hCG doubling rate of 2 days. Thus, vaginal ultrasound and hCG go hand in hand in the diagnosis of EP in cases of minor or no abdominal symptoms (EL 5 [222]). In cases with EP, laparoscopic surgery should be undertaken also because of its total cost is cheaper (EL 1b [101]). It is fast, and fertility outcome is comparable to laparotomy. Furthermore, sick leave and hospitalization are shorter and adhesion development is minor compared to laparotomy (EL 1b [171, 172, 279]; EL 2b [79, 189]). Laparoscopic salpingectomy should be performed in cases of ruptured tubal pregnancy. In cases of unruptured tubal pregnancy, a tube-preserving operation should be considered. Hemodynamic instability is a contraindication for laparoscopy.

Torsion of ovarian cysts is an organs-threatening disease. Patients often present with acute abdominal pain. After excluded pregnancy, a transvaginal ultrasound is mandatory to exclude ovarian cyst formation. In the majority of patients, free fluid can be seen in the abdomen, and if symptoms decline, an expectative attitude can be undertaken. In cases with persistent pain and/or if a larger cyst is seen on ultrasound, a diagnostic laparoscopy must be performed to exclude adnexal torsion. Ovarian cysts that are found during diagnostic laparoscopic should be treated laparoscopically (EL 1b [175, 291]). Pregnant women with acute pelvic pain and clinical signs of torsion of ovarian cyst should be offered laparoscopic repair. Laparoscopic surgery was also reported to be superior compared to open surgery for resecting other types of ovarian cysts (EL 1b [203]).

Endometriosis often causes infertility and pain. Pain is usually chronic and recurrent, but some patients present with acute symptoms. Surgical treatment may be indicated in some patients and may be performed as an open procedure or laparoscopically. Only one trial has compared the two approaches (EL 1b [175]) and documented a significantly faster and less painful recovery after laparoscopy. More evidence is available on the comparative effectiveness of laparoscopic excision versus conservative treatment of endometriosis. Although these studies included elective rather than emergency patients, their results in-

dicate that laparoscopic excision results in clear and patient-relevant advantages as opposed to conservative treatment (EL 1 a [116]; EL 1 b [1, 260]).

Salpingo-oophoritis commonly causes acute pelvic pain and often mimics other diseases. Conservative treatment consists of antibiotics. Laparoscopy is useful to exclude other pathologies, which may be present in approximately 20% of patients (EL 4 [*22*]). Furthermore, microbiological specimens can be taken to guide antibiotic therapy. Depending on the severity of symptoms, laparoscopy is therefore considered to be advantageous for acute salpingitis (EL 4 [22, 251]) and pyosalpinx (EL 4 [267]).

Nonspecific Abdominal Pain

Patients with severe nonspecific abdominal pain (NSAP) after full conventional investigations should undergo diagnostic laparoscopy if symptoms persist (GoR A). Patients with NSAP of medium severity may undergo diagnostic laparoscopy after a period of observation (GoR C).

According to symptoms and diagnostic findings, most patients with acute abdominal pain can easily be categorized into different groups of presumed diagnoses, but some patients will not fit into these diagnostic categories due to unclear or equivocal findings. In these cases, of NSAP, the severity of symptoms determines the necessity of emergency surgery. Some patients definitely require surgical exploration, a second group can safely be monitored under conservative therapy, and in a third group the decision between operative or conservative management is unclear. If symptoms are severe enough to require surgical exploration, this should be done laparoscopically. The reason lies more in the therapeutic than the diagnostic value of laparoscopic surgery. As described previously, laparoscopic surgery is advantageous for many intraabdominal diseases, which may also turn out to be the underlying cause of an unclear abdomen. Also, because converted cases have a similar outcome compared to primarily open cases (EL 2 b [57]), the benefits of a laparoscopic approach outweigh its potential negative effects.

Four randomized controlled trials have compared early laparoscopy versus observation for nononspecific acute abdominal pain (Table 17.4). Three trials focused exclusively on right iliac fossa pain in women after excluding clear cases of appendicitis (EL 1 b [43, 92, 187]). The fourth trial included 120 men and women with acute abdominal pain regardless of pain localization (EL 1 b [64]). Three out of four trials found that early laparoscopy clearly facilitated the establishment of a diagnosis with subsequent therapy, whereas more patients in the control group left the hospital without a clear diagnosis. More important, hospital stay was shorter in two of the trials (EL 1 b [*43*, *92*]). At 1-year follow-up, recurrent pain episodes were less frequent (EL 1 b [187]) and health-related quality of life was better (EL 1 b [64])

Table 17.4. Randomized controlled trials comparing laparoscopic surgery and conservative management for acute nonspecific abdominal pain

Study year	LoE	No. of patients	Patients in conservative group receiving surgical exploration (%)	Patients remaining without a final diagnosis (%)	Difference in hospital stay (days)
Champault et al. [43] 1993	1 b	33/32	50	3/72	–2 sign[a)]
Decadt et al. [64] 1999	1 b	59/61	28	19/64	±0 NS[b)]
Gaitán et al. [92] 2002	1 b	55/55	40	5/2	–1 sign[a)]
Morino et al. [187] 2003	1 b[c)]	24/29	31	12/55	NA

Data are shown for laparoscopic/conservative group. Studies are ordered according to year of publication
[a)] Data are difference of means
[b)] Data are difference of medians
[c)] Only published abstract available

in the laparoscopic group. Based on these data, it seems justified to lower the threshold for surgical exploration when using a laparoscopic rather than an open approach. However, it seems advisable to observe patients over some hours because abdominal symptoms may become more specific over time or simply disappear in some cases (EL 4 [128]).

Abdominal Trauma

For suspected penetrating trauma, diagnostic laparoscopy is a useful tool to assess the integrity of the peritoneum and avoid a nontherapeutic laparotomy in stable patients (GoR B). Stable patients with blunt abdominal trauma may undergo diagnostic laparoscopy to exclude relevant injury (GoR C).

Laparotomy for abdominal trauma used to be negative or nontherapeutic in approximately one-third of patients (EL 4 [162, 226]), but modern imaging techniques have reduced this figure to less than 10% (EL 4 [104]). The literature contains approximately 40 prospective or retrospective cohort studies on the diagnostic role of laparoscopy in trauma (EL 4 [281]). The major advantage of laparoscopy as identified in these studies was the obviation of unnecessary laparotomy in approximately 60% of cases. However, relevant injuries went undetected in 1% of all laparoscopies, particularly after blunt trauma affecting solid organs or hollow viscus (EL 4 [281]). Because the majority of the available evidence derives from patients with stab or gunshot wounds, di-

agnostic laparoscopy seems to be recommendable as a screening tool for patients with a moderate to high index of suspicion for intraabdominal injuries. However, in hemodynamically unstable patients, emergency surgical exploration of the abdomen may be life-saving. In this situation, delaying definitive therapy by laparoscopy is contraindicated.

Two randomized studies have been published on laparoscopy in trauma. A small study compared laparoscopy with peritoneal lavage and found higher diagnostic specificity in the laparoscopic group (EL 1b [63]). The second trial was, in fact, a double trial (EL 1b [161]). First, it compared exploratory laparotomy and diagnostic laparoscopy for stab wounds that had penetrated the peritoneum. Second, patients with equivocal peritoneal violation were randomized to diagnostic laparoscopy or expectant nonoperative management. Not unexpectedly, laparoscopy reduced hospital stay compared to laparotomy but prolonged hospital stay compared to conservative management (EL 1b [161]). Although laparoscopy saved more than half of patients from laparotomy, the postoperative clinical course and costs failed to differ between laparoscopic and laparotomic group. Because the study was relatively small and did not report on the potential long-term advantages of laparoscopy, further research is needed. Accordingly, the panel believes that the available evidence does not justify a high-grade recommendation.

Although the trials mentioned previously did not use laparoscopy for therapeutic reasons, it is clearly possible to treat certain injuries laparoscopically. Bleeding from minor injuries to the liver or the spleen can be controlled through the laparoscope (EL 4 [50, 53, 293]). Diaphragmatic lacerations (EL 4 [179, 248, 249]) and perforating stab wounds of the gastrointestinal tract can be sewn or stapled (EL 4 [53, 177, 293]). Nevertheless, the scarceness of clinical data prohibits a clear recommendation in favor of therapeutic laparoscopy for trauma.

Discussion

Available evidence clearly demonstrates the superiority of a laparoscopic approach in various emergency situations, but laparoscopy offers less or unclear benefit in other acute conditions. Therefore, a policy of laparoscopy for all patients with acute abdominal pain still seems unjustified, although laparoscopy will be to the advantage of the majority of patients. The initial usage of diagnostic procedures and imaging should aim to identify those patients who would probably not benefit from laparoscopy. On the other hand, it usually carries only minor disadvantages for a patient if a diagnostic laparoscopy has to be converted to an open procedure. Because the current guidelines deal with complex laparoscopic procedures, a low threshold toward early conversion is generally useful in order to avoid delays in the operating room.

Although the current recommendations address the most common diagnoses, some less prevalent causes of acute abdominal pain were not specifically discussed. Some of the more rare diagnoses were encountered in the cohort studies summarized in Table 17.1. These diseases include abdominal abscess, peritoneal tuberculosis, and intestinal volvulus. Due to their low occurrence, these diseases will probably never be studied in a randomized trial, but their relative importance in the treatment of an average patient is low. Laparoscopic therapy has been described to be useful for many of these conditions (EL 2b [265]; EL 4 [9, 127, 245]).

The panel also decided not to prepare separate recommendations on the usage of laparoscopy in children with acute abdominal pain. The disease spectrum of pediatric acute abdominal pain is completely different compared to that of adults, but older children and adolescents are good candidates for laparoscopy (EL 4 [118, 287]). The value of specific procedures in pediatric surgery, such as laparoscopic appendectomy, is still under intensive debate. In consequence, these guidelines are valid only for adult patients. Also, there was no pediatric surgeon on the panel to define the possible role of laparoscopic surgery for pyloric stenosis, congenital malformations, and other disorders of the newborn or small child.

Future research should concentrate on those fields or which only low-level evidence is available. The current guidelines have identified some topics that have been described only in feasibility studies. It is highly desirable to supplement these studies with additional comparative data on effectiveness and cost-effectiveness. Because the EAES updates its guidelines regularly, such data are also important before stronger recommendations can be issued. On the other hand, in those fields for which there is good evidence, laparoscopic surgery has been shown to be highly beneficial. Therefore, optimism with regard to laparoscopy may prove to be justified. Laparoscopy has already had a major impact on the management of abdominal emergencies and has become an indispensable technique.

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Perforated Peptic Ulcer – Update 2006

Dejan Ignjatovic, Roberto Bergamaschi

Definition

Perforated peptic ulcer is a relatively uncommon condition characterized by local or general peritonitis due to perforation of a gastric, duodenal, jejunal or ileal ulcer.

Epidemiology and Clinical Course

Perforated peptic ulcer accounts for about 5% of all abdominal emergencies. After simple surgical closure and *Helicobacter pylori* eradication, ulcer relapse and reperforation rates are 6.1 and 4.1%, respectively [5]. All three reperforations were in gastric locations. Crude rates for duodenal ulcer recurrence were 2.6% at 2 years and for duodenal ulcer reperforation rates were nil at 2 years. These results imply that laparoscopic suture repair and *H. pylori* eradication is safe in duodenal ulcers, however with recurrence in gastric ulcers [5].

Operative Versus Conservative Treatment

No new data are available. Surgery is indicated.

Choice of Surgical Approach and Procedure

A recent Cochrane systematic review suggests that a decrease in septic abdominal complications may occur when laparoscopic surgery is performed to repair a perforated peptic ulcer [6]. However, it is necessary to develop more randomized-controlled trials that include a greater number of patients to confirm such an assumption. Such trials should exclude the surgical learning curve in order to be valid. With the evidence at hand, the results of laparoscopic surgery are not clinically different from those of open surgery [3]. Other studies provide data on significantly shorter hospital stay and shorter operating time in the case of laparoscopic access [1]. In summary, we still

believe that laparoscopic surgery is advantageous in the hands of an experienced surgeon.

Technical Aspects of Surgery

Omental patch–repair, patch–repair with fibrin sealing and simple suture are reported without enough comparative evidence on which repair technique is superior. Conversion to an upper midline incision may be necessary in 10–20% of operations, usually for multiple, large, or rear-side perforations and for advanced peritonitis. Conversion does not seem to worsen the clinical outcome [1, 2]. It seems that the size of the perforation is a significant risk factor influencing the conversion and complication rates [2].

Peri- and Postoperative Care

Laparoscopic surgery seems to have the benefit of shorter duration of postoperative nasogastric aspiration and time to resume oral intake, fewer postoperative analgesic requirements, and lower overall complications rate [2]. There was no statistically significant difference in mortality rate between open and laparoscopic access. Patients who developed suture leakage had acute symptoms for more than 9 h preoperatively [4]. Conversions seemed to occur with surgeons whose previous experience involved 1.8±2.3 cases compared with 3.9±2.9 cases in successful laparoscopic repair [4].

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Acute Cholecystitis – Update 2006

Giuseppe Borzellino, Ivan Tomasi, Claudio Cordiano

This update is based on a systematic literature search in Medline. The search strategy is available from the authors on request.

Definition

Acute cholecystitis is defined as an acute inflammation of the gallbladder wall. Gallstone cholecystitis is differentiated from alithiasic cholecystitis on the basis of its aetiology, when bile outflow is obstructed by gallstones or biliary sludge.

Epidemiology and Clinical Course

Epidemiology

Epidemiological data are reported in a recent review [13] and are therefore based on previous studies. Gallstone cholecystitis is the most common form since it is reported in 90% of cases of acute cholecystitis [7], women up to 50 years old are 3 times more likely to develop an acute gallstone cholecystitis than men [7] and 10–30% of patients with acute cholecystitis develop severe complications such as gangrene, empyema or perforation [3, 8, 18]. A more recent retrospective study [10] confirmed results of previous retrospective or prospective studies [3, 6, 12] for which severe acute cholecystitis was observed more frequently in male and old patients, with reported odds ratios of 1.76 ($P=0.029$) for the former and 2.24 ($P=0.004$) for the latter. A Canadian study [17] reported an 18% reduction in the rate of acute cholecystitis after the introduction of laparoscopic cholecystectomy in 1991. The average annual rate of acute cholecystitis per 100,000 population was reported to be 109 (95% confidence interval 107–110) in the period 1988–1991 and 88 (87–89) in the period 1992–2000. The interpretation of the authors is that this highly significant reduction may be explained by an increase of 35% of elective cholecystectomies after the introduction of laparoscopy. However, the postlaparoscopic period is about 3 times longer than the prelaparoscopic one and since a greater number of elective cholecystectomies were performed in the early laparoscopic period,

a division of the latter into another two 4-year periods for final comparison would have given a more precise measure of the effects registered.

Clinical Course

The clinical course of acute cholecystitis may be explained by its pathogenesis. There have been no new data since those reported in the review by Indar and Beckingham [7]. Increase in the intraluminal pressure and distension of the gallbladder wall due to bile obstruction outflow stimulates synthesis of prostaglandins, the mediators of the inflammatory response. Intraluminal pressure may rise up to a value above the arterial perfusion pressure of the gallbladder wall, with ischemia, necrosis and possible perforation as a result. The percentage of patients which develop such complications and therefore need urgent surgical intervention is reported to be 20% [7]. Another possible evolution of the cholecystitis is secondary bacterial infection, with enteric bacteria observed in about 20% of cases, with possible empyema formation as a result [7].

Diagnostics

There are no new data available on the diagnosis of cholecystitis other than those in one retrospective study [2] published with the aim to predict bile infection. However, no clinical, biological nor radiological parameters alone or in combination reached statistical significance, neither by univariate analysis nor by multivariate logistic regression.

Operative Versus Conservative Treatment

No new data have been found, neither for observation versus cholecystectomy after conservative treatment nor for medical treatment versus cholecystostomy in critically ill patients. Sooner or later, a surgical intervention is indicated in patients with acute cholecystitis.

Choice of Surgical Approach and Procedure

Open Versus Laparoscopic Cholecystectomy

Two meta-analyses on timing, one randomized controlled trial (RCT) and two retrospective studies on cholecystostomy and one prospective study on the effect of conversion in gangrenous cholecystitis have recently been published, but no new data have been found on laparoscopic versus open cholecystectomy.

Early Versus Delayed Cholecystectomy

One of the meta-analyses [9] published is not a high-quality study since at least six of the criteria of the QUORUM checklist [5] for quality assessment of meta-analysis of RCT were not fulfilled. Some are of minor importance, but a selection bias by including a nonrandomized study and not other RCTs published at the time of the research and a lack of quality assessment of the studies included make the results uncertain and conclusions have to be drawn with caution. The other meta-analysis [14] was conducted following the criteria of the QUORUM checklist [5], but either laparoscopic or open cholecystectomies were analysed, including study from 1970 to 2003, a period of time during which peri- and postoperative care have changed. Only absolute risk by calculation of the risk difference was reported and data on laparoscopy may be extracted from a table but little information is available.

Cholecystostomy

A randomized clinical trial [1] compared two treatment regimens: cholecystostomy followed by early laparoscopic cholecystectomy (PCLC group) versus medical treatment followed by delayed laparoscopic cholecystectomy (DLC group) in high-risk patients. This was a medium-quality study, since six patients were excluded from the analysis in the PCLC group, thus violating the intention-to-treat principle. Patients were excluded because they failed to reach an APACHE II score of less than 12 within 120 h, which was required for surgery. Three patients were excluded from the DLC group, one patient died from multiple organ failure and the other two refused surgery. Definition of the risk is mainly based on the APACHE II score and therefore it is determined either by the comorbidity conditions or by the severity of the cholecystitis; however, associated diseases with an ASA score greater than 3 were reported in the majority of patients in both groups. Symptom relief time was significantly shorter in the PCLC group, being achieved within 24 h in all included patients compared with the 48–72 h in the DLC group ($P = 0.001$). Two patients in the DLC group experienced mild pancreatitis during the waiting period and this was taken into account in the mean hospital stay. The results of the laparoscopic cholecystectomies do not show differences in conversion rate (6.5% in the PCLC group versus 13.4% in the DLC group with P=0.42) and in postoperative hospital stay (1.58, standard deviation 0.72 in the PCLC group versus 1.66, standard deviation 0.72, in the DLC group, with $P = 1$). Two results favoured the PCLC group: total hospital stay, with 5.3 days versus 15.2 days ($P = 0.001$), and total cost, with US $ 2,612 versus 3735 ($P = 0.001$). Two retrospective uncontrolled studies were found on gallbladder aspiration [15] and the use of cholecystostomy [16] in high-risk patients, but no critical evaluation of these approaches was reported.

Conversion for Gangrenous Cholecystitis

In a prospective study on gangrenous cholecystitis [4], early conversion after initial visualization of the gallbladder, intermediate conversion after an initial attempt at dissection or late conversion after a protracted attempt at dissection do not influence significantly morbidity nor hospital stay, but just operative time from 1.8 to 2.1 and 2.7 h, respectively ($P < 0.01$).

Technical Aspects of Surgery

No new data are available other than those from a prospective study that reports aspiration of distended gallbladder with a Veress needle, but no critical evaluation of this technique was performed [11].

Peri- and Postoperative Care

No new data are available.

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Acute Pancreatitis – Update 2006

James Arbuckle, Alberto Isla

Definition, Epidemiology and Clinical Course

Acute pancreatitis is a common diagnosis requiring admission onto the surgical ward. Eighty percent of patients have mild acute pancreatitis, and will recover within a few days. Twenty percent have severe acute pancreatitis, and will require intensive management. This chapter aims to outline some fundamental principles of the disease, and to consider the specific management of mild gallstone pancreatitis.

Classification

The Atlanta classification is widely accepted as the standard system for describing acute pancreatitis [3]. A summary of terms and definitions from the Atlanta classification follows.

Acute pancreatitis is defined as an acute inflammatory process of the pancreas with variable involvement of other regional tissues or remote organ systems.

Severe acute pancreatitis is associated with organ failure and/or local complications, such as necrosis, abscess or pseudocyst. Scoring systems to characterise severe acute pancreatitis are discussed in the next section. The deterioration in physiological parameters is a reflection of the development of pancreatic necrosis.

Mild acute pancreatitis is associated with minimal organ dysfunction and an uneventful recovery. Approximately 75% of cases fall within this group.

Acute fluid collections occur early in the course of acute pancreatitis and are located in or near the pancreas. They always lack a wall of granulation or fibrous tissue. They occur in 30–50% of cases of severe pancreatitis, and more than half spontaneously regress.

Pancreatic necrosis is a diffuse or focal area of non-viable pancreatic parenchyma. Dynamic contrast-enhanced CT demonstrates a contrast density of less than 50 Hounsfield units in areas of necrosis (normal enhancement 50–150 Hounsfield units). The clinical distinction between sterile and infected necrosis is critical, the former being treated conservatively, and the latter surgically.

A *pseudocyst* is a collection of pancreatic juice enclosed by a wall of fibrous or granulation tissue arising as a result of acute or chronic pancreatitis, pancreatic trauma or surgery. The formation of a pseudocyst requires at least 4 weeks from the onset of acute pancreatitis.

Scoring Systems

The purpose of the various scoring systems available to the clinician is to identify the 20% of patients who present with acute pancreatitis with severe disease. No system has 100% sensitivity or specificity, but the prompt stratification of a patient on admission to a particular grade of severity is an essential step in the initial management of acute pancreatitis. Several scoring systems have been proposed to assess the severity of pancreatitis. Ranson, Glasgow and APACHE II all use physiological parameters to score the level of severity of the episode of pancreatitis.

In the classic paper of Ranson et al. [13] from 1976, 300 consecutive patients admitted with acute pancreatitis were assessed. Eleven factors (Table 20.1) were identified to be associated with increased morbidity and mortality in the first 100 patients. The 11 factors were then prospectively applied to the next 200 patients. The mortality rate in the first group of 100 patients was 15%. When the second group of 200 patients were assessed using the 11 factors identified in the first group, and treated according to the predicted severity of the episode of pancreatitis, the mortality rate was 3.5%. In the latter group of 200 patients, 38 patients had three or more positive factors, and 24 became seriously ill or died. Of the remaining 162 patients with fewer than three factors, only one patient died.

Imrie modified Ranson's criteria in 1978, and these factors were reviewed in 1984 in a series of 347 patients [2]. It was found that of the nine factors originally described by Imrie, omission of the aminotransferase values (to give an eight-factor score) increased the predictive value from 72 to 79% in attempting to classify mild or severe pancreatitis. This is the most widely used scoring system in daily UK clinical practice (Table 20.1).

Further scoring of severity by APACHE II (acute physiology and chronic health evaluation) to predict the severity of acute pancreatitis has been described [18]. The principal difference between the APACHE II and Ranson/Glasgow scoring systems is that physiological parameters (temperature, mean arterial pressure, heart rate, respiratory rate, Glasgow coma score) are combined with laboratory blood values in APACHE II. APACHE II scored as well as the established systems for gallstone pancreatitis, but less well for alcoholic pancreatitis.

A scoring system based on CT appearances (Table 20.2) has been developed by Balthazar et al. [1], taking into account the degree of inflammation

Table 20.1. Scoring systems for acute pancreatitis

Ranson		Glasgow
At admission	During initial 48 h	
Age above 55 years	Haematocrit value decrease over 10%	Age above 55 years
White blood count above 16×10^9/l	Blood urea nitrogen level rise over 5 mg%	White blood count above 15×10^9/l
Blood glucose levelabove 200 mg%	Serum calcium level below 8 mg%	Blood glucose above 10 mmol/l (no diabetic history)
Serum lactate dehydrogenase over 350 international units per litre	Arterial oxygen tensionbelow 60 mmHg	Serum urea above 16 mmol/l (no response to intravenous fluids)
Serum glutamic oxalacetic transaminase level over 250 Sigma Frankel units percent	Base deficit over 4 mEq/l	PaO_2 below 60 mmHg
	Estimated fluid sequestration over 6 l	Serum calcium below 2 mmol/l
		Serum albumin below 32 g/l
		Lactate dehydrogenase above 600 µl/l

PaO_2 partial pressure of oxygen in arterial blood

Table 20.2. Balthazar grading system based on CT appearances

Grade	Findings
A	Normal
B	Gland enlargement, small intrapancreatic fluid collection
C	Any of above, peripancreatic inflammation, less than 30% pancreatic necrosis
D	Any of above, single extrapancreatic fluid collection, 30–50% pancreatic necrosis
E	Any of above, extensive extrapancreatic fluid collection, pancreatic abscess, more than 50% pancreatic necrosis

of the pancreas, the presence of fluid collections, and the percentage of pancreatic necrosis. The severity of these changes has been shown to correlate with prognosis.

General Principles of Management of Acute Pancreatitis

Resuscitation of the patient with acute pancreatitis is the priority in the first 24 h of admission [11, 19]. Patients with fewer than two positive criteria may be carefully observed on a standard ward, but those with three or more should be managed in a high-dependency or intensive care unit.

Early, aggressive fluid resuscitation should be instituted because of the potential for sequestration of large volumes of fluid, specifically within the retroperitoneum. Intravenous cannulae to allow rapid infusion of fluids should be combined with a urinary catheter, together with central venous pressure monitoring and arterial pressure monitoring in severe cases. It may be necessary to infuse 5–10 l of fluid within the first 24 h in a case of severe acute pancreatitis. Meticulous observation of the patient to detect early signs of cardiac, respiratory or renal failure should be performed, with prompt treatment at the first sign of compromise.

Much has been written about feeding in severe acute pancreatitis. The principle of keeping patients nil by mouth to rest the pancreas has been discarded. There have also been several trials of parenteral versus enteral feeding. An international consensus conference in April 2004 [11] recommended that enteral nutrition should be used in preference to parenteral nutrition in severe acute pancreatitis. Nasojejunal feeding is preferable to nasogastric feeding, and it should be started after initial resuscitation. Parenteral nutrition can be used if enteral nutrition trials fail after 5 days, and the parenteral nutrition should be supplemented with glutamine to help maintain the gut mucosal barrier and prevent bacterial translocation. The importance of strict glycaemic control is emphasised. The most recent UK guidelines [17] are similar to the American recommendations and suggest use of the enteral route via a nasogastric tube.

The role of prophylactic antibiotics in severe acute pancreatitis remains a difficult subject. Many studies are underpowered, and use different regimes for varying durations. In light of these problems there is no consensus. The UK guidelines [17] do not recommend routine prophylaxis, but if it is used it should be given for a maximum of 14 days. The American group specifically recommend against the use of prophylactic antibiotics [11]. Both groups highlight the need for a high index of suspicion of fungal infection.

Acute Biliary Pancreatitis – Latest UK Guidelines (2005)

The most recent British guidelines for the management of acute pancreatitis were published in 2005 [17]. They recommend that urgent endoscopic retrograde cholangiopancreatography (ERCP) should be performed (ideally within the first 72 h of the onset of pain) in patients with severe pancreatitis of suspected or proven gallstone aetiology. Urgent ERCP should also be performed in cases associated with cholangitis, jaundice or a dilated common bile duct. They recommend that endoscopic sphincterotomy is performed in all cases, even if gallstones are not present in the common bile duct.

After an episode of gallstone pancreatitis, definitive treatment should be performed, usually laparoscopic cholecystectomy. In those patients who are

unfit for surgery, endoscopic sphincterotomy is thought to be sufficient. However, a randomised trial by Targarona et al. [15] has shown that in elderly or high-risk patients surgical treatment was no more hazardous than endoscopic sphincterotomy in terms of morbidity and mortality, and was superior in terms of late complications of biliary origin. Ideally, cholecystectomy with intraoperative cholangiography should be performed on the same admission, after recovery from the acute inflammatory complications of pancreatitis. If the surgery is not performed at this time, it should be booked within 2 weeks of discharge, although this exposes the patient to the administrative risks associated with cancellation of surgery, and therefore a second, potentially fatal attack of acute pancreatitis.

Acute Biliary Pancreatitis – ERCP

One of the central questions in the management of acute biliary pancreatitis is the role of preoperative ERCP and sphincterotomy. If the surgical expertise exists to perform laparoscopic common bile duct exploration and clearance at the same time as laparoscopic cholecystectomy, is preoperative ERCP and sphincterotomy necessary?

There have been three published trials examining the role of preoperative ERCP. Neoptolemos et al. [12] published a trial in the Lancet in 1999 of 121 patients with acute pancreatitis thought due to gallstones. Fifty-nine had an ERCP within 72 h of admission, 62 did not. There was no difference in overall mortality between the groups, but the overall complication rate was 12% in the group who had ERCP within 72 h, and 24% in those who did not have ERCP. The major complications in the non-ERCP group were more frequent pseudocyst formation, and organ failure (respiratory, cardiac, renal – in decreasing order of frequency). They also observed that when the episode of acute pancreatitis was mild, the complication rate was similar in both groups; however, in severe pancreatitis, the difference in complications between the ERCP and non-ERCP groups was highly significant, being much higher in the non-ERCP group.

The study of Fan et al. [6] from Hong Kong involved random assignment of 195 patients with acute pancreatitis to ERCP within 24 h (97 patients), or conservative management (98 patients). No symptoms of biliary sepsis developed in the ERCP group, but 12 patients in the non-ERCP group developed biliary sepsis. Interestingly, there was no significant difference in complication rates between the two groups, in contrast to the case for the study of Neoptolemos et al.

The third trial, by Fölsch et al. [7], was multicentre, and randomised 126 patients to ERCP within 72 h of symptom onset, and 112 to conservative management. Patients with obvious biliary obstruction were excluded (more

than 5mg/dl bilirubin). They found that there was no significant difference in mortality or complication rate between the two groups.

Therefore, although ERCP appears to be appropriate if biliary obstruction or sepsis is present, the role is not so clear if these conditions are absent.

Single-Stage and Two-Stage Management: the Debate

The traditional view of two-stage management of acute biliary pancreatitis (preoperative ERCP followed by laparoscopic cholecystectomy) has been challenged by single-stage management (laparoscopic cholecystectomy with intraoperative cholangiogram, and laparoscopic exploration of the common bile duct if the cholangiogram shows filling defects suggestive of stones). A European multicentre trial has shown equivalent success rates, but much shorter hospital stays with the single-stage treatment [4].

The rationale behind this change in management is based on observations that most gallstones spontaneously pass through the common bile duct within 7 days of the onset of pancreatitis.

Uhl et al. [16] noted that, in patients diagnosed with acute biliary pancreatitis, when ERCP was performed within a median time of 14 h from admission to hospital, 74% of patients had stones in the common bile duct. The study of Fan et al. [6] showed that the incidence of common bile duct stones in those undergoing emergency ERCP for acute biliary pancreatitis within 24 h of admission was 38%. The study of Fölsch et al. [7] shows that this figure drops to 46% if ERCP is performed within 72 h of symptom onset.

The study of Neoptolemos et al. [12] was based on ERCP performed within 72 h of admission, rather than symptom onset, and shows common bile duct stones to be present in 25% of those patients with mild pancreatitis and 63% of those with severe pancreatitis. In the other arm of the study which had ERCP between 6 and 30 days, common bile duct stones were detected in 21% of cases. The incidence of common bile duct stones has been shown to be between 5 and 10% at 10 week after admission [14].

In a study performed in our unit [8], 45 patients with mild acute biliary pancreatitis underwent management with the single-stage approach. Thirty-nine patients required laparoscopic cholecystectomy only. The remaining six patients underwent laparoscopic common bile duct exploration in addition to laparoscopic cholecystectomy. In one of the six patients, the intraoperative cholangiogram revealed a false positive result (probable air bubbles in the common bile duct) and the common bile duct exploration was therefore negative (transcystic approach). In the remaining five of the six patients, the common bile duct was explored through a choledochotomy in four patients, and transcystically in one. All cases were completed laparoscopically, and there were two complications (umbilical port bleed-discharged on the second

postoperative day, and T-tube dislodgement requiring a second operation for replacement). As a result of problems associated with T-tubes, they are not routinely used in our practice (our current approach is described later in this chapter). No cases of recurrent pancreatitis occurred in the median follow-up period of 25 months (interquartile range 14–42 months).

If only one patient in ten has common bile duct stones 1 week after admission with acute biliary pancreatitis, then ERCP performed within 24–72 h is not necessary in nine cases. ERCP and endoscopic sphincterotomy is not without risk (morbidity includes 1% pancreatitis, 0.8% ascending cholangitis, 0.4% bleeding requiring transfusion, and 0.2% mortality [5]).

Therefore we feel that, apart from the absolute indications for ERCP in acute pancreatitis (obstructive jaundice and cholangitis), patients with mild acute biliary pancreatitis should not undergo routine ERCP. Rather, they should have the single-stage approach with laparoscopic cholecystectomy, intraoperative cholangiogram and laparoscopic common bile duct exploration, dependent on the results of the cholangiogram. Only in patients who are unfit for surgery should ERCP with endoscopic sphincterotomy be routinely performed. The rationale for this approach is that 90% of common bile duct stones spontaneously pass within approximately 7 days [15].

It is accepted that laparoscopic common bile duct exploration may not be successful in all patients, and therefore postoperative ERCP may be necessary in a limited number of cases.

Single-Stage Management: Technique for Laparoscopic Cholecystectomy, Intraoperative Cholangiogram and Common Bile Duct Exploration.

In view of the evidence presented here, we feel that the single-stage approach should be the standard treatment for patients who present with mild acute biliary pancreatitis.

Intraoperative cholangiography is performed through a catheter advanced via the cystic duct into the common bile duct. Common bile duct exploration may be performed transcystically or through a choledochotomy. Laparoscopic choledochotomy is indicated if the common bile duct is dilated to 8 mm or more, if calculi are 1 cm or more, or are multiple, impacted or intrahepatic. Laparoscopic choledochotomy has been associated with higher morbidity rates, mainly related to T-tube insertion [10].

If the intraoperative cholangiogram is suggestive of stones within the common bile duct, a 10-mm longitudinal choledochotomy is performed. The choledochotomy is performed at the level of the cystic duct and common bile duct junction, away from the upper border of the duodenum. As previously described [9], after stone extraction, a 10 French biliary stent is placed into the common bile duct with the distal end protruding into the duodenum, and the proximal end distal to the lower edge of the choledochotomy. We have found this technique to have fewer complications than traditional T-

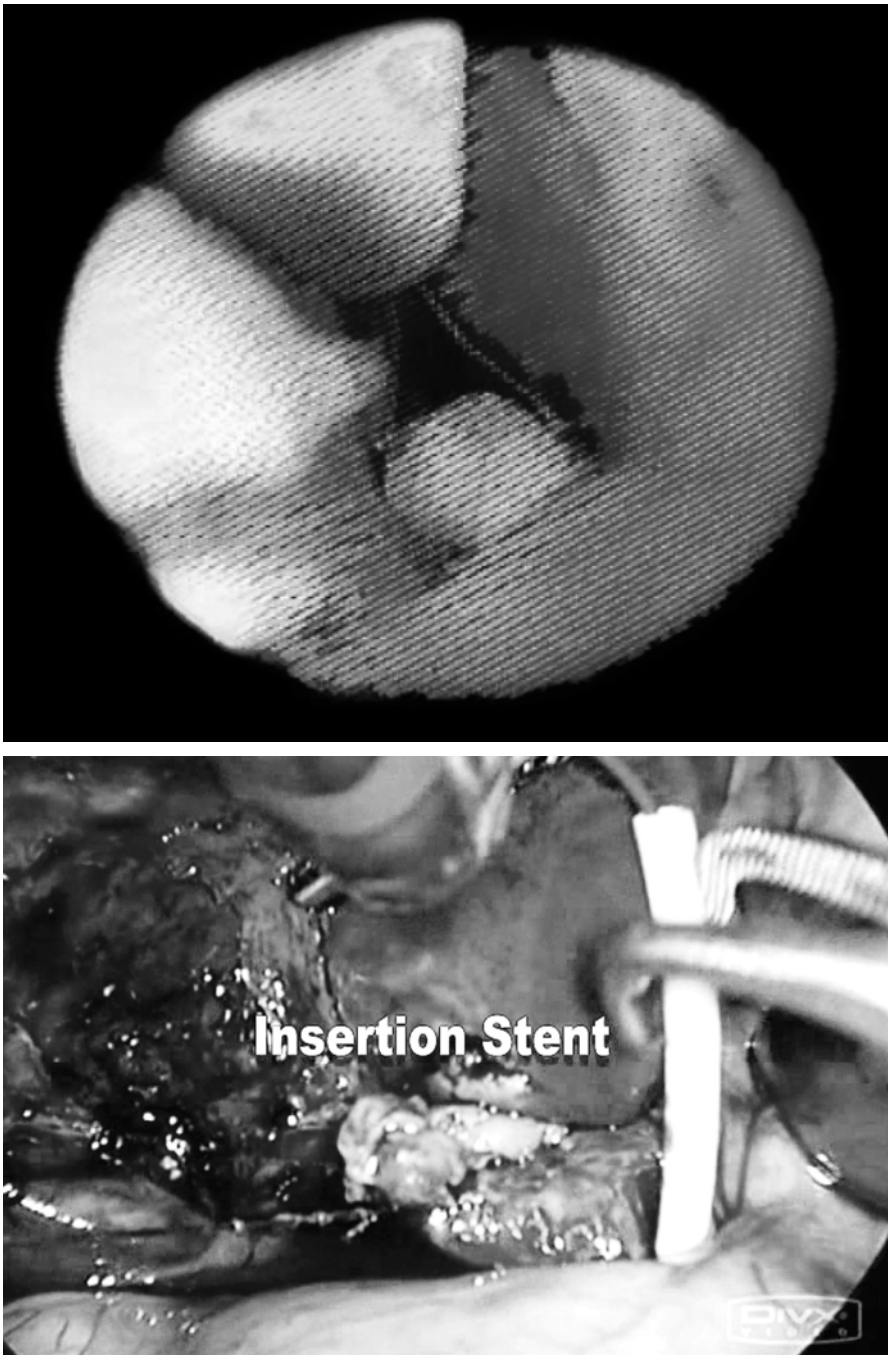

Fig. 20.1. View of stone in common bile duct being retrieved with Dormia basket, and insertion of stent

tube insertion, and it is probably safer than primary closure. The common bile duct is closed with interrupted 4/0 absorbable sutures (Vicryl), and a drain is placed in the gallbladder fossa. The stent may be removed 4 weeks later at upper gastrointestinal endoscopy.

The technique outlined previously and illustrated in Fig. 20.1 is appropriate for most cases of mild pancreatitis. It is not intended to be performed in cases of severe acute pancreatitis with signs of biliary sepsis or obstruction, where an urgent ERCP is clearly indicated.

Summary

Acute pancreatitis is a common surgical problem, with approximately 50% of cases attributable to gallstones. The definitive management involves eradication of the gallstones from the gallbladder and bile duct. Laparoscopic cholecystectomy should be performed as soon as the general condition of the patient allows. Because most common bile duct stones have passed within 10 week of the episode of mild acute biliary pancreatitis, if expertise is available, we recommend the single-stage approach with laparoscopic cholecystectomy, and intraoperative cholangiogram, proceeding to laparoscopic common bile duct exploration if necessary. If the expertise is not available, we recommend non-invasive imaging of the common bile duct before preoperative ERCP, MRI cholangiogram or endoscopic ultrasound.

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Acute Appendicitis – Update 2006

Stefan Sauerland

Definition, Epidemiology and Clinical Course

Acute appendicitis, defined as an acute inflammation of the vermiform appendix, is the most frequent condition leading to emergent abdominal surgery in children and young adults. The clinical course of the disease is characterized by loss of appetite, nausea, mild fever, and pain in the lower-right abdominal quadrant. Although signs and symptoms are typical in many patients, there are about 20% of atypical presentations.

Noninvasive Diagnostics

Laboratory investigations are considered to be a standard in any patient with abdominal pain. Other diagnostic tests may be used additionally depending on symptoms. Ultrasonography has been studied extensively, but as yet no definitive conclusions can be drawn, most probably owing to the large interobserver variability of the technique. Computed tomography is being used at increasing rates. The diagnostic accuracy in terms of sensitivity and specificity is about 95%, but there is no comparison yet with diagnostic laparoscopy.

Invasive Diagnostics

There are no new data available on the value of diagnostic laparoscopy; therefore, the consensus statement is correct in recommending diagnostic laparoscopy in patients with symptoms and diagnostic findings suggestive of acute appendicitis. Of course, the potential benefit of diagnostic laparoscopy is greater the larger the uncertainty of the diagnosis is.

Operative Versus Conservative Treatment

Acute appendicitis generally requires appendectomy, although some cases may resolve without therapy or under conservative treatment [14]. Controversy surrounds those situations, where the surgeon finds a normal-appearing appendix. If no other cause for the patient's problem can be detected, re-

moval of the appendix is considered to be the safest option. However, if the patient's symptoms can be ascribed to an abdominal pathology other than appendicitis, it is better to leave a normal-appearing appendix, as stated in the EAES recommendations.

Choice of Surgical Approach and Procedure

The relative advantage of laparoscopic over conventional appendectomy has been under debate for more than a decade. According to the most recent Cochrane review [12], laparoscopic appendectomy offers certain advantages, although the difference from open appendectomy is not large. Accordingly, the EAES recommends laparoscopic over open appendectomy. This statement holds true, although some new data have been published recently. In 2006, paediatric trials comparing laparoscopic and open appendectomy were summarized in a meta-analysis [2], which mainly confirmed the findings of the Cochrane review. However, some advantages of laparoscopic appendectomy reached statistical significance, because nonrandomised trials were also included in the meta-analysis.

One randomized controlled trial (RCT) published on appendectomy in adults by Katkhouda et al. [8] only concluded that "choice of the procedure should be based on surgeon or patient preference", because postoperative pain was similar in both therapy groups of this blinded trial. Other results were in line with previous studies. A trial from Israel compared inflammatory markers after open and laparoscopic appendectomy [1], but no clinical data were collected (M. Almagor, personal communication). A third new trial, by Olmi et al. [11], failed to have a formal randomization, as the admission code numbers were used to assign patients to treatment groups. The results of this pseudo-randomized trial, however, clearly favoured laparoscopic appendectomy.

In summary, the relative advantages of laparoscopic over open appendectomy are small but well-proven; therefore, the EAES recommendation holds true, although in everyday practice surgical expertise, patient expectations and cost considerations also need to be considered [6]. Hospital costs of laparoscopic appendectomy are still slightly higher than those for open appendectomy [4, 5].

Technical Aspects of Surgery

Needlescopic instruments were used in a recent RCT from Hong Kong [10]. Pain levels were similar in needlescopic and conventional laparoscopic appendectomy, but operating time was longer. This is not in full agreement with the first RCT on this topic [7], but in general needlescopic appendect-

omy seems to offer few additional advantages compared with standard laparoscopic appendectomy.

Appendix stump closure is another important aspect of the laparoscopic technique. An inspection of more recent data suggests that wound infection is less likely to occur if the appendiceal base is secured with staples [3, 9, 13]. Again, cost considerations will have a strong impact on the acceptability of the ENDO GIA.

Peri- and Postoperative Care

No new data are available.

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Acute Nonspecific Abdominal Pain – Update 2006

Ferdinando Agresta

Definition and Epidemiology

Nonspecific acute abdominal pain (NSAP) is a significant problem in general surgery and accounts for up to an estimated 40% of all emergency surgical admissions [14]. It is defined as a condition of acute abdominal pain of less than 7 days' duration in which, after examination and (radiological and laboratory) investigations, the diagnosis still remains uncertain [6, 7, 19]. The diagnosis is important in order to avoid an unnecessary laparotomy (as high as 29%) and/or in order to plan the right abdominal incision [1, 6, 7, 17, 19]. With the traditional "wait-and-see management" the mean hospital stay for patients admitted with a NSAP ranges between 4 and 6 days, which it is costly owing to the repeated clinical, radiological and laboratory investigations [1, 10, 12, 14].

Diagnosis

The accuracy of conventional radiography in NSAP, although considered an essential part of the patient's workup, reaches only 50%, whereas that of abdominal ultrasound is 60–89%. The CT scan is more accurate (84–98%) but is expensive and is not always possible to perform in all hospital situations, 24 h a day [2, 10, 13, 14, 18, 19]. A delay in surgical intervention while further investigations are performed may increase morbidity and prolong hospital stay (average delay period of 6.12 days), especially if it is taken into account that patients admitted with NSAP might be old, obese, critically ill and with comorbidity situations (such as diabetic and immunosuppressive therapy) [6, 10, 11].

Operative Versus Conservative Treatment

When patients are admitted to hospital with acute abdominal pain, clinicians, irrespective of a specific diagnosis, select three diagnostic classes: operation definitely required; operation definitely not required, need for operation uncertain [12, 17].

Choice of Surgical Approach and Procedure

If a surgical exploration is required, and if there are no absolute contraindications to the approach, a laparoscopic exploration should be preferred [1, 4, 7]. This is due not only to its diagnostic value/accuracy (89–100%) but also to the potential—which is mainly related to the human factor (surgeons' skills)—for therapeutic manipulation during the same setting (up to 88.2%) (or to plan the right abdominal approach) [1, 6–8, 10, 14, 19, 21]. It is reported in the literature that with an open approach such as in suspected appendicitis, the accurate on-table diagnosis is missed in up to 14.3% of cases and that the sensitivity for diagnosing normal appendices is low at 51.3%, thus suggesting that almost half of normal appendicitis cases might be misdiagnosed as pathological, with the risk of no further exploration for other pathologies [17, 20, 22]. As already described, laparoscopic surgery is advantageous for many abdominal diseases, which may also turn out to be the underlying cause of the hospital admission. Thus, especially in lower abdominal and pelvic pain among female patients during their reproductive years, a laparoscopic approach might lead to correction of an erroneous preoperative diagnosis in up to 40% of cases and/or exclude other pathologies (which may be present in approximately 20% of cases) [3, 6, 16, 22].

To undertake emergency laparoscopic operations, the surgeon must be experienced [1, 6]. A possible small operating theatre together with the wide variety of therapeutic findings require a well-trained and experienced surgeon as well as a well-trained surgical team. Mastery of two-handed dissection is suggested, as laparoscopic suturing technique has to be considered as an absolute requirement. Good judgment is needed for a timely decision to convert the procedure (and plan a "target" incision) in order not to jeopardize and prolong the attempts to complete the operation laparoscopically [1]. The morbidity (0.6–24%) and mortality (less than 1%) of a laparoscopic approach in an emergency situation are comparable if not lower than those reported with laparotomy, and converted cases (up to 16%) have a similar outcome compared with primarily open cases [1, 6, 8, 9].

As stated by the controlled trials in which an early laparoscopy is compared with observation for NSAP, diagnostic laparoscopy benefits patients by avoiding unnecessary surgery, avoiding a possibly deleterious delay in diagnosis and treatment, shortening the operative and hospitalized period and reducing the readmission rate and helps in containing health-care costs [5, 7, 9, 15] (EL 1b). On the basis of these data, it seems justified to lower the threshold for surgical exploration when using laparoscopy rather than laparotomy [1, 4]. However, it has to be kept in mind that laparoscopy provides only an alternative not a substitute for traditional diagnostic and clinical procedures and will never lessen the importance of a needed conventional laparotomy.

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Adhesions and Small Bowel Obstructions – Update 2006

Benoit Navez

Introduction

Acute small bowel obstruction (ASBO) remains a significant surgical problem and is commonly caused by postoperative adhesions.

Definition

Adhesions consist of obstructive bands and/or matted adhesions. The mechanism of ASBO can be either strangulation or volvulus of one or several bowel loops.

Epidemiology and Clinical Course

Colorectal surgery (odds 2.7) and vertical incisions (odds 2.5) more frequently produce intestinal obstruction (reported rate of ASBO of 3.6% at 3 years' time interval) and predispose to multiple matted adhesions than an obstructive band [6, 8].

In a retrospective study, it seems that ASBO requiring hospitalization with conservative management occurs less frequently after laparoscopic bowel resection than after open surgery; however, the need for surgical release of ASBO is similar [2].

The risk of ASBO recurrence increases with the number of ASBO episodes. Surgical treatment decreases the risk of future admissions for ASBO but not the risk of new surgically treated ASBO [4].

Diagnostics

Computed tomography (CT) has proven useful in the diagnosis of mechanical ASBO. Its specificity is superior to that of plain abdominal film. Although CT can seldom identify the obstructive adhesion, it has the advantage of eliminating another cause of obstruction (e.g. tumour) [3]. The highly specific CT criteria used for differentiating simple from strangulated ASBO

include the poor or no enhancement of the bowel wall, a serrated beak, a large amount of ascites, diffuse mesenteric changes and an abnormal mesenteric vascular course. However, to improve the diagnostic accuracy of CT and to avoid unnecessary surgical exploration, CT findings must be correlated with clinical and biochemical criteria [5].

Operative Versus Conserative Treatment

Use of an oral water-soluble contrast medium is a useful predictive test for non-operative resolution of adhesive ASBO. The appearance of contrast medium in the caecum on an abdominal radiograph within 24 h of its administration predicts the resolution of an obstruction with a sensitivity and specificity of 96%. However Gastrografin is only a predictive test and does not cause resolution of ASBO [1]. In the absence of clinical and CT signs of acute intestinal ischemia requiring an urgent operation, it seems to be safe to attempt a non-operative management of ASBO. The use of a short versus a long tube for gastrointestinal decompression remains under debate as well as the duration of conservative treatment (from 1 day to several days). When non-operative treatment is unsuccessful, emergency surgery is required.

Choice of Surgical Approach and Procedure

There are no prospective randomized trials comparing open and laparoscopic adhesiolysis for ASBO. The benefits of laparoscopic approach in ASBO that have been reported in case series and in one retrospective matched-pair analysis are the same as in laparoscopy for other conditions: quicker return of intestinal function, lower morbidity, shorter hospital stay [9]. However, laparoscopic adhesiolysis in an emergency has not gained wide acceptance because of the limited visualization of the abdominal cavity secondary to the distended bowel and because of the risk of iatrogenic intestinal injury. The high conversion rate is also an issue, ranging from 15 to 43%. The best cases for laparoscopic approach are patients with moderate abdominal distension (proximal obstruction), a bowel diameter not exceeding 4 cm, a few adhesions and a limited number of previous scars [7].

Technical Aspects of Surgery

In order to limit the risk of injury to the underlying adherent bowel, open Hasson technique is required to enter the abdominal cavity. Instrumental manipulation of fragile dilated bowel loops should be avoided. It is recommended to run the flat small bowel with atraumatic graspers from the ileo-

caecal valve until the site of obstruction is found. Only pathologic adhesions should be cut. In case of any doubt about the viability of the bowel, a minilaparotomy can be performed to check the intestinal blood supply and if necessary bowel resection [7].

Peri- and Postoperative Care

No new data are available.

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Abdominal Trauma – Update 2006

Abe Fingerhut, Selman Uranues

To the best of our knowledge, there have been no new randomized controlled trials concerning laparoscopy in the trauma setting since the consensus report published by Sauerland et al. [1] in 2005.

One recent prospective evaluation study from Japan [2] involving 399 hemodynamically stable patients suspected of having blunt bowel injury (BBI) showed that a physical examination and contrast CT scanning at admission and once again approximately 12 h (range, 6–24 h) after admission was safe and could prevent nontherapeutic laparotomy and delayed diagnosis in patients with suspected BBI.

A new role for laparoscopic surgery was heralded when in a two-center study of post-non-operative management of severe (grades 3–5) hepatic injuries, laparoscopy was used to diagnose and treat biliary complications [3].

Laparoscopy may also have a potential role in setting up direct intraabdominal pressure measurement using a continuous indwelling compartment pressure monitor [4], and therefore may facilitate the early detection of the abdominal compartment syndrome. Caution must be exercised, however, not to use high insufflation pressures for the exploration in order not to unduly increase the abdominal compartment syndrome.

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Laparoscopic Surgery: Strategies for Future Outcome Studies

Henrik Kehlet

The concept of minimally invasive surgery, including laparoscopic procedures, represents a major breakthrough as one of the important components of multimodal rehabilitation (fast-track surgery) to improve postoperative outcome. It is well documented that minimally invasive surgery reduces wound size, surgical stress responses and organ dysfunctions, mostly as a result of decreased pain and inflammatory responses. These effects have during the last 10 years translated into major improvements in clinical outcome in certain operations where the alternative was a large incision i.e. surgery for gastro-oesophageal reflux, hiatal hernias, adrenalectomy, bariatric surgery, splenectomy, nephrectomy, etc., most of which can be performed as day cases or with the need of 1–2 days' hospitalisation. So what is the problem? Do we need more scientific, randomised studies before we have a more widespread implementation of laparoscopy? Do we need more research and improvement? The answer is complex and has not been solved, except in the aforementioned procedures where there is no need for randomised studies to show improvements in *early* postoperative outcome compared with conventional open surgery. However, in many other, more common procedures, the role of laparoscopy is still debatable despite initial positive results reported in several randomised trial and meta-analyses in hernia surgery, cholecystectomy, colonic surgery, hysterectomy, etc. On the positive side, these studies have repeatedly demonstrated some improvements with laparoscopy because of less pain, need for hospitalisation, and convalescence. On the other hand, it is also well established that a significant learning curve is required for optimal results of laparoscopy, amounting to about 60 patients in colonic procedures and up to 100–200 patients with groin hernia repair. In addition, there may be increased direct costs from laparoscopy, which to some extent have been outweighed by the demonstrated postoperative benefits.

However, the main reason for a required new debate on the advantages of laparoscopy and the future strategies for further improvement is the concomitant developments within multimodal perioperative rehabilitation (i.e. fast-track surgery) [10, 12]. This concept, which ideally includes minimally invasive surgery (laparoscopy), combines improved preoperative patient information with optimal, dynamic pain relief, reduction of surgical stress responses,

revision of perioperative care principles adjusted to evidence (tubes, drains, restrictions, etc.) and revision of nurse care principles to utilise the benefits of stress reduction and pain relief into early oral nutrition and mobilisation [2, 10]. The concept has repeatedly been demonstrated to lead to major improvements in recovery of organ functions, reduction of medical morbidity, need for hospitalisation, and convalescence in a variety of procedures [8, 10]. In many areas, the results have been more impressive by this approach compared with the effects reported by laparoscopy and where revision of perioperative care principles were not reported or instituted. Thus, several fast-track colonic resection series have documented hospital stays between 2 and 4 days where randomised studies comparing a laparoscopic vs. an open approach have shown hospital stays of 5–7 and 7–9 days, respectively [8, 11].

One of the outcome parameters often quoted in randomised studies comparing open vs. laparoscopic surgery is postoperative convalescence. Although convalescence is an important outcome parameter, unfortunately most studies have insufficient or no information on postdischarge pain intensity, analgesic treatment or advice given for duration of convalescence. Thus, it is well established that the duration of convalescence is highly dependent on traditions and recommendations and several studies have documented a shorter duration of convalescence, for example after cholecystectomy or inguinal herniorrhaphy, when short recommendations have been given [5] compared with longer convalescence times reported in randomised studies. Most existing data from previous randomised studies are therefore difficult to interpret since the reported duration of convalescence may also depend on bias induced by surgeons or patients expecting shorter convalescence after a laparoscopic approach, but where the patients operated on with an open technique were often treated with traditional, unadjusted convalescence recommendations [5].

A logical approach to document the exact role of minimally invasive surgery is therefore a combined approach where laparoscopy is integrated with the principles of fast-track surgery [5, 10], thereby minimising the effects of traditional and restrictive care principles on functional recovery. Unfortunately, only two such randomised studies have been performed, where the surgical approach was blinded by an opaque abdominal dressing, thereby eliminating the bias from previous studies where surgeon and patient expectances may have influenced the outcome results. One study in elderly high-risk colonic resection patients showed no differences in a detailed assessment of functional recovery, and with a median hospital stay of 2 days in both groups [1], significantly shorter than reported in previous unblinded, randomised studies [11]. The other study in appendectomy [4] did not show relevant clinical differences in outcome. A third randomised study [14] with blinding of the surgical approach in cholecystectomy did not include the

principles of multimodal rehabilitation and therefore showed no differences in outcome between a laparoscopic vs. an open technique, since hospital stay was 3 days in both groups and with 3–4 weeks' convalescence reflecting traditions of care, rather than the influence of the surgical approach per se [5].

So, what are the future strategies for further development and improvement of the effects of laparoscopy on outcome. First of all, laparoscopy should be combined with evidence-based principles of perioperative care (i.e. fast-track surgery) [2, 10, 11, 13]. Secondly, perioperative pain management should be further developed to be opioid-free, multimodal analgesia [6] in order to avoid opioid-related side effects and thereby improve functional recovery. In addition, such pain therapy should be procedure-specific, adjusted to available evidence [7]. Thirdly, future studies should combine laparoscopy and the principles of fast-track surgery with additional pharmacological modification of stress responses [9]. Thus, several techniques are available (i.e. glucocorticoids, beta-blockers, anabolic steroids, insulin, statins, etc.), all of which may further reduce hormonal as well as inflammatory responses, thereby aiming at a "stress and pain free" patient [9], with subsequent improvement in recovery and reduction in morbidity, hospital stay, and convalescence. Finally, evidence-based principles of perioperative fluid management should be integrated in such strategies [3], with a focus on early, goal-directed haemodynamic optimisation and balancing volume administration to avoid fluid excess and hypovolaemia [3].

In future outcome studies it is crucial to include a detailed description/revision of perioperative patient information (convalescence recommendations, etc.), techniques of perioperative analgesia, resource utilisation (nurse workload, direct and indirect costs, including additional postdischarge costs on readmission, use of home nurses, visits to general practitioners, etc.). Also potential benefits of laparoscopy on late sequelae such as bowel obstruction due to adhesions, chronic pain and ventral hernias must be assessed [11].

In summary, the future is open for further fascinating improvements in surgical outcome and where laparoscopy is a rational, but not the only component since the pathogenesis of perioperative morbidity includes multifactorial components [10]. Hopefully, minimally invasive surgeons will adopt the principles of multimodal rehabilitation in their daily clinical practice as well as in future research.

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