Marco Lucioni

Practical Guide to Neck Dissection

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Forewords by

Italo Serafini, Jatin P. Shah, Jesus Medina, Wolfgang Steiner, Antonio Antonelli

With 135 Figures, Mostly in Colour

Springer

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Foreword (I)

It was three o'clock in the afternoon: time for anatomy class. A badly lit room, a caretaker to collect tips, and a single lecturer for 30 students. The material on which to study practical anatomy consisted of a humerus, a femur, and an entire decomposing human forearm with skeletized muscles and tendons, reduced to shreds by previous inexperienced dissectors. Then, 2 years later at midday, I found myself in a pathologic anatomy amphitheater with 300 students. An empty corpse lay on the distant dissection table with various removed organs lined up by its side. The lecturer was giving his last class for the course and gratefully addressed the deceased, "for donating his body to the progress of science". These are my recollections as a student of medicine 35 years ago. Yet Padua was an important University, one of the most ancient, most prestigious universities in Europe! These experiences go back many years, but I do believe the situation has changed very little since then.

These were my thoughts 15 years ago when I was invited to direct a neck dissection course in the corpse at the Vrije Universiteit Brussel. To prepare the course, after 30 years' experience in neck surgery, I went back to, or rather, I found myself for the very first time dissecting a cadaver. I would like to thank all colleagues at the University of Pavia for lending me their dissection theater. It was a stimulating, highly positive experience, enabling my coworker and me to broaden and develop our knowledge of neck anatomy and its border areas. While we iconographically documented the various cervical regions and dissection planes, our thoughts turned to past experiences in this type of activity.

Anatomic dissection for research purposes dates back to the Egyptians in Alexandria, but was prohibited in the Western world for many centuries by Jewish and Christian religious culture. A decree was passed in the Kingdom of Sicily in 1231 by Frederick II of Swabia, stating that "… all those who studied surgery should become learned in operations and particularly in the anatomy of the human body …" Mondino dei Liuzzi, author in 1316 of the treatise Anathomia, introduced cadaveric dissection into the university teaching curriculum in Bologna. The chief Council of the Serenissima Republic in Venice decreed that every year a number of corpses should be dissected "propter urbis honorem civiumque salutem".

However, the "anatomy century" was undoubtedly the 16th century, with its Renaissance anatomists. The most outstanding figure in the scientific revolution of that period was clearly Andreas Vesalius from Brussels (1514–1564) with his De Humani Corporis Fabrica. Prevented from practicing dissection at the University of Leuven, Vesalius came to Padua where, despite his very young age, the Serenissima government appointed him to the chair of anatomy in virtue of his extensive knowledge on the subject and corpse-dissecting skills.

Five and a half centuries later, we were to make the same journey as Vesalius, only in the opposite direction. Prevented by law and custom from holding a course on dissection in Italy, we left the land of the Serenissima in the direction of Brussels, where a modern university organization provided us with all the necessary technical equipment and 15 cadavers. We armed ourselves with our long and inveterate experience in neck surgery and our more recent know-how in cadaveric neck dissection with related iconography. When, after the second "Andreas Vesalius course", as we call them, Dr. Marco Lucioni, my faithful coworker in the preparation and conduction of these scientific-teaching ventures, expressed the desire to produce a volume on anatomic neck dissection techniques, based on our experience, I did not hesitate to encourage him. I then enthusiastically observed the text being drawn up and divided into the various chapters and figures.

Now the volume by Lucioni is complete and ready to go to press. I find it a very carefully prepared, comprehensive, well-illustrated work, constituting an essentially practical, valid reference tool that freshens up notions in normal and topographical neck anatomy and a precious guide for anyone practicing anatomic neck dissection in the corpse.

I trust my favorable, but not impartial, judgment will encourage those who wish to browse through, and hopefully read it.

Italo Serafini
Chairman Emeritus
ENT Department
Vittorio Veneto, Italy

Foreword (II)

The first report on neck dissection can be traced to Richard Volkmann in 1882; however it was Franciszek Jawdynski who described the technique of the operation in 1888. Henry Butlin proposed an upper neck dissection for the treatment of tongue cancer at the turn of the nineteenth century; however, George Crile is credited for the first systematic report on classical radical neck dissection over 100 years ago, based on his personal experience of 132 cases. Since then, neck dissection has remained the mainstay of surgical treatment of metastatic cervical lymph nodes from mucosal and cutaneous carcinomas of the head and neck. Increasing experience with this surgical technique and improved understanding of biological progression of metastatic cancer to cervical lymph nodes led to the development of numerous modifications in neck dissection, with the aim of retaining oncologic efficacy but reducing the morbidity of the operation. Thus, Oswaldo Suarez initially proposed a modified neck dissection that was subsequently popularized by Ettore Bocca in English literature. Further modifications in neck dissection were proposed by Allando Ballantyne and others during the latter half of the twentieth century. The systematic classification of various types of neck dissections and its applications have been proposed and popularized by the American Academy of Otolaryngology/Head and Neck Surgery, and these are currently employed in clinical practice worldwide.

Dr. Marco Lucioni is to be complimented on putting together this outstanding piece of work initially stimulated by Italo Serafini. The book is prepared from sequential photographs of cadaver dissections of systematic steps at understanding the topographical anatomy of various layers of tissues in the neck. The author systematically describes anatomic structures in the cadaver under four different headings: the parotid region, submandibular triangle, the lateral neck, and the median cervical region. Each section describes anatomy in the superficial layer as well as the deep layer. Clinical implications of the anatomic structures in therapeutic interventions are highlighted with bullet points indicating “take home messages” and “core messages”. Each section begins with a diagram of the anatomic structures important in that region, followed by cadaver dissection, highlighting the salient features of each step of the operation. The book is complemented by a DVD showing video clips of neck dissection in the cadaver, further familiarizing the reader with step-by-step anatomic structures encountered during various types of neck dissections. The author has also thus included various modifications in neck dissection, which are currently employed in clinical practice.

For the student of head and neck surgery, this book would be a valuable resource to his or her personal library, since it is a stepwise approach to understanding the anatomy of the neck and its importance in performing a systematic, safe, and effective surgical procedure for excision of cervical lymph nodes, either involved or at risk by metastatic cancer from primary tumors in the head and neck. The photographic reproduction is crisp and clear, both in the cadaver dissections as well as in the DVD. Highly accurate and effective works such as this are crucial to further solidify the surgical prowess of head and neck surgeons of the future.

Jatin P. Shah
Professor and Chairman
Memorial Sloan-Kettering Cancer Center
New York, New York, USA

Foreword (III)

Through many years of collecting textbooks of anatomy, I have cherished the magnificent descriptions of anatomy provided by the likes of Testut, Latarjet, and Rouviere. As an academic head and neck surgeon practicing and teaching in North America, I have frequently struggled not only translating them into English, but also making these descriptions intuitively usable by students of head and neck surgery.

A few years ago, I was invited to Italy to lecture on selective neck dissections. As a memento, I was given a copy of foul proof of Practical Guide to the Neck Dissection by Marco Lucioni. I was thrilled to encounter in this book the anatomy of the neck depicted in a way that only a surgeon can, when his or her knowledge and expertise are combined with the talents of a good artist and a good photographer.

As I reflect on my reactions when I read the book, I predict that a potential reader, who picks up this book out of curiosity and begins leafing through it, will at first be intrigued, if nothing else, by the exceptional quality of the drawings and by the clarity of the photographs of anatomic dissections. The reader will then feel compelled to study these illustrations and the text that accompanies them and will, shortly thereafter, come to the realization that this is not just a collection of beautiful illustrations; it is, rather, an insightful documentation of surgical anatomy of the different regions of the neck, the parotid, and the larynx. As such, it would be treasured by medical students of anatomy, who will find in it a clear, almost three-dimensional depiction of the different muscular, vascular, and neural structures of the neck. It would be equally valued by students of otolaryngology and head and neck oncologic surgery for they will find that the complex relationships of these anatomic structures are shown in a manner and sequence similar to what they would encounter during different surgical procedure in the neck, the thyroid, the parotid gland and the larynx. Teachers of anatomy and of surgery will also find it valuable since it will enable them, as it has often enabled me, to illustrate for students, residents, and fellows important anatomic structures and their relationships in a way that is not always possible in the classroom or in the operating theater.

This book will find and keep a preferential place in the library of many for it represents what we always hope for in a book of this kind, but rarely get.

Jesus E. Medina
Professor and Chairman
University Health Sciences Center
Oklahoma City, Oklahoma, USA

Foreword (IV)

It is my great pleasure to write a preface for this anatomical surgical compendium for head and neck surgery edited by Marco Lucioni.

I have known Lucioni for many years and have had the opportunity in his courses and during visits to Vittorio Veneto to become acquainted with and to appreciate his surgical talents.

Someone with such extensive experience and deftness in head and neck surgery is predestined to edit an anatomically detailed, illustrated presentation of operations of the neck, the larynx, and the salivary glands.

The impressive, excellently photographed intraoperative sites together with the informative schematic drawings will be of help to ENT specialists, laryngologists, and head and neck surgeons in performing anatomically oriented and precise surgical dissections, while preserving structure and function. The excellent illustrations of the complex topographical relationships between muscles, blood vessels, nerves, and lymphatic structures in detailed photographs will allow the surgeon to proceed confidently even in the difficult and risk-fraught dissection of the head and neck region.

This book is a valuable contribution and is to be highly recommended as a guide for head and neck surgeons in the Italian tradition of anatomy and surgery.

Wolfang Steiner
Professor and Chairman
Georg-August Universität
Göttingen, Germany

Foreword (V)

I met Dr. Lucioni in Milan, about 30 years ago while he was resident at the Otorhinolaryngology Clinic of the University, then directed by Prof. Bocca. I supported Dr. Lucioni in his thesis on vasomotor rhinitis. This thesis was an excellent one, and Dr. Lucioni entered with top marks the world of Italian otorhinolaryngologists.

He then soon started to get around, looking for a position as an assistant, and, at the end of this search, asked my opinion about the chance of joining the group of Prof. Italo Serafini in the hospital of Vittorio Veneto, one of the most outstanding temples of head and neck oncology in Italy. I approved warmly.

Since then, I have had the opportunity to follow Dr. Lucioni in his career at the many meetings organized in Vittorio Veneto by Prof. Serafini. His "learning curve" in head and neck oncologic surgery was reflected in a series of anatomosurgical manuals, of which the present one is the most complete version. Anatomical drawings and beautiful photographs from cadavers are integrated into the schemes of the main surgical procedures, along a teaching path which, through the accuracy of the details and the appealing clarity of the images, achieves a noticeable didactical goal.

This book, which in my opinion is a very useful reminder for any head and neck surgeon, whichever his or her degree of skill, mirrors the talent of Dr. Lucioni and the high quality of the Vittorio Veneto Otorhinolaryngological School.

Antonio Antonelli
Professor and Chairman
Brescia University, Italy

Preface

I consider this a road book. An authentic road book is a set of kilometric notes and route indications that long-distance automobile competition organizers provide for participants. It has everything you need to cover the best available itinerary, and the journey becomes a relaxing discovery in which all team members participate.

The idea of an illustrated manual on neck dissection, which dates back roughly 2 years, was based on this philosophy. It seeks to guide the reader (presumably a neck surgeon wishing to improve his or her own technical skill) through the various cervical structures in all their complexity. Accordingly, the itinerary is divided into sections, from the most superficial to the deepest planes in each anatomic region, along the routes taken by surgeons operating in vivo. The structures warranting most surgical and anatomic attention and interest are also identified. Regional "visits" are generally supported by concise references to normal human anatomy, physiology, and clinical studies and by practical indications on operating techniques, thereby simulating in the corpse what should be correctly performed in vivo.

This event is a great honor for me, and I can now admit having always believed in this work. I am once again grateful to my maestro Prof. Italo Serafini, from whom I have learned a lot. I sincerely thank Dr. Giuseppe Rizzotto, colleague and friend, who encourages, participates, and makes feasible the scientific adventures of our Team in Vittorio Veneto.

Marco Lucioni
Vittorio Veneto, December 2006

Acknowledgments

I thank Piero Della Libera, Punto Immagine, for the elaboration of the photographs; Alexandra Speirs, for her English translations; Giorgio De Novellis, dgPixel, for the realization of the video DVD; Piergiorgio Saccomano, for his anatomic tables; Andrea Porzionato, Anatomy Institute, University of Padua, for his information on law rules in cadavers dissection; Duilio Della Libera, Anatomy Service of the Hospital of Conegliano, for his laryngeal macrosections; and Irmela Bohn, for her kind aid in editing this book.

Contents

Chapter 1

Introduction to Dissection

1

Core Messages

- From the anatomic and surgical point of view, the neck is an extraordinarily interesting place. It is like a bridge where fundamental functional units meet and transit. The operating field is on a convenient scale for the surgeon's hands: not so small that it can be explored only with a microscope (like the brain), nor so large as to require ample movements of the arms (abdomen).

1.1 Prologue

Sul parquet, tra la tavola e la credenza piccola, a terra … quella cosa orribile … Un profondo, un terribile taglio rosso le apriva la gola, ferocemente. Aveva preso metà il collo, dal davanti verso destra, cioè verso sinistra, per lei, destra per loro che guardavano: sfrangiato ai due margini come da un reiterarsi dei colpi, lama o punta: un orrore! da nun potesse vede. Palesava come delle filacce rosse, all'interno, tra quella spumiccia nera der sangue, già raggrumato, a momenti; un pasticcio! con delle bollicine rimaste a mezzo. Curiose forme, agli agenti: parevano buchi, al novizio, come dei maccheroncini color rosso, o rosa. "La trachea", mormorò Ingravallo chinandosi, la carotide! la iugulare … Dio!

("On the floor, between the table and the sideboard, lay a horrible sight . . . A ferociously deep red cut opened her throat. Half her neck had been removed, from front to right, that is front to left for her or front to right for any onlookers. It was frayed at the edges as though she had been struck again and again, by a point or blade: what horror! A sight for no eyes! Red strips were showing on the inside, between the blackened, coagulating blood. What a mess! Strange shapes emerged: to the police they looked like holes, to the novice like red or pink macaroni. "The trachea", murmured Ingravallo, bending over her. "The carotid! The jugular . . . Oh my God!") [1].

This piece from a high school novel presents a dramatically curious, subtly humorous approach to the neck. Other cervical images that come to mind are the pale, lunar necks in Bram Stocker's original black-and-white screenplay versions of Dracula; the "long", ethereal simplicity of Modigliani's necks; or photographs of the ringed necks of Burmese women depicted in National Geographic. During a school trip to Castello del Buon Consiglio in Trento, I vividly recollect feeling very uneasy when I saw the unnatural posture of Cesare Battisti's head that had been photographed after execution by hanging.

The neck does indeed conjure up more images than any other part of the body, depending on mode of reproduction. It can inspire the maternal sweetness of sixteenth-century Madonnas with Child, erotic fantasies of long-legged models on metropolitan catwalks, or anxiety as the strangler's hands close around it in a horror movie. Its versatility probably stems from its being anatomically and conceptually hard to define, and the lack of a material or symbolic identity of its own, compared say, to the eye or liver. It presents virtual anatomic boundaries, with arbitrary lines rather than natural limits of its own. Its main function of supporting the head has nothing special or exclusive about it. Its true essence seems instead to be its function as a linking structure,

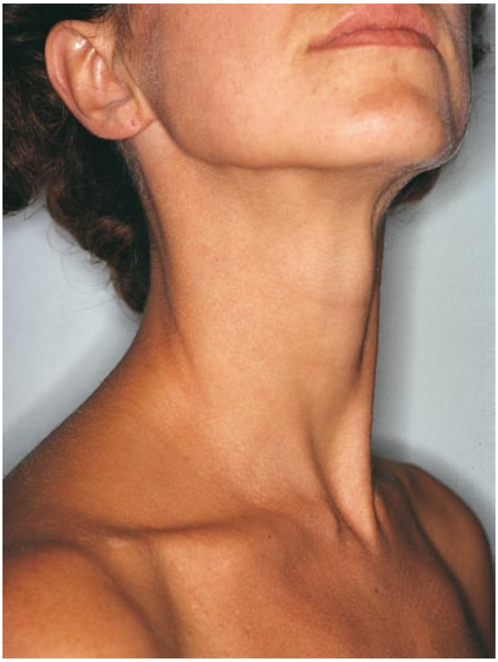

Fig. 1.1 Carolina's neck

a sort of bridge between head and body, transporting blood, air, emotions, and information on movement and sensitivity, i.e., it is the point where the "breath of life" converges and is conveyed. We use the neck of a classic ballerina, like Carolina (Fig. 1.1), as a graceful introduction to our dissection class (Figs. 1.2, 1.3). Let us start by getting to know the superficial landmarks.

1.2 Releasing a Corpse for Research Purposes

Over the eras, in accordance with political and religious precepts, precise restrictions, in many cases prohibitions, have been placed on scientific research on corpses.

In the Western world in particular, Christian and Jewish culture condemned autopsy by virtue of the belief that "the human body is sacred since it was created in God's image and likeness," and because it was "contrary to Christian dogma on the resurrection of the flesh" [2]. Consequently, records on anatomic practice are only available

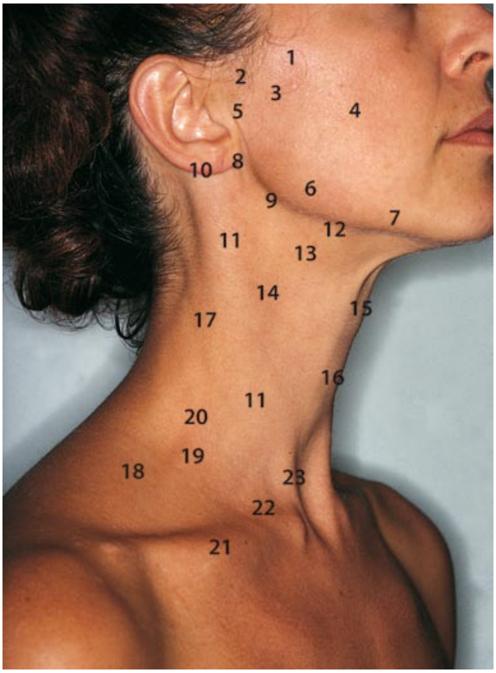

Fig. 1.2 Superficial landmarks: lateral view

1 = zygomatic process of the temporal bone
2 = auriculotemporal nerve and superficial temporal pedicle
3 = caput mandibulae
4 = parotid duct
5 = external auditory canal
6 = angle of mandible
7 = facial pedicle
8 = transverse process of atlas
9 = inferior parotid pole
10 = apex of mastoid
11 = sternocleidomastoid muscle
12 = submandibular gland
13 = apex of greater cornu of hyoid bone
14 = carotid bifurcation
15 = laryngeal prominence
16 = cricoid cartilage
17 = emergence of spinal accessory nerve (peripheral branch)
18 = trapezius and entrance of spinal accessory nerve (peripheral branch)
19 = inferior belly of omohyoid muscle
20 = external jugular vein
21 = clavicle
22 = sternocleidomastoid muscle (clavicular head)
23 = sternocleidomastoid muscle (sternal head)

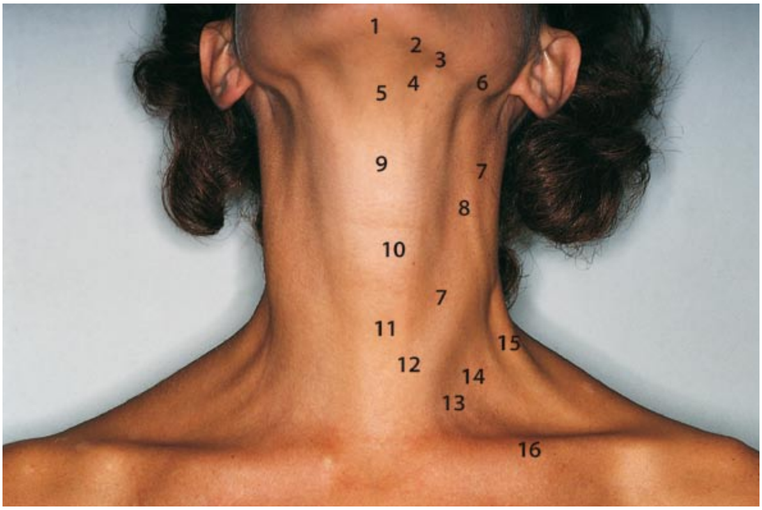

Fig. 1.3 Superficial landmarks: anterior view

1 = mental eminence
2 = inferior border of mandible
3 = facial pedicle
4 = submandibular gland
5 = hyoid bone
6 = angle of mandible
7 = sternocleidomastoid muscle
8 = external jugular vein
9 = laryngeal prominence
10 = cricoid
11 = isthmus of thyroid gland
12 = sternocleidomastoid muscle (sternal head)
13 = sternocleidomastoid muscle (clavicular head)
14 = inferior belly of omohyoid muscle
15 = anterior border of trapezius muscle
16 = clavicle

from the 13th century onward. Scientists, anatomists, and fine arts students were thus forced either to bribe grave-diggers and cemetery guards in order to obtain the anatomic material they required, or to perform dissections on animals (Fig. 1.4).

A chronicler of the time wrote of the anatomist Jacques Dubois (1478–1555): "Having no manservant, I saw him carry alone the uterus and intestine of a goat, or the thigh or arm of a hanged man, on which to perform anatomic dissections, which produced such a stench that many of his students would have vomited, had they been able" [3]. Even the University of Padua, one of the most famous in Europe in the early sixteenth century, was allowed a quota of two corpses, one male and one female, on which to practice dissection, thanks to a specific privilege granted by the Church. However, the chronicles of the period speak of the secret conveyance of the bodies of hangman's victims through an underground river passage leading directly to the

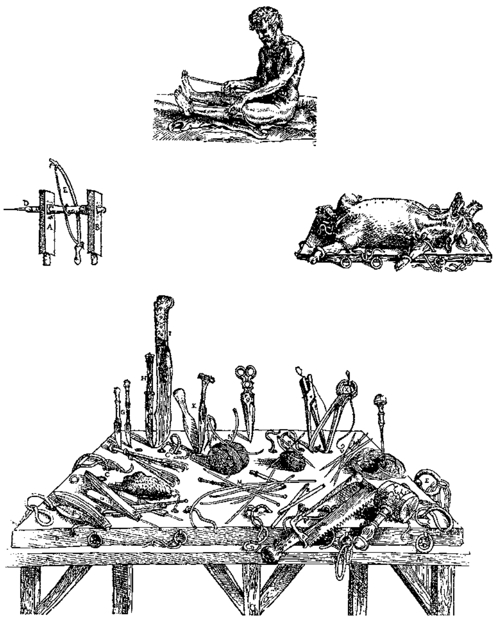

Fig. 1.4 Sixteenth-century dissection instrumentation

Fig. 1.5 Anatomy Theatre, Palazzo del Bò, Padua

Anatomy Theatre of Palazzo del Bo', where Andreas Vesalius taught for 5 years (Figs. 1.5, 1.6).

The sixteenth century was the century of the great anatomists, and Vesalius stands head and shoulders above them all. With the Renaissance, anatomy moved away from the religious and dogmatic doctrines that had dominated the Middle Ages, and was subordinate to the neutral observation of natural phenomena. Vesalius was therefore the successor of Galen, just as in physics Copernicus took over from Ptolemy. With Vesalius, anatomical science officially became an essential part of the experimental method. In teaching, "Vesalius's reform" meant the replacement of a method of teaching anatomy based on books and dogma with another, revolutionary method, based on the practice of direct and systematic dissection, and therefore more "faithful to anatomical reality." In 1543, Vesalius published the first great modern treatise on anatomy, *De humani corporis fabrica*, an educational text with very clear text and illustrations. He was helped by painters such as Jan Stephan van Calcar, a student of Titian, and the drawings were transferred into woodcuts by Valverde. The frontispiece of the *Fabrica* is in the Academy of Medicine in New York; it shows a lesson held by Vesalius in the Anatomy Theatre of Padua University (Fig. 1.7).

Anatomic dissection has always been considered a fundamental subject for the teaching of medicine. Nevertheless, in European degree courses in medicine and surgery, in recent decades there has been a drastic reduction in the hours, methods, and contents of the teaching of human anatomy, and in particular of the hours of practical lessons. However, there has recently been a renewed interest in the subject, and it is usually specialists in surgery who want to perfect their surgical techniques on cadavers, or learn new ones. For this reason there is a growing offer of courses in surgical anatomy on cadavers.

In Italy, the use of corpses for research purposes is considered a legitimate practice, albeit governed by specific state legislation; reference should be made in particular to the Consolidation Act on Higher Education Legislation (1933) and the Mortuary Police Regulations (1990).

First, the place of dissection is established, i.e., at a university institution. Theoretically, the law permits hospitals to request parts of corpses from university institutions, but, in practice, the excessive bureaucracy involved makes such requests prohibitive (suffice it to consider the transportation of corpses or parts of them).

Regarding the selection procedure for cadavers for teaching and research purposes, Italian legislation allows only the following: corpses admitted to forensic investigation (through the courts) but not requested by family members (excluding suicides), and corpses for whom

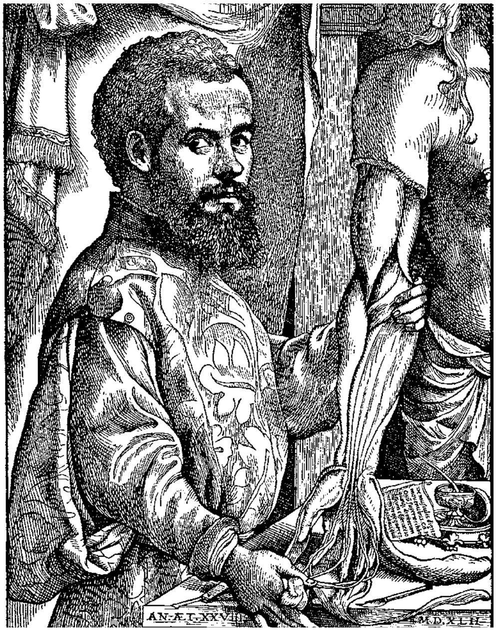

Fig. 1.6 Andreas Vesalius

Fig. 1.7 Frontispiece of *De humani corporis fabrica,* 1543

transportation has not been paid by the respective family but has been provided free of charge by the local authorities.

Anyone during his or her lifetime can donate by a living will the entire body for teaching and research purposes. This is not, however, a customary practice in Italy. Indeed, in order to have several corpses simultaneously, the three editions of the Practical Course in Neck Dissection (1991, 1992, and 1994), edited by the ENT team of Vittorio Veneto, were carried out in Brussels, Belgium, where the decision to leave one's own body to medical science is a far more common practice. This probably derives from the fact that in other European countries and in the United States, the law has already approved and regulated this possibility for several years now.

Our hypothetical dissection class therefore takes place in a university institution of normal human anatomy or pathologic anatomy. A diagnosis has recently been formulated for the corpse before us; hence, at least 24 h have passed since time of death, and rigor mortis is resolving. We have already ascertained the absence of disease and previous surgical operations on the neck in the structures to be dissected. We are very fortunate if the person in question was fairly tall as this will greatly aid dissection.

1.3 Instrumentarium

Anatomic dissection is a contemplative manual activity. It requires silence and above all should be subject to no time restrictions, as its value is depreciated by hurried performance. Very good lighting conditions are needed and are best provided by scialytic operating lamps. Alternatively, two revolving cold light lamps can be adopted. As a last resort, environmental light focally reinforced by a Clar forehead mirror can be used. Figure 1.8 illustrates the operating instruments that we consider necessary for neck dissection, in addition to a few helpful tools.

Neck dissection may be conducted by a lone surgeon, but this makes it a very awkward task. Two surgeons should instead be involved, alternating with each other in the roles of chief and assistant, thereby promoting efficacy and cultural exchange. The classic error to avoid is to

Fig. 1.8 Instrumentarium

1 = septum-type separator
2 = medium surgical scissosr
3 = small surgical scissor
4 = disposable scalpel
5 = cocker
6 = surgical forceps
7 = anatomic forceps
8 = self-retaining retractor
9 = silk
10 = three-point hook
11 = medium-sized Farabeuf

have two surgeons acting separately at opposite sides of the neck.

Last, at the end of dissection, the body should be carefully recomposed. Where possible, unnecessary deforming maneuvers should be avoided. Consideration and respect should reign at all times toward those who have willingly or unknowingly donated their bodies to science.

Take Home Messages

- Anatomic dissection is a contemplative manual activity. It requires silence, and haste should be avoided at all costs. It is best to have two surgeons working on the neck dissection, because one has to help the other expose the field and possibly discuss the concepts learned.
- My Professor used to say that on the learning scale, it is one thing for a surgeon to find a structure and know how to recognize it, while it is quite a different thing to look for that structure in the precise place where he is sure to find it.

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Chapter 2

General Anatomical Layout

2

Core Messages

- At the start of the dissection exercise, we must take a panoramic look for orientation. We then establish the limits of the area of operation and the main landmarks.

2.1 Anatomic Layout

The neck is the part of the trunk that joins the head and the chest and constitutes its most mobile part. It is essentially cylindrical in shape; length is constant while diameter varies. The expression "long neck/short neck" is incorrect, because the length of the neck, understood to be the cervical portion of the vertebral column, does not present significant variations. Conversely, neck width, determined by the development of muscular and adipose masses is extremely variable [2].

Significant anatomical structures: superficial, middle, and deep cervical fasciae; lymph nodes.

Landmarks: mandible, external auditory canal, mastoid, clavicle, jugulum.

- 2.1.1 Its upper limits run along the inferior and posterior borders of the mandible, the extreme posterior of the zygomatic arches, the anteroinferior borders of the external auditory canals, the profiles of the mastoid apophyses, the superior nuchal line, and the external occipital protuberance. Its lower boundaries lie along the superior border of the sternum and clavicles, the acromioclavicular joints, and an imaginary line joining the acromioclavicular joints to the spinous process of the seventh cervical vertebra (Fig. 2.1).

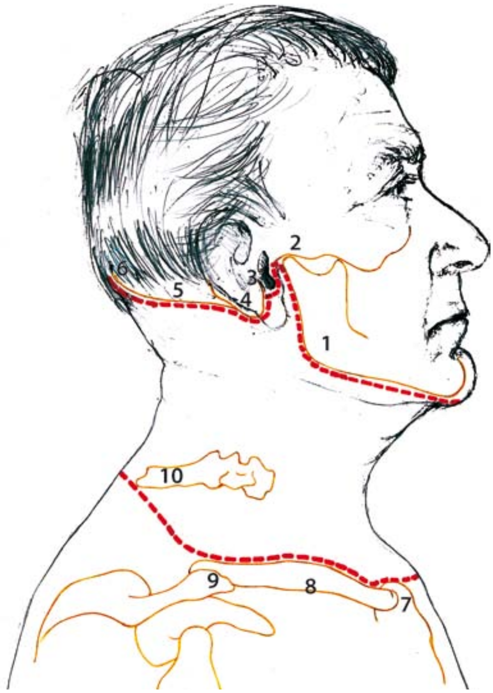


Fig. 2.1 Neck boundaries

1 = mandible
2 = zygomatic process of the temporal bone
3 = external auditory canal
4 = mastoid
5 = superior nuchal line
6 = external occipital protuberance
7 = manubrium sterni
8 = clavicle
9 = acromioclavicular joint
10 = spinous process of seventh cervical vertebra

- 2.1.2 On transverse section, the neck appears to be roughly divided into two parts, a posterior or nuchal (osteo–muscular) part and an anterior or tracheal (muscular–fascial) part. The conventional dividing line extends from the transverse vertebral processes to the anterior edges of the trapezius muscles (Fig. 2.2).

The function of the posterior region is essentially static and dynamic–powerful, articulated muscles support a bone framework with the head at the top. This structure functions as an articulated joint since the two interapophyseal joints between one vertebra and the next permit head movement; it also functions as a shock absorber for intravertebral disk compressibility in addition to being a fastening point for the muscles of mastication, swallowing, and speech. The cervical portion of the vertebral column is curved with anterior convexity (cervical lordosis). In contrast, the anterior region, which is the object of this dissection, holds the internal organs. It contains the parotid and submandibular glands, the thyroid gland, several lymph nodes, and is crossed by important blood and lymphatic vessels, nerves, and by the respiratory and digestive tracts.

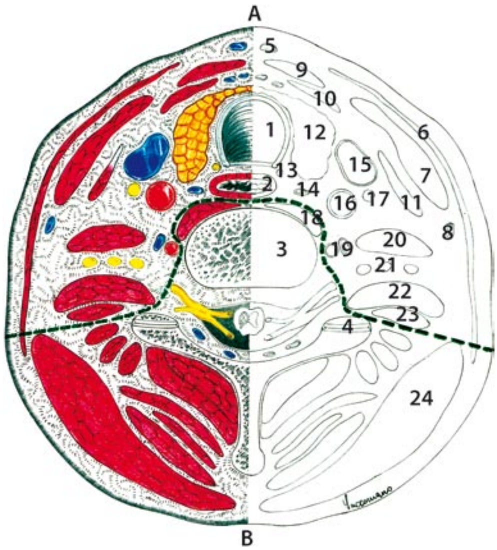


Fig. 2.2 Transverse cervical section: tracheal region and nuchal region. **A** Tracheal region **B** Nuchal region

1 = trachea
2 = esophagus
3 = vertebral body of seventh cervical vertebra
4 = interapophyseal articulation
5 = anterior jugular vein
6 = platysma muscle
7 = sternocleidomastoid muscle
8 = external jugular vein
9 = sternohyoid muscle
10 = sternothyroid muscle
11 = omohyoid muscle
12 = thyroid gland
13 = recurrent nerve
14 = inferior thyroid vein
15 = internal jugular vein
16 = common carotid artery
17 = vagus nerve
18 = prevertebral muscles
19 = vertebral artery and vein
20 = anterior scalene muscle
21 = brachial plexus
22 = medial scalene muscle
23 = posterior scalene muscle
24 = trapezius muscle

- 2.1.3 In addition to being prevalently a structure of transit and union, the neck is an important point of autonomous physiological activity, linked to the presence of exocrine glands (parotid and submandibular), endocrine glands (thyroid, parathyroid, and thymus), muscle and tendon neuroreceptors, visceral receptors, vascular chemopressoreceptors, and lymph nodes.

- 2.1.4 Almost all cervical viscera originate from or lead to the thorax or upper extremities; the loose connective tissue surrounding them is in direct, continuous contact with the loose connective tissue of the mediastinum and axillary regions. In some points, the loose connective tissue thickens to form fibrous sheaths (around neurovascular bundles, the laryngotracheal canal, and the thyroid) and perimuscular aponeuroses. These latter define important dissection planes, particularly:
1. The superficial cervical fascia (*fascia colli*), extending from the anterior edge of the trapezius and splenus capitis muscles on both sides, which divides into two to enclose the sternocleidomastoid muscles, parotid gland and submandibular gland; it fuses with the middle cervical fascia on the midline.
2. The middle cervical fascia, lying between the omohyoid muscles on both sides; as a whole, it forms a triangle with the hyoid bone at its apex and the clavicles at the base; it divides in two to contain the infrahyoid muscles.

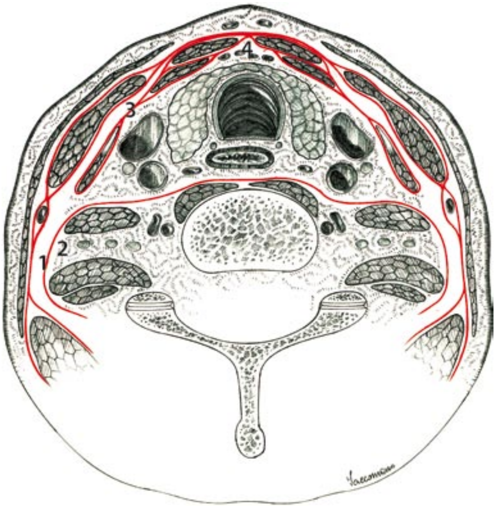


Fig. 2.3 Transverse cervical section: cervical fasciae

1 = superficial cervical fascia
2 = deep cervical fascia
3 = middle cervical fascia
4 = white infrahyoid line

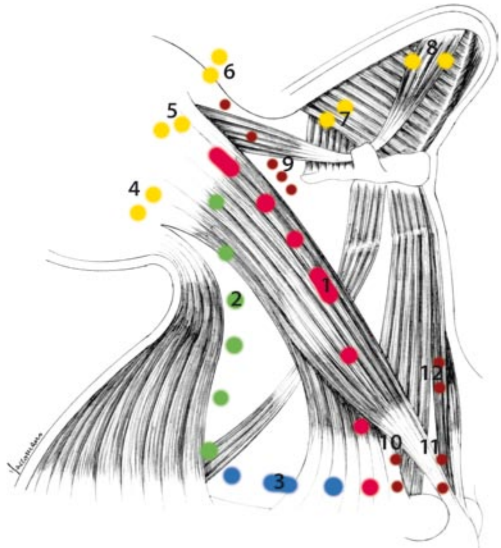


Fig. 2.4 Lymph node stations

1 = jugular chain
2 = spinal chain
3 = supraclavicular chain
4 = occipital lymph nodes
5 = mastoid lymph nodes
6 = parotid lymph nodes
7 = submandibular lymph nodes
8 = submental lymph nodes
9 = retropharyngeal lymph nodes
10 = recurrent lymph nodes
11 = pretracheal lymph nodes
12 = prethyroidean lymph nodes

3. The deep (or prevertebral) cervical fascia, investing the prevertebral muscles and dividing laterally to contain the scalene and levator scapulae muscles (Fig. 2.3).

- 2.1.5 The cervical lymphatic system forms a three-dimensional network into whose nodal points the lymph nodes are intercalated. Although they vary in number and dimensions, they do keep a relatively constant position, and they can thus be considered topographically grouped into lymph gland stations (Fig. 2.4).

These are divided in the neck as follows:
1. A superficial, subfascial lymph node system with a circular arrangement between chin and occiput (occipital, mastoid, parotid, submandibular, and submental lymph nodes) and along the course of the external jugular vein.
2. A deep, more consistent lymph node system in a bilateral triangular arrangement, bounded anteriorly by lymph nodes adjacent to the internal jugular vein, and posteriorly by the spinal lymph node chain, with a supraclavicular lymph node.
3. A perivisceral lymph node system close to the median viscera (prethyroidean, pretracheal, retropharyngeal, recurrent and finally prelaryngeal lymph nodes, the more defined of which, called "delficus", is situated between the cricothyroideal muscles).

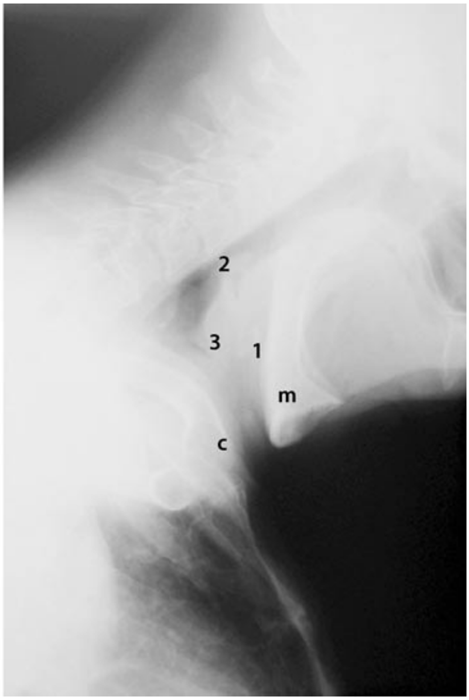
Remarks: The relationships between the lymph nodes/lymphatic vessels and the muscles/vessels/nerves and glands in the neck are of a contiguous nature, always in normal conditions, and nearly always in pathological ones. Thanks to the removal of the fasciae, they may be separated from the contiguous structures and moved away easily. There may be an interruption of the fascia and colonization of the contiguous structures only if the lymph node capsule gives way as a result of carcinomatous invasion [1].

- 2.1.6 Anatomists divide the neck into two major regions:
1. The anterior region, situated between the two sternocleidomastoid muscles, encompassing the suprahyoid, infrahyoid, and prevertebral regions.
2. The lateral regions, comprising the parotid, sternocleidomastoid or carotid, and supraclavicular regions.

For the sake of simplicity and for dissection purposes, we instead divide the neck into three lateral regions (parotid, submandibular, and laterocervical) and three median regions (inferior median, superior median, and prevertebral).

- 2.1.7 The anatomic arrangement of the neck organs varies considerably with neck movements, especially flexing–extending movements. For example, at maximum flexion, the hyoid bone, one of the more cranial structures,

a



b

Fig. 2.5 Neck mobility. a Flexion, b extension

m = mandible
c = clavicle
1 = hyoid bone
2 = epiglottis
3 = laryngeal ventricle
4 = trachea
5 = cervical esophagus
6 = seventh cervical vertebra
7 = first thoracic vertebra

can almost reach the thorax (Fig. 2.5a, b). Surgeons should bear this in mind since they can take advantage of great cervical mobility to achieve the widest possible dissection areas.

Remarks: We stress that the symmetrical posture of the neck is commonly defined the normal position. The surgical maneuvers will be carried out on a neck, which we shall try to hyperextend as much as possible. To obtain this position, a thickness of at least 10 cm must be placed under the scapulae. That is as far as the anterior regions are concerned.

For the lateral regions, the head must be turned contralaterally with respect to the operator; this is defined the operating position. Instead, when the head is bent and slightly inclined toward the explored side, the structures relax and this allows deep exploration of the neck. This is defined as the clinical exploration position.

Take Home Messages

- The correct position of the head (extended as far as possible) is of fundamental importance both in anatomic specimens and when operating in vivo.

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Chapter 3

Superficial Dissection

3

Core Messages

- A large area of operation makes dissection easier. The cutaneous flap is raised between the platysma and the superficial cervical fascia, as in vivo. The superficial cervical fascia is interrupted as little as possible. It contains the vessels and lymph nodes that in neck dissection would be removed with the specimen.

3.1 Anatomic Layout

The neck is placed in a normal position, hyperextended. The incision is very low and posterior, to allow reconstitution of the cadaver at the end of dissection without scars that disfigure the uncovered cutaneous areas. Our references are the mastoid and the inferior margin of the mandible superiorly, the clavicles, and the sternal manubrium inferiorly.

Significant anatomical structures: superficial cervical fascia, platysma, sternocleidomastoid muscle, digastric muscle.

Landmarks: jugulum, clavicle, anterior margin of the trapezius, mastoid, mental protuberance, laryngeal protuberance (Adam's apple), cricoid cartilage.

3.2 Dissection

- 3.2.1 A large cutaneous flap is raised, with an incision approximately 3 cm beneath the inferior margin of the clavicle, extending along the acromioclavicular joint, and ascending laterally by approximately 3 cm behind the trapezius margin and posterosuperiorly to the posterior profile of the mastoid apophysis, beyond the level of the external auditory canal (Fig. 3.1).

- 3.2.2 The flap may be raised above the platysma, which thus becomes fully exposed (Fig. 3.2).

  The platysma muscle extends from the corpus mandibulae to the outer surface of the

Fig. 3.1 Cutaneous line of incision

1 = manubrium sterni
2 = clavicle
3 = acromioclavicular joint
4 = anterior margin of trapezius muscle
5 = mastoid

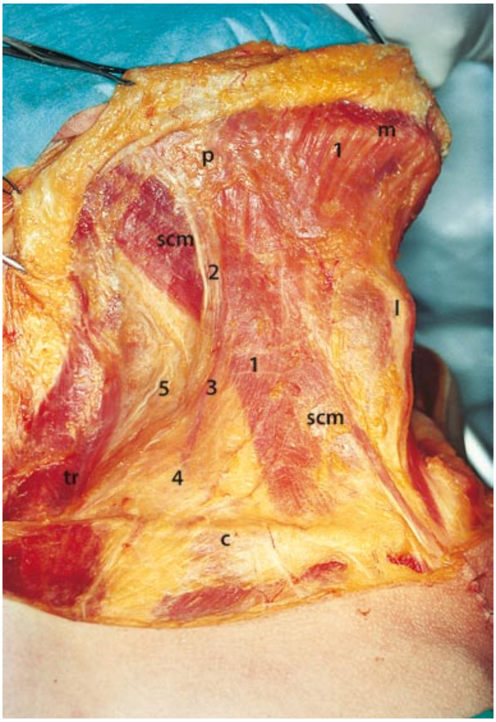

Fig. 3.2 Platysma muscle plane

m = mandible
p = parotid
scm = sternocleidomastoid muscle
tr = trapezius muscle
c = clavicle
l = larynx
1 = platysma muscle
2 = great auricular nerve
3 = external jugular vein
4 = superficial cervical fascia
5 = spinal accessory nerve (peripheral branch)

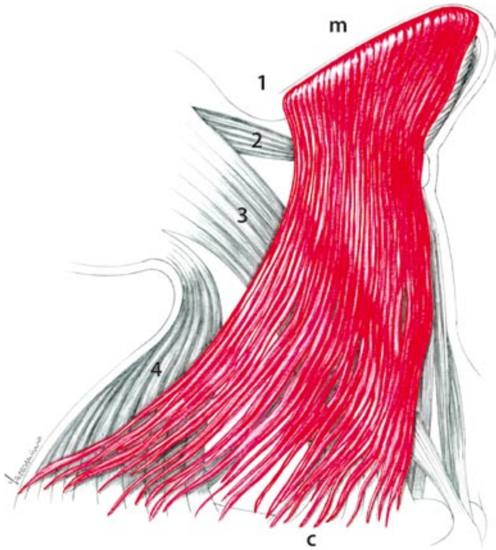

Fig. 3.3 Platysma muscle

m = mandible
c = clavicle
1 = angle of mandible
2 = posterior belly of digastric muscle
3 = sternocleidomastoid muscle
4 = trapezius muscle

clavicle. Its lateral margin crosses the sternocleidomastoid muscle between its third median and third superior, and then descends toward the acromioclavicular joint; from the mental symphysis, its medial margin deviates from the midline in an inferior direction; its outer surface is more or less rectangular and invested with subcutaneous tissue and its inner surface is contiguous with the superficial cervical fascia. The platysma is innervated by a branch of the facial nerve (Fig. 3.3).

Remarks: This anatomic cut-down, which permits excellent platysma exposure, is not always easy to perform in preserved cadavers, owing to the muscle's slenderness and fragility. Accordingly, a flap incorporating the platysma is often required, and it is indeed more useful for teaching purposes. In routine surgical practice, preparation of a flap formed by skin, subcutaneous tissue, and the platysma is in fact envisaged in all cervical operations. It is raised from the superficial cervical fascia

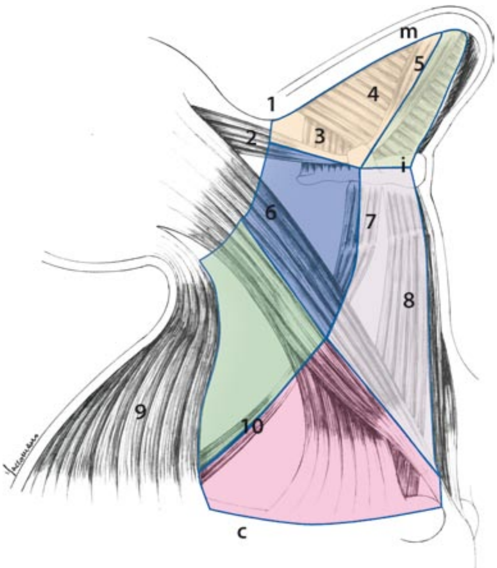

Fig. 3.4 Superficial surgical triangles

m = mandible
c = clavicle
i = hyoid bone
1 = angle of mandible
2 = posterior belly of digastric muscle
3 = hyoglossus muscle
4 = mylohyoid muscle
5 = anterior belly of digastric muscle
6 = sternocleidomastoid muscle
7 = superior belly of omohyoid muscle
8 = sternohyoid muscle
9 = trapezius muscle
10 = inferior belly of omohyoid muscle

by upward traction and cut with a scalpel at a tangent to the flap; if this plane is carefully followed, the superficial vessels and nerves in the fascia are not interrupted because they remain below.

- 3.2.3 In the resulting dissection field, sternocleidomastoid muscle prominence is clearly evident as it crosses the region on both sides from top to bottom and from back to front, describing two large superficial, topographic triangles on each side, one anterior and one posterior (Fig. 3.4).

The *anterior triangle* is bounded by the sternocleidomastoid muscle, the inferior margin of the mandible, and the midline. It is further divided into:

1. The submental triangle, lying between the anterior belly of the digastric muscle, the corpus ossis hyoidei, and the midline.
2. The digastric triangle, lying between the two bellies of the digastric muscle, and the inferior margin of the mandible.
3. The muscular triangle, lying between the sternocleidomastoid muscle, the superior belly of the omohyoid muscle, and the midline.
4. The carotid triangle, lying between the sternocleidomastoid muscle, the posterior belly of the digastric muscle, and the superior belly of the omohyoid muscle.

The *posterior triangle* is bounded by the sternocleidomastoid muscle, trapezius, and clavicle. It is further divided into:

1. The spinal triangle, lying between the sternocleidomastoid muscle, the trapezius, and the inferior belly of the omohyoid muscle.
2. The supraclavicular triangle, lying between the sternocleidomastoid muscle, the inferior belly of the omohyoid muscle, and the clavicle.

The above topographic division of the neck is the one used by anatomists and is certainly a helpful method of orienting general anatomy.

- 3.2.4 In routine oncological practice, importance is laid on an additional, internationally accepted topographical subdivision, introduced by K. Thomas Robbins in 1991 [2]; it was updated by him in 2002 [4], and is now internationally accepted. Its aim is to achieve uniformity in the nomenclature of various types of cervical lymph node neck dissection, which it does by classifying the various topographical regions involved in the excision and any sacrificed anatomic structures. The neck is therefore divided into a total of 6 six levels (five on each side plus a sixth anterior median level) (Fig. 3.5).

Remarks: The concept of neck dissection as an indispensable complement to the treatment of tumors of the upper aerodigestive tract began with George Crile more than a century ago [1]. Neck dissection was always carried out with the demolitive technique. In the 1960s, Ettore Bocca introduced the so-called functional neck dissection in Europe [3]. It is based on Osvaldo

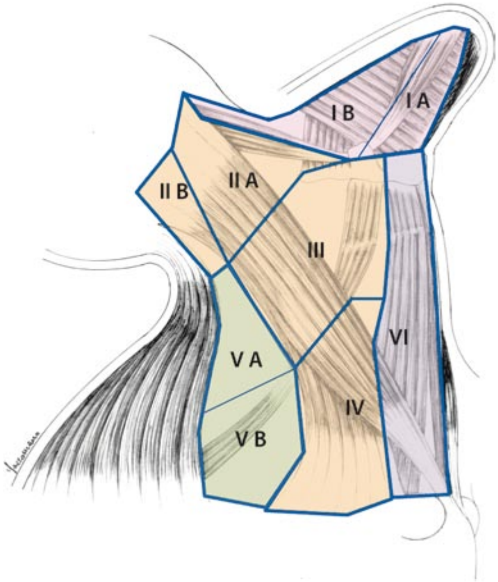

Fig. 3.5 Cervical levels according to Robbins (2002)

Suarez's assertion that there are no lymph node formations outside the fascial investments of the neck. So, the surgeon can be just as radical as in the neck dissection proposed by Crile while preserving important structures such as the sternocleidomastoid muscle, the internal jugular vein, and the spinal accessory nerve. This applies as long as the lymph node capsule is intact. This new method has led to an appreciable reduction of morbidity.

In recent years the study of the pattern of metastatic diffusion of tumors of the head and neck has led surgeons performing prophylactic neck dissection (that is, in N0 necks), to neglect the lymphatic areas that are statistically less exposed to metastatic colonization. Selective neck dissections were therefore introduced in routine surgery. The reason behind this evolution is to reduce as far as possible the functional sequelae of cervical neck dissections.

- 3.2.5 At the end of this surgical phase, the vast dissection field extends inferiorly from the trapezius muscles to the clavicles and superiorly to encompass the mandible and external auditory canal (Fig. 3.6).

We now try to establish the limits of the Robbins levels conceptually and by palpation. At the top we identify the mastoid and the hyoid bone; farther down, the inferior margin of the cricoid and then the sternal manubrium and the clavicle; and posteriorly, the anterior margin of the trapezius.

Take Home Messages

- Neck dissection is the most complete surgical procedure regarding the anatomical knowledge of the neck. Succeeding in performing it with methodological exactness, sureness, and confidence is one of the goals of the excellent surgeon.
- The Robbins levels (2002) are the fundamental map for oncological surgery of the neck. Cervical adenopathies should always be located in the Robbins levels, both in the objective examination prior to surgery and in the description of the neck dissection.

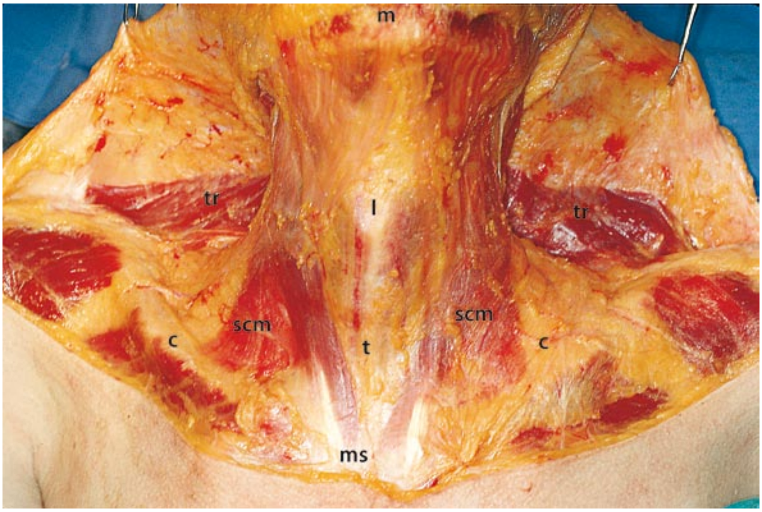

Fig. 3.6 Cutaneous flap

m = mandible
l = larynx
t = thyroid gland
ms = manubrium sterni
c = clavicle
scm = sternocleidomastoid muscle
tr = trapezius muscle

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Chapter 4

Parotid Region

4

Core Messages

- The essence of parotid surgery consists of removing the gland without harming the facial nerve and its branches. The first surgical stage always consists of identifying the common trunk of the facial nerve.
- The identification of the facial nerve and the isolation of its branches may be carried out using the operating microscope, with a magnifying prismatic loop (enlargement between 2x and 4x) or even with the naked eye, depending on what the surgeon is accustomed to.

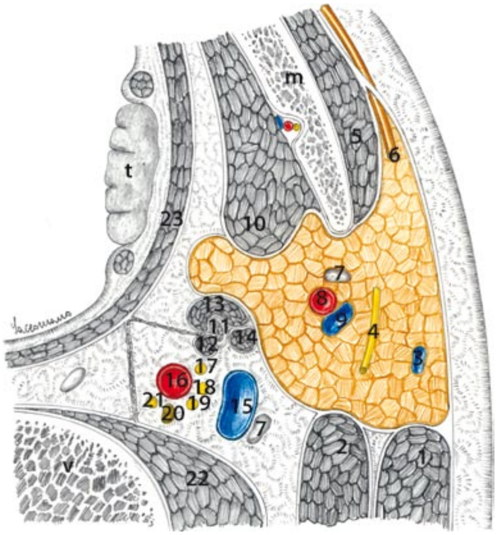

Fig. 4.1 Parotid region: cross-section

m = mandible
t = palatine tonsil
v = vertebral body
1 = sternocleidomastoid muscle
2 = posterior belly of digastric muscle
3 = external jugular vein
4 = facial nerve
5 = masseter muscle
6 = Stenone's duct
7 = lymph node
8 = external carotid artery
9 = retromandibular vein (or posterior facial vein)
10 = internal pterygoid muscle
11 = styloid process
12 = stylopharyngeus muscle
13 = styloglossus muscle
14 = stylohyoid muscle
15 = internal jugular vein
16 = internal carotid artery
17 = glossopharyngeal nerve
18 = spinal accessory nerve
19 = vagus nerve
20 = cervical sympathetic chain
21 = hypoglossal nerve
22 = prevertebral muscles
23 = superior constrictor muscle of the pharynx

4.1 Anatomic Layout

The parotid region is bounded anteriorly by the ramus of the mandible with the masseter muscle laterally and the medial pterygoid muscle medially; posteriorly, by the mastoid, sternocleidomastoid muscle, and posterior belly of the digastric muscle; medially by the jugular–carotid tract, the styloid process with the stylienus muscles (Riolan's bundle), and the pharyngeal wall (superior constrictor muscle of the pharynx); superiorly, by the external auditory canal and the extreme posterior of the zygomatic arch; inferiorly by the imaginary horizontal line between the angle of the mandible and the anterior margin of the sternocleidomastoid muscle.

The superficial and deep parotid fasciae invest the gland and are formed by the division of the superficial cervical fascia into two. The parotid lymph nodes are concentrated in two sites, one superficial, immediately below the fascia and one deep, intraparotid site, adjacent to the external carotid artery (Fig. 4.1).

Significant anatomical structures: external jugular vein, great auricular nerve, facial nerve, marginal branch of the facial nerve, retromandibular vein (or posterior facial vein), temporal artery, external carotid artery.

Landmarks: angle of the mandible, apex of the mastoid process, external auditory canal, anterior margin of the sternocleidomastoid muscle, posterior belly of the digastric muscle, pointer.

4.2 Dissection

- 4.2.1 Elevation of the cutaneous flap must extend superiorly beyond the caput mandibulae, after dissection of the external auditory canal and ascend anteriorly to the zygomatic arch (posterior portion). At this point we can recognize the limits of the parotid gland. We can also find our way by identifying a few landmarks, such as the corner of the mandible, the external auditory canal, and the sternocleidomastoid muscle (Fig. 4.2).

- 4.2.2 On removal of the superficial cervical fascia, the superior superficial pedicles of the parotid cavity are immediately visible. Now we look for and isolate the superficial temporal artery, which in vivo can be felt pulsating just in front of the tragus (Fig. 4.3).

- 4.2.3 Inferiorly, the platysma (unless already removed) and superficial cervical fascia are dissected and everted, exposing the inferior portion of the parotid cavity (Fig. 4.4).

- 4.2.4 Examining the right parotid gland, we identify the following superficial structures:
  - 7 o' clock: the great auricular nerve (cutaneous branch of the cervical plexus, innervating the auricle and parotid region); the external jugular vein runs alongside the great auricular nerve in proximity to the inferior parotid margin and exits the region. The two subfascial structures can be easily recognized on the surface of the sternocleidomastoid muscle.
  - 5 o' clock: the branch of the facial nerve serving the platysma; the marginal branch of the facial nerve serving the inferior mimetic muscles.
  - 4 o'clock: the stomatic branches of the facial nerve.
  - 3 o' clock: the parotid duct, situated at the apex of the gland's anterior process; it passes

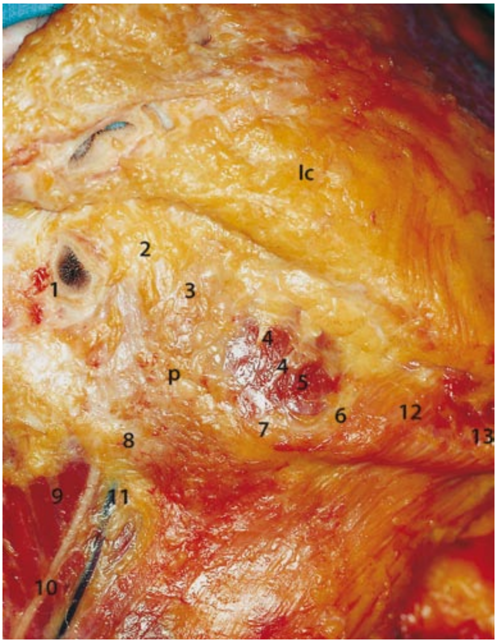

Fig. 4.2 Superficial fascial plane

p = parotid
lc = everted cutaneous flap
1 = external auditory canal cartilage
2 = mandibular caput mandibulae
3 = ramus of the mandibulae
4 = stomatic branches (facial nerve)
5 = masseter muscle
6 = marginal branch (facial nerve)
7 = angle of mandible
8 = superficial cervical fascia
9 = sternocleidomastoid muscle
10 = great auricular nerve
11 = external jugular vein
12 = platysma muscle
13 = basis mandibulae

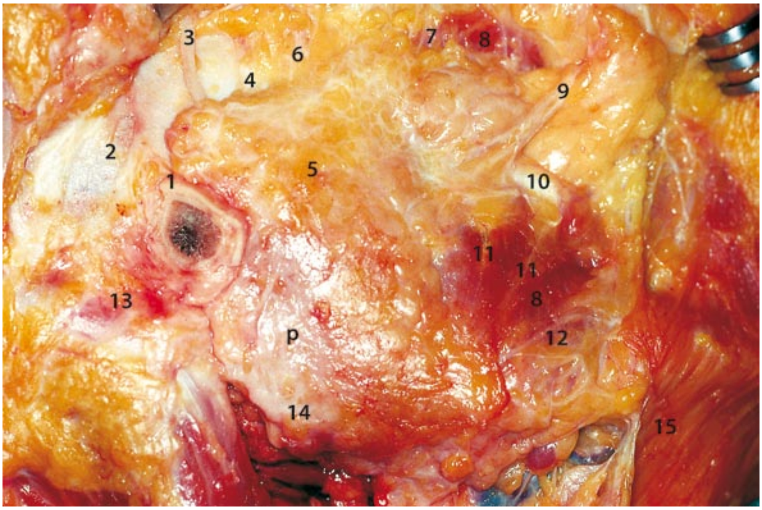

Fig. 4.3 Subfascial plane (I)

p = parotid
1 = external auditory canal cartilage
2 = fascia temporalis
3 = superficial temporal artery
4 = auriculotemporal nerve
5 = caput mandibulae
6 = temporal branches (facial nerve)
7 = zygomatic branches (facial nerve)
8 = masseter muscle
9 = transverse facial artery
10 = Stenone's duct
11 = stomatic branches (facial nerve)
12 = marginal branch (facial nerve)
13 = mastoid
14 = angle of mandible
15 = platysma muscle

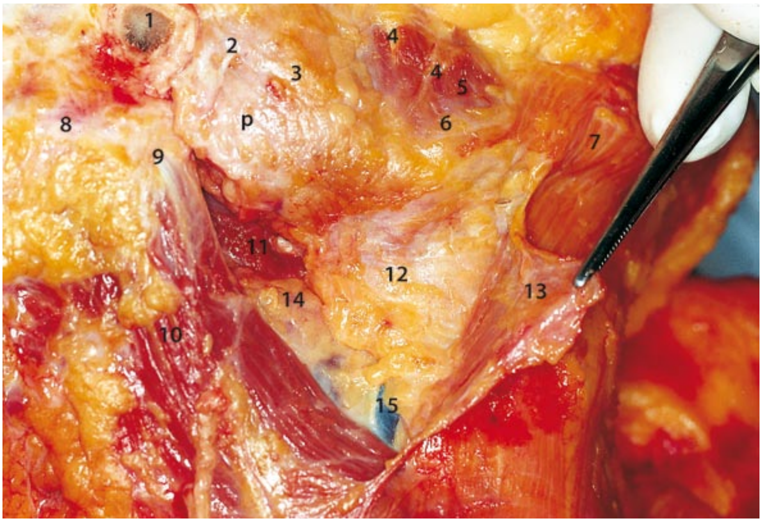

Fig. 4.4 Subfascial plane (II)

p = parotid
1 = external auditory canal
2 = caput mandibulae
3 = ramus of the mandible
4 = stomatic branches (facial nerve)
5 = masseter muscle
6 = marginal branch (facial nerve)
7 = basis mandibulae
8 = mastoid
9 = sternocleidomastoid tendon
10 = sternocleidomastoid muscle
11 = posterior belly of digastric muscle
12 = superficial cervical fascia
13 = platysma muscle
14 = lymph node
15 = thyrolinguofacial trunk

horizontally forward beyond Bichat's fat pad and then bends medially, embedding itself deep within the buccinator fibers; the transverse artery of the face, branch of the internal arteria maxillaris.

- 2 o'clock: the zygomatic branches of the facial nerve.
- 1 o'clock: the temporal branches of the facial nerve.
- 12 o'clock: the superficial temporal artery (and vein), a branch of the carotid artery arising in the parotid gland; the auriculotemporal sensory nerve, arising in the mandibular branch of the trigeminal nerve, emerging anteriorly to the external auditory canal and accompanying the ascent of the superficial temporal artery. It also sends secretory parasympathetic fibers to the parotid gland, (glossopharyngeal nerve → tympanic nerve → lesser petrosal nerve → otic ganglion → auriculotemporal nerve → parotid); the caput mandibulae.
- 10 o'clock: the external auditory canal.
- 9 o'clock: the posterior auricular artery (and vein), a branch of the external carotid artery arising in the parotid gland, passing over the sternocleidomastoid tendon (Fig. 4.5).

- 4.2.5 We begin the parotidectomy by freeing the superficial portion of the posteroinferior aspect of the gland and dissect the posterior auricular artery, great auricular nerve, and external jugular vein.

- 4.2.6 The posteroinferior portion of the parotid gland is elevated from the anterior margin of the sternocleidomastoid muscle. More deeply, we uncover the posterior belly of the digastric muscle and free its anterior margin. In this phase we advise the use of a self-retaining retractor clamped between the parotid gland and sternocleidomastoid tendon. Superiorly, dissection should not exceed the horizontal plane crossing the mastoid apex, to avoid encountering the facial nerve. Digital elevation is effective and avoids damage.

- 4.2.7 Now we free the anterior portion of the external auditory canal, taking care to remain on the perichondral plane. We must not go any deeper than the plane tangent to the digastric muscle, which was revealed previously.

- 4.2.8 It is now time to look for the common trunk of the facial nerve, immediately after the point where it emerges from the stylomastoid foramen of the temporal bone.

  The facial nerve is a mixed nerve. It carries sensitivity from the isthmus of the fauces; it has a secretory parasympathetic component for the tear glands and for the submandibu-

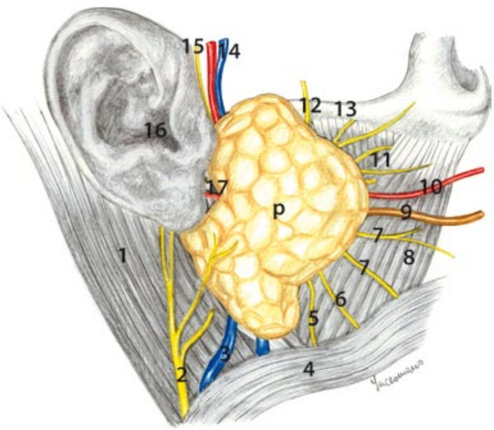

Fig. 4.5 Superficial parotid pedicles

p = parotid
1 = sternocleidomastoid muscle
2 = great auricular nerve
3 = external jugular vein
4 = platysma muscle
5 = platysma branch (facial nerve)
6 = marginal branch (facial nerve)
7 = stomatic branches (facial nerve)
8 = masseter muscle
9 = Stenone's duct
10 = transverse facial artery
11 = zygomatic branches (facial nerve)
12 = temporal branches (facial nerve)
13 = zygomatic arch
14 = superficial temporal artery and vein
15 = auriculotemporal nerve
16 = external auditory canal
17 = posterior auricular artery

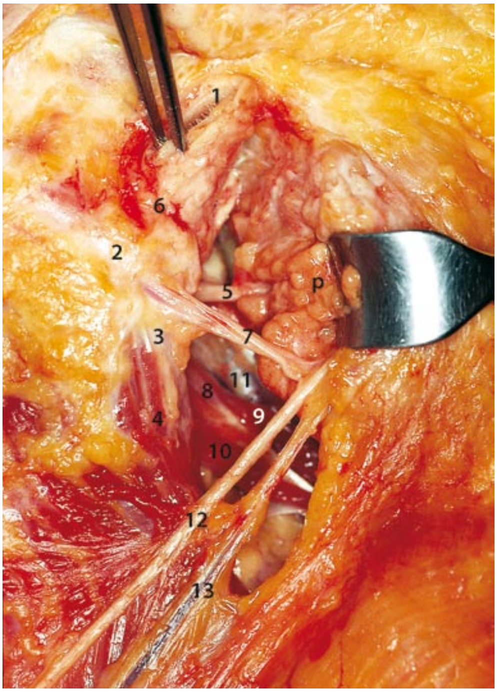

Fig. 4.6 Locating the facial trunk (I)

p = parotid
1 = external auditory canal
2 = mastoid
3 = sternocleidomastoid tendon
4 = sternocleidomastoid muscle
5 = facial nerve
6 = petrotympanic suture (in depth)
7 = posterior auricular artery and vein
8 = stylohyoid muscle
9 = styloglossus muscle
10 = posterior belly of digastric muscle
11 = internal jugular vein
12 = great auricular nerve
13 = external jugular vein

lar and sublingual glands (chorda tympani → lingual nerve), as well as for the glands of the nasal cavities (great superficial petrosal nerve → Vidian nerve → sphenopalatine ganglion). It innervates the stapes muscles, the platysma, the posterior belly of the digastric muscle, and the stylohyoid muscle, as well as the mimic muscles of the face.

Complications: Lesion of the facial nerve may result in important asymmetries of facial mimic motion. The marginal branch of the nerve for the cervical portion and the orbicular branch for the temporal portion must be accurately identified and preserved.

- 4.2.9 In parotidectomy the search for the common trunk of the facial nerve is carried out by identifying the inferior end of the cartilaginous external auditory canal that inferoposteriorly ends with a pointed triangular appendix. Rather like a thick compass needle, it indicates the facial nerve trunk (pointer). In regard to depth, reference is made to the superficial plane of the digastric muscle. It is less advisable to use the styloid process as a landmark because its dimensions vary; moreover, the facial nerve runs anterolaterally to the styloid process and therefore on finding the styloid process, a medial position has already been reached in relation to the nerve. Normally just above the facial nerve and following the same direction we can see the stylomastoid artery which, on account of its position, is also called the sentinel artery because the nerve is to be found immediately beneath it (Fig. 4.6).

- 4.2.10 Exercise 1: Facial Nerve (Fig. 4.7) To find the nerve we must have a clear idea of the landmarks of approach to the facial nerve, which are (1) the anterior margin of the external auditory canal, (2) the anterior margin of the sternocleidomastoid muscle, and (3) the posterior belly of the digastric muscle.

  Next, we must remember the landmarks of interception of the facial nerve, which are (1) for the direction in which to search, the pointer, and (2) for the depth, the plane tangent to the lateral surface of the posterior belly of the digastric muscle.

Once the common trunk has been identified, more distally we shall uncover the goose's foot, which gives us further confirmation that we are indeed dissecting the facial nerve.

Next we shall free the facial nerve tree, following the same dissection methods that are adopted in vivo. With Pean forceps inserted in a parallel position above each nerve trunk, the overlying parenchyma will be widened into a "bridge" and cut between the divaricated branches, lifting it up from the nerve.

■ 4.2.11 A second possibility for identifying the common trunk of the facial nerve is to follow the petrotympanic suture, also called the facial valley. A retroauricular incision is made in the periosteum, which is elevated anteriorly to expose the suprameatal spine, which continues caudally with the petrotympanic suture. The entire descent of this structure is then followed: The stylomastoid foramen, where the facial nerve emerges, is always situated 6–8 mm medially to the point where the petrotympanic suture ends (Fig. 4.8).

■ 4.2.12 Once the facial nerve has been found, forward traction is applied to the gland with the help of a Farabeuf, thus exposing the deep structures of the parotid cavity, particularly:
1. Riolan's bundle, arising in the styloid process of the temporal bone, formed by the stylohyoid, styloglossal, and stylopharyngeus muscles.
2. The stylomastoid artery, which accompanies the facial nerve trunk.
3. The retromandibular vein, a branch of the thyrolinguofacial venous trunk, also called the posterior facial vein.
4. The internal jugular vein, lying posterolaterally to the styloid process.
5. The external carotid artery at its entry to the parotid gland, at approximately the point

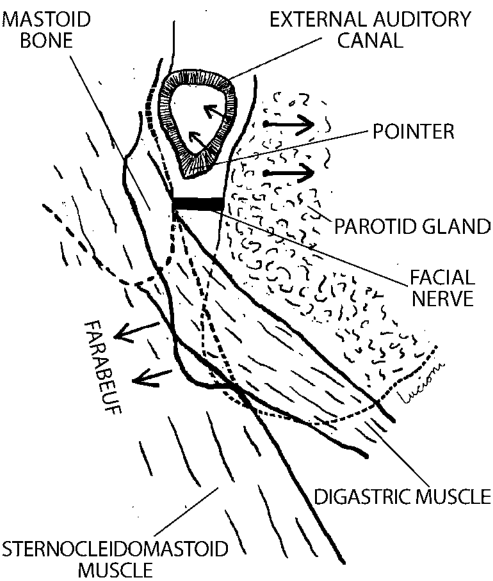

Fig. 4.7 Exercise 1: facial nerve

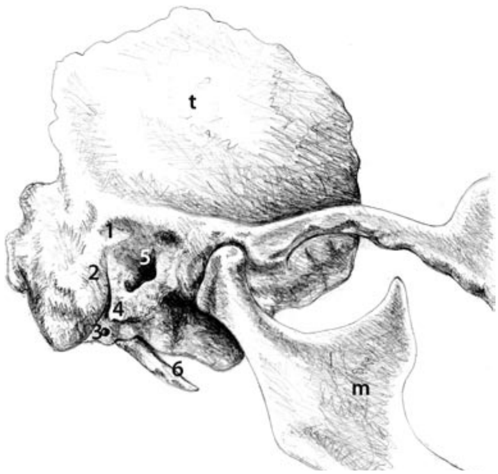

Fig. 4.8 Locating the facial trunk (II)

t = temporal bone
m = mandible
1 = suprameatal spine
2 = petrotympanic suture
3 = stylomastoid for amen
4 = pointer
5 = external auditory canal
6 = styloid process

of union between the lower third and upper two thirds of the medial wall of the gland.

6. The glossopharyngeal nerve.

The glossopharyngeal nerve is a mixed nerve since it contains motor fibers for the superior constrictor muscles of the pharynx and stylopharyngeus, parasympathetic pregangliar fibers for secretory innervation of the parotid (tympanic nerve → otic ganglion → mandibular nerve → auriculotemporal nerve), and sensory fibers (sensory innervation of the middle ear and pharynx; sensory innervation of taste buds in the area immediately anteriorly and posteriorly to the lingual "V"). Together with the vagus nerve, it also governs circulatory and respiratory homeostasis. It emerges from the cranial cavity through the posterior foramen lacerum, extending anteriorly and describing an anterosuperiorly concave curve; it initially runs between the internal jugular vein and the internal carotid artery, then between the styloglossus and stylopharyngeus and, laterally accompanying the pharynx, reaches the base of the tongue. It transmits impulses generated by stretch receptors located in the arterial wall of the bifurcation through one of its peripheral branches. This is called the Hering nerve and runs from the bifurcation of the carotid artery along the anterolateral surface of the internal carotid artery until it joins the main branch. Information on the partial pressure of oxygen in the blood perfusing the carotid bodies travels along the same pathway. In turn, the central nervous system transmits to the periphery impulses that tend to modify arterial pressure (reduction in peripheral vascular resistance, heart rate, and contractility, and increase in venous system capacity) and impulses that increase breathing capacity (increase in respiratory rate and tidal volume). A similar reflex arc is supported by the vagus, but in this case, afferent impulses arise from receptors located in the aortic arch (Figs. 4.9, 4.10).

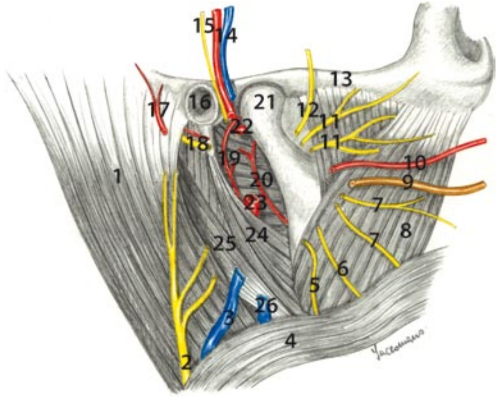

Fig. 4.9 Deep parotid pedicles

1 = sternocleidomastoid muscle
2 = great auricular nerve
3 = external jugular vein
4 = platysma muscle
5 = platysma branch (facial nerve)
6 = marginal branch (facial nerve)
7 = stomatic branches (facial nerve)
8 = masseter muscle
9 = Stenone's duct
10 = transverse facial artery
11 = zygomatic branches (facial nerve)
12 = temporal branches (facial nerve)
13 = zygomatic arch
14 = superficial temporal artery and vein
15 = auriculotemporal nerve
16 = external auditory canal
17 = posterior auricular artery
18 = facial nerve and stylomastoid artery
19 = ascending pharyngeal artery
20 = ascending palatine artery
21 = caput mandibulae
22 = internal maxillary artery
23 = external carotid artery
24 = stylienus muscles
25 = posterior belly of digastric muscle
26 = retromandibular vein

Complications: Interruption of the glossopharyngeal nerve is usually manifested by slight difficulty in swallowing and alterations in taste; however, since the regions innervated by the vagus and glossopharyngeal nerves bilaterally cover a similar area, effective control is maintained over circulation and respiration. This nerve is rarely identified in cervical surgery. Iatrogenic lesions of the glossopharyngeal nerve may occur in the course of otoneurosurgery of the cerebellopontine angle or base of the skull, during cervical excision (dissection of voluminous jugular–digastric adenopathies), in lateral pharyngotomies, and in ablation of parapharyngeal tumors. Surgical operations on tumors of the pharynx, tonsils, 4

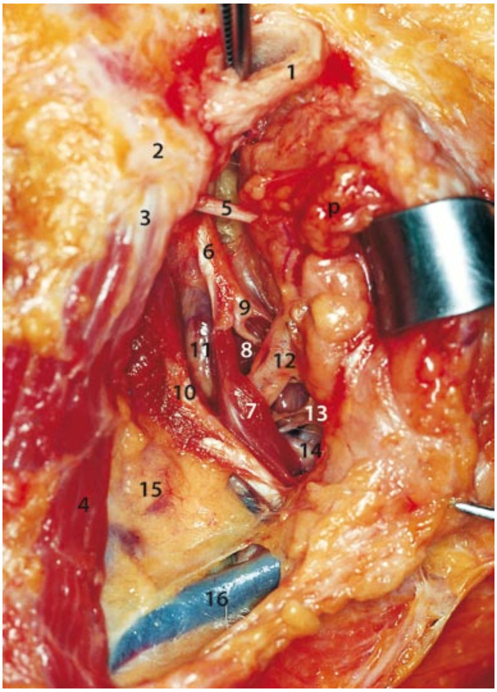

Fig. 4.10 Parotid region: deep plane

p = parotid
1 = anterior wall of external auditory canal
2 = mastoid
3 = sternocleidomastoid tendon
4 = anterior margin of sternocleidomastoid muscle
5 = facial nerve
6 = styloid process
7 = stylohyoid muscle
8 = stylopharyngeus muscle
9 = styloglossus muscle
10 = posterior belly of digastric muscle
11 = internal jugular vein
12 = external carotid artery
13 = ascending palatine artery
14 = glossopharyngeal nerve
15 = lymph node
16 = thyrolinguofacial trunk

and tongue base may also cause injury to the glossopharyngeal nerve, with functional sequelae of dysphagia and dysgeusia secondary to surgical excision. In tonsillectomy, the glossopharyngeal nerve, running in deep proximity to the inferior tonsil pole, may be injured during dissection or electrocoagulation; however, damage is usually reversible.

Last, it should be borne in mind that intraoperative stimulation through manipulation of either the glossopharyngeal or vagus nerve may induce transitory bradycardia and hypotension.

- 4.2.13 We now expose the intraglandular tract of the facial nerve. There is some debate about the existence of a superficial and deep parotid lobe. Indeed, there is no real cleavage plane between the two so-called lobes and the superficial parotid portion is far more voluminous than the deep portion, comprising about 90% of the whole glandular parenchyma.

Following the facial trunk from its emergence at the periphery, we find the goose's foot, i.e., the subdivision of the nerve into its two terminal trunks, the temporofacial and the cervicofacial. The first is appreciably more voluminous than is the second and has more collateral branches. An imaginary horizontal line crossing the labial commissure roughly divides the areas of musculocutaneous innervation of the two trunks. In particular, it can be seen how the most important of these, the marginal branch, is situated laterally to the retromandibular vein. Remember that the conformation of the facial trunk is rather inconstant. Anastomoses occur frequently between the two main trunks (Ponce Tortella loop) and this may explain the functional recovery of iatrogenic mediofacial lesions. Instead, the absence of collaterals in the front and mandibular branches would explain the nonreversibility of the deficits caused by the interruption of the nerve branches in these locations (Fig. 4.11).

- 4.2.14 The superficial portion of the parotid is stretched anterosuperiorly, thus isolating the terminal branches of the facial nerve. The parotid duct and the superficial temporal artery are identified and sectioned. The transverse facial artery, which comes at depth from the internal arteria maxillaries and rises to the surface anteriorly on the masseter muscle, is left intact (Fig. 4.12).

- 4.2.15 After having removed the superficial portion, another dissection exercise is ablation

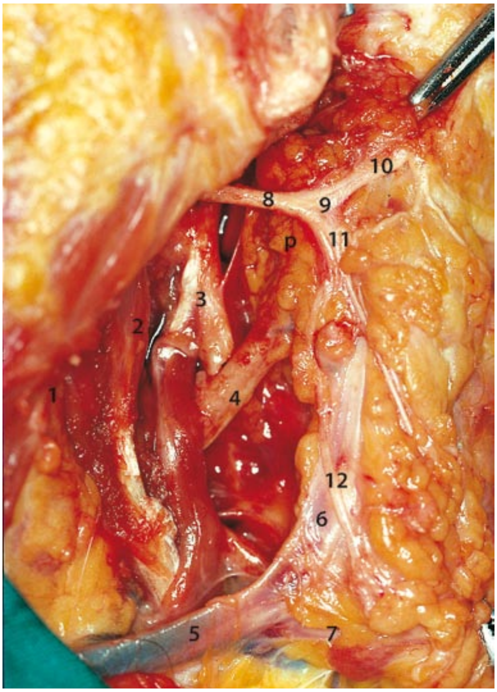

Fig. 4.11 The goose's foot

p = parotid
1 = anterior margin of sternocleidomastoid muscle
2 = posterior belly of digastric muscle
3 = styloid process and stylienus muscles
4 = external carotid artery
5 = thyrolinguofacial trunk
6 = retromandibular vein
7 = facial vein
8 = facial nerve
9 = goose's foot of facial nerve
10 = temporofacial trunk (facial nerve)
11 = cervicofacial trunk (facial nerve)
12 = marginal branch (facial nerve)

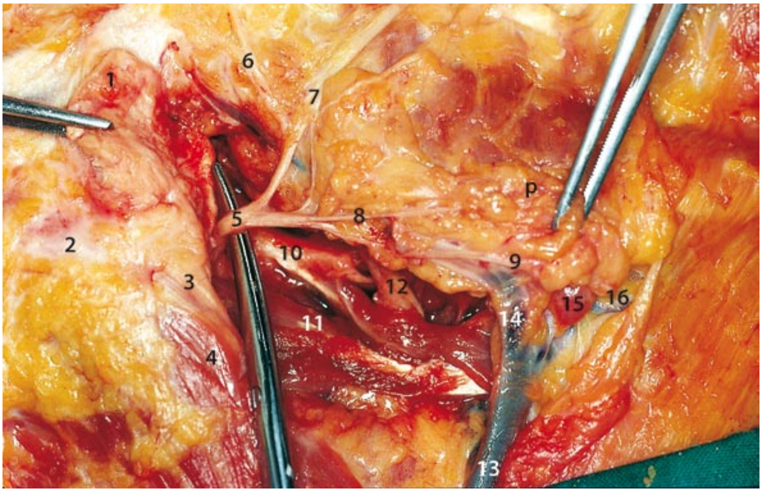

Fig. 4.12 The facial tree

p = anterior parotid remnants
1 = anterior wall of external auditory canal
2 = mastoid
3 = sternocleidomastoid tendon
4 = sternocleidomastoid muscle
5 = facial nerve
6 = temporal branches (facial nerve)
7 = zygomatic branches (facial nerve)
8 = stomatic branches (facial nerve)
9 = marginal branch (facial nerve)
10 = styloid process and stylienus muscles
11 = posterior belly of digastric muscle
12 = external carotid artery
13 = thyrolinguofacial trunk
14 = retromandibular vein
15 = lymph node of facial peduncle
16 = facial vein

of the deep portion of the gland, posteroanteriorly exposing the styloid process, cervical vasculonervous bundle, cervical sympathetic nerve trunk, and glossopharyngeal, accessory, and hypoglossal nerves (Fig. 4.13).

- 4.2.16 Dissection may be extensive, elevating the pharyngeal process of the parotid as far as the superior constrictor muscle of the pharynx, whose surface reveals the ascending palatine branch of the facial artery and, posteriorly to the latter, the ascending pharyngeal branch of the external carotid artery. The following elements are then dissected:

1. The retromandibular vein.
2. The external carotid artery at the entrance to the gland.
3. The internal maxillary artery and vein, anteriorly, at 2 o' clock.

Following ablation of the deep portion of the parotid gland, the parotid cavity is completely cleared of its contents. The various components of the facial nerve can now be examined (Fig. 4.14).

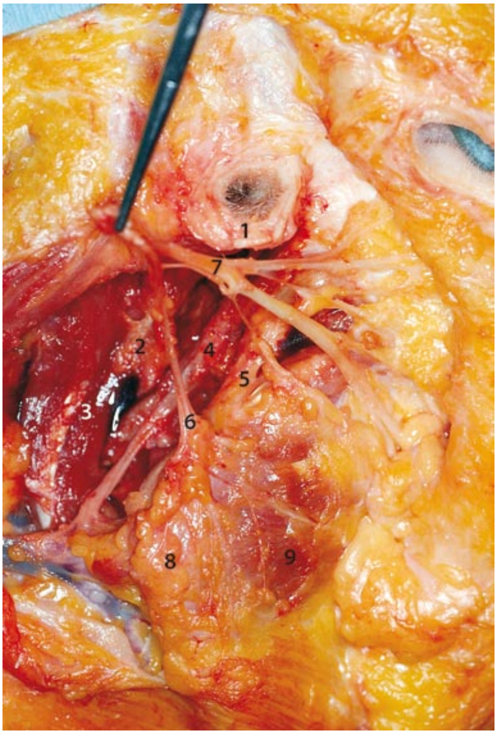

Fig. 4.13 Terminal branches of facial nerve (I)

1 = external auditory canal
2 = styloid process and stylienus muscles
3 = posterior belly of digastric muscle
4 = retromandibular vein
5 = external carotid artery
6 = cervicofacial trunk (facial nerve)
7 = temporofacial trunk (facial nerve)
8 = angle of mandible
9 = masseter muscle

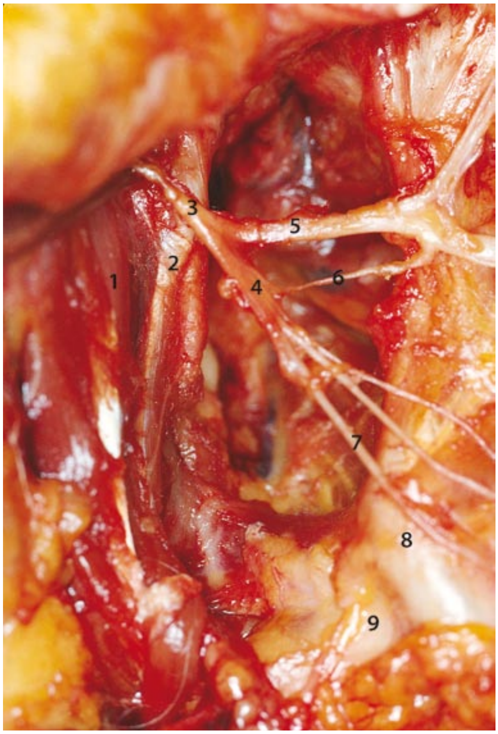

Fig. 4.14 Terminal branches of facial nerve (II)

1 = posterior belly of digastric muscle
2 = styloid process and stylienus muscles
3 = facial trunk
4 = cervicofacial trunk (facial nerve)
5 = temporofacial trunk (facial nerve)
6 = Ponce Tortella's loop
7 = marginal branch (facial nerve)
8 = angle of mandible
9 = interglandular septum

Complications: Periprandial symptomatology may occasionally manifest itself after parotidectomy and is characterized by hyperhidrosis and reddening of the cutis around the area served by the auriculotemporal nerve (Frey's syndrome). This phenomenon is due to abnormal innervation by auriculotemporal parasympathetic fibers that, after interruption by gland ablation, communicate with the sympathetic nervous system directed toward the skin glands and vessels. In some cases, symptoms regress spontaneously. Where this is not the case, the syndrome can only be cured by resection of the tympanic nerve, which runs along the medial wall of the middle ear.

- 4.2.17 At this point, the anatomical "minus" that remains after the complete removal of the gland can be clearly seen. A further dissection exercise may be to cut away a small flap from the anterior edge of the sternocleidomastoid muscle, hinged at the top. The anterior rotation and suture at the cranial end of the masseter muscle can fill the space and partially make up for the unaesthetic appearance, besides reducing the incidence of Frey's syndrome.

Take Home Messages

- To identify the common trunk of the facial nerve, we must constantly remember the landmarks of approach and the landmarks of interception.
- We must bear in mind that the marginal edge of the facial nerve usually crosses the retromandibular vein laterally; consequently, the ligating and sectioning of this vein, which we encounter early at the inferior pole of the gland, is superfluous in the exeresis of the superficial lobe. Indeed, it may be of assistance in identifying the common trunk of the facial nerve with a retrograde approach, starting from the vein at the inferior pole, identifying the marginal branch at this level, and coming up along the nerve to the goose's foot.
- We must consider that the great auricular nerve should not be completely sectioned in the phase of isolating the anterior margin of the sternocleidomastoid muscle. Intervention may be limited to the cutaneous anesthesia of the auricle and of the neighboring zones, sectioning only the branches that enter the gland, while leaving intact the posterior branches that go up along the mastoid region.
- Last, the flap of skin over the parotid gland should be cut in an arbitrary intra-adipose plane, more superficial than the cervical fascia that covers the gland. This guards against any lesions of the terminal branches of the goose's foot which, anteriorly, rise to the surface on the masseter.

Chapter 5

Submandibular–Submental Region (Robbins Level I)

5

Core Messages

- Submandibular surgery essentially consists of gland ablation or complete excision of the region; some important structures must, however, be preserved, such as the marginal branch of the facial nerve and the lingual and hypoglossal nerves. The most significant surgical stage is to succeed in revealing, on the plane of the hyoglossus, the lingual nerve, Wharton's duct, and the hypoglossal nerve.

5.1 Anatomic Layout

The region we are going to dissect corresponds to Robbins level I. Sublevel IA coincides with the submental region, and sublevel IB coincides with the submandibular level. The two sublevels are separated by the anterior belly of the digastric muscle.

The almond-shaped submandibular gland is located in the cavity of the same name and invested by a layer of superficial cervical fascia. The cavity has a superomedial wall contiguous with the mylohyoid and a lateral wall contiguous with the body of the mandible. The inferolateral wall is invested with split-open superficial cervical fascia, subcutaneous tissue, and skin. The anterior end of the gland is inserted between the mylohyoid and hyoglossal muscles and communicates with the sublingual cavity. The posterior end of the gland is separated from the parotid by the interglandular septum, which marks a thickening in the superficial cervical fascia, and is in close contact with the origin of the facial artery. The submandibular lymph nodes are prevalently subfascial and are situated by the superolateral margin of the gland. The submandibular cavity is bounded caudally by the digastric muscle. The anterior belly bounds the submental region with its median line (Fig. 5.1).

Significant anatomical structures: marginal branch of the facial nerve, facial artery, submental artery, lingual artery, lingual nerve, Wharton's duct, hypoglossal nerve.

Landmarks: angle of the mandible, mental protuberance, hyoid bone, posterior margin of the mylohyoid muscle.

5.2 Dissection

- 5.2.1 Below the platysma, the region is invested with superficial cervical fascia, which divides into two at this level to envelop the gland. In the thickness of the fascia we can identify two of the inferior branches of the facial nerve, i.e., the marginal nerve and nerve serving the platysma muscle. The former runs 1 cm above the inferior margin of the corpus mandibulae; the latter, which is more difficult to find, runs through the posterosuperior angle of the region, descending to innervate the platysma (Fig. 5.2).

- 5.2.2 After dissecting the superficial cervical fascia, the submandibular gland is exposed. On the surface of its posterior pole we look for the facial nerve, which in its downward course unites anteriorly with the submental vein and posteriorly with the retromandibular vein (or external carotid vein) to form the facial venous trunk. It should be borne in mind that venous circulation in this region is somewhat variable, and the situation described is the most frequent one. The interglandular

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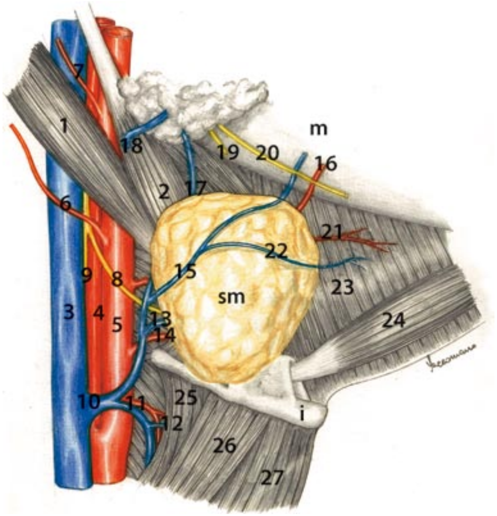

Fig. 5.1 Ablation of the submandibular gland (I)

sm = submandibular gland
p = parotid
m = mandible
i = hyoid bone
1 = posterior belly of digastric muscle
2 = stylohyoid muscle
3 = internal jugular vein
4 = external carotid artery
5 = internal carotid artery
6 = occipital artery
7 = posterior auricular artery
8 = hypoglossal nerve
9 = descending branch of hypoglossal nerve
10 = thyrolinguofacial venous trunk
11 = superior thyroid artery and vein
12 = superior laryngeal artery and vein
13 = lingual vein
14 = lingual artery
15 = facial vein
16 = facial artery
17 = retromandibular vein
18 = external jugular vein
19 = platysma branch (facial nerve)
20 = marginal branch (facial nerve)
21 = submental artery
22 = submental vein
23 = mylohyoid muscle
24 = anterior belly of digastric muscle
25 = thyrohyoid muscle
26 = omohyoid muscle
27 = sternohyoid muscle

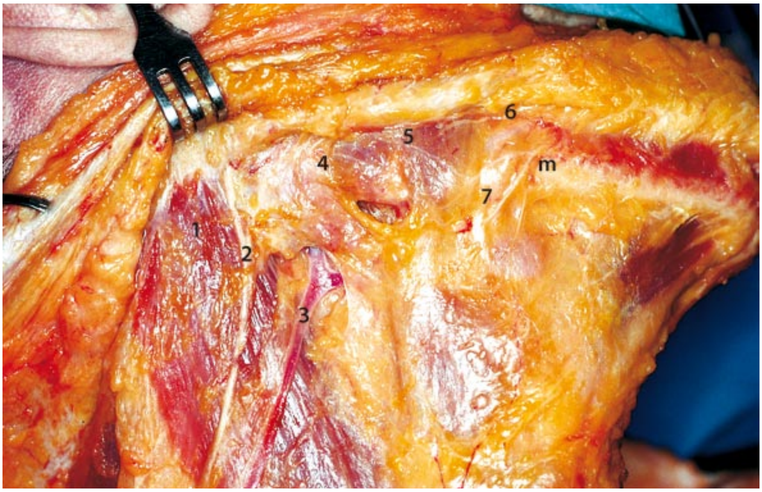

Fig. 5.2 Fascial plane

m = mandible
1 = sternocleidomastoid muscle
2 = great auricular nerve
3 = external jugular vein
4 = angle of mandible
5 = masseter muscle
6 = marginal branch (facial nerve)
7 = facial pedicle

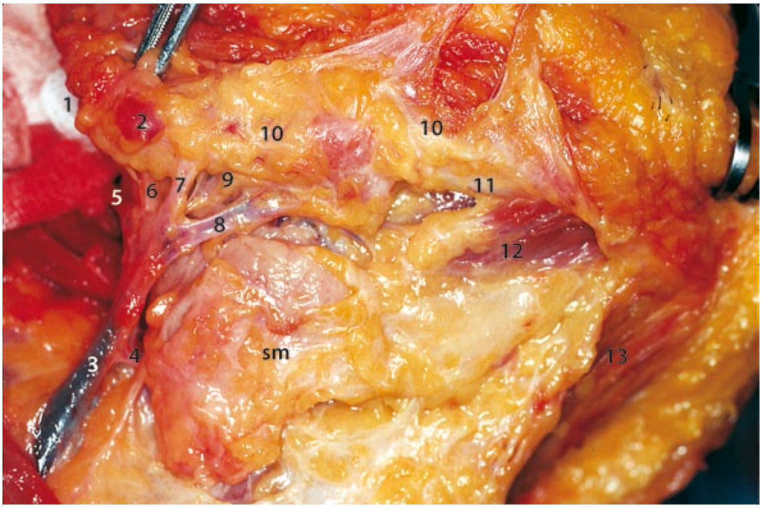

Fig. 5.3 Subfascial plane

sm = submandibular gland
1 = angle of mandible
2 = lymph node
3 = linguofacial venous trunk
4 = lingual vein
5 = retromandibular vein
6 = interglandular septum
7 = facial vein
8 = submental vein
9 = facial artery
10 = marginal branch (facial nerve)
11 = mandibular inferior margin
12 = mylohyoid muscle
13 = anterior belly of digastric muscle

septum can be viewed further behind, which is a thickening of the superficial cervical fascia separating the submandibular gland from the parotid (Fig. 5.3).

- 5.2.3 Dissection then proceeds by elevating the superficial cervical fascia from the contents of the cavity, exposing at the top the distal part of the facial pedicle. At the bottom the two bellies are uncovered and the intermediate tendon of the digastric muscle that binds the submandibular cavity at the bottom (Fig. 5.4).

- 5.2.4 The facial pedicle can be found straddling the inferior margin of the mandible, by the anterior border of the masseter muscle. The marginal branch of the facial nerve crosses the facial pedicle at the top and innervates the mimetic muscles of the lower lip. We ligate the distal facial pedicle 1 to 2 cm from the inferior margin of the mandible (Fig. 5.5).

  Complications: Traumatization of the marginal nerve causes temporary paresis of the depressor labii inferioris. It is therefore good practice to maintain a caudal position with respect to the cutaneous incision, to avoid exerting excessive traction on the flap in proximity to the mandibular margin and, where necessary, to dissect the facial pedicle as close as possible to the gland. In the latter case we are sure to preserve it by turning the sectioned pedicle upward. The nerve, which always passes over the pedicle, is thus stretched upward, away from the surgical field (Hayes Martin maneuver).

- 5.2.5 Gland ablation begins from the posterior pole, demonstrating the course of the facial artery branch of the external carotid artery. It emerges behind the posterior belly of the digastric muscle, posteriorly skimming the submandibular gland; running backward and forward, and upward and downward, it surfaces to surround the inferior margin of the mandible, immediately anterior to the facial vein. We ligate the proximal facial pedicle where it appears behind the digastric muscle. In the benign pathology of the submandibular

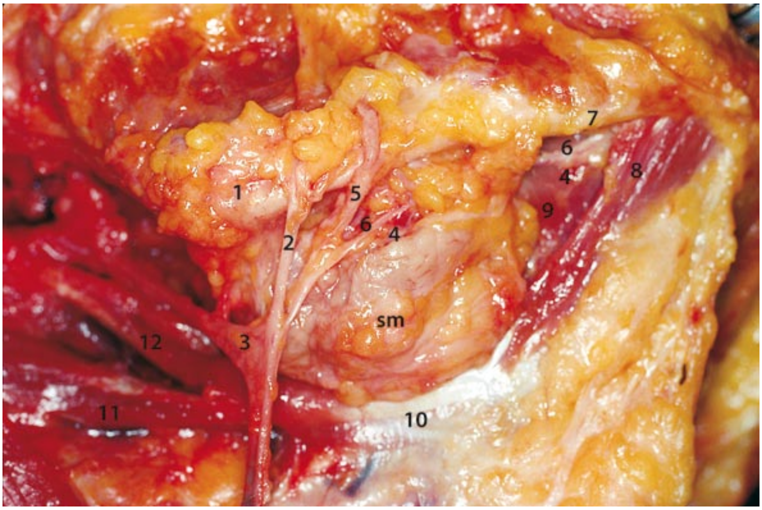

Fig. 5.4 Facial pedicle plane

sm = submandibular gland
1 = angle of mandible
2 = facial vein
3 = retromandibular vein
4 = submental vein
5 = facial artery
6 = submental artery
7 = mandibular inferior margin
8 = anterior belly of digastric muscle
9 = mylohyoid muscle
10 = intermediate tendon of digastric muscle
11 = posterior belly of digastric muscle
12 = stylohyoid muscle

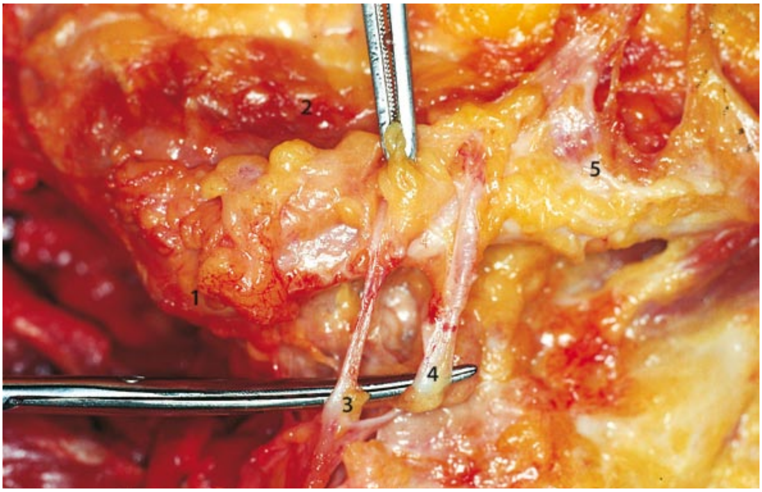

Fig. 5.5 Facial pedicle

1 = angle of mandible
2 = masseter muscle
3 = facial vein
4 = facial artery
5 = marginal branch (facial nerve)

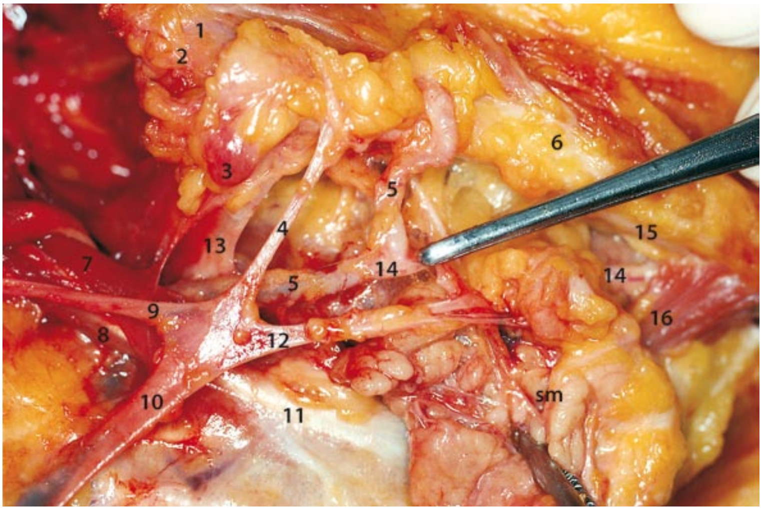

Fig. 5.6 Facial artery

sm = submandibular gland
1 = angle of mandible
2 = proximal portion of marginal branch (facial nerve)
3 = lymph node
4 = facial vein
5 = facial artery
6 = distal portion of marginal branch (facial nerve)
7 = stylohyoid muscle
8 = posterior belly of digastric muscle
9 = retromandibular vein
10 = facial venous trunk
11 = intermediate tendon of digastric muscle
12 = submental vein
13 = interglandular septum
14 = origin of submental artery
15 = mandibular inferior margin
16 = anterior belly of digastric muscle

gland, the facial artery is preserved as a rule (Fig. 5.6).

Its anterior branch, the submental artery, thrusts itself in an anteromedial direction, toward the submental region, and is the only important vessel above the mylohyoid muscle. Once we arrive at this plane, we reveal the posterior margin of the muscle (Fig. 5.7).

The gland is then raised from the deep muscle plane (hyoglossus muscle) and intermediate muscle plane (mylohyoid muscle) and everted. The submental artery is dissected together with the previously isolated venous collectors of the facial trunk (Fig. 5.8).

The exposure of the plane of the hyoglossus allows above all the identification of the hypoglossal nerve, which runs anteriorly beneath the mylohyoid muscle and above the intermediate tendon of the digastric muscle. Above the nerve we shall isolate Wharton's duct (Fig. 5.9).

A small Farabeuf is used to move the posterior margin of the mylohyoid muscle forward, revealing the hyoglossal plane. The following can be seen from the top downward:

1. The lingual nerve (a sensory nerve arising in the posterior trunk of the mandibular branch of the trigeminal nerve; it provides sensory and taste innervation of the mucosa in front of the lingual "V") connected to the submandibular ganglion (parasympathetic, with afferent impulses from the chorda tympani of the facial nerve, and efferent impulses to the lingual nerve with a submandibular and sublingual secretory function).
2. Wharton's duct, oriented anteriorly toward the sublingual gland.
3. The hypoglossal nerve (motor nerve of the tongue and—in concert with the descending branch of the cervical plexus—the subhyoid muscles, save the thyrohyoid muscle, which it innervates separately) (Fig. 5.10).

Complications: On reaching the hyoglossal muscle plane, it is essential when ligating Wharton's duct to avoid injuring the lingual nerve or, worse still, the hypoglossal nerve,

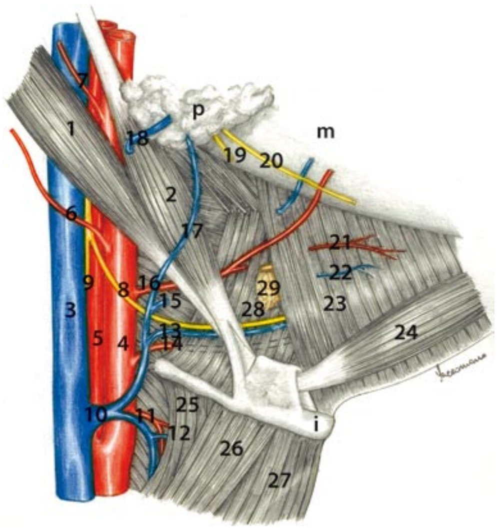

Fig. 5.7 Ablation of the submandibular gland (II)

p = parotid
m = mandible
i = hyoid bone
1 = posterior belly of digastric muscle
2 = stylohyoid muscle
3 = internal jugular vein
4 = external carotid artery
5 = internal carotid artery
6 = occipital artery
7 = posterior auricular artery
8 = hypoglossal nerve
9 = descending branch of hypoglossal nerve
10 = thyrolinguofacial venous trunk
11 = superior thyroid artery and vein
12 = superior laryngeal artery and vein
13 = lingual vein
14 = lingual artery
15 = facial vein
16 = facial artery
17 = retromandibular vein
18 = external jugular vein
19 = platysma branch (facial nerve)
20 = marginal branch (facial nerve)
21 = submental artery
22 = submental vein
23 = mylohyoid muscle
24 = anterior belly of digastric muscle
25 = thyrohyoid muscle
26 = omohyoid muscle
27 = sternohyoid muscle
28 = hyoglossus muscle
29 = anterior process of submandibular gland

as by rash cautery. Lesion of the hypoglossal nerve causes dysphagia and the tongue, when protruded, deviates toward the paretic side.

- 5.2.6 The lingual artery, which is the second branch of the external carotid artery, is sought and bound. Almost immediately after its origin, accompanying the middle constrictor of the pharynx, it meets the posterior margin of the hyoglossal muscle, which takes a horizontal, parallel route to the greater cornu of the hyoid bone, approximately half a centimeter above it (Fig. 5.11).

- 5.2.7 Exercise 2: Lingual Artery (Fig. 5.12)
In clinical practice, the seeking and binding of the lingual artery are indicated at the preliminary stage of surgery of the oropharynx and of the oral cavity, and are carried out at the point of origin. In dissection classes, it is nonetheless interesting to isolate it behind and in front of the posterior belly of the digastric muscle, where anatomists locate Beclard's triangle and Pirogoff's triangle, respectively. The former is bounded by the posterior belly of the digastric muscle, the greater cornu of the hyoid bone, and the posterior margin of the hyoglossal muscle. Dissection in this space involves the hyoglossal fibers, just below the hypoglossal nerve and the lingual vein. The latter triangle is formed by the intermediate tendon of the digastric muscle, the hypoglossal nerve, and the posterior margin of the mylohyoid muscle. In this case too, the lingual artery is isolated by dissecting the hyoglossal muscle fibers. Such well-defined anatomic details enable the lingual artery to be identified and ligated with extreme precision.

- 5.2.8 To conclude the exercise, dissection is extended anteriorly to the submental region, which lies between the two anterior bellies of the digastric muscles. We shall remove the adipose tissue that fills this space until we expose the plane of the mylohyoid muscles, which, uniting on the median line, form a fibrous raphe extending from the hyoid bone to the mental protuberance, known as the suprahyoid linea alba (Fig. 5.13).

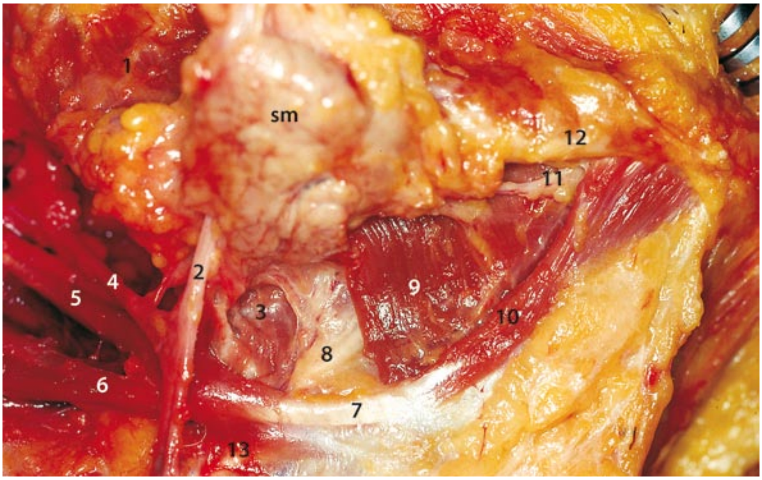

Fig. 5.8 Mylohyoid muscle plane (I)

sm = submandibular gland
1 = masseter muscle
2 = facial vein
3 = hyoglossus muscle
4 = retromandibular vein
5 = stylohyoid muscle
6 = posterior belly of digastric muscle
7 = intermediate tendon of digastric muscle
8 = hypoglossal nerve
9 = mylohyoid muscle
10 = anterior belly of digastric muscle
11 = submental artery
12 = mandibular inferior margin
13 = apex of great cornu of hyoid bone

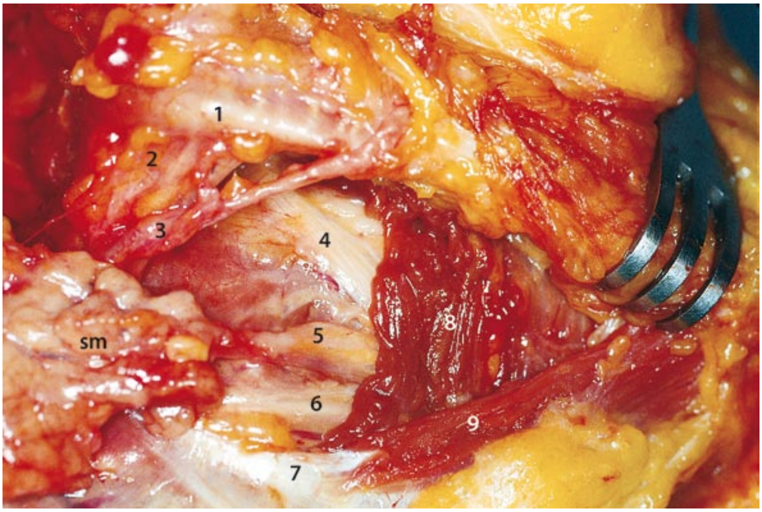

Fig. 5.9 Mylohyoid muscle plane (II)

sm = submandibular gland
1 = angle of mandible
2 = interglandular septum
3 = facial artery
4 = lingual nerve
5 = Wharton's duct
6 = hypoglossal nerve
7 = intermediate tendon of digastric muscle
8 = mylohyoid muscle
9 = anterior belly of digastric muscle

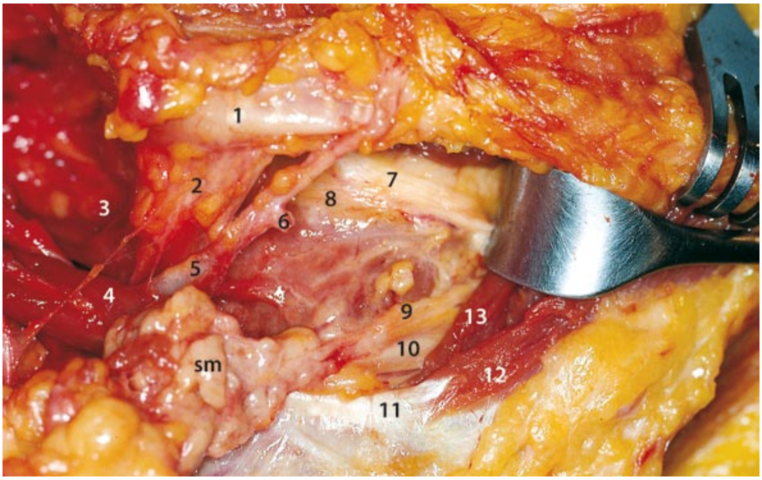

Fig. 5.10 Hyoglossal muscle plane

sm = submandibular gland
1 = angle of mandible
2 = interglandular septum
3 = parotid region
4 = stylohyoid muscle and posterior belly of digastric muscle
5 = facial artery
6 = origin of submental artery
7 = lingual nerve
8 = submandibular ganglion
9 = Wharton's duct
10 = hypoglossal nerve
11 = intermediate tendon of digastric muscle
12 = anterior belly of digastric muscle
13 = mylohyoid muscle

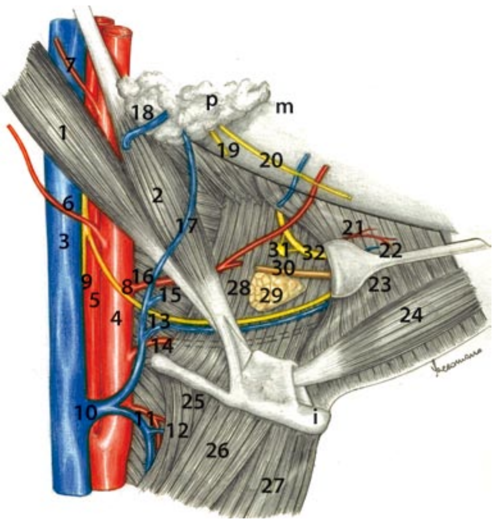

Fig. 5.11 Ablation of the submandibular gland (III)

p = parotid
m = mandible
i = hyoid bone
1 = posterior belly of digastric muscle
2 = stylohyoid muscle
3 = internal jugular vein
4 = external carotid artery
5 = internal carotid artery
6 = occipital artery
7 = posterior auricular artery
8 = hypoglossal nerve
9 = descending branch of hypoglossal nerve
10 = thyrolinguofacial venous trunk
11 = superior thyroid artery and vein
12 = superior laryngeal artery and vein
13 = lingual vein
14 = lingual artery
15 = facial vein
16 = facial artery
17 = retromandibular vein
18 = external jugular vein
19 = platysma branch (facial nerve)
20 = marginal branch (facial nerve)
21 = submental artery
22 = submental vein
23 = mylohyoid muscle
24 = anterior belly of digastric muscle
25 = thyrohyoid muscle
26 = omohyoid muscle
27 = sternohyoid muscle
28 = hyoglossus muscle
29 = anterior process of submandibular gland
30 = Wharton's duct
31 = submandibular ganglion
32 = lingual nerve

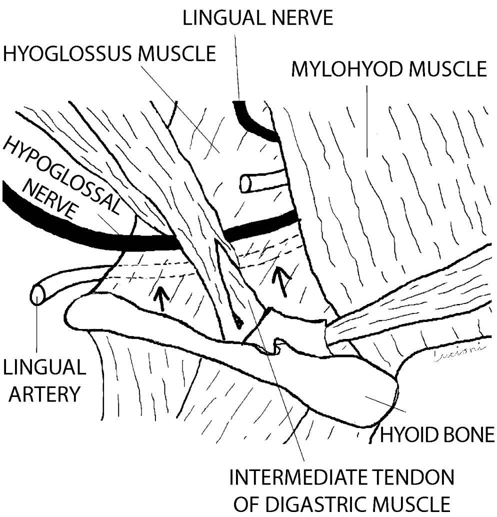

Fig. 5.12 Exercise 2: lingual artery

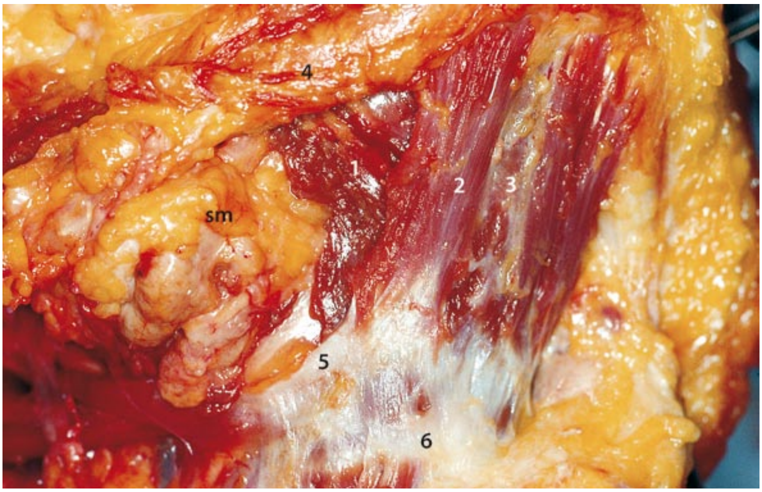

Fig. 5.13 Submental region

sm = submandibular gland
1 = mylohyoid muscle
2 = anterior belly of digastric muscle
3 = suprahyoid white line
4 = mandibular inferior margin
5 = intermediate tendon of digastric muscle
6 = hyoid bone

Take Home Messages

- In submandibular surgery in benign pathology, we must remember that, after repeated phlogosis, for example in sialolithiasis, the removal of the gland may be more exacting due to scars and to more intense bleeding. In these cases, there is an increased risk of lesion of the lingual and hypoglossal nerves. In the case of calculosis, it is necessary to check that the section of Wharton's duct does not let any calculi and parenchyma pass into the distal stump.
- In submandibular surgery in malignant pathology, the ablation includes the gland and the adipose and fascial tissue of the region; when required, exeresis may extend to the deep muscles, to the lingual artery and, if infiltrated by neoplasm, to the hypoglossal nerve. The excision of this region is required for the rare primitive tumors of the gland or as a stage of laterocervical excisions (Robbins level I), especially for tumors of the oropharynx, of the oral cavity, and of the lower lip. It may also be a transit surgical stage for access to the parapharyngeal space, after having dissected the digastric and stylienus muscles, as an alternative to transmandibular access.

Chapter 6

Laterocervical Region (Supraclavicular Region – Robbins Level V)

6

Core Messages

- The surgery of this region has a specific oncological significance for the treatment of lymphnodal metastases of tumors of the rhinopharynx, oropharynx, and of the posterior cutaneous tumors of the head and neck. It may also be considered for tumors of the larynx or of the hypopharynx if the presence of metastases at Robbins levels II or III has been ascertained. In the surgical exploration of this region, the peripheral branch of the spinal accessory nerve must be identified and preserved.

6.1 Anatomic Layout

The laterocervical region is bounded posteriorly by the anterior margin of the trapezius and by the splenius capitis muscle, anteriorly by the lesser cornu of the hyoid bone and lateral margins of the sternothyroid and thyrohyoid muscles, inferiorly by the superior margin of the clavicle, and superiorly by the inferior margin of the digastric muscle. The deep boundary of the region corresponds to the scalene, levator scapulae, and prevertebral muscle plane (Fig. 6.1).

Dissecting from bottom to top and from rear to front, we will adhere closely to the correct technique used for neck dissection in oncological patients, performing it here at least theoretically, to avoid the spread of any metastatic emboli.

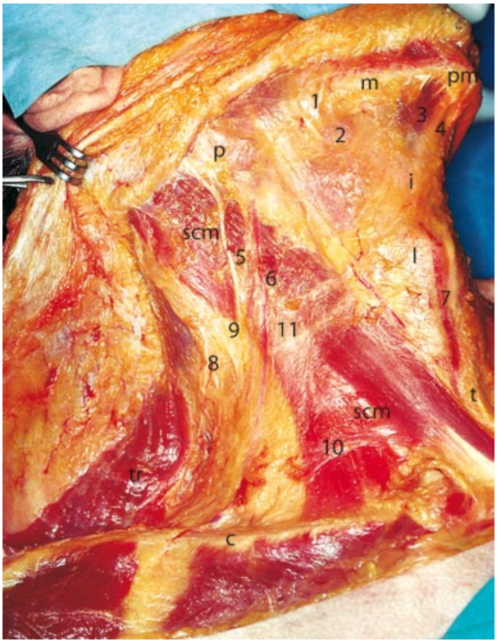

Fig. 6.1 Laterocervical region

p = parotid
m = mandible
pm = mental protrusion
scm = sternocleidomastoid muscle
i = hyoid bone
l = larynx
tr = trapezius muscle
t = thyroid gland
c = clavicle
1 = facial pedicle
2 = submandibular gland
3 = anterior belly of digastric muscle
4 = interdigastric (submental) area
5 = great auricular nerve
6 = external jugular vein
7 = anterior jugular vein
8 = spinal accessory nerve (peripheral branch)
9 = Erb's point
10 = superficial cervical fascia
11 = cutaneous cervical nerve

We shall start from the supraclavicular region and then move on to the jugulocarotid region. Translating the anatomic nomenclature of the Robbins levels, our dissection will start with level V and then proceed, in the following chapter, with levels II, III, and IV.

The supraclavicular region corresponds to Robbins level V. It is bounded superiorly by the apex formed by the convergence of the trapezius and sternocleidomastoid muscles, inferiorly by the clavicle, anteriorly by the posterior margin of the sternocleidomastoid muscle, and posteriorly by the anterior margin of the trapezius.

This level has the shape of a pyramid with the base at the bottom, where the first rib separates it from the pulmonary apex. In depth, the emerging of the cervical and brachial plexi separates level V from levels II, III, and IV. An imaginary horizontal line, inferiorly at a tangent to the cricoid cartilage, divides level V into VA (upper, lymph nodes of the spinal chain) and VB (lower, supraclavicular lymph nodes).

The celluloadipose content of this region is superiorly and medially in continuity with that of the jugulocarotid region, inferiorly and medially with that of the superior mediastinum, and inferiorly and laterally with that of the axilla.

The significant groups of lymph nodes are those adjacent to the peripheral portion of the spinal accessory nerve and those of the transverse cervical artery.

Significant anatomical structures: external jugular vein, spinal accessory nerve, great auricular nerve, middle cervical fascia, brachial plexus, scalene muscles, phrenic nerve, transverse cervical artery, subclavian artery.

Landmarks: clavicle, Erb's point, anterior margin of the trapezius, omohyoid muscle, Lisfranc's tubercle.

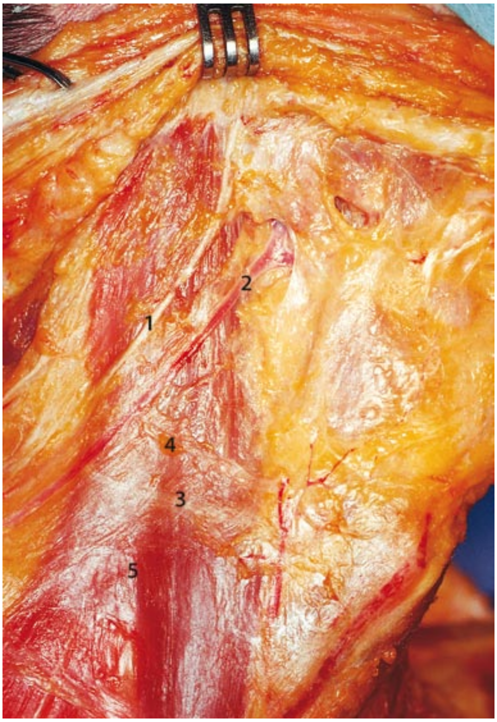

Fig. 6.2 Superficial cervical fascia plane

1 = great auricular nerve
2 = external jugular vein
3 = cutaneous cervical nerve
4 = superficial cervical fascia
5 = sternocleidomastoid muscle

6.2 Dissection

- 6.2.1 The neck is extended and rotated as far as possible in the opposite direction to the operator. If still present, the platysma is now completely resected, leaving the superficial cervical fascia in place. On the surface of the sternocleidomastoid muscle, under the superficial cervical fascia, three structures can clearly be seen which cross the muscle: (1) the great auricular nerve, (2) the external jugular vein with its branches, and (3) the cutaneous cervical nerve; both nerves are cutaneous (sensory) branches of the cervical plexus (Fig. 6.2).

  The superficial cervical fascia is dissected along the external surface of the sternocleidomastoid muscle, in the center, following a craniocaudal direction, and so the abovementioned structures are interrupted. The fascia is raised from the muscle fibers by holding the scalpel at a tangent to the muscle along its entire length (Fig. 6.3).

- 6.2.2 The dissection of level V begins with the identification and isolation of the spinal accessory nerve.

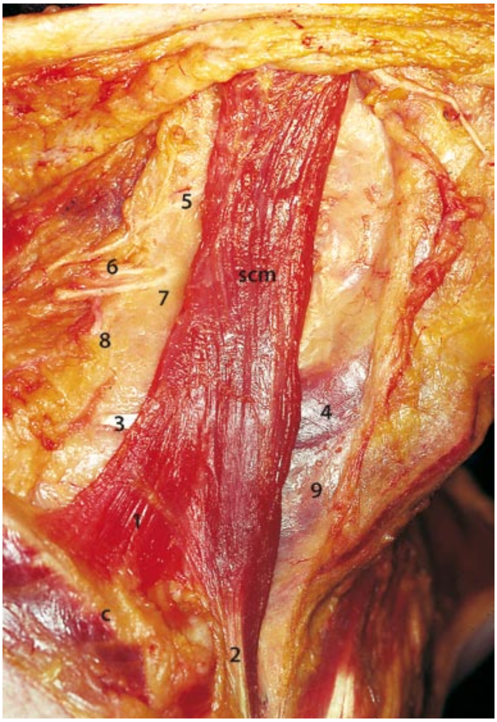

Fig. 6.3 Sternocleidomastoid muscle

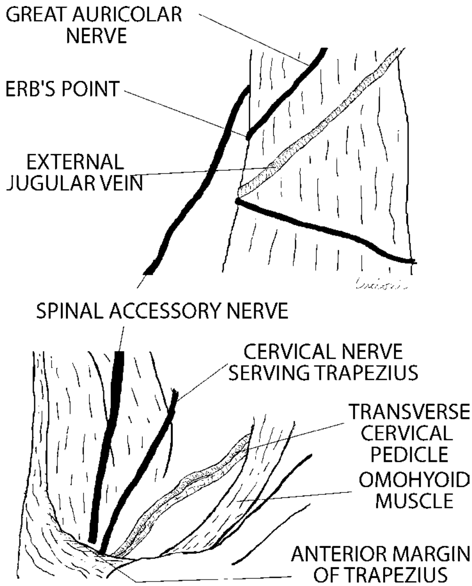

Fig. 6.4 Exercise 3: spinal accessory nerve

scm = sternocleidomastoid muscle
c = clavicle
1 = clavicular head of sternocleidomastoid muscle
2 = sternal head of sternocleidomastoid muscle
3 = intermediate omohyoid tendon
4 = superior belly of omohyoid muscle
5 = great auricular nerve (dissected)
6 = other branches of cervical plexus
7 = cutaneous cervical nerve (dissected)
8 = spinal accessory nerve (peripheral branch)
9 = sternohyoid muscle

The accessory nerve originates in the cranium from the union of the vagal accessory nerve (parasympathetic fibers/visceral effector) and spinal accessory nerve (somatic motor); it exits from the posterior foramen lacerum and divides once again – the vagal portion (internal or medial branch) joins the vagus nerve and participates in innervating the larynx. The spinal portion (external or lateral branch) passes anteriorly to the internal jugular vein, enters the sternocleidomastoid muscle (which it innervates), and exits in proximity to the posterior margin of the muscle. Running from top to bottom and from front to rear, the peripheral portion of the nerve then enters the trapezius, which it innervates.

6.2.3 Exercise 3: Spinal Accessory Nerve (Fig. 6.4).

We shall look for the peripheral portion of the spinal accessory nerve in two points:
1. At the exit from the posterior margin of the sternocleidomastoid muscle, about 1 cm

superiorly to Erb's point, i.e., where the great auricular nerve, which is part of the cervical plexus, surrounds the muscle and surfaces.
2. On entry to the trapezius, about 2 cm above the point where this muscle and the inferior belly of the omohyoid muscle cross.

The second approach is the more practical because neck dissection is normally performed from bottom upward and from back to front. First, we must identify the anterior margin of the trapezius just beneath the skin. The nerve, which penetrates the muscle medially at its anterior margin, is thus more easily protected. Here we shall identify the cervical branch for the trapezius and, after that, the distal portion of the transverse pedicle of the neck.

Once identified, the spinal accessory nerve is isolated along its entire course from the trapezius to the sternocleidomastoid muscle (Fig. 6.5). During this procedure, some spinal chain lymph nodes may be found, which follow the course of the nerve.

Complications: The trapezius and the sternocleidomastoid muscle have a double innervation, one coming from the spinal accessory nerve and another pertaining to the roots C2 and C3 of the cervical plexus. The sectioning of both afferents leads to what is defined "shoulder syndrome", and consists of the lowering and anterolateral rotation of the shoulder and of pain associated with the movements of lifting the limb. In some cases, this may be followed by marked hypertrophy of the sternoclavicular articulation, due to microfractures or capsular distortions from lifting and anteriorization of the medial section of the clavicle. Clinically speaking, a clavicular "pseudotumor" is presented, which, at first sight, may lead to the suspicion of metastases at level IV or secondary bone localization.

- 6.2.4 The medial surface of the trapezius is freed from the overlying loose connective tissue until, at the top and on a deeper plane, the levator scapulae muscle and the scalene muscles are revealed, covered by the deep cervical fascia (level VA). On the levator scapulae muscle the lesser occipital nerve can be identified, another cutaneous branch of the cervical plexus (Fig. 6.6).

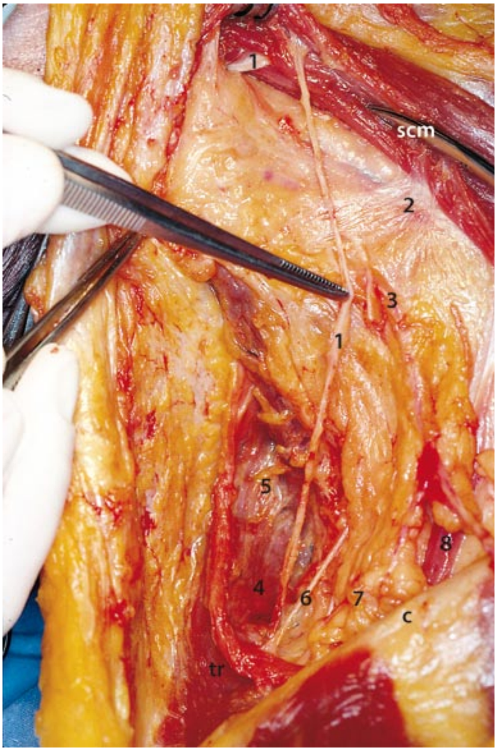

Fig. 6.5 Spinal accessory nerve

scm = sternocleidomastoid muscle
tr = trapezius muscle
c = clavicle
1 = spinal accessory nerve
2 = superficial cervical fascia
3 = branches of cervical plexus
4 = levator scapulae muscle
5 = deep cervical fascia
6 = cervical nerve serving trapezius muscle
7 = transverse cervical artery
8 = inferior belly of omohyoid muscle

Dissection will encounter other posterior branches of the plexus, and will stop medially at the level where the anastomotic loops of the cervical plexus emerge, medially to which there are the Robbins levels II and III.

The following structures are sought and isolated below the spinal accessory nerve (level VB):
1. The distal portion of the transverse cervical artery.

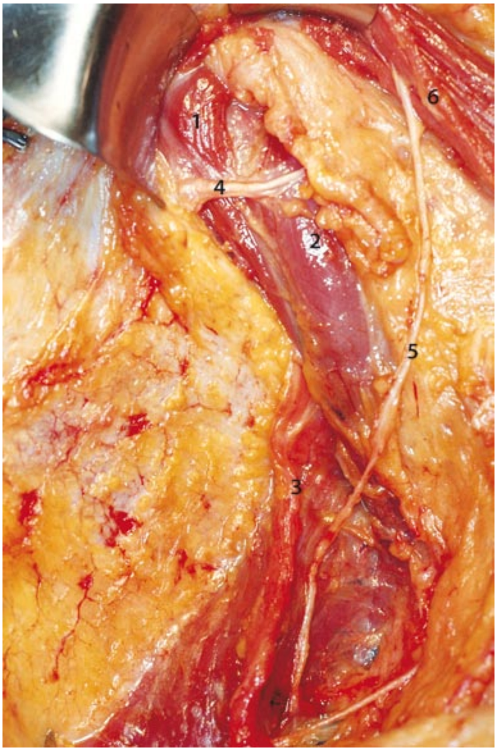

Fig. 6.6 Robbins level V

1 = levator scapulae muscle
2 = scalene muscles
3 = trapezius muscle
4 = lesser occipital nerve
5 = spinal accessory nerve
6 = sternocleidomastoid muscle

2. The cervical plexus branch serving the trapezius.

These structures are exposed by medially lifting the loose connective tissue from the supraclavicular fossa with the scissors (Fig. 6.7).

- 6.2.5 The omohyoid muscle is identified in the superficial portion of the supraclavicular triangle. The external jugular vein is evident in the immediate subfascial plane, thus above the plane of the omohyoid muscle. It arises from the external surface of the sternocleidomastoid muscle, lateralizes and descends toward the clavicle, and then meets the subclavian vein. It is served laterally by a single significant venous branch, i.e., the transverse cervical vein. These vessels are isolated and dissected at their ends (Fig. 6.8).

- 6.2.6 The next step is to isolate the inferior belly of the omohyoid muscle, which is invested in the more lateral portion of the mid–cervical fascia divided into two (Fig. 6.9).

- 6.2.7 We section the omohyoid muscle distally and evert it. Any hypertrophic lymph nodes of the supraclavicular chain lying on the posterosuperior margin of the clavicle are identified. With the aid of dry gauze, the adipose tissue is lifted medially, thus revealing the deep plane where we identify the plane of the scalene muscles, the brachial plexus and the overlying transverse cervical artery.

- 6.2.8 There are three scalene muscles: the anterior, medial, and posterior. They descend from the cervical column, diverging laterally, and inserting in the first and second ribs. They are invested by the deep cervical fascia, which continues medially on the prevertebral muscles (Fig. 6.10).

- 6.2.9 The brachial plexus is formed by the anterior branches of the fifth through eighth cervical nerves and of the first thoracic nerve. Three primary nerve trunks exit between the anterior scalene muscle and the median scalene muscle. One branch of the brachial plexus, the dorsal scapular nerve, exits between the median scalene and the posterior scalene muscles. The brachial plexus innervates the upper limb.

Remarks: Pancoast syndrome is the painful symptom complex propagated to the arm due to compression of the brachial plexus by laterocervical metastasis or a primary tumor of the apex of the lung.

Complications: In neck surgery, particularly neck dissection, lesions of the brachial plexus are very rare. The plexus is readily identifiable as a white, fibrous, triangular-shaped cord with an inferior base, forming the space between the scalene muscles. The plexus

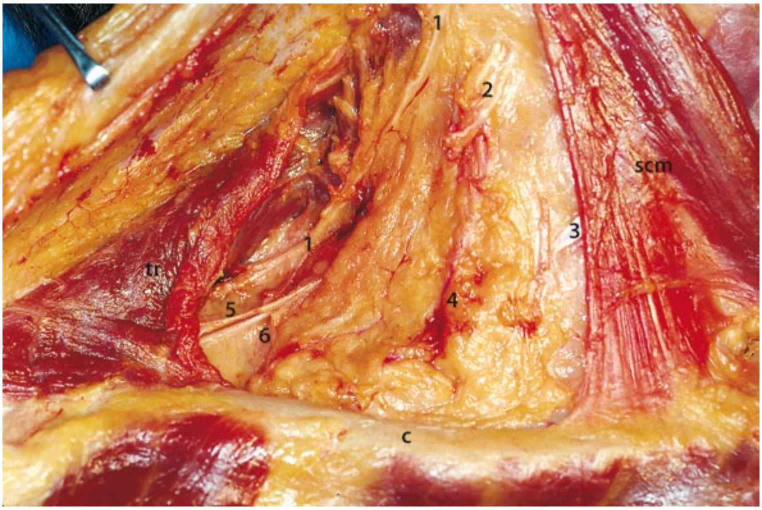

Fig. 6.7 Inferior subfascial plane

scm = sternocleidomastoid muscle
tr = trapezius muscle
c = clavicle
1 = spinal accessory nerve (peripheral branch)
2 = cervical plexus nerve
3 = intermediate omohyoid tendon
4 = external jugular vein
5 = cervical nerve serving trapezius muscle
6 = transverse cervical artery

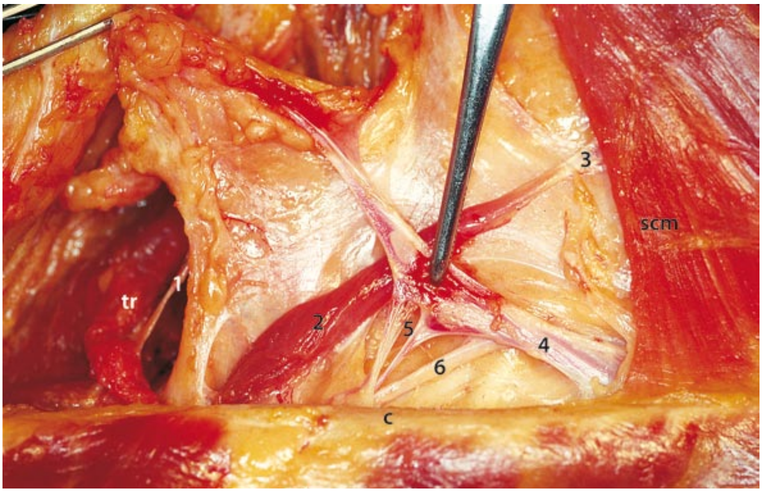

Fig. 6.8 Omohyoid muscle plane

scm = sternocleidomastoid muscle
tr = trapezius muscle
c = clavicle
1 = spinal accessory nerve (peripheral branches)
2 = inferior belly of omohyoid muscle
3 = intermediate omohyoid tendon
4 = external jugular vein
5 = transverse cervical vein
6 = transverse scapular artery

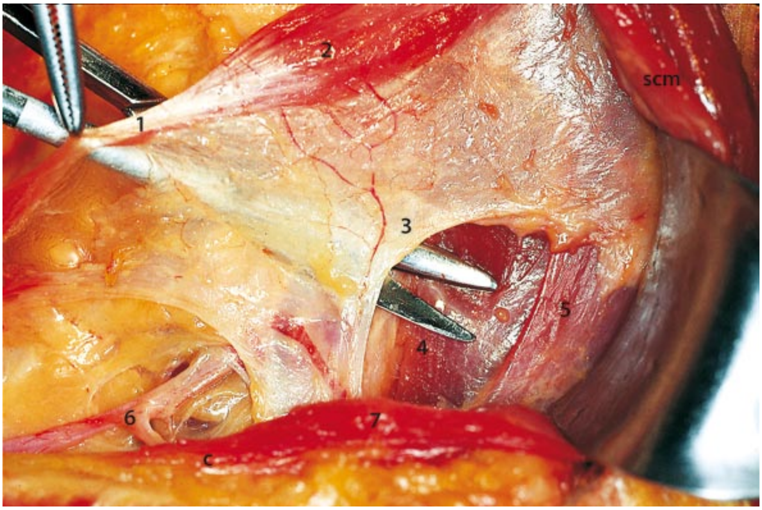

Fig. 6.9 Middle cervical fascia

scm = sternocleidomastoid muscle
c = clavicle
1 = intermediate omohyoid tendon
2 = superior belly of omohyoid muscle
3 = middle cervical fascia
4 = sternothyroid muscle
5 = sternohyoid muscle
6 = transverse scapular artery and vein
7 = clavicular insertion or sternocleidomastoid muscle

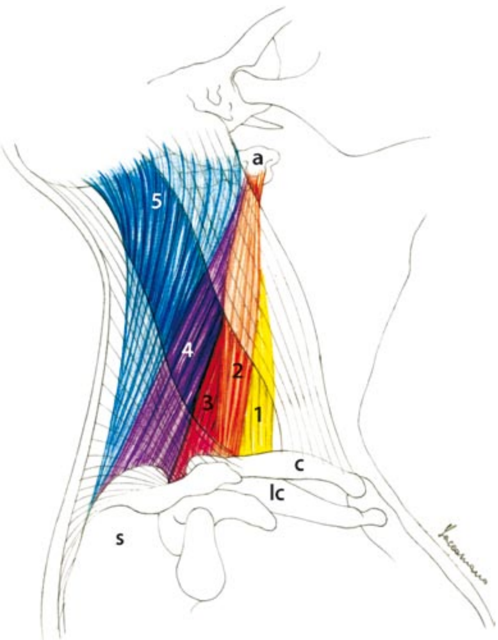

Fig. 6.10 Deep cervical muscles

a = transverse process of atlas
c = clavicle
Ic = first rib
s = scapula
1 = anterior scalene muscle
2 = medial scalene muscle
3 = posterior scalene muscle
4 = levator scapulae muscle
5 = splenius capitis muscle

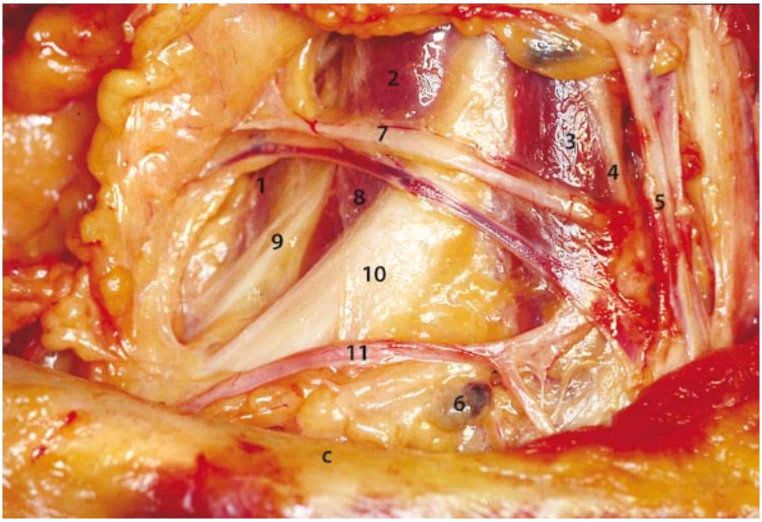

Fig. 6.11 Brachial plexus

c = clavicle
1 = posterior scalene muscle
2 = medial scalene muscle
3 = anterior scalene muscle
4 = phrenic nerve
5 = internal jugular vein
6 = anthracotic lymph node
7 = transverse cervical artery and vein
8 = deep cervical fascia
9 = dorsal scapular nerve
10 = brachial plexus
11 = transverse artery of the scapula

and muscles are invested by the deep cervical fascia (Fig. 6.11).

It is generally easy to elevate the supraclavicular cellulo–adipose tissue from the scalene plane with gauze since the surface of the deep cervical fascia is an excellent cleavage plane. Since the superior primary nerve trunk (C5–C6) is in a more superficial position than are the medial and inferior trunks, it is more exposed to trauma or lesions. Anatomic variants are also possible: In the loose supraclavicular cellular tissue, I personally witnessed the C5–C6 trunk running superficially and consequently, accidentally sectioned. This iatrogenic lesion induces motor impairment in the shoulder, which becomes lowered, with frequent dislocation of the head of the humerus; the arm droops on the trunk, exhibiting internal rotation and pronation. There is abduction paralysis of the arm and flexion paralysis of the forearm; 2 to 3 weeks later, atrophy appears in the muscles concerned.

- 6.2.10 The transverse cervical artery (and vein) (or superficial cervical artery) and transverse scapular artery (and vein) (or suprascapular artery) originate from the thyrocervical trunk. They enter the region medially and diverge laterally, crossing at two different levels of the brachial plexus. They must be isolated and their course followed to the region boundaries.

- 6.2.11 The phrenic nerve is a ramus muscularis of the four of the cervical plexus. It induces movement of the diaphragm, and contains sensory fibers for the pulmonary pleura and pericardium. It rests on the surface of the anterior scalene muscle, taking a slightly diverging lateromedial course with respect to the brachial plexus (as a memory aid, the phrenic nerve can be thought of as the thumb of a hand, while the other four fingers represent the branches of the brachial plexus).

The phrenic nerve can be easily identified by continuing digital elevation medially along the cleavage plane formed by the deep cervical prescalene fascia. It appears medially to the brachial plexus, invested by fascia on the external surface of the anterior scalene muscle. Dissection of the cutaneous branches of the cervical plexus, with the scissor point craniad, must be performed on a more superficial plane to the course of the phrenic nerve, which must always be identified beforehand.

Complications: Injury to or dissection of a phrenic nerve presents as paralysis of a hemidiaphragm and its elevation. Patients with monolateral phrenoplegia are generally asymptomatic; however, they may complain of dyspnea when lying down, since the contents of the abdomen tend to raise the flaccid hemidiaphragm. The resulting compensatory expansion of the rib cage forces the intercostal and accessory muscles to work hard to produce an effective inspiratory volume. Spirometry in patients with monolateral phrenoplegia exhibits a 25% decrease in total lung capacity (TLC), vital capacity (VC), inspiratory capacity and maximum inspiratory pressure (MIP), while the reduction in forced expiratory volume at the first second (FEVI) may be as high as 40%. These values are not normally associated with important clinical consequences, except in the presence of previous pulmonary pathologies with reduced respiratory functioning.

Bilateral phrenoplegia, which is very rare in cervical surgery, is more commonly related to central or systemic neurological pathologies. Transitory bilateral paralysis may in some cases result from heart surgery–related hypothermia. Assisted ventilation is required in such cases. Reparatory operations, requiring optimum physical performance, may also be conducted in patients with monolateral phrenoplegia, and consist of "folding" the flaccid hemidiaphragm to reduce compliance.

- 6.2.12 To conclude dissection of this region, it may be worth seeking and isolating the subclavian artery. It lies immediately inferomedially to the brachial plexus in the tract where the artery, straddling the first rib beneath the scalene muscles and, passing below the clavicle, becomes the axillary artery. Its passage on the first rib occurs immediately laterally to Lisfranc's tubercle, which is a bony prominence where the anterior scalene muscle is attached. This is an excellent landmark for ligating the interscalene portion of the subclavian artery. To reveal it, it is advisable to dissect the lateral portion of the anterior scalene muscle, of course after having identified and preserved the phrenic nerve.

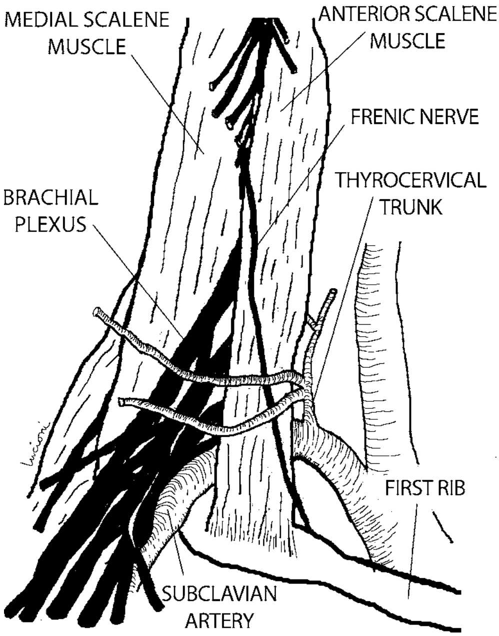

Fig. 6.12 Exercise 4: subclavian artery

- 6.2.13 Exercise 4: Subclavian Artery (Fig. 6.12). We identify the attachment of the anterior scalene muscle on the first rib and seek Lisfranc's tubercle by palpation. We look for the artery at the superior margin of the first rib, under the emergence of the brachial plexus. We can reveal it better by dissecting the lateral portion of the anterior scalene muscle, always after having revealed and preserved the phrenic nerve.

Remarks: At this point we recall the rare anterior scalene muscle syndrome, which consists of ischemic disturbances of the upper limb and of the hand and of ulnar neuralgia; these disturbances are accentuated with the limb hanging down and are alleviated when it is raised; they are due to compression of the subclavian artery and of the brachial plexus in the fissure between the median and anterior scalene muscles. The disturbances are cured by sectioning the anterior scalene muscle.

Take Home Messages

- Regarding the spinal accessory nerve, recall that at the bottom it may be confused with the branch of the cervical plexus for the trapezius, so before cutting the nerve it should be isolated to ascertain its identity. It may present anomalies in its course: For example in approximately 6% of cases it ends in the sternocleidomastoid muscle [3], and in 30% of cases it does not enter the muscle but remains posterior to it [4, 5]. It has also been demonstrated that the part of the spinal nerve with by far the greatest risk of iatrogenic lesion is its peripheral portion [6].
- In regard to the the peripheral branches of the cervical plexus, it must be considered that their sectioning (considered in both radical and modified radical neck dissection by Calearo and Teatini [2], but not in Bocca's functional neck dissection [1], involves a hypoanesthesia of the skin, which may extend from the auricle to the skin of the thorax adjacent to the clavicle.
- Solitary metastases on level VB must point to suspect neoplasias coming from the lung, the esophagus, the breast, and the stomach (on the left, Troisier's sign).

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Chapter 7

Laterocervical Region (Sternocleidomastoid or Carotid Region – Robbins Levels II, III, and IV)

7

Core Messages

- The surgery of this region has a specific oncological significance for the treatment of lymph node metastases of tumors of the upper respiratory and digestive tracts. The surgical exploration of this region will concern mainly the jugulocarotid axis and its adnexa. It is the area that the oncological surgeon of the head and neck explores most frequently.

7.1 Anatomic Layout

The sternocleidomastoid region as defined by anatomists corresponds approximately to Robbins levels II, III, and IV. It comprises roughly the sternocleidomastoid muscle and all that lies below it, considering the head in a normal position.

Robbins's classification (2002) [2] gives its precise limits, which are the base of the skull and the stylohyoid muscle at the top, the clavicle at the bottom, the posterior margin of the sternocleidomastoid muscle at the side, and, anteriorly, the lateral edge of the sternocleidomastoid muscle.

The three levels are divided in the craniocaudal direction by the inferior edge of the hyoid bone and the inferior edge of the cricoid cartilage.

The significant lymph node groups are above all those of level II and III, which represent the principal stations of lymphatic drainage of the neck.

Significant anatomical structures: common trunk of the spinal accessory nerve, cervical plexus, carotid arteries, internal jugular vein, vagus nerve, hypoglossal nerve, thyrolinguofacial trunk, phrenic nerve, subclavian artery, thoracic duct.

Landmarks: transverse process of the atlas, stylohyoid muscle, omohyoid muscle, greater cornu of the hyoid bone, carotid tubercle.

7.2 Dissection

- 7.2.1 We begin the dissection of this region from the most cranial part. We identify the deep musculofascial plane, which is formed, lateromedially, by the splenius capitis, levator scapulae, and scalene muscles. After having applied traction medially on the sternocleidomastoid muscle with a Farabeuf, we seek by palpation the transverse process of the atlas, which is an important landmark and the upper limit of lymph node drainage of the neck; close by runs the occipital artery or some of its branches. The overlying loose cellular connective tissue is stretched medially and the lesser occipital nerve, a cutaneous branch of the cervical plexus, can be demonstrated in the deep muscle plane (Fig. 7.1).

- 7.2.2 It is important at this point to find the common trunk of the spinal accessory nerve, which runs anteriorly to the internal jugular vein in a mediolateral direction and penetrates the sternocleidomastoid muscle. A reliable method of identifying it amid the cellulo–adipose tissue is to grasp the muscle with the hand, after isolating it from bottom to top, and to palpate with the index finger the stretched nerve within this soft tissue setting (Fig. 7.2).

  Instead, the most practical method is direct access from level II. The anterior margin of

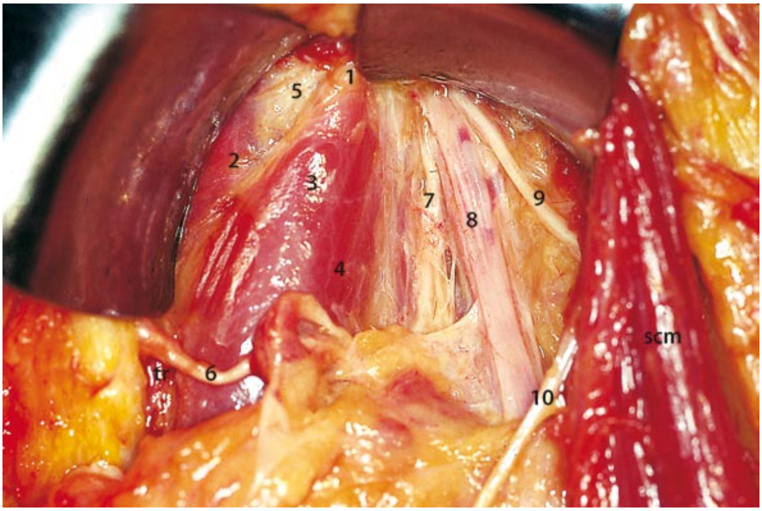

Fig. 7.1 Cervical deep plane and atlas

scm = sternocleidomastoid muscle
tr = trapezius muscle
1 = transverse process of atlas
2 = splenius capitis muscle
3 = levator scapulae muscle
4 = medial scalene muscle
5 = occipital artery
6 = lesser occipital nerve
7 = cervical plexus
8 = internal giugular vein
9 = spinal accessory nerve (common trunk)
10 = spinal accessory nerve (peripheral branch)

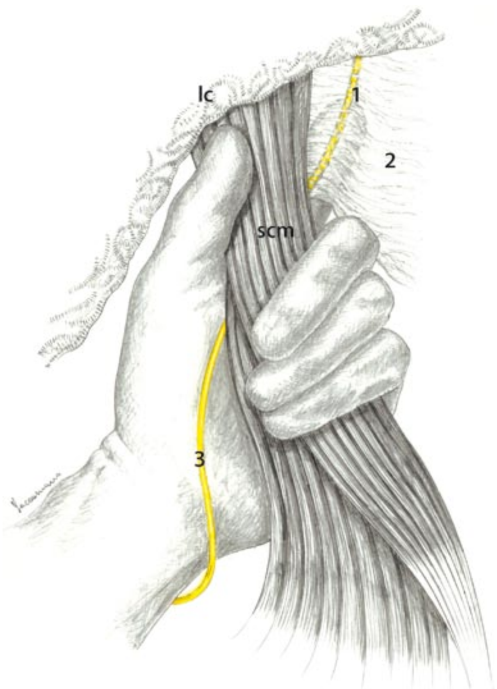

Fig. 7.2 Common trunk of the spinal accessory nerve

lc = cutaneous flap
scm = sternocleidomastoid muscle
1 = spinal accessory nerve (common trunk)
2 = loose and fascial connective tissue
3 = spinal accessory nerve (peripheral branch)

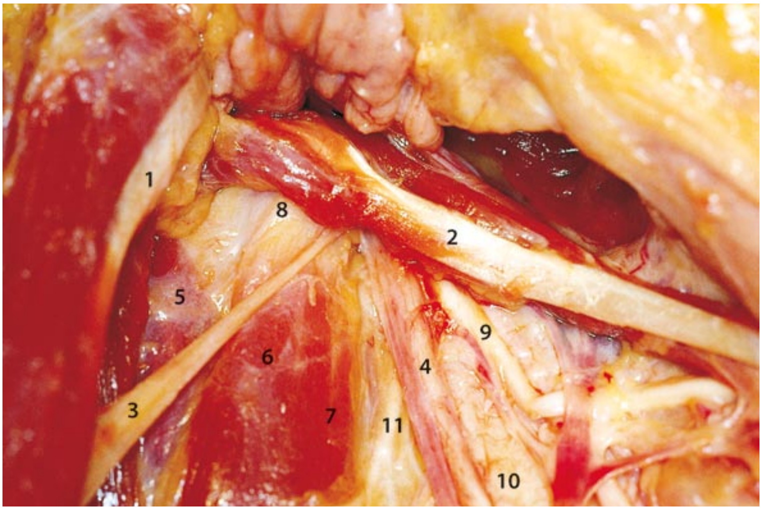

Fig. 7.3 Robbins level II

1 = sternocleidomastoid muscle
2 = posterior belly of digastric muscle
3 = spinal accessory nerve (common trunk)
4 = internal jugular vein
5 = splenius capitis muscle
6 = levator scapulae muscle
7 = anterior scalene muscle
8 = transverse process of atlas
9 = hypoglossal nerve
10 = carotid bifurcation
11 = branches of cervical plexus

the sternocleidomastoid muscle and the posterior belly of the digastric muscle are freed; the latter is another important landmark, on the surface of which there are no dangerous structures for dissection. Divaricating these two muscles allows access to Robbins level II. The common trunk of the spinal accessory nerve, which normally (though not always) runs above the internal jugular vein, divides into an anterior sector (level IIA) and a posterior one (level IIB) (Fig. 7.3).

Remarks: In tumors of the larynx, the presence of metastases at level IIB when level IIA is intact is a negligible occurrence. So, once the intraoperative histological examination has ascertained that level IIA is free from metastases, level IIB is not removed.

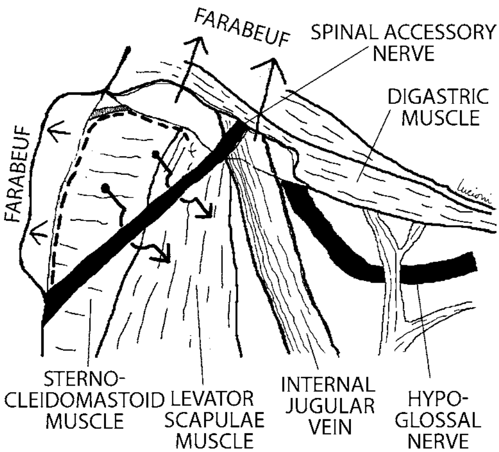

Fig. 7.4 Exercise 5: Robbins level IIB

- 7.2.3 Exercise 5: Robbins Level IIB (Fig. 7.4). It may be interesting to proceed with the surgical technique of approach to level IIB as used in modified radical and selective dissections. Once the common trunk of the spinal accessory nerve has been identified and the sternocleidomastoid and digastric muscles have been well divaricated, we first identify the internal jugular vein, which must be left medially. The nerve is delicately raised and separated from the adipose tissue below. We dissect the adipose tissue along an arched line with upper convexity, until we reach the deep muscle plane (levator scapulae and splenius capitis muscles). The upper limit of the dissection is the transverse process of the atlas, which is always easy to identify by palpation. In this area, we may encounter the occipital artery or one of its collateral branches. The adipose tissue is then elevated from the muscular plane from top to bottom and passed below the spinal nerve as a "bridge".

- 7.2.4 The inferior insertions of the sternocleidomastoid muscle are now dissected, that is:
  1. The head of the clavicle, corresponding to the deepest muscular portion, more wide and thin, which inserts on the medial quarter of the clavicle.
  2. The sternal head, corresponding to the most superficial and most consistent portion, which inserts on the anterior face of the sternal manubrium with a conoid tendon.

  The two components of the sternocleidomastoid muscle have different functions. The contraction of the head of the clavicle induces the flexion of the head onto the clavicle; the contraction of the sternal head induces the rotation and the contralateral extension of the head. The two muscle heads mark off a small triangular space with the base at the bottom (fossa supraclavicularis minor), which corresponds in depth to a length of the common carotid artery.

  The sternocleidomastoid muscle is dissected and everted up to the exit point of the spinal accessory nerve and the omohyoid muscle is entirely isolated (Fig. 7.5).

- 7.2.5 The dissection from the deep plane and the lateromedial shifting of the loose and fascial cellular tissues isolated so far allows the cervical plexus to be revealed.

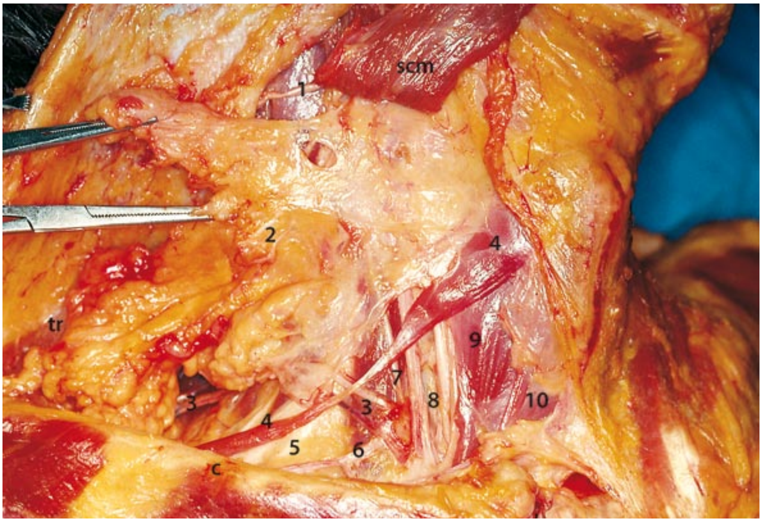

Fig. 7.5 Lateral deep plane

scm = sternocleidomastoid muscle
tr = trapezius muscle
c = clavicle
1 = lesser occipital nerve
2 = cervical plexus nerves (dissected)
3 = transverse cervical artery and vein
4 = omohyoid muscle
5 = brachial plexus
6 = transverse scapular artery and vein
7 = phrenic nerve
8 = cervical vasculonervous bundle
9 = sternothyroid muscle
10 = sternohyoid muscle

It is composed of three anastomosing loops formed by the anterior branches of the upper four cervical nerves (C1–C4). It gives rise to cutaneous, superficial, and sensory nerves (lesser occipital, great auricular, supraclavicular, and cutaneous nerves of the neck) and to muscular, deep, and motor nerves (nerves serving the sternocleidomastoid and trapezius muscles, phrenic, and descending cervical nerves). The descending cervical nerve, lying laterally to the cervical vasculonervous bundle, joins the descending branch of the hypoglossal nerve and forms the hypoglossal loop. It distributes branches serving the infrahyoid muscles, except for the thyrohyoid muscle, which is directly innervated by the hypoglossal nerve. The cervical plexus emerges between the anterior and medial scalene muscles; the cutaneous branches are dissected while the phrenic nerve and descending cervical nerve are identified and preserved (Fig. 7.6).

- 7.2.6 Dissection in a lateromedial direction takes us to the cervical vasculonervous bundle, formed laterally by the internal jugular vein, medially by the common carotid artery, and posteriorly, in the dihedral angle formed by the two vessels, by the vagus nerve. It should be remembered that the omohyoid muscle is a good guide in this phase, as it is invariably situated above the internal jugular vein. The only significant item on the surface of the omohyoid muscle is the external jugular vein.

The vessels are freed, as in routine surgical practice, from the tunica externa and consequently separated from the celluloadipose tissue and perijugular lymph nodes immerged therein. The specimen is pulled gently upward and the perivasal fasciae are cut with scissors. When working on the right side of the neck, right-handed operators proceed more easily from right to left (Fig. 7.7).

- 7.2.7 As a rule, the internal jugular vein does not present lateral tributaries. Medially we seek and isolate the main tributary, the thyrolinguofacial trunk, which enters it with a superior acute angle. Superiorly, subadventitial

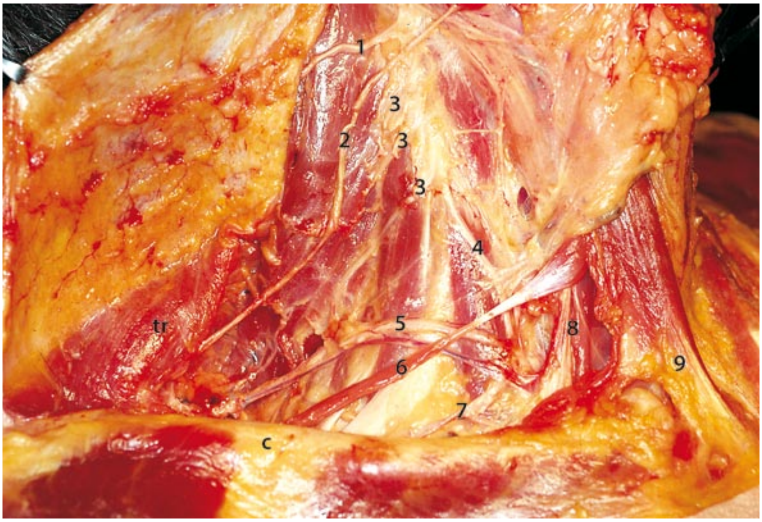

Fig. 7.6 Cervical plexus

tr = trapezius muscle
c = clavicle
1 = lesser occipital nerve
2 = spinal accessory nerve
3 = cervical plexus nerve
4 = phrenic nerve
5 = transverse cervical artery and vein
6 = omohyoid muscle
7 = transverse scapular artery and vei
8 = cervical vasculonervous bundle
9 = sternal head of sternocleidomastoid muscle

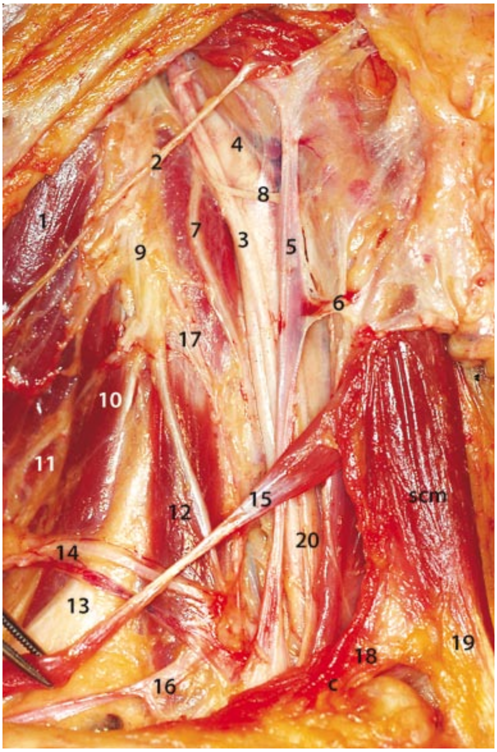

Fig. 7.7 Prescalene plane

scm = sternocleidomastoid muscle
c = clavicle
1 = levator scapulae muscle
2 = spinal accessory nerve
3 = vagus nerve
4 = internal carotid artery
5 = internal jugular vein
6 = thyrolinguofacial trunk
7 = descending branch of hypoglossal nerve
8 = hypoglossal nerve
9 = cervical plexus
10 = medial scalene muscle
11 = posterior scalene muscle
12 = anterior scalene muscle
13 = brachial plexus
14 = transverse cervical artery and vein
15 = omohyoid muscle
16 = transverse scapular artery and vein
17 = descending cervical nerve
18 = clavicular head of sternocleidomastoid muscle
19 = sternal head of sternocleidomastoid muscle
20 = common carotid artery

dissection may encounter an occasional vein, namely the vena thyreoidea ima. Our exercise will isolate each of the major trunk components, that is, the superior thyroid, lingual, and facial veins.

The specimen, composed of adipose tissue and of the cervical fascia, generally contains numerous lymph nodes. The perijugular lymph nodes are the most important group in the cervical lymphatic system. Most superior respiratory–digestive tract lymphatics empty into them and lie subfascially between the sternocleidomastoid muscle and lateral surface of the internal jugular vein. They extend from the stylohyoid process to the point where the internal jugular empties into the brachiocephalic vein, and are habitually divided by anatomists into three groups: (1) superior jugular (or jugular–digastric) lymph nodes, lying between the posterior belly of the digastric muscle and the thyrolinguofacial trunk; (2) middle jugular lymph nodes, lying between the thyrolinguofacial trunk and the superior belly of the omohyoid muscle; and (3) inferior jugular lymph nodes, situated below the omohyoid muscle (Fig. 7.8).

- 7.2.8 Dissection of the cervical vasculonervous bundle continues in a superior direction. From the sternoclavicular joint to the ipsilateral parotid cavity, it has variable relations with the sternocleidomastoid muscle, according to the position of the head. In the anatomic position, or with limited rotation, the carotid axis tends to protrude from the anterior margin of the sternocleidomastoid muscle and occupies the so-called carotid triangle.

At the superior margin of the thyroid cartilage, the common carotid artery divides into the internal and external carotid. The former runs laterally and is recognizable by the absence of collateral branches, while the latter runs medially. Higher up, the two vessels rotate and invert their position.

We may try to show the carotid body at the posterior wall of the carotid bifurcation. Its ap-

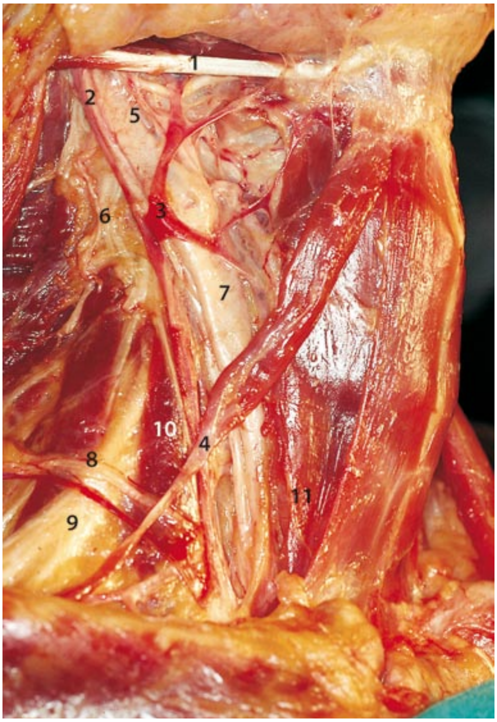

Fig. 7.8 Robbins levels II, III, and IV (I)

1 = posterior belly of digastric muscle
2 = internal jugular vein
3 = thyrolinguofacial trunk
4 = superior belly of omohyoid muscle
5 = internal carotid artery
6 = cervical plexus
7 = common carotid artery
8 = transverse cervical artery
9 = brachial plexus
10 = anterior scalene muscle
11 = sternothyroid muscle

pearance is that of a reddish corpuscle as large as a grain of wheat, invested in a perivascular fibrous sheath, lying adjacent to the posterior surface of the bifurcation. It is innervated by the glossopharyngeal, cervical sympathetic, and vagus nerves. It functions as a chemoreceptor because it transmits variations in blood oxygen and carbon dioxide content to the nerve centers, thanks to extensive vascularization and innervation (Fig. 7.9).

- 7.2.9 Dissection proceeds by isolating, again from top to bottom and back to front, the external carotid artery and, one by one, its anterior collateral branches:

1. The superior thyroid artery, which arises immediately after the carotid artery, describes a descending curve of about 100°, and medially branches into the superior laryngeal artery. The latter artery, accompanied by the homonymous vein and superior laryngeal nerve together form the superior laryngeal pedicle.
2. The lingual artery, situated above the superior laryngeal nerve is accompanied by the homonymous vein and runs superomedially, embedding itself just above the apex of the greater cornu of the hyoid bone and passing inferiorly to the posterior border of the hyoglossal muscle. Although parallel to the lingual artery, the lingual vein takes a more superficial course, running anteriorly to the hyoglossal muscle. It thus accompanies the hypoglossal nerve in the direction of the submandibular region.
3. The facial artery, which, in close proximity to its origin, runs behind the posterior belly of the digastric muscle and heads toward the submandibular region.
4. The posterior collateral branches of the external carotid artery are also sought and their course followed:
   a. The ascending pharyngeal artery, arising just above the origin of the superior thyroid artery; it rests on the middle constrictor of the pharynx and reascends.

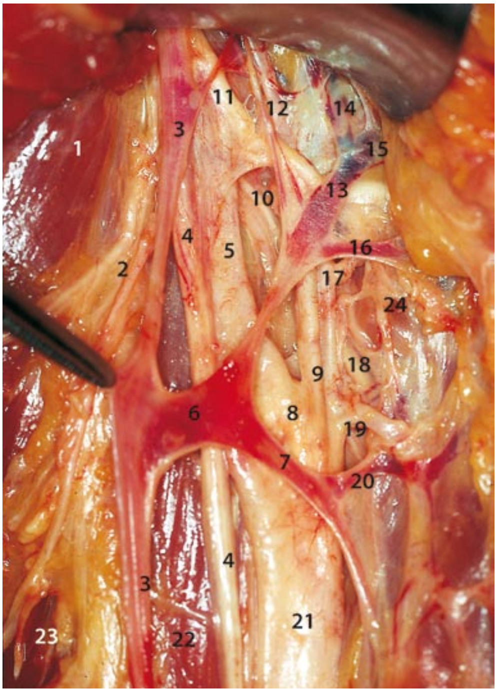

Fig. 7.9 Carotid bifurcation (I)

1 = levator scapulae muscle
2 = cervical plexus nerves
3 = internal jugular vein
4 = vagus nerve
5 = internal carotid artery
6 = thyrolinguofacial trunk
7 = superior thyroid vein
8 = carotid bifurcation
9 = external carotid artery
10 = superior laryngeal nerve
11 = hypoglossal nerve
12 = occipital artery
13 = facial vein (common trunk)
14 = retromandibular vein
15 = facial vein
16 = lingual vein
17 = lingual artery
18 = cervical sympathetic chain
19 = superior thyroid artery
20 = superior laryngeal vein
21 = common carotid artery
22 = anterior scalene muscle
23 = medial scalene muscle
24 = greater cornu of hyoid bone

b. The occipital artery, originating just below the junction between the hypoglossal nerve and the external carotid artery; it ascends laterally, passing behind the hypoglossal nerve and heading toward the mastoid (Fig. 7.10).

- 7.2.10 We now look for the hypoglossal nerve, which arches anteriorly, passing between the internal jugular vein and the two carotid arteries. At this point, it gives rise to a descending branch, which accompanies the anterior scalene muscle. This branch is anastomosed inferiorly with the descending cervical branch of the cervical plexus, forming the hypoglossal ansa. On medially reaching the extreme posterior of the greater cornu of the hyoid bone, the hypoglossal nerve gives rise to a branch serving the thyrohyoid muscle, which passes anteriorly to the greater cornu of the hyoid bone.

Remarks: The hypoglossal nerve is the most important structure in this region from the functional point of view, of course excluding the internal carotid artery. Any surgical maneuver in this site should identify the hypoglossal nerve beforehand so as not to damage it.

Complications: The hypoglossal nerve conducts motor nerves to the tongue. Its paralysis deviates the protruded tongue toward the side of the lesion, and the resting tongue toward the unimpaired side. Iatrogenic injury to the hypoglossal nerve is a very serious event in view of the importance of tongue movement in speech, mastication, and deglutition; the lack of backward movement by the base of the tongue to project ingested food toward the hypopharynx causes dysphagia, which is more severe after partial supraglottic surgery. There is a risk of injuring the hypoglossal nerve particularly: (1) in submandibular surgery, when periglandular scarring processes or excessive bleeding make it difficult to identify the nerve; (2) in functional laryngeal surgery, during isolation of the greater cornu of the hyoid bone, where dissection is not performed in very close contact to the bone; and (3) in functional supraglottic surgery, during

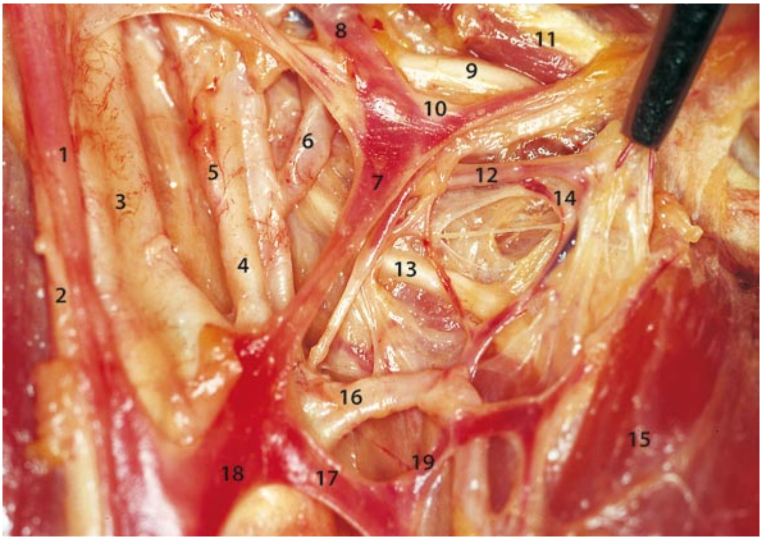

Fig. 7.10 Carotid bifurcation (II)

1 = internal jugular vein
2 = vagus nerve
3 = internal carotid artery
4 = external carotid artery
5 = ascending pharyngeal artery
6 = lingual artery
7 = common facial trunk
8 = retromandibular vein
9 = hypoglossal nerve
10 = facial vein
11 = hypoglossal muscle
12 = lingual vein
13 = superior laryngeal nerve
14 = greater cornu of hyoid bone
15 = sternohyoid muscle
16 = superior thyroid artery
17 = superior thyroid vein
18 = thyrolinguofacial trunk
19 = superior laryngeal vein

suturing of the supra- and infrahyoid muscles when the hyoid bone has been resected, as the nerve runs in the immediate vicinity.

- 7.2.11 The greater cornu of the hyoid bone, treated separately in view of its importance as a major landmark within this region, is above all a landmark in identifying the lingual artery and hypoglossal nerve. It is also an important landmark in seeking and ligating the superior laryngeal pedicle and, in surgical practice, in accessing the piriform recess. Finally, it is a precious indicator of the starting point for external carotid artery ligature (Fig. 7.11).

Complications: The external carotid artery or its branches may be ligated to arrest otherwise uncontrollable cervicofacial hemorrhaging or for preventive purposes in ablative oncological surgery of the upper respiratory and digestive tracts. The entire external carotid system may be sacrificed when englobed by neoplasms or tumorous metastases with rupture of the lymph node capsule. Ligation or excision of one side of the external carotid does not lead to functional impairment, given the extensive anastomotic network with the contralateral arterial system.

Normally, the external carotid artery is bound between the origin of the superior thyroid artery and the origin of the lingual artery. One very precious landmark is the lateral extremity of the greater cornu of the hyoid bone, lying immediately medially. In order to identify the external carotid artery at its origin, anatomists describe a "triangular window" bounded by the medial wall of the internal jugular vein, the lateral wall of the thyrolinguofacial trunk, and, at the top, the hypoglossal nerve; this space is referred to as Farabeuf's triangle (Fig. 7.12).

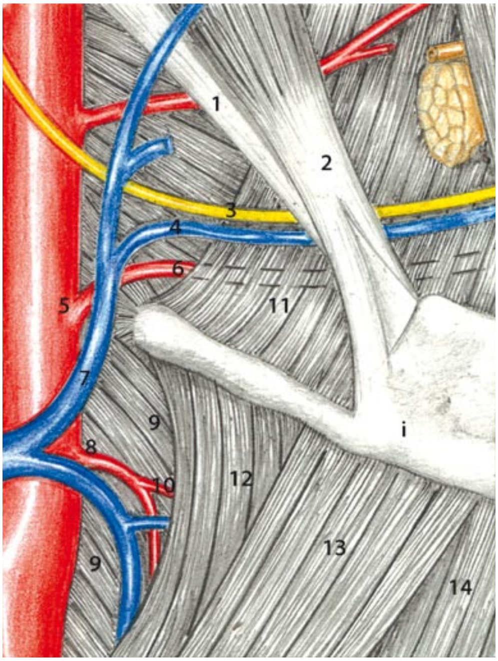

Fig. 7.11 Greater cornu of the hyoid bone

i = hyoid bone
1 = posterior belly of digastric muscle
2 = stylohyoid muscle
3 = hypoglossal nerve
4 = lingual vein
5 = external carotid artery
6 = lingual artery
7 = linguofacial trunk
8 = superior thyroid artery
9 = inferior constrictor muscle of pharynx
10 = superior laryngeal artery
11 = hyoglossal muscle
12 = thyrohyoid muscle
13 = omohyoid muscle
14 = sternohyoid muscle

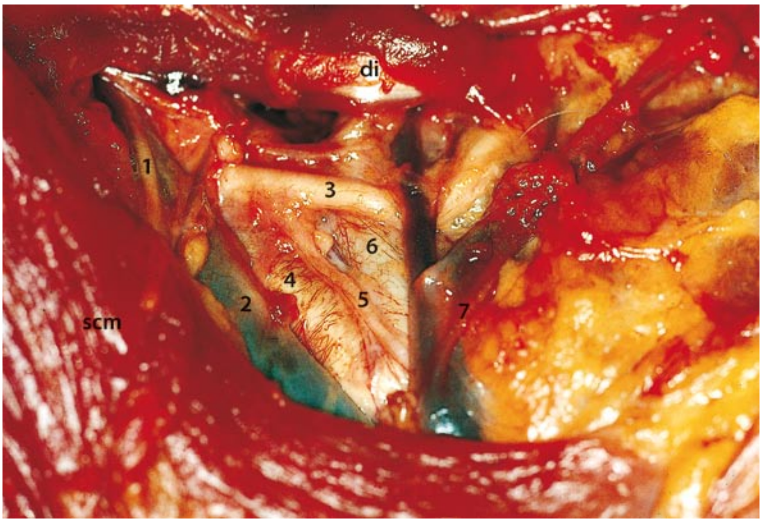

Fig. 7.12 Farabeuf's triangle

scm = sternocleidomastoid muscle
di = digastric muscle
1 = spinal accessory nerve
2 = internal jugular vein
3 = hypoglossal nerve
4 = internal carotid artery
5 = descending branch of hypoglossal nerve
6 = external carotid artery
7 = thyrolinguofacial trunk

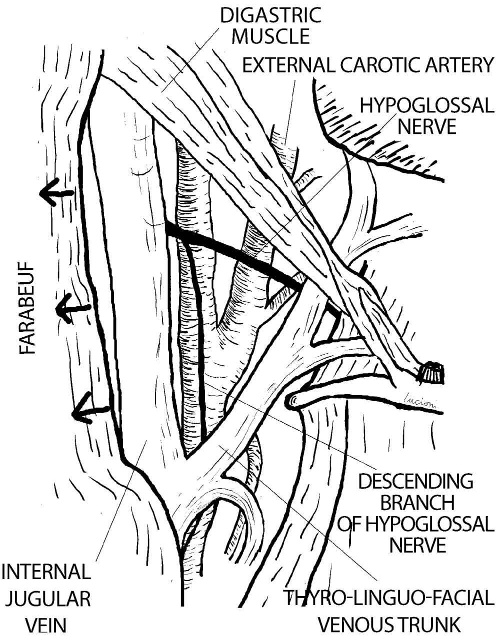

Fig. 7.13 Exercise 6: Farabeuf's triangle

- 7.2.12 Exercise 6: Farabeuf's Triangle (Fig. 7.13). It is certainly a useful exercise, to be carried out when the sternocleidomastoid muscle is still intact, to find and ligate the external carotid in Farabeuf's triangle. It is a typical emergency surgical procedure carried out in cases of hemorrhage of the pharynx or of the oral cavity that cannot be controlled in any other way.

  The first thing to is find the anterior margin of the sternocleidomastoid muscle which, in its medial portion, will be isolated at top and bottom for about 10 cm. Following the muscle medially we arrive at the internal jugular vein. This too must be well exposed. On the anterior margin of the vein we look for the thyrolinguofacial venous trunk. At the top, transversely and under the vein, we look for and isolate the hypoglossal nerve. In this triangle, formed by the anterior margin of the internal jugular vein, the lateral margin of the thyrolinguofacial venous trunk and the hypoglossal nerve, we look in depth for the carotid arteries. The external carotid artery is the one with collateral branches.

- 7.2.13 At this point most of the sternocleidomastoid region is revealed. Medially dissection reaches the subhyoid muscles and stops here because this is the medial limit of the region. Dissection continues in a downward direction, following the vasculonervous axis of the neck. We distinguish and skeletalize its three components. The fragility of the wall of the internal jugular vein, which is exposed with a subadventitious approach, can be clearly seen.

  Complications: The limited laceration of the wall of the internal jugular vein may be recomposed with a vascular suture, followed by the application of gauzes soaked in very hot water, which induces the formation of a vascular thrombus. The complete interruption of an internal jugular vein normally occurs in radical neck dissection, and this does not involve severe functional consequences. The problem may arise when both internal jugular veins are infiltrated by metastases and therefore have to be sacrificed; in this case, the neck dissection operations are carried out at an interval of at least 1 month to allow time for the establishment of sufficient lymphatic drainage.

- 7.2.14 The dissection of the common carotid artery is extended down as far as the confluence with the subclavian artery. Its wall is robust and does not tear easily. It lies very close to the prevertebral plane, particularly the transverse processes of the cervical vertebrae. It may be easily compressed against these for temporary hemostatic purposes in the event of hemorrhage. In particular, the artery lies close to the transverse process of the sixth cervical vertebra, which is more prominent on palpation. It is located two transverse fingers above the junction between the carotid and inferior thyroid artery. This bony prominence takes the name of carotid tubercle and is the landmark for ligating the common carotid artery.

  Complications: Internal carotid artery ligation is an exceptional clinical requirement. It is only required in the event of cataclysmic hemorrhage secondary to irreparable, spontaneous, or provoked wall rupture. Rupture of the common or of the internal carotid generally occurs in ablative neck operations in patients irradiated at maximum dosages or in neck cancer–related wall consumption. In these cases, ligation of the carotid axis is performed up- and downstream from the lesion. In the majority of cases, carotid englobement by neoplasia or tumorous metastases does not involve the arterial wall, and the vessel may be isolated subadventitiously. In cases where the tumor has infiltrated the carotid wall, preventing isolation, the arterial segment concerned must be excised and replaced by a vascular prosthesis or the reversed saphenous vein, autotransplanted after temporarily clamping the carotid axis. This surgical procedure, not devoid of danger from potential cerebral ischemia-related functional injury, does not produce long-term satisfactory oncological results.

Temporary or permanent interruption of blood flow in the internal carotid artery, in the absence of sufficient contralateral compensatory circulation through the arterial circle of the cerebrum, causes homolateral cerebral ischemia, with alteration in the state of consciousness and contralateral hemiparesis. Sometimes common carotid artery ligation does not produce neurological deficits, because it is already appreciably excluded by arteriosclerotic plaques or by neoplastic thrombi (Fig. 7.14).

- 7.2.15 As has already been seen in the vasculonervous bundle, the internal jugular vein is laterally positioned and the common carotid artery medially. The vagus nerve lies in the dihedral angle behind the two vessels. It can be easily isolated from the posterior foramen lacerum (where it exits from the cranium to-

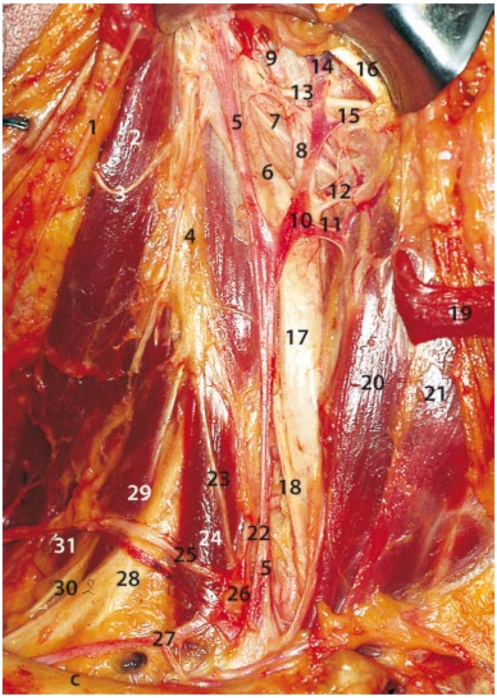

Fig. 7.14 Robbins levels II, III, and IV (II)

c = clavicle
1 = spinal accessory nerve
2 = levator scapulae muscle
3 = lesser occipital nerve
4 = cervical plexus
5 = internal jugular vein
6 = internal carotid artery
7 = superior laryngeal nerve
8 = external carotid artery
9 = occipital artery
10 = thyrolinguofacial trunk
11 = superior thyroid vein
12 = superior thyroid artery
13 = hypoglossal nerve
14 = facial vein
15 = lingual vein
16 = intermediate tendon of digastric muscle
17 = common carotid artery
18 = vagus nerve
19 = omohyoid muscle
20 = sternothyroid muscle
21 = sternohyoid muscle
22 = inferior thyroid artery
23 = phrenic nerve
24 = anterior scalene muscle
25 = transverse cervical artery
26 = thyrocervical trunk
27 = transverse scapular artery
28 = brachial plexus
29 = anterior scalene muscle
30 = dorsal scapulae nerve
31 = posterior scalene muscle

gether with the glossopharyngeal and accessory nerves) to its entrance to the thorax.

The vagus is a mixed nerve. It contains motor fibers (muscles of the velum palatinum, middle and inferior constrictors of the pharynx, muscles of the larynx, and cervical esophagus), parasympathetic fibers (extensive splanchnic innervation: heart, respiratory, and digestive tracts, involuntary muscles and glandular secretion), and sensory fibers (general sensitivity of part of the external auditory meatus, velum palatinum, pharynx, larynx and trachea; chemopressor reflex arcs). Its most important cervical branch is the superior laryngeal nerve, which separates posteriorly very high up, accompanies the pharyngeal muscles, and, running posteriorly to the carotid arteries, converges toward the larynx to form the superior laryngeal pedicle.

The nerve filaments for the striated pharyngeal muscles are hard to isolate; together with the terminal branches of the glossopharyngeal nerve they govern the deglutition mechanism and receive pharyngolaryngeal sensitivity.

Complications: Sectioning the vagus is fully compatible with life, since numerous anastomoses between the two vagal hemisystems permit any necessary compensatory action, thus avoiding the appearance of clinical symptoms, except obviously for paralysis of the hemilarynx and corresponding hemivelum palatinum or hemipharyngolaryngeal anesthesia. Conversely, dissecting both vagus nerves is not compatible with life (Fig.7.15).

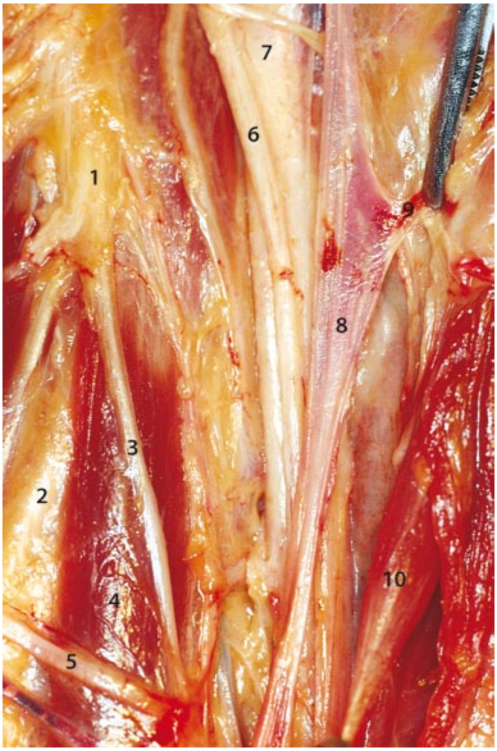

Fig. 7.15 Cervical vasculonervous bundle

1 = cervical plexus
2 = brachial plexus
3 = phrenic nerve
4 = anterior scalene muscle
5 = transverse cervical artery
6 = vagus nerve
7 = common carotid artery
8 = internal jugular vein
9 = thyrolinguofacial trunk
10 = superior belly of omohyoid muscle

- 7.2.16 We now come to the lower portion of the sternocleidomastoid region where some important anatomic structures are identified and followed.

In the left laterocervical region, the thoracic duct is located in the laterally open dihedral angle formed by the internal jugular and subclavian veins. This is much larger than the right great lymphatic vein, since it collects lymph from the entire subdiaphragmatic area and from the left half of the supradiaphragmatic region. The duct posteriorly surrounds the subclavian vein, and, making a 180° reverse turn in direction, empties into it (see Chap. 10, "Prevertebral Region").

Complications: Lymphorrhage may be favored by anatomic anomalies (high outlet of the thoracic duct, up to 5 cm from the clavicle) or by surgical maneuvers on metastases at level IV.

Usually it is autolimited with compressive medications and gravity drainage. If it exceeds 600 ml per day and persists for more than a week, surgical revision is indicated to avoid general complications, and granulations and scars in the surgical bed of neck dissection. The latter occurrence would pose problems for subsequent re-exploration [1].

- 7.2.17 In relation to the medial margin of the anterior scalene muscle, it is easy to find the thyrocervical trunk, which arises in the subclavian artery and branches out at this point into secondary arteries, namely:
  1. The transverse scapular artery, which becomes intrathoracic at the junction with the brachial plexus.
  2. The transverse cervical artery, which laterally traverses the phrenic nerve, scalene muscles and brachial plexus.
  3. The ascending cervical artery.
  4. The inferior thyroid artery, which arches medially, passing the common carotid artery posteriorly, and heads toward the recurrent region.
  5. Often, as appears in the anatomic specimen in the figure, the ascending cervical and inferior thyroid arteries have a common origin (Fig. 7.16).

  We also consider that at this level, the largest lower branch of the subclavian artery is the internal thoracic artery (or internal mammary artery), which gives rise to the perforating branches that feed the deltopectoral reconstructive flap. The myocutaneous flap of the major pectoral is instead fed by the thoracoacromial artery, a branch of the axillary artery.

- 7.2.18 In the triangular space bounded by the clavicular and sternal head tendons of the sternocleidomastoid muscle, which anatomists refer to as the fossa supraclavicularis minor, the common carotid artery is separated from the skin solely by interposition of subcutaneous tissue, superficial cervical fascia, and middle cervical fascia.

- 7.2.19 We conclude the dissection of this region by assessing below the origins of the common carotid artery and of the subclavian artery from the anonymous artery We observe the course of the vagus nerve, which passes the subclavian artery anteriorly (on the right, and the aortic arch on the left). Last, we seek the origin of the inferior or recurrent laryngeal nerve, which, passing behind the artery, reascends toward the larynx (Fig. 7.17).

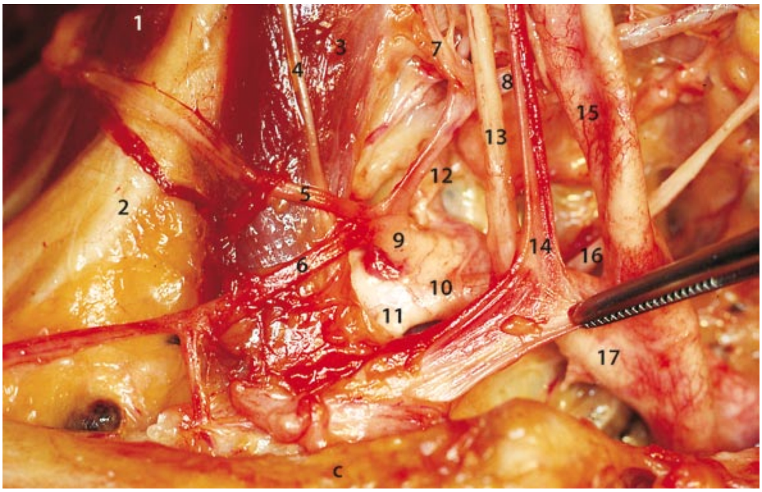

Fig. 7.16 Thyrocervical trunk

c = clavicle
1 = medial scalene muscle
2 = brachial plexus
3 = anterior scalene muscle
4 = phrenic nerve
5 = transverse cervical artery
6 = transverse scapular artery
7 = ascending cervical artery
8 = inferior thyroid artery
9 = thyrocervical trunk
10 = subclavian artery
11 = internal thoracic artery
12 = vertebral artery
13 = vagus nerve
14 = internal jugular vein
15 = common carotid artery
16 = recurrent nerve
17 = innominate artery (brachiocephalic trunk)

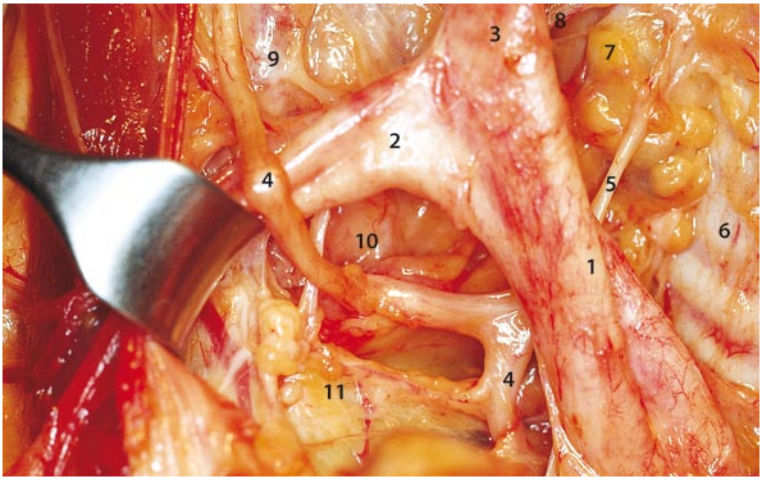

Fig. 7.17 Vagus nerve and recurrent nerve

1 = innominate artery (brachiocephalic trunk)
2 = subclavian artery
3 = common carotid artery
4 = vagus nerve
5 = recurrent nerve
6 = trachea
7 = recurrent region
8 = inferior thyroid artery
9 = middle cervical ganglion (cervical sympathetic chain)
10 = stellate ganglion (sympathetic chain)
11 = apex of the lung

Take Home Messages

- In the dissection of the carotid axis, above the bifurcation, the vessel encountered laterally is the internal carotid artery. One must always consider the possibility of anomalies of the arteries, known as "kinking", especially in elderly patients. Though they are rare, the failure to recognize them promptly in this site may be very dangerous.
- The ligation of the internal jugular vein must be tightened only after having ensured that the vagus nerve is outside the tie.
- The sternocleidomastoid muscle and the trapezius have a double innervation (C3, and C4 of the cervical plexus and spinal accessory nerve). This explains how shoulders without functional deficits may be observed after ascertained resections of the spinal accessory nerve.

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1. Crumley RL, Smith JD (1976) Postoperative chylous fistula prevention and management. Laryngoscope 86:804–813
2. Robbins KT, Clayman G, Levine PA et al (2002) Neck dissection classification update: revision proposed by the American Head and Neck Society and the American Academy of Otolaryngology-Head and Neck Surgery. Arch Otolaryngol Head Neck Surg 128:751–758

Chapter 8

Anterior Region (Robbins Level VI – Inferior Part) 8

Core Messages

- In this chapter we shall discuss above all the surgical anatomy of the thyroid. The essence of the exercise consists of removing the gland after having identified and followed the inferior laryngeal nerve (or recurrent nerve) with the intention of preserving it. The correct preparation of the area of operation and the precise knowledge of the landmarks must ensure that the finding of the nerve is not arrived at by chance.
- The cervical trachea will then be examined and we shall make a few considerations on tracheotomies. The dissection of this region will conclude with the exploration of the large vessels at the base of the neck and of the cervical oesophagus.

8.1 Anatomic Layout

The anterior region that we shall explore in this chapter and in the following one corresponds to what anatomists call the anterior infrahyoid region, since the suprahyoid region, which we called submandibular and submental, has already been dealt with in a previous chapter.

It coincides approximately with Robbins level VI, and has as its upper limit the hyoid bone and lower limit the medial end of the clavicles, the acromioclavicular articulation, and the jugular incisure of the manubrium sterni. Laterally it extends from the anterior margin of one sternocleidomastoid muscle to that of the contralateral muscle. Robbins's classification specifies superficial lateral limits, which are the lateral margins of the sternocleidomastoid muscles, and the deep limits, which are the common carotid arteries.

The lymph node stations of this compartment include the prelaryngeal lymph node (Delphian lymph node), the pretracheal lymph nodes, and the recurrent lymph nodes.

In order to balance out the topic more evenly for teaching purposes, in our dissection we have divided the median region into an *inferior part*, corresponding to the trachea, esophagus, and thyroid gland, and a *superior part*, corresponding to the larynx and hypopharynx (Fig. 8.1).

Significant anatomical structures: anterior jugular veins, infrahyoid muscles, thyroid gland, parathyroid glands, inferior thyroid artery, recurrent nerve, trachea, cervical esophagus, brachiocephalic artery (or innominate artery), vagus nerve, subclavian artery, thyrocervical trunk, vertebral artery.

Landmarks: jugulum, infrahyoid white line, carotid tubercle, cricothyroid articulation.

8.2 Dissection

- 8.2.1 First, we identify the main landmarks of this region, that is, the body of the hyoid bone and its greater cornua, the laryngeal prominence, the cricoid ring, and the intercricothyroid space, and finally, the jugulum (Fig. 8.2).

- 8.2.2 Dissection begins lateromedially by elevating the superficial and middle fasciae of the infrahyoid muscle plane (Fig. 8.3).

  Below are some important data on the superficial fascial plane:
  1. The medial margin of the platysma takes a divergent downward course and is consequently not present in the medioinferior part of the region.
  2. The superficial and middle cervical fasciae fuse on the midline into a single aponeurosis, a sort of raphe extending from the hyoid bone

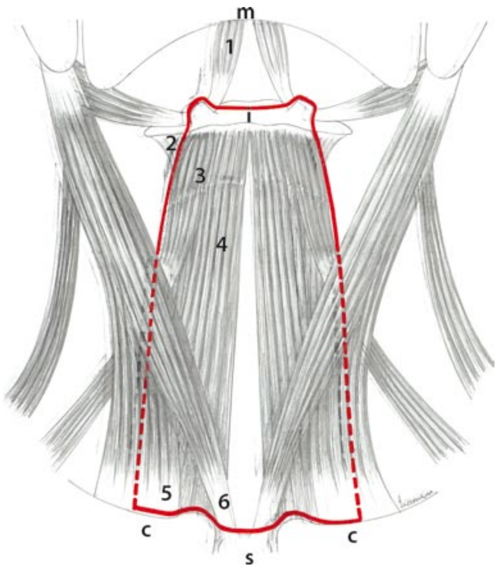

Fig. 8.1 Boundaries of the anterior region

m = mandible
i = hyoid bone
c = clavicle
s = sternum
1 = anterior belly of digastric muscle
2 = thyrohyoid muscle
3 = omohyoid muscle
4 = sternohyoid muscle
5 = sternocleidomastoid muscle (clavicular head)
6 = sternocleidomastoid muscle (sternal head)

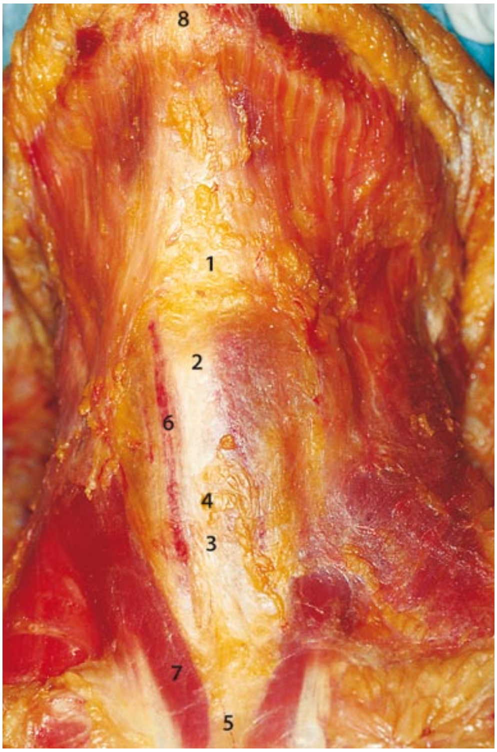

Fig. 8.2 Anterior region: orientation

1 = body of hyoid bone
2 = laryngeal prominence
3 = cricoid ring
4 = intercricothyroid space
5 = jugular notch
6 = anterior jugular vein
7 = sternocleidomastoid muscle (sternal head)
8 = mental prominence

to the sternum, which is referred to as the infrahyoid white line.

3. The superficial vessels are negligible, except for the anterior jugular veins, which run vertically to the neck along the paramedian line. At approximately 2 cm from the sternum they bend laterally and become embedded, passing posteriorly to the sternal tendon of the sternocleidomastoid muscle and empty into the brachiocephalic veins.

4. A few centimeters superior to the sternum, the cervical fascia divides into two sheets, one directed to the anterior and the other to the posterior border of the manubrium sterni. They delimit a space called the suprasternal space (Gruber's recess)—it contains cellulo–adipose tissue with a few lymph nodes and an anastomosis joining the anterior jugular veins that cross it.

- 8.2.3 Fascia resection extends superiorly to the hyoid bone, thereby exposing the muscle plane formed by the omohyoid, sternohyoid, and thyrohyoid muscles (Fig. 8.4).

We can see that the middle cervical fascia extends laterally from one omohyoid muscle

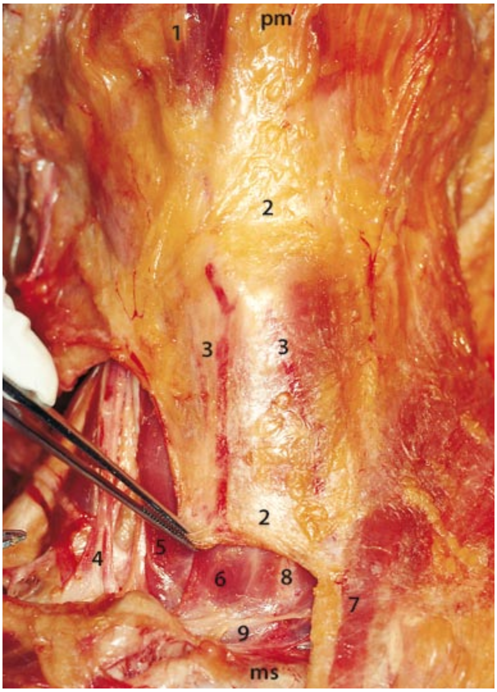

Fig. 8.3 Superficial fascial plane.

pm = mental prominence
ms = manubrium sterni
1 = platysma muscle
2 = superficial cervical fascia
3 = anterior giugular vein
4 = internal jugular vein
5 = sternothyroid muscle
6 = sternohyoid muscle
7 = sternocleidomastoid muscle (sternal head)
8 = infrahyoid white line
9 = Gruber's recess

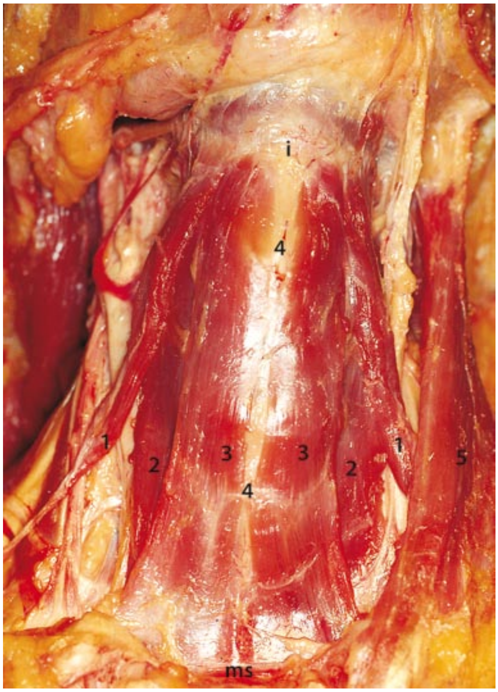

Fig. 8.4 Infrahyoid muscles plane

i = hyoid bone
ms = manubrium sterni
1 = omohyoid muscle
2 = sternothyroid muscle
3 = sternohyoid muscle
4 = infrahyoid white line
5 = sternocleidomastoid muscle

to the other, and that the sternothyroid muscle laterally overlaps more than the overlying sternohyoid muscle.

- 8.2.4 The infrahyoid muscles are then sectioned at the sternoclavicular level and raised from the thyroid gland, and cricoid and thyroid cartilages by applying cranial traction. The sternohyoid muscles are elevated up to the hyoid bone and the sternothyroid muscles up to the line of attachment to the thyroid lamina. The innervation of these muscles derives from the ansa cervicalis, with the exception of the thyroid muscle, which is directly innervated by a branch of the hypoglossal nerve. At the end of this maneuver, the thyroid gland is well revealed (Fig. 8.5).

- 8.2.5 The next step is to examine and dissect the thyroid gland and parathyroid glands.

  The thyroid is an endocrine gland lying medially to the base of the neck, whose front view has an open H shape and on cross-section a horseshoe shape, enclosing the cervical trachea in its concavity and the larynx and esophagus laterally. It is invested by a slender,

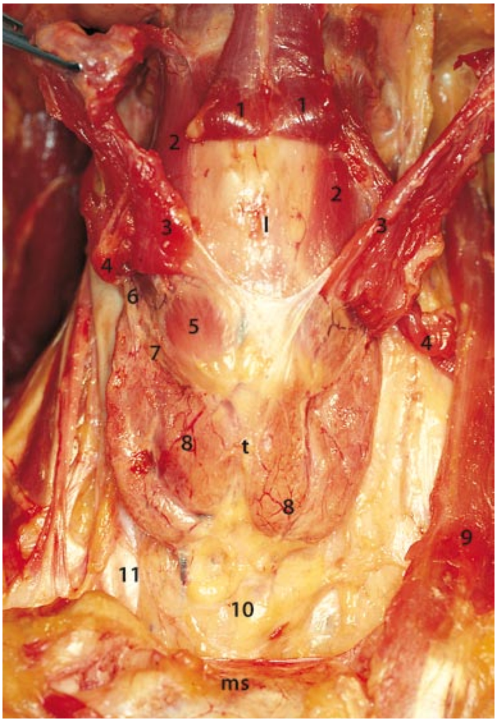

Fig. 8.5 Thyroid (I)

l = larynx
t = thyroid
ms = manubrium sterni
1 = sternohyoid muscle
2 = thyrohyoid muscle
3 = sternothyroid muscle
4 = omohyoid muscle
5 = cricothyroid muscle
6 = superior thyroid artery
7 = medial branch of superior thyroid artery
8 = thyroid capsule vessel
9 = left sternocleidomastoid muscle
10 = pretracheal region
11 = common carotid artery

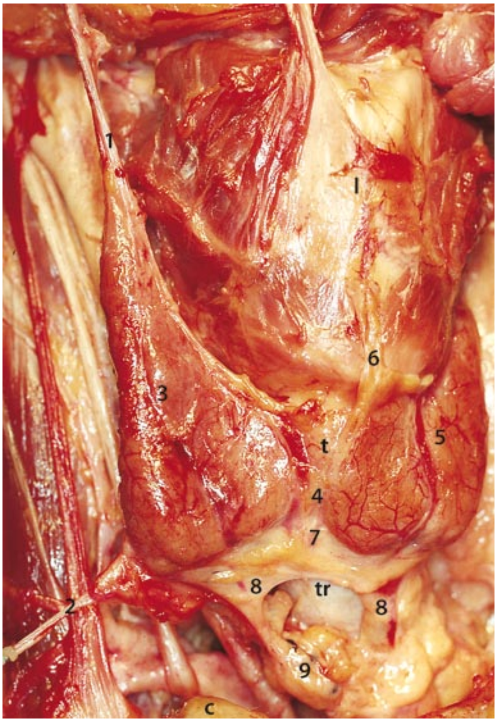

Fig. 8.6 Thyroid (II)

l = larynx
t = thyroid gland
tr = trachea
c = clavicle
1 = superior thyroid artery
2 = inferior thyroid artery
3 = right thyroid lobe
4 = isthmus of the thyroid gland
5 = left thyroid lobe
6 = pyramidal thyroid lobe (Lalouette's lobe)
7 = ima thyroid artery
8 = inferior thyroid artery
9 = pretracheal lymph nodes

fibrous perithyroid sheath, which proceeds laterally along the pedicles and attaches to the cervical vasculonervous bundle. This covering is part of the vascular sheath and is independent of the superficial and middle cervical fasciae [2]. Lying below the sheath is the thyroid capsule, which is an integral part of the parenchyma enclosing the gland's superficial vessels (Fig. 8.6).

As in clinical practice, the gland is dissected after identifying and ligating the superior vascular pedicles. The superior thyroid artery (and vein), an upper branch of the external carotid artery, initially runs horizontally, parallel to the greater cornu of the hyoid bone, then descends toward the homolateral thyroid lobe; medially it gives rise to the superior laryngeal artery and then divides into three

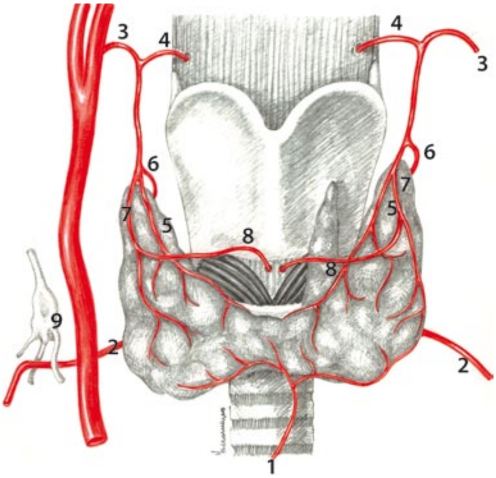

Fig. 8.7 Thyroid vascular pedicles

1 = ima thyroid artery
2 = inferior thyroid artery
3 = superior thyroid artery
4 = superior laryngeal artery
5 = superior thyroid artery (medial branch)
6 = superior thyroid artery (posterior branch)
7 = superior thyroid artery (lateral branch)
8 = cricothyroid artery
9 = middle cervical ganglion (sympathetic cervical chain)

branches: one medial, which is the largest and runs along the superior thyroid margin, one posterior and one lateral, from which the cricothyroid artery arises and takes a medial course, perforating the homonymous membrane (Fig. 8.7).

Complications: In thyroid surgery, the superior thyroid pedicle must be ligated downstream from the laryngeal artery origin and, above all, should not involve the external branch of the superior laryngeal nerve. Once the upper pedicle has been ligated, we must avoid proceeding downward with the elevation of the thyroid from the larynx, because we would arrive immediately near the recurrent nerve just where it enters the larynx.

- 8.2.6 Near the isthmus of the thyroid gland, the pyramidal lobe (Lalouette's lobe) is then identified. It consists of an ascending process of the thyroid parenchyma. It has the following characteristics. It saddles the thyroid cartilage of the larynx, generally in a left paramedian position; it is present three times out of four; it extends upward like a more or less evident fibrous cord passing just posteriorly to the corpus ossis hyoidei; and ascends toward the foramen cecum linguae. Lalouette's lobe is the embryonic remnant of the thyroglossal duct that shows the descent of the thyroid gland from its embryonic anlage situated in the corpus linguae at the base of the neck (Fig. 8.8).

  Remarks: Cysts and median fistulae of the neck develop along the path of the thyroglossal duct, like "aberrant" thyroids or accessory thyroids. Their removal requires the complete exeresis of these structures and, to avoid recurrences, of the median portion of the hyoid bone with which the thyroglossal duct establishes close relations.

- 8.2.7 Before beginning to look for the recurrent nerves, we free the anterior surface of the trachea. The thyroid gland/cervical trachea complex needs to be stretched as far as possible cranially in order to expose an extensive tract of the trachea (Fig. 8.9).

- 8.2.8 The subthyroid pretracheal space is occupied by the so-called thyropericardial lamina, which is sectioned to expose the anterior trachea wall. We section the tissue that is on a more superficial plane than the anterior surface of the trachea, that is, we avoid going any deeper laterally because, in doing so, we would risk encountering the recurrent nerves (Fig. 8.10).

  The middle cervical fascia is attached superiorly to the hyoid bone and laterally to the omohyoid muscles. Inferiorly, it adheres to the osteofibrous contour of the superior opening of the thoracic cavity (sternum, clavicle, and upper ribs). Inferiorly, the fascia continues downward with more or less consistent thickness associated with the large vessels of the mediastinum and pericardial serosa. This median fascial structure takes the name of thyropericardial lamina and encloses the fol-

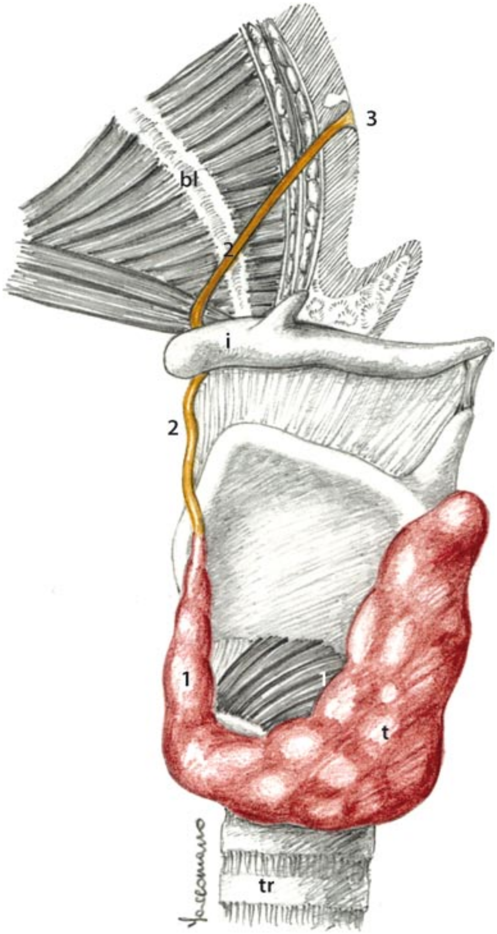

Fig. 8.8 Thyroglossal duct and Lalouette's lobe

bl = tongue base
i = hyoid bone
t = thyroid gland
tr = trachea
1 = Lalouette's lobe
2 = thyroglossal duct
3 = foramen cecum

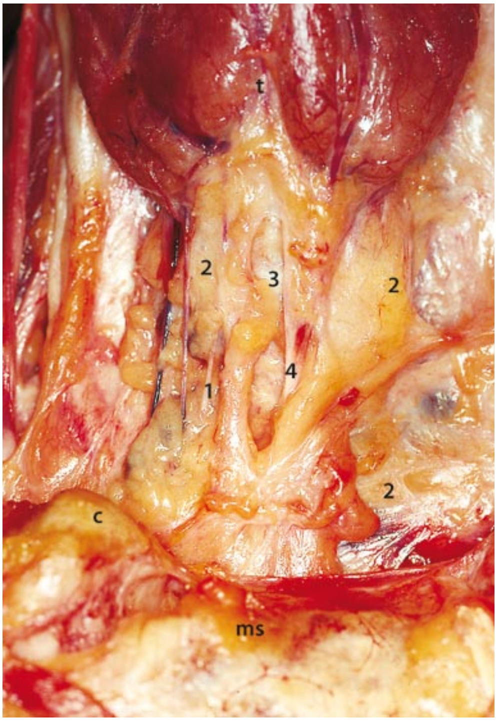

Fig. 8.9 Pretracheal area

t = thyroid gland
c = clavicle
ms = manubrium sterni
1 = inferior thyroid veins
2 = thyropericardial lamina
3 = trachea
4 = ima thyroid artery

lowing: the arteria thyroidea ima, which arises directly from the innominate artery or aortic arch (with inconsistent presence and caliber), and the pretracheal lymph nodes.

On exposure, proceeding craniocaudally, the trachea can be seen increasingly embedding below the cutaneous plane.

Complications: Perfect familiarity with this anatomic site is essential to ensure a risk-free subthyroid tracheotomy. In some cases the inferior thyroid nerves may be rather large and numerous. The accidental interruption and downward loss of a sectioned inferior thyroid vein, which naturally tends to retract

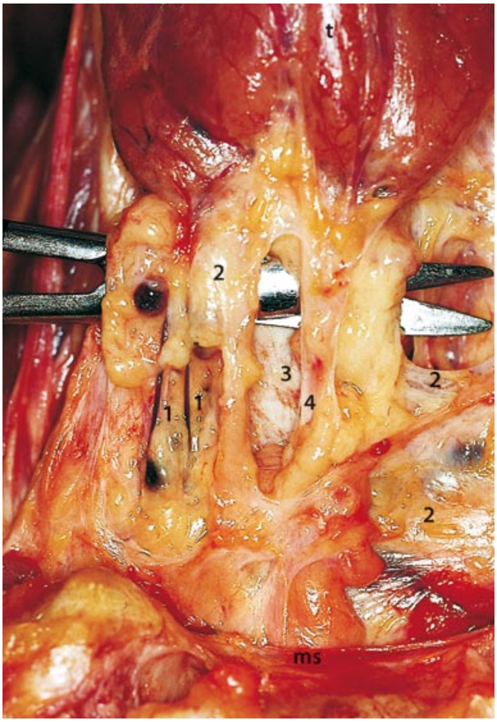

Fig. 8.10 Thyropericardial lamina

t = thyroid gland
ms = manubrium sterni
1 = inferior thyroid veins
2 = thyropericardial lamina
3 = trachea
4 = ima thyroid artery

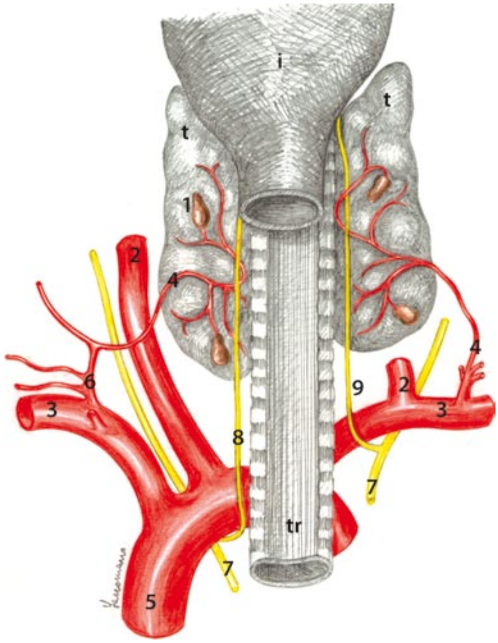

Fig. 8.11 Recurrent nerves

i = hypopharynx
t = thyroid gland
tr = trachea
1 = parathyroid gland
2 = common carotid artery
3 = subclavian artery
4 = inferior thyroid artery
5 = aortic arch
6 = thyrocervical trunk
7 = vagus nerve
8 = left recurrent nerve
9 = right recurrent nerve

into the mediastinic adipose tissue and to bleed, may become a serious problem.

- 8.2.9 At this point we can turn our attention to the recurrent nerves. The inferior laryngeal nerve, or recurrent nerve, originates in the first intrathoracic tract of the vagus nerve: it arises more cranially to the right than to the left, and immediately encloses the subclavian artery anteroposteriorly and inferosuperiorly. To the left it takes a similar course, enclosing the aortic arch. The recurrent nerves reascend, running through the dihedral angle between trachea and esophagus, with slight asymmetry insofar as the esophagus protrudes further to the left than does the trachea. In this tract, it gives rise to numerous collateral branches (middle cardiac branches serving the cardiac plexus, pharyngeal branches serving the pharyngeal plexus, in addition to tracheal and esophageal branches). It penetrates the larynx behind the articulation between the inferior cornu of the thyroid cartilage and the cricoid ring.

The recurrent nerve is a mixed nerve. It innervates all intrinsic laryngeal muscles, except for the cricothyroid muscle, which is innervated by the superior laryngeal nerve; sensory fibers innervate the mucosa of the inferior aspect of the vocal folds, the hypoglossal region, and the upper tracheal rings (Fig. 8.11).

Complications: Thyroid and tracheal surgery present the surgeon with the risk of recurrent nerve injury. Such lesions are generally manifested by vocal fold fixity in a paramedian or intermediate position. If the lesion is not bilateral (in which case tracheotomy is often required, with subsequent surgery to extend the glottis), the main symptom is dysphonia owing to incomplete glottal closure. When the lesion is incomplete, because, for example, the nerve has been excessively stretched, the paralysis may regress spontaneously.

Where, instead, paralysis persists, the voice may spontaneously improve through compensation by the healthy voice fold, which exceeds the midline during phonation. This compensatory mechanism, which develops over a period of months, is helped by speech rehabilitation.

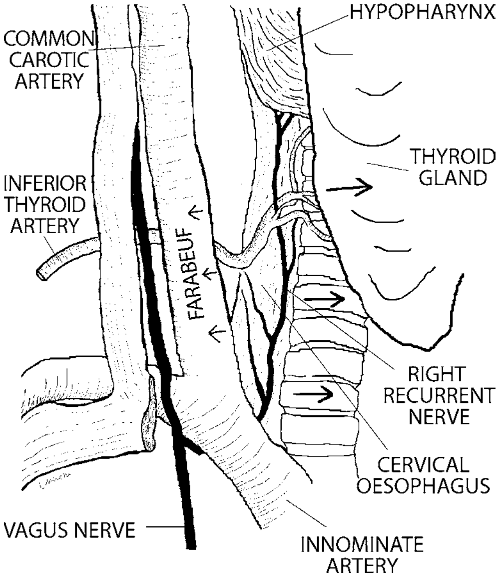

Fig. 8.12 Exercise 7: recurrent nerve

- 8.2.10 First, we look for the inferior thyroid artery. It arises from the thyrocervical trunk and enters the recurrent region, passing posteriorly to the common carotid artery. Its relations with the recurrent nerve are important for the surgeon who, on ligating the inferior thyroid pedicle during thyroidectomy, should be careful not to impair the nerve. Unfortunately, relations between the two structures are variable—the artery is often already divided when it crosses the nerve, which may run between its branches. The right recurrent nerve more commonly runs anteriorly to the artery and the left one posteriorly. In routine surgical practice, ligation of the inferior thyroid pedicle should only be performed after definitely identifying and isolating the homolateral recurrent nerve.

Complications: In vivo the inferior thyroid artery must be ligated with particular attention. It is a vessel of considerable caliber, and if its ligature comes undone, considerable difficulties may arise in recovering the interrupted and bleeding vessel. It is useful to remember that it enters our field of operation by passing posteriorly to the common carotid artery; this knowledge should avoid serious trouble in surgical movements that in these cases are often agitated.

- 8.2.11 Exercise 7: Recurrent Nerve (Fig. 8.12). The search for and isolation of the inferior laryngeal nerve (recurrent nerve) is the focal point of this dissection exercise. To be successful, we must prepare the field of operation precisely.

First, we must apply traction medially on the thyroid lobe and identify, farther down, the hypopharynx and the cervical esophagus. Laterally we seek the common carotid artery, which is lateralized with a Farabeuf. Deep down, by palpation, we can identify the prevertebral plane.

We then seek tangentially in the triangle between the trachea (medially), the common carotid artery (laterally), and the inferior thyroid artery (superiorly) (whose name is Lorè's triangle). This is the recurrent region in which the recurrent nerve and inferior thyroid artery are found, embedded in the celluloadipose connective tissue and crossing each other at right angles. To seek the nerve we divaricate the adipose tissue with scissors in the dihedral angle between the esophagus and the trachea, proceeding craniocaudally. Once it has been found it must be isolated and followed until it enters the larynx, posterior to the cricothyroid articulation. In this region, we can also find some lymph nodes of the recurrent chain, which form the lymphatic drainage of the thyroid gland, of the hypoglossal region, and of the cervical trachea. Last, we shall try to identify the parathyroid glands.

Complications: If it is difficult to identify the right recurrent nerve, we must also consider the possibility of a "nonrecurrent" recurrent nerve (0.5–1% of cases) [1]. That means that, due to a congenital anomaly of the right subclavian artery, the right nerve starts directly from the vagus nerve next to the thyroid gland.

- 8.2.12 At the point where the recurrent nerve and the inferior thyroid artery cross, we can try to identify some of the parathyroid glands, of which there are generally four. The inferior ones are generally more voluminous; the dimensions are about the size of a lemon seed, and they are brown in color (Fig. 8.13).

Complications: The removal of the thyroid gland must normally be performed preserving both the recurrent nerve and the parathyroid glands, which control the calcium and phosphorus metabolism through the parathyroid hormone. Their removal leads to tetany, and the replacement therapy must associate calcium and vitamin D.

It is believed that their number can be halved without causing imbalance due to calcemia. The correct procedure is to identify them and preserve them together with the actual vascular pedicle. If removed accidentally, they may be reimplanted in a niche in the sternocleidomastoid muscle, after having been finely chopped on a slide with a scalpel.

- 8.2.13 The completely isolated thyroid gland is now removed, after having sectioned the lateral Berry–Gruber ligaments, extending between the thyroid capsule and the cricoid perichondrium, and the residual pedicles. We follow the upward course of the recurrent nerve, checking in particular the point of embedment behind the cricothyroid articulation (Fig. 8.14).

To conclude the dissection of the thyroid gland, we recall that there are two methods of thyroidectomy, at least in the benign pathology, which differ in whether or not the recurrent nerve is identified beforehand. The most

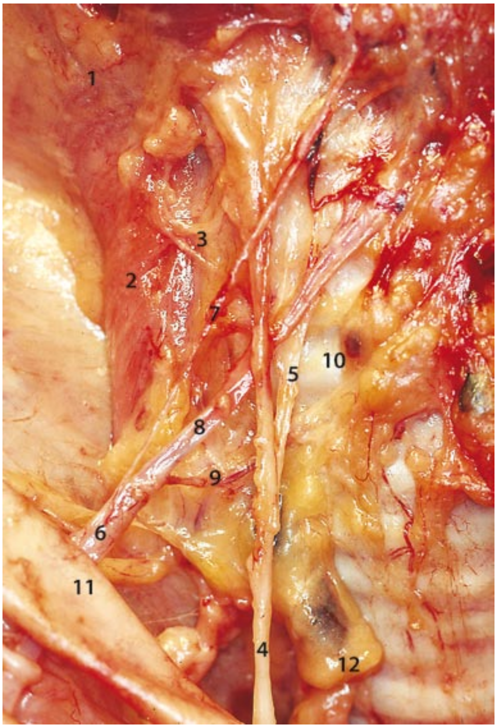

Fig. 8.13 Recurrent region

1 = hypopharynx
2 = cervical esophagus
3 = recurrent nerve (esophagus branches)
4 = recurrent nerve
5 = recurrent nerve (tracheal branches)
6 = inferior thyroid artery
7 = inferior thyroid artery (superior branch)
8 = inferior thyroid artery (inferior branch)
9 = inferior thyroid artery (tracheal branches)
10 = trachea
11 = common carotid artery
12 = recurrent lymph nodes

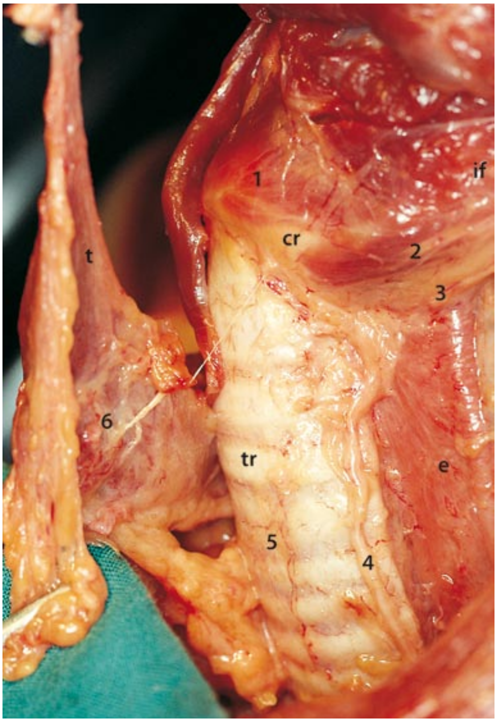

Fig. 8.14 Esophagotracheal angle

if = hypopharynx
cr = cricoid cartilage
tr = trachea
e = esophagus
t = thyroid
1 = cricothyroid muscle
2 = cricopharyngeal muscle
3 = Killian's mouth
4 = recurrent nerve
5 = tracheal vascular arches
6 = parathyroid gland

recent case histories say that the percentage of paralysis is considerably lower when the recurrent nerve is sought, identified, and preserved.

- 8.2.14 Isolation of the major arteries of the base of the neck starts from the bottom, with exposure concentrating in particular on the common carotid artery in relation to the superior opening of the thorax. Following the common carotid caudad, the subclavian artery can be reached from the right and isolated. The first thing to control is the course of the vagus nerve, already observed in the dissection of the sternocleidomastoid region, which passes anteriorly to the artery and gives rise to the recurrent nerve in proximity to its inferior border; the recurrent nerve ascends posteriorly to the vessel toward the junction with the inferior thyroid artery, where it was isolated beforehand. The arterial branches of the subclavian artery, particularly the thyrocervical trunk, lying just medially to the anterior scalene muscle, are then isolated. The transverse cervical, transverse scapular, ascending cervical, and inferior thyroid arteries all arise from this main branch of the subclavian, and the latter two often have a common origin.

The origin of the vertebral artery, which ascends medially (reemerging in the prevertebral region) is sought at roughly the same level, on the posterosuperior border of the subclavian artery. Just after its origin, it accompanies the vertebral vein, which descends and passes anteriorly to the subclavian artery (Fig. 8.15).

The internal thoracic artery, instead, arises from the inferior margin of the subclavian. The subclavian artery then embeds itself, passing posteriorly to the anterior scalene muscle and inferiorly to the brachial plexus, overstriding the first rib. The lateral portion has already been examined in supraclavicular dissection.

- 8.2.15 The subclavian artery and right common carotid artery arise from the brachiocephalic trunk or innominate artery; on the left, the origins of the subclavian and common carotid arteries are instead separate from the arch of the aorta. The adipose and fascial connective tissue enclosing the great paratracheal vessels continues with the mediastinal cellular tissue (upper mediastinum). It abounds in lymph nodes, some anthracotic, in continuity with the overlying recurrent lymph node chains. The innominate artery, hidden below the manubrium sterni, is short and fat and may be a major source of danger during performance of low tracheotomy (Fig. 8.16).

Complications: Tracheostomy, as a preliminary stage in oncological surgery of the

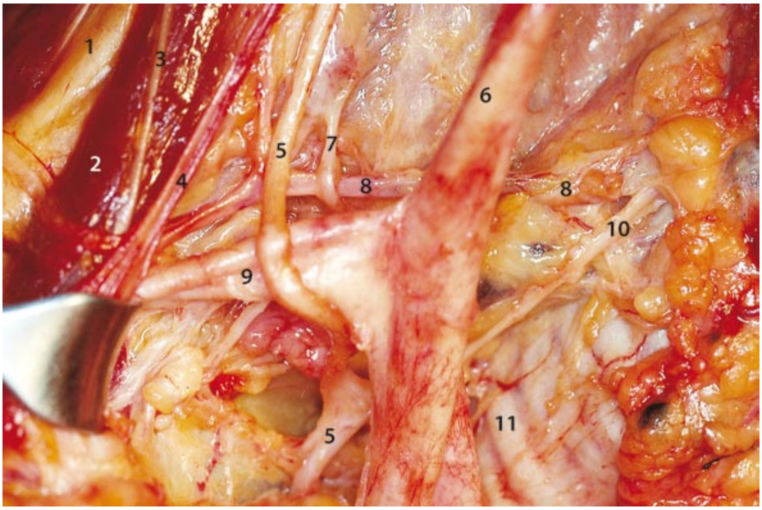

Fig. 8.15 Inferior perivisceral area

1 = brachial plexus
2 = anterior scalene muscle
3 = phrenic nerve
4 = internal jugular vein
5 = vagus nerve
6 = common carotid artery
7 = sympathetic cervical chain
8 = inferior thyroid artery
9 = subclavian artery
10 = recurrent nerve
11 = trachea

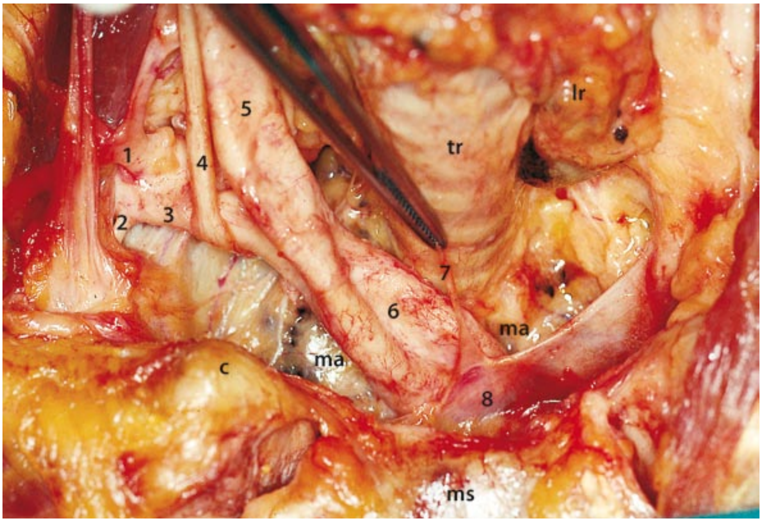

Fig. 8.16 Brachiocephalic trunk (innominate artery)

tr = trachea
lr = recurrent lymph nodes
c = clavicle
ms = manubrium sterni
ma = upper mediastinum
1 = thyrocervical trunk
2 = internal thoracic artery
3 = subclavian artery
4 = vagus nerve
5 = common carotid artery
6 = brachiocephalic trunk (innominate artery)
7 = anterior jugular vein
8 = brachiocephalic vein

larynx and hypopharynx, is preferably performed below the isthmus of the thyroid gland. This mode of access is more exploratory than the trans- and supraisthmic routes since the trachea is deeper than the cutaneous plane, but there are two advantages: (1) it enables the surgeon to operate at a distance from the neoplasia and, as has been demonstrated, this reduces the incidence of paratracheostomal recurrences; and (2) the surgeon remains at a considerable distance from the hypoglottic cone, which is often the site of secondary cicatricial stenoses. This applies also in functional surgery of the larynx or for provisional tracheostomies, which are usually performed in the third/fourth tracheal ring.

Besides, the proximity of the tracheotomy to the innominate artery exposes the patient to the risk of this vessel rupturing, generally because of tracheotomy tube decubitus. This event invariably has a fatal prognosis due both to the extent of hemorrhaging, and to the fact that there is no effective form of emergency compressive plugging. It has thus been decided to reduce this low tracheotomy-related risk by protecting the upper mediastinum with an everted, lower-hinge tracheal flap, sutured to the cutis (Bjork's flap) (Fig. 8.17).

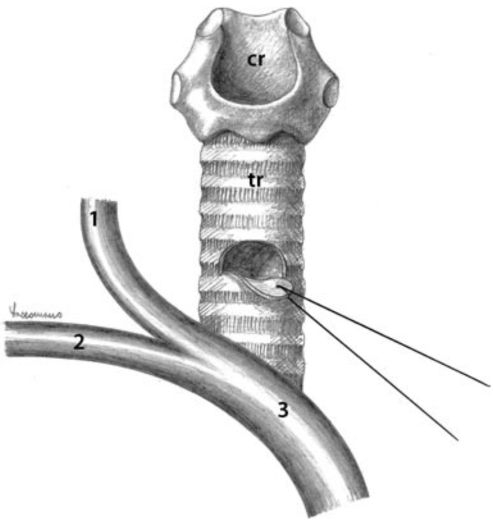

Fig. 8.17 Tracheostomy

cr = cricoid cartilage
tr = trachea
1 = common carotid artery
2 = subclavian artery
3 = innominate artery

Remarks: One disadvantage of systematic tracheostomy in preservative surgery of the larynx is the need for plastic surgery to close the tracheostoma, requiring a minor operation under local anesthetic. One certain benefit is, instead, the ease with which the tracheotomy tube can be replaced in the postoperative period by nursing staff. The tracheal flap joined to the cutis provides a handy "slide" by which to access the tracheal lumen and the risk of taking the wrong mediastinal route is practically nonexistent.

The current tendency regarding tracheotomies is the following:

1. Confirmation of the tracheostomic rather than the tracheotomic procedure, that is, the trachea is always joined to the cutis (for safety when changing the tube, even at home, and ease of managing the tracheostoma).
2. Tracheostomas are increasingly smaller and are closed much earlier.
3. The use of cuffed or fenestrated tubes is avoided, unless in exceptional cases.

- 8.2.16 The great veins of the base of the neck are sought in this area, anteriorly to the great arterial trunks. A useful guide for this purpose is the internal jugular vein, whose descending course leads to the subclavian vein and medial course to the bilaterally present brachiocephalic vein.

To conclude this dissection phase, the trachea is completely skeletized; the prevertebral plane is at once exposed laterally to the median organs (Fig. 8.18).

- 8.2.17 After removing the thyroid gland, the complete cervical esophagus can be examined. The esophagus can immediately be seen protruding more to the left than does the trachea. Its superior end can be clearly identified near the cricoid cartilage. Its caliber narrows at this point (more markedly than the constriction present on crossing the aortic arch and diaphragm) and takes the name of Killian's mouth (Fig. 8.19).

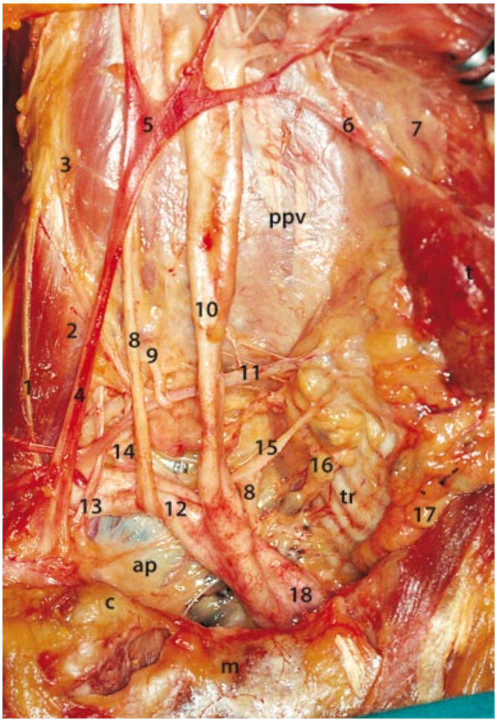

Fig. 8.18 Prevertebral perivisceral area

ppv = prevertebral plane
t = thyroid gland
tr = trachea
ap = apex of the lung
c = clavicle
m = manubrium sterni
1 = phrenic nerve
2 = anterior scalene muscle
3 = branches of cervical plexus
4 = internal jugular vein
5 = thyrolinguofacial trunk
6 = superior thyroid pedicle
7 = lateral hypopharyngeal wall
8 = vagus nerve
9 = cervical sympathetic chain
10 = common carotid artery
11 = inferior thyroid artery
12 = subclavian artery
13 = vertebral vein
14 = vertebral artery
15 = recurrent nerve
16 = recurrent lymph nodes
17 = pretracheal lymph nodes
18 = innominate artery

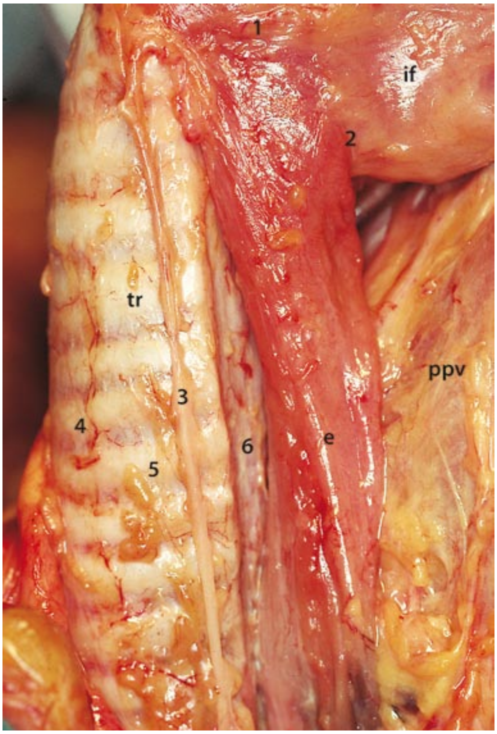

Fig. 8.19 Trachea and cervical esophagus

if = hypopharynx
tr = trachea
e = esophagus
ppv = prevertebral plane
1 = cricopharyngeal muscle
2 = Killian's mouth
3 = recurrent nerve
4 = tracheal vascular arches
5 = tracheal ring
6 = pars membranacea of the trachea

Remarks: Killian's mouth has a sphincteric function provided by the action of the cricopharyngeal fibers of the inferior constrictor muscle of the pharynx. These muscle fibers play a part in establishment of the neoglottis, which produces the esophageal voice in total laryngectomees. This is when selective myotomy is performed in the event of excessive esophageal stricture after supraglottic, subtotal reconstructive, or total laryngectomy with a phonatory fistula.

- 8.2.18 The esophagus is then isolated from both the prevertebral plane and the trachea. It is worth noting that the tracheal rings are interrupted along the contact surface with the esophagus. The posterior wall (pars membranacea) is devoid of cartilage; it does instead possess smooth muscle fibers (tracheal muscle) which, on contraction, approximate the ends of the cartilage arches, thereby decreasing the transverse diameter of the trachea during respiration. Finally, we consider that the sixth cervical vertebra represents the level of passage between the hypopharynx and the cervical esophagus, as also between the larynx and the trachea and, indirectly, between Robbins level III and IV. The transverse processes of the sixth cervical vertebra are known as the carotid tubercles.

Take Home Messages

- The white line is an important landmark: (a) in thyroid surgery, it allows access to the thyroid gland simply by divaricating the infrahyoid muscles on this line, without necessarily sectioning them, and (b) as the "tracheotomy rhombus", since in that spot only two planes, the cutis and the fascia, cover the laryngotracheal duct; the surgeon passes through these planes when he or she wants to open the trachea.
- The tracheotomy may be performed with a vertical or transverse incision of the cutis. We usually prefer the transverse incision for aesthetic reasons. The vertical incision tends to adhere to the scar of the infrahyoid white line, which is necessarily opened craniocaudally. In this way, an unattractive adherence is formed between the cutis and the muscular plane, which is clearly seen during deglutition.
- The trachea is nourished segmentarily, above all by branches of the inferior thyroid arteries. When a temporary tracheostomy is being performed, it is good practice to limit the skeletization of the tracheal rings to what is strictly indispensable to avoid peritracheostomal chondronecrosis induced by ischemia, especially in patients treated with radiotherapy.
- The dissection of the recurrent region is very important and is often overlooked in laryngeal tumors with hypoglottic extension. This factor may explain cases of peritracheostomal recurrence after total laryngectomy. Moreover, it must not be forgotten that the recurrent region is in continuity with the upper mediastinum; hence the indication for postoperative radiotherapy even in this seat in hypoglottic tumors.

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Chapter 9

Anterior Region (Robbins Level VI – Superior Part) 9

Core Messages

- In this chapter, we explore chiefly the larynx and the hypopharynx. In all surgical specialties, in recent years there has been an increased preference for the conservative approach to malignant tumors. This is particularly true in oncological surgery of the larynx, thanks especially to endoscopic laser surgery and to the so-called reconstructive laryngectomies. The precise anatomical knowledge of the larynx, in regard to both its surface appearance and its deep spaces, and of the preferential means of diffusion of neoplasias, is of fundamental importance to allow the surgical indication to be as conservative as possible, without decreasing the survival percentage.

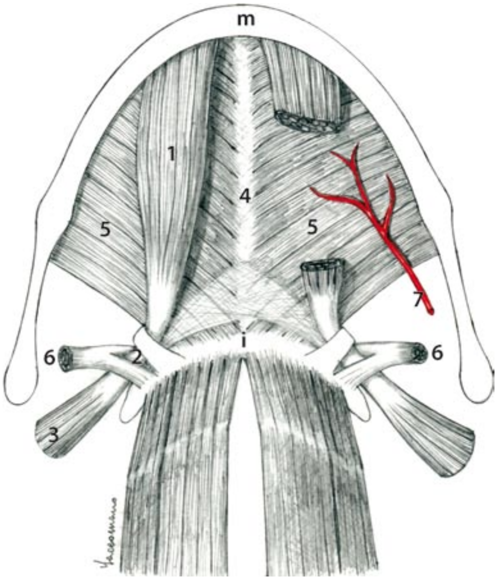

Fig. 9.1 Interdigastric space

m = mandible
i = hyoid bone
1 = anterior belly of digastric muscle
2 = intermediate tendon of digastric muscle
3 = posterior belly of digastric muscle
4 = suprahyoid white line
5 = mylohyoid muscle
6 = stylohyoid muscle
7 = submental artery

- **Significant anatomical structures:** infrahyoid muscles, larynx, quadrangular membrane, elastic cone, Reinke's space, anterior commissure, Morgagni's ventricle, cricothyroid artery, hypopharynx, Galen's loop**.**
- **Landmarks:** hyoid bone, intercricothyroid space, foramen cecum linguae.

9.1 Dissection

- 9.1.1 We begin dissection from the top, starting from the hyoid bone, which we identify by palpation to distinguish its parts: the body, the greater cornua and the lesser cornua, the latter being close to the point of insertion of the stylohyoid muscles. The hyoid bone is the only bone that is not joined to the rest of the skeleton; instead, in most vertebrates it is joined through the ossification of that structure which, in exceptional cases, is ossified also in humans, that is, the stylohyoid ligament. It is an important point for the support of the larynx during the ample craniocaudal excursions of deglutition (which may be as much as 2 to 3 cm) (Fig. 9.1).

We recognize the submental triangle, also referred to as the interdigastric space, which

Fig. 9.2 Hyoid area

m = mandible
i = hyoid bone
1 = hyoglossal muscle
2 = mylohyoid muscle
3 = anterior belly of digastric muscle
4 = intermediate tendon of digastric muscle
5 = posterior belly of digastric muscle
6 = greater cornu of hyoid bone
7 = thyrohyoid muscle
8 = omohyoid muscle
9 = sternohyoid muscle
10 = infrahyoid white line

we already drained in a previous exercise and that corresponds to Robbins level IA. The suprahyoid white line, which runs from the mental symphysis to the corpus ossis hyoidei, is formed by fusion of the mylohyoid muscles on the midline (Fig. 9.2).

- 9.1.2 The sternohyoid and sternothyroid muscles already interrupted at the bottom are removed. The thyrohyoid muscles are sectioned at the point of insertion in the thyroid cartilage and hyoid bone and then ablated, thereby exposing the thyrohyoid membrane (Fig. 9.3).

- 9.1.3 The larynx is thus completely exposed. Posteriorly, the hypopharynx is separated from the prevertebral plane (Fig. 9.4).

The larynx is situated anteriorly to the hypopharynx, superiorly to the trachea, and inferiorly to the base of the tongue and hyoid bone. It is formed by the following structures:
1. A cartilaginous skeleton formed by nine cartilages, three unpaired and six paired, with two articulations (cricothyroid and cricoarytenoid).
2. Two elastic submucous membranes, the quadrangular lamina and the elastic cone. The first extends from the lateral margin of the epiglottis to the anterolateral aspect of the corresponding arytenoid cartilage, supporting the aryepiglottic fold. The second extends from the margin of the vocal fold, where it thickens to form the vocal ligament, to the superior margin of the cricoid cartilage.
3. Three fibroelastic sheets: the hyoepiglottic membrane, the thyrohyoid membrane, and the cricothyroid membrane.
4. Intrinsic muscles for moving the mobile parts of the larynx (arytenoid cartilages, vestibular folds, and vocal folds). Adduction movements are effected by the interarytenoid (transverse and oblique) and lateral cricoarytenoid muscles and abduction movements by the posterior cricoarytenoid muscles; vocal cord tension is provided by the thyroarytenoid and cricothyroid muscles (Fig. 9.5).
5. The larynx is vascularized by the superior laryngeal and cricothyroid branches of the superior thyroid arteries; a minor contribution is made by the inferior laryngeal branches of the inferior thyroid arteries.

Fig. 9.3 Larynx and infrahyoid muscles

1 = corpus of hyoid bone
2 = thyrohyoid muscle
3 = thyrohyoid membrane
4 = laryngeal prominence
5 = insertion line of thyrohyoid muscle
6 = sternothyroid muscle (cut)
7 = cricothyroid muscle
8 = cricoid ring

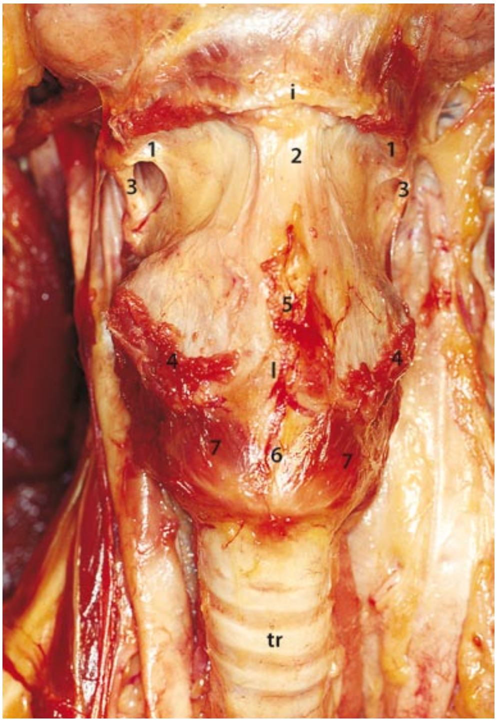

Fig. 9.4 Larynx (anterior view)

i = hyoid bone
l = larynx
tr =trachea
1 = greater cornu of hyoid bone
2 = thyrohyoid membrane
3 = thyrohyoid ligament
4 = thyrohyoid muscles insertion line
5 = laryngeal prominence
6 = cricothyroid membrane
7 = cricothyroid muscle

6. The intrinsic muscles are innervated by the inferior laryngeal nerve, except for the cricothyroid muscle, which is served by the superior laryngeal nerve (external branch). Sensory innervation is provided by the superior laryngeal nerve for the supraglottic mucosa and by the recurrent nerve for the inferior aspect of the vocal folds and hypoglottis (Fig. 9.6).

- 9.1.4 At this point we have "skeletized" the larynx and hypopharynx, without interrupting the superior laryngeal pedicles that enter the larynx at the level of the thyrohyoid membrane. The inferior boundary of the larynx, corresponding to the inferior margin of the cricoid cartilage, is at the level of the sixth cervical vertebra, whose transverse process, which juts out further than the others, is called the carotid tubercle (already indicated as a landmark). The hypopharynx ends and the cervical esophagus begins at this level (Fig. 9.7).

- 9.1.5 Regarding laryngeal innervation, we now identify the point of entry of the recurrent nerve into the larynx, which lies just beneath the inferior cornu of the thyroid cartilage.

Remarks: In supracricoid laryngectomies, the inferior cornu of the thyroid cartilage is

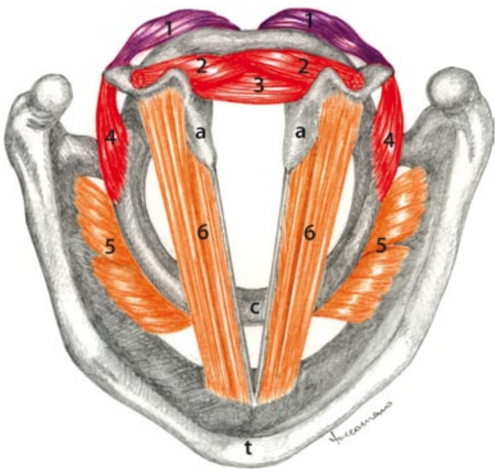

Fig. 9.5 Intrinsic laryngeal muscle

c = cricoid cartilage
t = thyroid cartilage
a = arytenoids
1 = posterior cricoarytenoid muscle
2 = interarytenoid muscle (oblique component)
3 = interarytenoid muscle (transverse component)
4 = lateral cricoarytenoid muscle
5 = cricothyroid muscle
6 = thyroarytenoid muscle

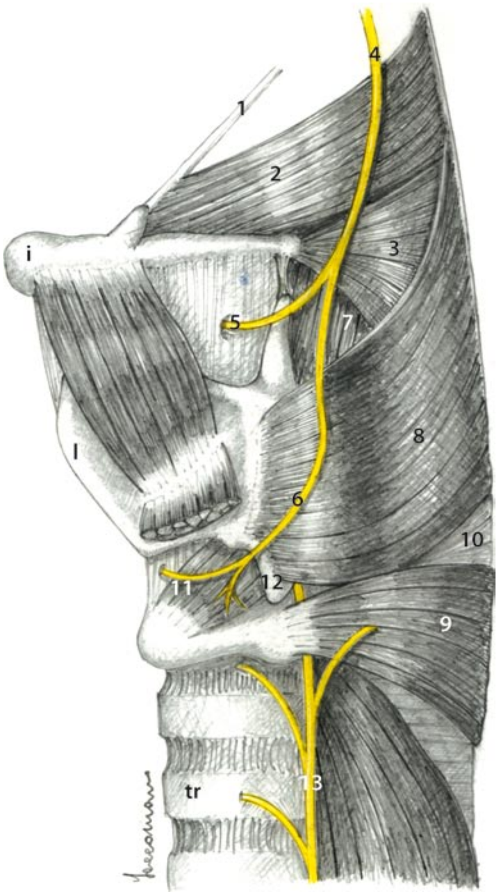

Fig. 9.6 Laryngeal nerves

i = hyoid bone
l = larynx
tr = trachea
1 = stylohyoid ligament
2 = middle constrictor muscle of pharynx (superior component)
3 = middle constrictor muscle of pharynx (inferior component)
4 = superior laryngeal nerve
5 = internal branch of superior laryngeal nerve
6 = external branch of superior laryngeal nerve
7 = palatopharyngeus muscle
8 = inferior constrictor muscle of pharynx
9 = cricopharyngeus muscle
10 = Laimer's triangle
11 = cricothyroid muscle
12 = inferior cornu of thyroid cartilage
13 = recurrent nerve

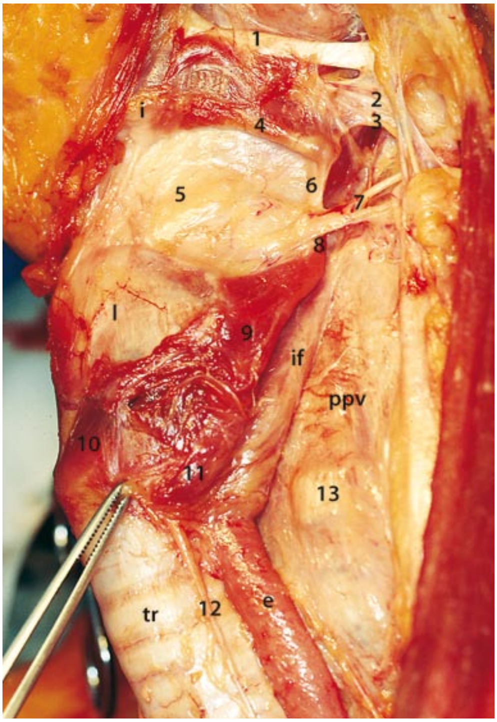

Fig. 9.7 Larynx (lateral view)

i = hyoid bone
l = larynx
if = hypopharynx
tr = trachea
e = esophagus
ppv = prevertebral plane
1 = intermediate tendon of digastric muscle
2 = hypoglossal nerve
3 = lingual artery
4 = greater cornu of hyoid bone
5 = thyrohyoid membrane
6 = thyrohyoid ligament
7 = laryngeal pedicle
8 = superior cornu of thyroid cartilage
9 = inferior constrictor muscle of pharynx
10 = cricothyroid muscle
11 = cricopharyngeal muscle
12 = recurrent nerve
13 = sixth cervical vertebra

generally sectioned, at least on the side where the arytenoid is preserved. In doing so the line of caudal resection is far from the recurrent nerve at its entrance into the larynx, and there is less risk of damaging it, which could cause fixity of the residual arytenoid.

In the larynx, the recurrent nerve divides into two terminal branches, a posterior one that serves the posterior cricoarytenoid muscle (sole abductor muscle of the vocal folds) and an anterior one that, with subsequent divisions, innervates all the other intrinsic muscles of the larynx.

With the branches of the superior laryngeal nerve, the sensory component of the recurrent nerve forms Galen's loop and, with afferents from the hypoglottic mucosa, runs into the extralaryngeal tract of the common recurrent trunk (Fig. 9.8).

- 9.1.6 The superior laryngeal nerve is then identified and followed. Laterally, at the apex of the greater cornu of the hyoid bone, it divides into an internal branch (component of the superior laryngeal pedicle), which penetrates the thyrohyoid membrane and conducts sensory fibers to the supraglottic portion of the larynx, and an external branch, which runs obliquely in an anteroinferior direction to innervate the cricothyroid muscle; it then perforates the cricothyroid ligament and transmits sensory fibers to the glottis and the laryngeal ventricle (Fig. 9.9).

Complications: Accidental injury to the superior laryngeal nerve during ligation of the superior thyroid pedicle causes homolateral hypotonia of the vocal flap, which on laryngoscopy can be seen lying below the level of the contralateral fold, leading to dysphonia of prevalently acute pitch. Another outcome is homolateral supraglottic hemilaryngeal anesthesia.

- 9.1.7 The thyrohyoid membrane joins the superior margin of the thyroid cartilage and the hyoid. Its lateral margins thicken to form

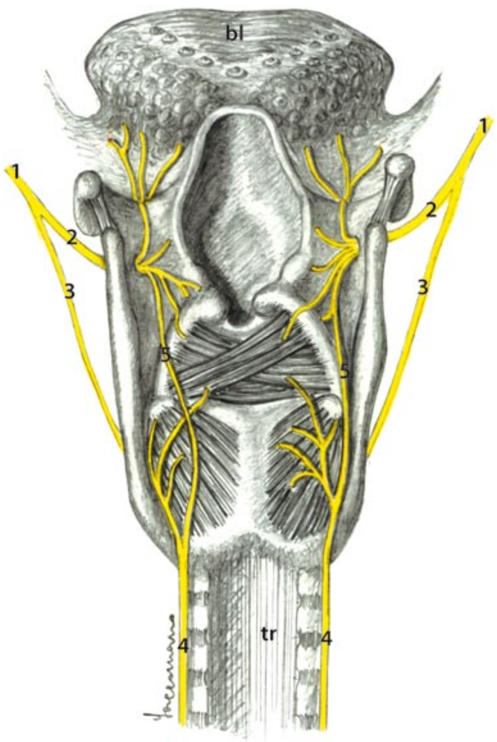

Fig. 9.8 Laryngeal nerves and Galen's loop

bl = tongue base
tr = trachea
1 = superior laryngeal nerve
2 = internal branch of superior laryngeal nerve
3 = external branch of superior laryngeal nerve
4 = recurrent nerve
5 = Galen's loop

two fibrous ligaments (thyrohyoid ligaments), which join the superior cornua of the thyroid cartilage to the apexes of the greater cornua of the hyoid bone.

Remarks: The thyrohyoid ligaments and posterior margins of the thyroid cartilage correspond to the lateral hypopharyngeal walls and are a good landmark for lateral pharyngotomy, providing access to the piriform recesses and vestibule of the larynx in surgery in this region.

In the lateral portion of the thyrohyoid membrane, we identify the point where the laryngeal pedicle enters the larynx. It is formed by the superior laryngeal artery and by the corresponding vein and nerve.

We see how the vessels come from the superior thyroid pedicle, while the superior laryngeal nerve, which is deeper down, comes from the vagus nerve. We ligate and section the pedicle.

- 9.1.8 The hypopharynx extends from the superior margin of the hyoid bone to the inferior margin of the cricoid cartilage. It is formed by two lateral grooves (piriform recesses), a retrocricoid portion (corresponding to the cricoid lamina) and a posterior wall. The palatopharyngeal muscles and inferior and middle constrictors of the pharynx provide the muscular coat.

We can observe the hypopharyngeal muscle morphology, in particular how the middle constrictor inserts in the greater cornu of the hyoid bone. The inferior constrictor has two components: The first, which is much larger, runs obliquely and inserts in the lateral margin of the thyroid cartilage, while the second, with horizontal fibers, inserts in the lateral margin of the cricoid cartilage. This portion of the inferior constrictor of the pharynx is called the cricopharyngeus. The middle and inferior constrictors are innervated by the vagus nerve.

Remarks: Posteriorly, the oblique fibers of the superior portion of the inferior constrictor of the pharynx, and the horizontal fibers of its inferior portion (cricopharyngeus) describe a triangle with an inferior base, lacking in muscular fibers and with lower resistance. Said space, referred to as Laimer's triangle, is the place where Zenker's pulsion diverticula are formed (Fig. 9.10).

We rotate the larynx just enough to reveal the profile of the lateral margin of the thyroid cartilage under the inferior constrictor; the sectioning of this muscle along this margin is the preliminary surgical step to obtain access to the piriform recess.

- 9.1.9 The intercricothyroid space is identified and defined by palpation. This space is easily accessible in laryngotracheal lumen surgery, should severe respiratory stenosis require emergency incision (intercricothyroid laryngotomy). This is in fact the point where the

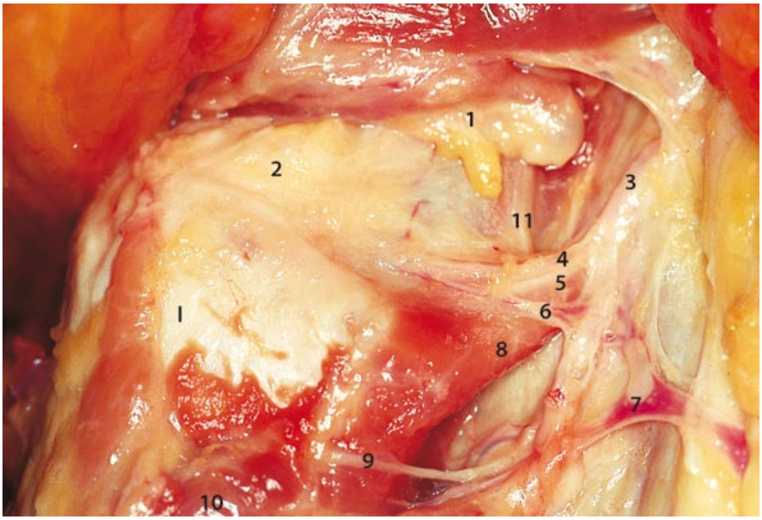

Fig. 9.9 Superior laryngeal pedicle

I = larynx
1 = grater cornu of hyoid bone
2 = thyrohyoid membrane
3 = superior thyroid artery
4 = superior laryngeal artery
5 = internal branch of superior laryngeal nerve
6 = superior laryngeal vein
7 = superior thyroid vein
8 = superior cornu of thyroid cartilage
9 = superior laryngeal nerve (external branch)
10 = cricothyroid muscle
11 = thyrohyoid ligament

respiratory lumen is closest to the skin of the neck.

A small depression internally corresponding to the anterior commissure is appreciable by palpation between the third superior and third median of the anterior profile of the thyroid cartilage. This landmark is important in functional laryngeal surgery, in particular in supraglottic horizontal laryngectomy when, with Listen's forceps, the thyroid cartilage is sectioned transversely and its vestibular portion is removed.

- 9.1.10 The thyrohyoid membrane, hyoepiglottic membrane, and infrahyoid epiglottis bound the hyothyroepiglottic or pre-epiglottic cavity. Its contents essentially consist of celluloadipose tissue, to which supraglottic tumors easily spread. Accordingly, laryngectomy envisages complete ablation.

- 9.1.11 At this point, it is preferable to remove the larynx and hypopharynx en bloc in order to explore internal laryngeal morphology. A horizontal incision is made at the level of the second tracheal ring, where the trachea and cervical esophagus are at full thickness.

The laryngohypopharyngeal block is separated from the vertebral plane up to the hyoid bone. After opening the lateral hypopharyngeal wall, the tongue base is sectioned horizontally 4 to 5 cm superior to the epiglottis and the posterior pharyngeal wall a few centimeters caudad, thereby separating the orohypopharynx and larynx en bloc. On the removed piece, a vertical incision is made in the posterior wall of the hypopharynx, thereby exposing the vestibule of the larynx and the retrocricoid area (Fig. 9.11).

- 9.1.12 Exercise 8: Laryngectomy (Fig. 9.12) Alternatively, for those who are interested, we propose the ablation of the larynx as is performed in the classic procedure of total laryngectomy. The maneuvers described are performed on both sides.

After having gripped and laterally rotated the larynx, the inferior constrictor and the perichondrium are sectioned along the posterior margin of the thyroid cartilage (Fig. 9.12a).

The thyroid cartilage is pulled up with a hook. We then proceed to separate the anterior wall of the piriform recess with an internal subperichondrial approach (Fig. 9.12b).

We now section the trachea between the cricoid and the first tracheal ring. The hook pulls the cricoid ring upward. The pars membranacea of the trachea is then dissected, without going too deep because this would take us into the esophagus.

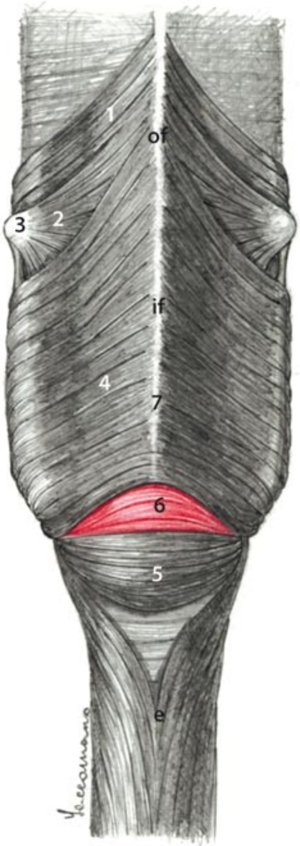

Fig. 9.10 Constrictor muscles of the pharynx

of = oropharynx
if = hypopharynx
e = esophagus
1 = middle constrictor muscle of pharynx (superior component)
2 = middle constrictor muscle of pharynx (inferior component)
3 = apex of greater cornu of hyoid bone
4 = inferior constrictor muscle of pharynx
5 = cricopharyngeus muscle
6 = Laimer's triangle
7 = posterior pharyngeal raphe

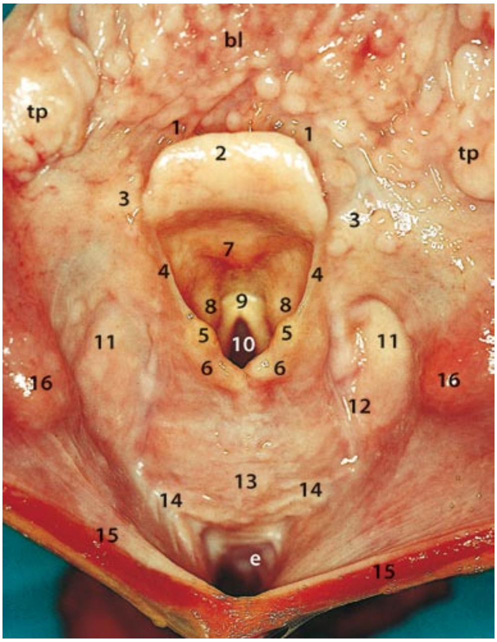

Fig. 9.11 Larynx and hypopharynx: intraluminal view (I)

bl = tongue base
tp = palatine tonsil
e = esophagus
1 = glossoepiglottic vallecula
2 = epiglottis
3 = pharyngoepiglottic fold
4 = aryepiglottic fold
5 = cuneiform tubercle (Wrisberg's tubercle)
6 = corniculate tubercle (Santorini's tubercle)
7 = epiglottic tubercle (petiolus)
8 = ventricular fold (false vocal cord)
9 = anterior commissure
10 = glottis
11 = piriform sinus
12 = Galen's loop
13 = retrocricoid area
14 = Killian's mouth
15 = inferior constrictor muscle of larynx
16 = apex of greater cornu of hyoid bone

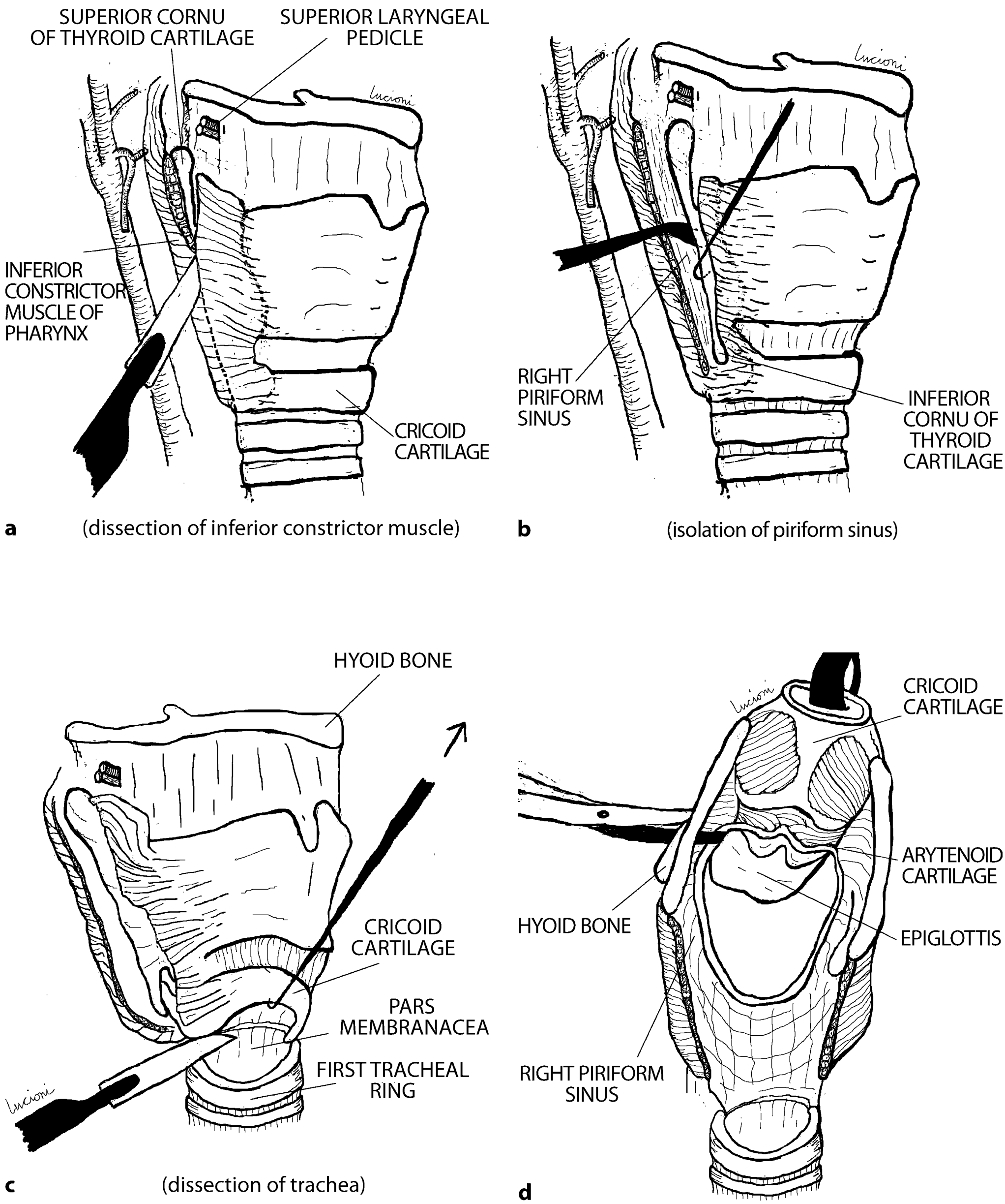

Fig. 9.12 Exercise 8: laryngectomy

We go up posteriorly as far as the arytenoid cartilages, where we cut right through the mucosa and enter the hypopharynx (Fig. 9.12c).

Still pulling the larynx upward, we continue to section the hypopharyngeal mucosa, keeping close to the larynx. The laryngectomy is concluded by transversely sectioning the mucosa of the glossoepiglottic valleculae (Fig. 9.12d).

- 9.1.13 Completion of the dissection caudal enables the three anatomic subareas of the hypopharynx to be extensively explored, i.e., the retrocricoid area, piriform recess, and posterior wall. A thread-like relief can be discerned traversing the anterosuperior part of each piriform recess in a craniocaudal direction. It is Galen's loop, an anastomosis between the internal branch of the superior laryngeal nerve and the recurrent nerve.

Remarks: Tumors of the piriform recess generally cause reflex otalgia: algogenic stimuli run along the superior laryngeal nerve and vagus nerve and reverberate in the external auditory canal. Stimulation of the external auditory canal cutis causes coughing via the same reflex arc (Fig. 9.13).

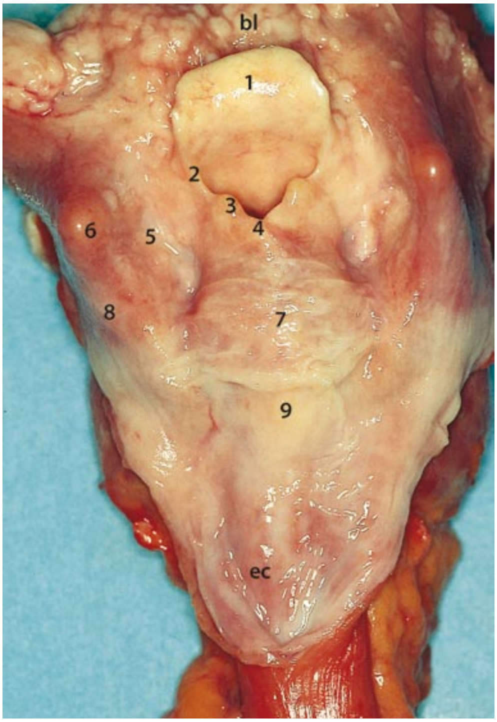

Fig. 9.13 Larynx and hypopharynx: intraluminal view (II)

bl = tongue base
ec = cervical esophagus
1 = epiglottis
2 = aryepiglottic fold
3 = cuneiform tubercle
4 = posterior commissure
5 = piriform sinus
6 = greater cornu of hyoid bone
7 = retrocricoid area
8 = posterior wall of hypopharynx
9 = cricoid cartilage

- 9.1.14 The lateral end of the greater cornu of the hyoid bone can be found by palpation laterally and superiorly at the entrance to the piriform recess. The hyoid arch keeps the hypopharynx and entrance to the piriform recesses open, aiding deglutition. This function is particularly important in the resumption of swallowing after partial or subtotal laryngectomy.

The lingual "V" can be seen on observation of the anterior oropharynx. It is formed by the circumvallate papillae and separates the body from the base of the tongue and, at its apex, the foramen cecum. The lingual tonsil, formed by numerous more or less developed lymphatic follicles, can be seen just posteriorly. The foramen cecum may be the site of an ectopic thyroid and the point of onset of thyroglossal duct remnants (fistulas and congenital median cysts).

Remarks: In laryngeal surgery extending to the tongue base, the foramen cecum is considered the maximum limit of lingual exeresis to avoid severe dysphagia.

The pharyngoepiglottic fold is also clearly identifiable and represents the boundary between the oropharynx and hypopharynx, and therefore also the superior limit of the piriform recess (Fig. 9.14).

- 9.1.15 Between the base of the tongue and the epiglottis, the median and lateral glosso-

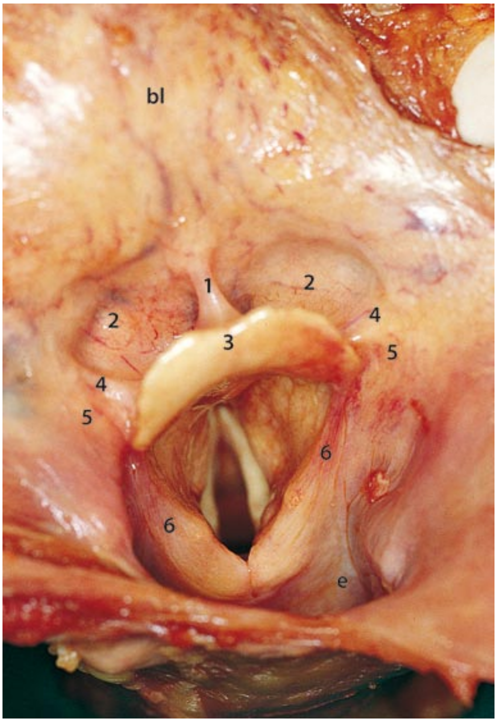

Fig. 9.14 Larynx and hypopharynx: intraluminal view (III)

bl = tongue base
e = esophagus
1 = median glossoepiglottic fold
2 = glossoepiglottic vallecula
3 = suprahyoid epiglottis
4 = lateral glossoepiglottic fold
5 = pharyngoepiglottic fold
6 = aryepiglottic fold

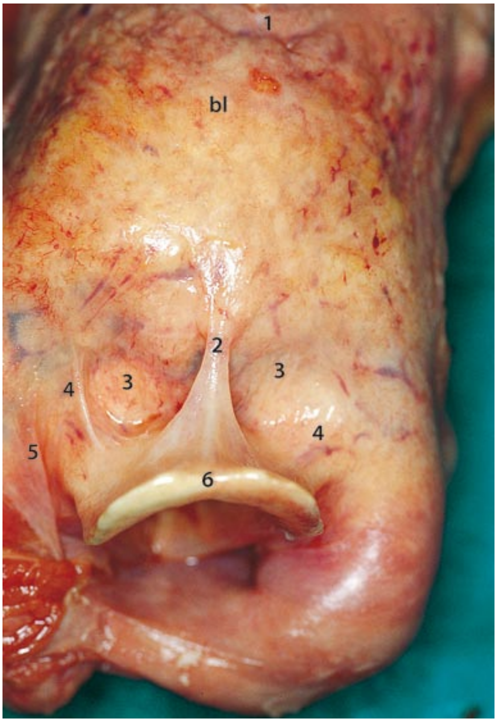

Fig. 9.15 Larynx and tongue base

bl = tongue base
1 = foramen cecum (apex of lingual "V")
2 = median glossoepiglottic fold
3 = glossoepiglottic vallecula
4 = lateral glossoepiglottic fold
5 = pharyngoepiglottic fold
6 = epiglottis

epiglottic folds delimit two depressions: the glossoepiglottic valleculae.

Remarks: The glossoepiglottic valleculae mark the roof of the pre-epiglottic cavity, often invaded by tumors of the laryngeal lamina of the epiglottis; the neoplasia occasionally perforates the epiglottis and emerges anteriorly in the form of a "swelling" in the glossoepiglottic valleculae (Fig. 9.15).

A potential site of pharyngolaryngeal tumors is the so-called three-folds region (pharyngoepiglottic, aryepiglottic, and lateral glossoepiglottic folds) (Fig. 9.16).

The laryngeal aditus, bounded by the epiglottic margin, the aryepiglottic folds, the cuneiform, and corniculate tubercles and the posterior commissure between the two arytenoid cartilages, is also clearly exposed. The cricoid lamina, situated inferiorly to the arytenoid cartilages and within the two piriform recesses, can be identified by palpation (Fig. 9.17).

- 9.1.16 The posterior laryngeal wall is then sectioned vertically along a line passing through the posterior commissure and in-

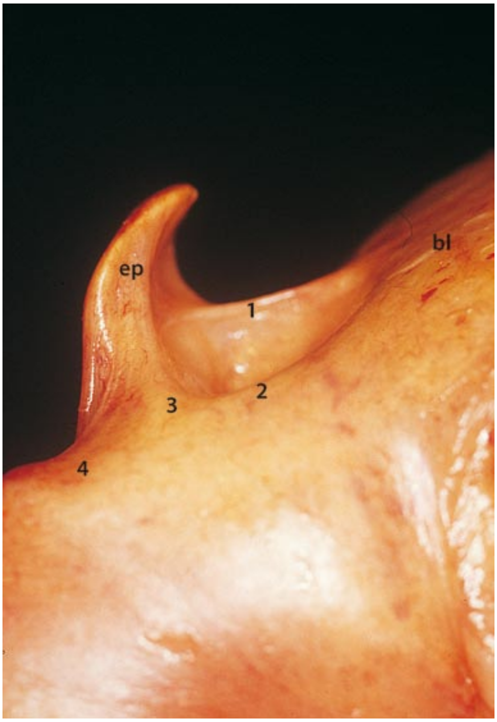

Fig. 9.16 Three-folds region

ep = epiglottis
bl = tongue base
1 = median glossoepiglottic fold
2 = lateral glossoepiglottic fold
3 = pharyngoepiglottic fold
4 = aryepiglottic fold

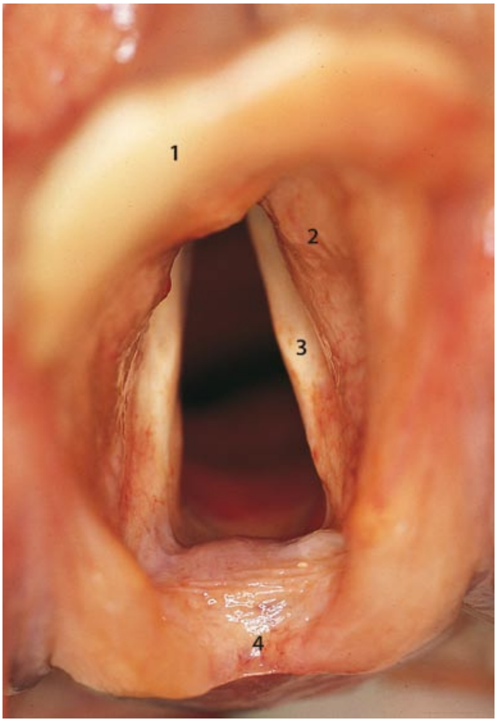

Fig. 9.17 Larynx: glottic plane

1 = epiglottis
2 = ventricular fold
3 = vocal cord
4 = posterior commissure

volving the center of the cricoid lamina. The vestibule of the larynx, the glottic plane, and the hypoglottis are exposed by divaricating the dissection margins with a self-retaining retractor (Fig. 9.18).

- 9.1.17 The anterior commissure region is also clearly evident (Fig. 9.19). The exposure of the anterior commissure also depends on the size of the angle between the two thyroid laminas; it is usually obtuse in females and in children, approximately a right angle in adult males.

- 9.1.18 Morgagni's ventricles can be explored with dissecting forceps. These lie between the ventricular fold and the vocal cords that separate in depth the superior and inferior infraglottic spaces. By palpation we identify the arytenoid cartilages and the cuneiform and corniculate accessory cartilages (Fig. 9.20).

Remarks: In TNM Staging, 6th ed., the arytenoid cartilages are a subsite of the supraglottis.

However, it appears clear that the arytenoid cartilage is a structure that belongs both anatomically and functionally to the glottic region [2].

- 9.1.19 Up until now we have examined the external conformation of the larynx. We shall now try to consider the submucous spaces and the structures that bound them. To do this we

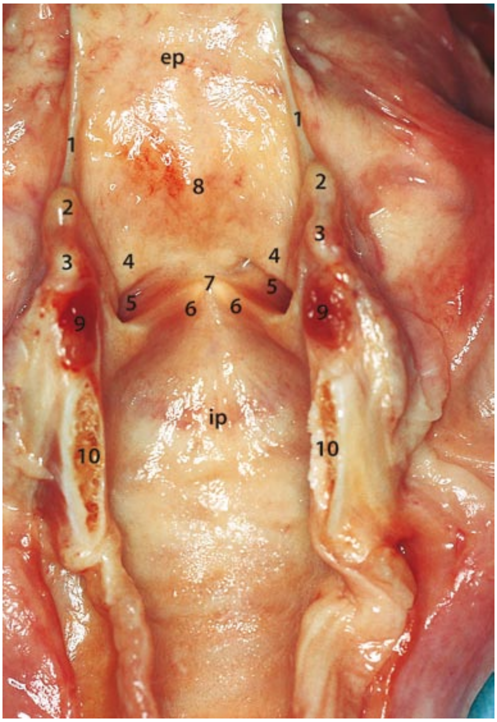

Fig. 9.18 Larynx and hypopharynx: intraluminal view (IV)

ep = epiglottis
ip = hypoglottis
1 = aryepiglottic fold
2 = cuneiform tubercle
3 = corniculate tubercle
4 = ventricular fold
5 = Morgagni's ventricle
6 = vocal cord
7 = anterior commissure
8 = petiole
9 = interarytenoid muscle
10 = cricoid lamina (sectioned)

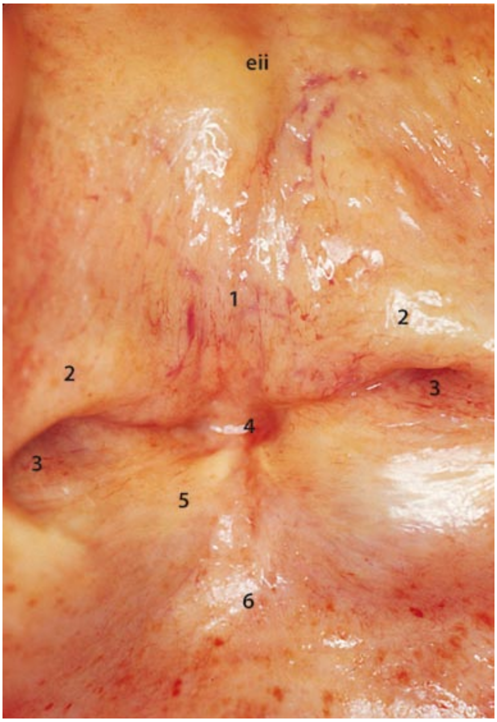

Fig. 9.19 Anterior commissure

eii = infrahyoid epiglottis
1 = petiole
2 = ventricular fold (false vocal cord)
3 = Morgagni's ventricle
4 = anterior commissure
5 = vocal cord
6 = hypoglottis

remove the portion of the base of the tongue, which is in front of the hypoid bone and the piriform recesses.

Remarks: The growth of laryngeal tumors depends a great deal on the site of onset and takes place along preferential routes. Some structures, such as tendons and cartilages, within certain limits "divert" the tumor, which instead easily colonizes the epithelium, and the adipose and glandular tissue. The knowledge of the anatomy of the larynx and the study of the spread of tumors are at the basis of the concepts of functional laryngeal surgery.

- 9.1.20 At this point, the exercise contemplates the dissection of the larynx along ventrodorsal planes, guided by anatomic macrosections obtained in autopsies. First, we evaluate four frontal sections, which give us an overall view of the larynx and of the submucous spaces. We shall then proceed with the dissection.

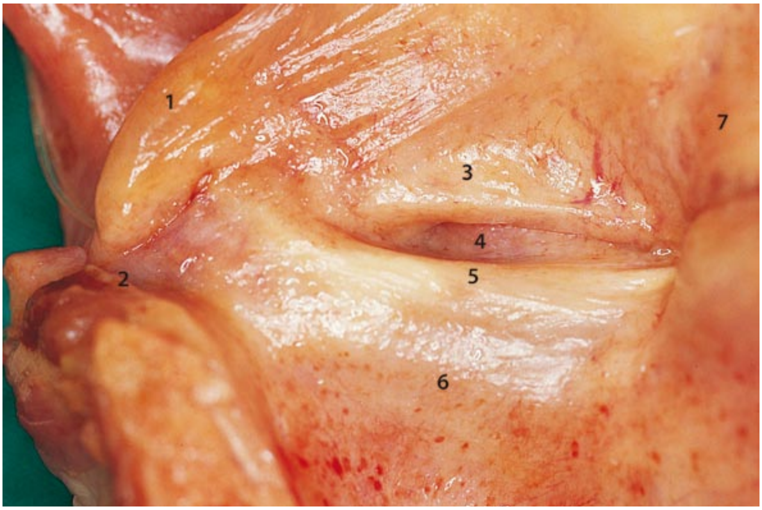

Fig. 9.20 Morgagni's ventricle

1 = arytenoid cartilage
2 = posterior commissure
3 = ventricular fold (false vocal cord)
4 = Morgagni's ventricle
5 = vocal cord
6 = hypoglottis
7 = "angle" region

Remarks: We must first observe a base structure that is constant: an external fibrocartilaginous skeleton (thyroid and cricoid cartilages, thyrohyoid membrane, cricothyroid membrane) and an internal fibroelastic skeleton (quadrangular membrane and elastic cone and epiglottis). The mucous coat rests on the fibroelastic skeleton (epithelium and lamina propria). Instead, between the two skeletons there is the submucosa (pre-epiglottic and paraepiglottic spaces, continuous with one another).

Of the four sections, the first is the most ventral and involves superiorly the hyoid bone in the intersection between the body, the greater cornua, and the lesser cornua (Fig. 9.21). The pre-epiglottic space is made up of adipose tissue and is crossed on the median line by elastic fibers that form the thyroepiglottic ligament. Laterally, the pre-epiglottic space is continuous with the superior paraglottic space, belonging to the ventricular band, and with the inferior paraglottic space, at the level of the vocal cords. In the anterior frontal sections, the laryngeal lumen assumes the shape of an upside-down swallow, the wings of which correspond with the laryngeal ventricles.

The second section clearly shows the epiglottis and its plurifenestrate appearance (Fig. 9.22). It must also be noted how the space between the thyroid lamina and the lateral margin of the epiglottis allows communication between the pre-epiglottic space, the superior paraglottic space, and the extralaryngeal tissues.

The third section is focused on the vocal cords, the ventricles, the bands, and the corresponding paraglottic spaces (Fig. 9.23). The paraglottic space looks like an "hourglass-shaped space" due to the presence of the ventricle.

Remarks: In this section, we consider how a possible route of expression of a glottic tumor is the lateral space that separates the inferior margin of the thyroid cartilage from the cricoid, where there is no ligamental structure.

We also note how a tumor of the laryngeal corner, which is the point of passage between

Fig. 9.21 Coronal macrosection of the larynx: pre-epiglottic space

1 = lesser cornu of hyoid bone
2 = corpus of hyoid bone
3 = greater cornu of hyoid bone
4 = pre-epiglottic space
5 = thyrohyoid membrane
6 = thyroid cartilage
7 = ventricular band
8 = Morgagni's ventricle
9 = vocal cord
10 = elastic fibers of hypoglottic cone
11 = cricoid ring

Fig. 9.22 Coronal macrosection of the larynx: epiglottis

1 = tongue base
2 = glossoepiglottic vallecula
3 = greater cornu of hyoid bone
4 = epiglottis
5 = ventricular fold
6 = Morgagni's ventricle
7 = vocal cord
8 = thyroid cartilage
9 = cricoid cartilage

the foot of the epiglottis and the ventricular band, tends to be expressed toward the superior laryngeal pedicle.

The fourth section borders on the posterior commissure and shows the articulation between the cricoid and arytenoid cartilages (Fig. 9.24). The cartilages are ossified in the portions that appear to be less intensely colored.

- 9.1.21 Now we make a median sagittal incision, which cuts the epiglottis in two halves, and arrives anteriorly at the hyoid bone and goes down along the dihedral angle of the thyroid cartilage until it arrives at the anterior commissure. We have thus exposed the adipose tissue of the pre-epiglottic space; we evaluate the conformation of the epiglottis cartilage and the consistency of the thyroepiglottic ligament (Fig. 9.25).

We identify the internal perichondrium of the thyroid cartilage and laterally raise the thyroid cartilage, always remaining in the supraglottis, until we reach the level of the bottom of the ventricle. We then section the aryepiglottic fold with forceps just in front of the arytenoid cartilage and, resecting the mucosa of the bottom of the ventricle, we arrive at the anterior commissure. At this point, we shall have removed the supraglottic larynx (mucosa, quadrangular membrane, submucosa, internal perichondrium).

Remarks: Let us remember that the laryngeal ventricle (Morgagni's ventricle) is no lon-

Fig. 9.23 Coronal macrosection of the larynx: glottis and paraglottic spaces

1 = epiglottis
2 = quadrangular membrane
3 = superior paraglottic space
4 = inferior paraglottic space
5 = elastic cone
6 = Morgagni's ventricle
7 = vocal ligament

Fig. 9.24 Coronal macrosection of the larynx: arytenoid cartilages and posterior commissure

1 = epiglottis
2 = interarytenoid muscles
3 = aryepiglottic fold
4 = piriform sinus
5 = thyroid cartilage
6 = arytenoid cartilage
7 = posterior commissure
8 = cricoarytenoid joint
9 = cricoid cartilage

ger considered a subsite of TNM staging (VI ed.) since it is considered formed by the inferior surface of the ventricular band and the superior surface of the vocal cord.

- 9.1.22 We now consider the glottic plane. We grip the epithelium of the vocal cord with forceps near the anterior commissure and pulling it medially, with the aid of the scalpel, we expose the vocal ligament, which appears as a thin fibrous tendon extending as far as the vocal process of the arytenoid cartilage. Laterally, the arytenoid cartilage presents instead a muscular process into which insert the vocal and cricoarytenoid muscles (Fig. 9.26).

  Remarks: In so doing we have reproduced what is normally called "peeling" or "decortications", or "stripping" of the vocal cord, that is the removal of the epithelium and of the tunica propria (Reinke's space), leaving the vocal ligament intact.

- 9.1.23 At the level of the anterior commissure, by palpation we can check that the mucosa is very close to the thyroid cartilage. In fact, the submucosa is not represented in this site (Fig. 9.27).

  Remarks: This fact introduces various considerations on the endoscopic laser treatment of the neoplasias affecting the anterior com-

Fig. 9.25 Sagittal paramedian macrosection of the larynx

1 = arytenoid cartilage
2 = epiglottis
3 = pre-epiglottic space
4 = hyoid bone
5 = ventricular fold
6 = Morgagni's ventricle
7 = vocal cord
8 = cricoid lamina
9 = thyroepiglottic ligament

Fig. 9.26 Axial macrosection of glottis: vocal ligament

1 = vocal process of arytenoid cartilage
2 = vocal ligament
3 = epithelial layer
4 = vocal muscle
5 = anterior commissure
6 = posterior commissure
7 = piriform sinus

Fig. 9.27 Sagittal median macrosection of the larynx: anterior commissure

1 = vocal ligament
2 = thyroid cartilage
3 = cordal mucosa
4 = anterior commissure

missure, since the distance that the tumor can travel to infiltrate the cartilage is minimum. For the same anatomic reason, even CT scans do not always succeed in efficiently evaluating this possibility.

For the sake of precision, we point out that the anterior commissure is conventionally defined as an area of mucosa interposed between the vocal cords, bounded superiorly by an imaginary line joining the corner of the ventricles and extending inferiorly for 3 mm [1].

- 9.1.24 We section the vocal cord midway between the anterior commissure and the vocal process of the arytenoid cartilage, cutting down until we reach and interrupt the internal perichondrium. We observe and evaluate the various planes that we encounter in this section, and remember that the stratification of the vocal cord is composed as follows: epithelium and tunica propria (together defined as the mucosa), vocal ligament, vocal muscle, submucosa, internal perichondrium, and cartilage (Fig. 9.28).

Remarks: The inferior limit of the glottis is conventionally established at 1 cm from the free edge of the vocal cord. This limit corresponds approximately to the point in which the elastic cone divides inferiorly into two components, one following the mucosa and the other enclosing the cartilage [2] (Fig. 9.29).

The attempt to have the glottic mucosa coincide with the pavement epithelium cannot be sustained because this covers the vocal cord with a maximum extent of 5 mm in its middle third, and it is reduced, and often disappears, at the level of the anterior commissure.

- 9.1.25 To conclude the dissection of this region, we transversely incise the cricothyroid membrane as in emergency tracheotomy (intercricothyroid laryngectomy). In this incision we may find the cricothyroid artery, which comes from the lateral branch of the superior thyroid artery.

Fig. 9.28 Coronal macrosection of the larynx: vocal cord

1 = Reinke's space
2 = vocal ligament
3 = vocal muscle
4 = elastic cone
5 = elastic cone (deep layer)
6 = elastic cone (superficial layer)
7 = thyroid cartilage
8 = cricoid cartilage
9 = cricothyroid space

Fig. 9.29 Coronal macrosection of the larynx: conus elasticus

1 = thyroid cartilage
2 = perichondrium
3 = inferior paraglottic space
4 = vocal muscle
5 = vocal ligament
6 = cordal mucosa (epithelial layer and tonaca propria)

Take Home Messages

- The anatomopathological observations of the stratification of the vocal cord and clinical and surgical evaluations have led to new protocols for the treatment of tumors of the vocal cord. The concept of functional surgery of the vocal cord was officially introduced in 2000 [3]. Considering that most glottic tumors do not go beyond the depth of the vocal ligament, it was deemed that the subperichondrial cordectomy systematically carried out for all T12 tumors was overtreatment in most cases. Endoscopic laser surgery takes this consideration into account and classifies cordectomies according to the depth of resection programmed for the various degrees of tumor infiltration. The result is a lower morbidity rate and often much less accentuated dysphonia.

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Chapter 10

Prevertebral Region

10

Core Messages

- The prevertebral plane is the deep limit of our dissection. It is usually exposed in demolitive surgery of the pharynx or in the drainage of retropharyngeal lymph node stations

10.1 Anatomic Layout

The prevertebral plane is exposed on exeresis of the median region viscera. Said plane is bounded laterally by the transverse processes of the cervical vertebrae, superiorly by the occipital bone, and inferiorly by the first thoracic vertebra.

The region consists of a slender musculoaponeurotic layer covering the cervical column. The most important structures are the cervical sympathetic chain and the vertebral artery, which cross the region from top to bottom (Fig. 10.1).

Significant anatomical structures: cervical sympathetic chain, vertebral artery, deep cervical fascia.

Landmarks: carotid tubercle, transverse process of the atlas.

10.2 Dissection

- 10.2.1 The dissection exercise begins by considering the prevertebral muscular plane and the deep cervical fascia that covers it. The pharynx, the esophagus, and the vascular nerve bundle of the neck can be easily separated from this plane. The complex of these structures is lifted with one hand while the other dissects the thin layer of loose cellular tissue that connects it to the deep plane.

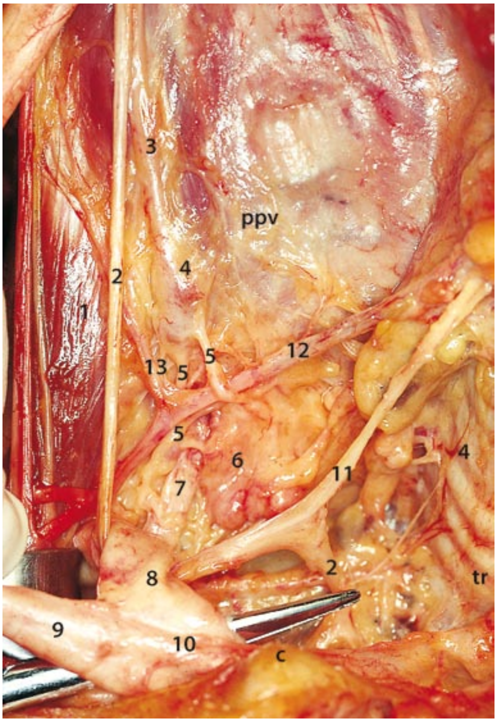

Fig. 10.1 Prevertebral plane

ppv = prevertebral plane
tr = trachea
1 = anterior scalenus muscle
2 = vagus nerve
3 = cervical sympathetic chain (superior portion)
4 = middle cervical ganglion
5 = cervical sympathetic chain (inferior portion)
6 = inferior cervical ganglion and first thoracic ganglion (stellate ganglion)
7 = vertebral artery
8 = subclavian artery
9 = common carotid artery
10 = brachiocephalic trunk (innominate artery)
11 = recurrent nerve
12 = inferior thyroid artery
13 = ascending cervical artery

- 10.2.2 The deep muscle plane is invested by the deep cervical fascia that continues laterally over the scalene muscles. This fascia divides into two to hold the cervical sympathetic chain, located just medially to the anterior tubercles of the transverse vertebral processes. This nerve cord adheres to the deep muscular plane, thereby distinguishing it from the vagus that, albeit adjacent, is an integral part of the cervical vasculonervous bundle, invested by a vascular sheath shared with the carotid artery and internal jugular vein.

Remarks: The cervical sympathetic chain extends from just beneath the external orifice of the carotid canal to the level of the first rib, where it continues with the thoracic tract. It presents three ganglia: the superior ganglion is 3 to 4 cm long, fusiform, and located just beneath the base of the skull; the middle, inconstant ganglion lies where the inferior thyroid artery crosses the sympathetic trunk; the inferior ganglion is the most voluminous, being fused with the first thoracic ganglion to form the stellate ganglion, and lies just posteriorly to the origin of the vertebral artery. Afferent distribution to the cervical sympathetic ganglia arises from the thoracic sympathetic ganglia, which receive white (myelinated) rami communicantes from the spinal cord through spinal nerves (preganglionic fibers). Efferent impulses, through gray (unmyelinated) rami communicantes, are conveyed by spinal nerves to the periphery and distributed to the various organs (postganglionic fibers), innervating their involuntary muscles and regulating secretory activity. The cervical sympathetic chain has a powerful vasomotor action, in the sense that its stimulation produces vasoconstriction and its interruption produces vasodilatation [2].

Complications: Injury to the iatrogenic cervical sympathetic chain is a very rare occurrence, less than 1% [3]. Instead, the neoplastic infiltration of the deep plane following metastatic adenopathies or tumors of the apex of the lung is more frequent. We must also consider the section of the cervical sympathetic chain during radical neck dissection when the adenopathy involves the structure. In all these cases, a clinical syndrome is found (Claude Bernard-Honer's syndrome), characterized by ptosis of the eyelid, miosis, and enophthalmos, rarely associated with an increase in saliva viscosity, alterations of the cerebral flow and pressor instability [1]. The enophthalmos is caused by paralysis of

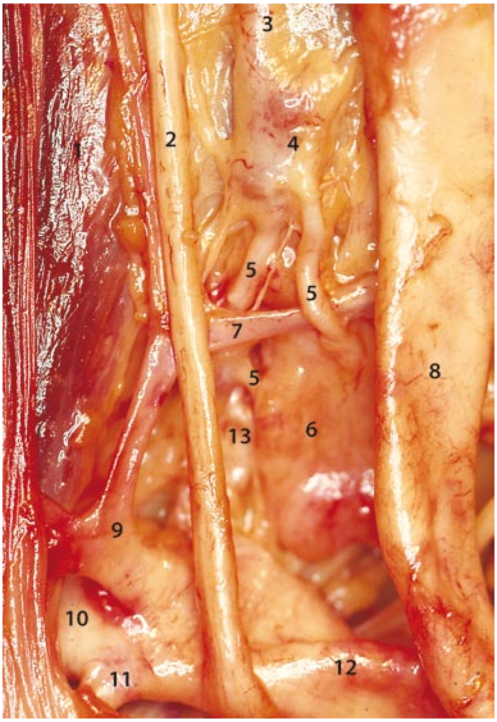

Fig. 10.2 Cervical sympathetic chain

1 = anterior scalene muscle
2 = vagus nerve
3 = cervical sympathetic chain (superior portion)
4 = middle cervical ganglion
5 = cervical sympathetic chain (inferior portion)
6 = inferior cervical ganglion and first thoracic ganglion (stellate ganglion)
7 = inferior thyroid artery
8 = common carotid artery
9 = thyrocervical trunk
10 = subclavian artery
11 = internal thoracic artery
12 = brachiocephalic trunk (innominate artery)
13 = vertebral artery

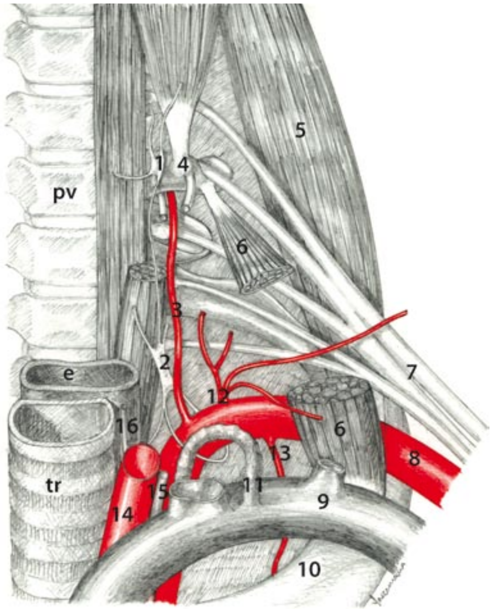

Fig. 10.3 Vertebral artery and carotid tubercle

pv = vertebral plane
e = esophagus
tr = trachea
1 = middle cervical ganglion
2 = inferior cervical ganglion and first thoracic ganglion, (stellate ganglion)
3 = vertebral artery
4 = carotid tubercle
5 = medial scalene muscle
6 = anterior scalene muscle
7 = brachial plexus
8 = subclavian artery
9 = subclavian vein
10 = first rib
11 = thoracic duct
12 = thyrocervical trunk
13 = internal thoracic artery
14 = common carotid artery
15 = vagus nerve
16 = recurrent nerve

the eye bulb detrusor and ptosis of the eyelid by paralysis of the tarsal muscle. Miosis is caused by paralysis of the dilator pupillae; the innervating fibers run a long course: They exit from the spinal cord with the first thoracic nerve (brachial plexus) and, through a communicating branch, reach the stellate ganglion, from which they ascend to the eye along the cervical sympathetic trunk. This course explains how pupillary alterations can also result from lesions to the brachial plexus, involving the first thoracic nerve at its origin (apex of the lung, upper mediastinum).

In the dissection, the three sympathetic ganglia and some communicating branches are identified and isolated; in particular there is the constant presence of a communicating branch between the middle ganglion and the stellate ganglion, which forms an eyelet around the inferior thyroid artery (Fig. 10.2).

- 10.2.3 The vertebral artery has already been identified at its origin, which is immediately proximal to the origin of the thyrocervical trunk. The inferior thyroid artery is immediately above it. The vertebral vein, instead, passes anteriorly to the subclavian artery and empties into the brachiocephalic vein. Our dissection follows the ascent of both vessels, medially to the anterior scalene muscle, to the level of the seventh cervical vertebra, where they bend medially and embed by penetrating the transverse foramina of the overlying cervical vertebrae.

The vertebral artery section, extending from the origin to the entrance to the transverse foramen of the sixth cervical vertebra, is the surgical portion and most easily accessible part of the artery. The carotid tubercle is an excellent landmark (Fig. 10.3).

- 10.2.4 Exercise 9: Vertebral Artery (Fig. 10.4). The vertebral artery reemerges and lateralizes between the transverse process of the epistropheus and the transverse process of the atlas, describing a curve with lateral convexity. We shall try to identify it between these two structures.

Turning the head contralaterally, we shall first identify the transverse process of the at-

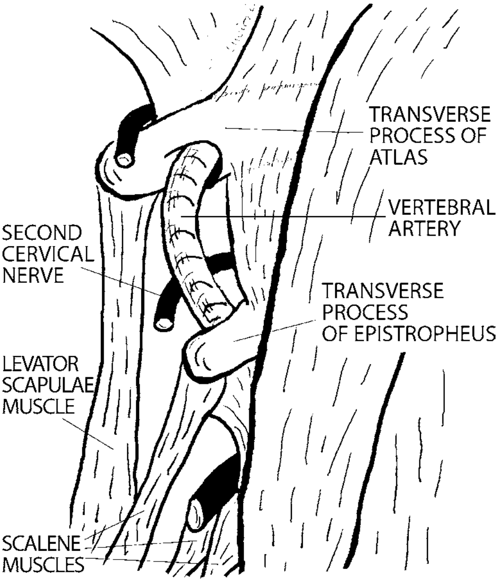

Fig. 10.4 Exercise 9: vertebral artery

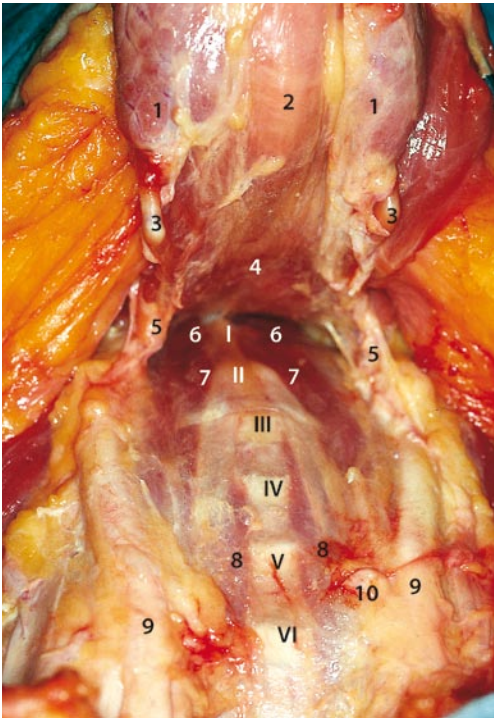

Fig. 10.5 Prevertebral muscles

1 = posterior margin of thyroid lobes
2 = posterior hypopharynx wall
3 = superior cornu of thyroid cartilage
4 = posterior oropharyngeal wall
5 = greater cornu of hyoid bone
6 = rectus capitis anterior muscles
7 = longus capitis muscles
8 = longus colli muscles
9 = common carotid artery
10 = right carotid tubercle
I–VI = cervical vertebrae

las, then that of the epistropheus. We look for the artery below, dissecting the interior intertransversal muscles, along a line that joins the apex of the two transverse processes. Farther down than the artery, with an oblique downward path, we can identify the anterior branch of the second cervical nerve, which will form the cervical plexus lower down.

This procedure may also be carried out between the transverse processes of the underlying vertebrae, but it is easier to reach the artery between the atlas and the epistropheus.

- 10.2.5 At the end of dissection, the composition of the prevertebral plane should be examined. Inferiorly to the deep cervical fascia, it comprises four muscle groups:

1. The rectus capitis anterior muscles, extending from the basal surface of the occipital bone to the transverse processes of the atlas.
2. The longus capitis muscles, extending from the basal surface of the occipital bone to the anterior tubercles of the third through sixth cervical vertebrae.
3. The longus colli muscles, which are composite and extend from the transverse processes of the atlas to those of the fourth through sixth cervical vertebrae and second and third thoracic vertebrae.
4. The intertransverse muscles, extending from one transverse vertebral process to the next (Fig. 10.5).

Take Home Messages

- The cervical sympathetic chain does not come from the skull but originates in the thorax and ends at the top just below the base of the skull.
- The deep cervical fascia that covers the prevertebral muscles may be used in demolitive surgery of the neck as an aid for the reconstruction of the hypopharynx.

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