ENDOSCOPIC DIAGNOSIS AND TREATMENT IN PROSTATE PATHOLOGY

ENDOSCOPIC DIAGNOSIS AND TREATMENT IN PROSTATE PATHOLOGY

HANDBOOK OF ENDOUROLOGY

Edited by

PETRIŞOR A. GEAVLETE

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Preface

The prostate represents one of the most important fields of modern urology, with new endoscopic procedures and technologies as well as new assessments and an unprecedented diversity of indications for endoscopic approach.

A correct positioning of the urologist in front of this avalanche of technical options is the main objective of the volume *Endoscopic Diagnosis and Treatment in Prostate Pathology: Handbook of Endourology*, the second volume of the *Handbook of Endourology*, edited by the Urology Clinic of Sfantul Ioan Hospital, Bucharest.

With an experience of over 500 endoscopic prostatic procedures per year (approximately 10,000 cases operated in this clinic in the last 20 years being assessed), this textbook analyzes almost exclusively our own experience in a high-performance clinic, unanimously recognized both in Romania and abroad.

In this volume, we describe the main techniques applied in the most frequent prostatic conditions: endoscopic electroresection of prostate adenoma (TURP), bipolar electroresection of prostate adenoma, electrovaporization of prostate adenoma, endoscopic incision of the prostate (TUIP), laser in the treatment of prostate adenoma, prostatic stents, the place of endoscopy in the modern treatment of prostate cancer, endoscopic treatment of prostatic abscesses, endoscopic treatment of prostatic lithiasis, etc.

Transurethral resection remains the standard technique in most centers worldwide. All assessments of new technologies are compared to this unanimously accepted endoscopic therapeutic alternative for prostate adenoma. The basic principles of transurethral resection, the operative technique, tips and tricks for resection of large adenomas, postoperative follow up, intraoperative and early and late postoperative complications, results, and prognosis are analyzed in this volume.

Bipolar resection applied in prostatic diseases is also analyzed in detail. Being one of the first clinics to apply this technology, we were able to assess, after a significant period of time, the basic principles of bipolar resection, the working systems, the Vista Coblation® system, the Autocon system, the Olympus UES-40 system, SurgMaster, specific operative techniques, complications, and results.

Electrovaporization of prostate adenoma is analyzed with regard to working systems, the PlasmaKinetic® system, and the TURis system.

Endoscopic incision of the prostate (TUIP) still has particular indications. The current indications, operative techniques, intra- or postoperative complications, and results are described.

The lasers applied in the treatment of prostate adenoma are analyzed in detail. Thus, the following laser types are also analyzed: Neodymium:Yttrium-Aluminum-Garnet (Nd:YAG laser); Holmium:Yttrium-Aluminum-Garnet (Ho:YAG laser); KTP laser (potassium-titanyl-phosphate); diode laser; Thulium laser; Erbium:Yttrium-Aluminum-Garnet (Er:YAG laser); combined lasers; transurethral laser-induced prostatectomy (TULIP); visual laser ablation of the prostate (VLAP); interstitial laser coagulation (ILC); laser vaporization of the prostate (LVP); Holmium laser ablation of the prostate (HoLAP); photoselective laser vaporization prostatectomy (PVP); diode laser vaporization prostatectomy (DVP); enucleation in the treatment of prostate adenoma; and Holmium laser enucleation of the prostate (HoLEP).

Enucleation in the bipolar system (button enucleation) was introduced by our clinic as a method for treating large adenomas. In this book, *Endoscopic Diagnosis and Treatment in Prostate Pathology: Handbook of Endourology*, we describe aspects related to the generalities, indications and contraindications, instruments, operative techniques, complications, and results.

We must also mention the assessment of some techniques that still have limited or particular indications or that have not been embraced in day-to-day practice: microwave thermotherapy in the treatment of prostate adenoma (TUMT), radiofrequency therapy of prostate adenoma (TUNA), transurethral balloon dilation of the prostate, and prostatic stents.

Brachytherapy, cryotherapy, and endoscopic treatment of prostatic abscesses and prostatic stones are also analyzed.

We are convinced that merely by looking over the structure of this book, the modern urologist will be encouraged to read about an experience that in the end also analyzes a minimally invasive treatment algorithm for prostate adenoma, the place of endoscopy in the modern treatment of prostate cancer, transurethral resection for unblocking, and the current value of minimally invasive ablative techniques.

With hundreds of full-color images, the analysis of exceptional experience, and a modern assessment of most techniques applied in prostatic diseases in 2015, this book will offer real support for any urologist, wherever he or she may be!

Editor
Professor Petrişor Aurelian Geavlete, MD, PhD

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CHAPTER

1

Endoscopic Aspects of Prostate Anatomy

Gheorghe Niţă, Petrişor Geavlete

The prostate is an accessory gland of the male reproductive system, located in the prostatic lodge in the pelvic subperitoneal space, above the urogenital diaphragm and under the bladder. It has the shape of an anterior–posterior flattened cone, with the base directed upward (toward the bladder) and the apex directed downward. It is crossed by the initial part of the urethra (prostatic urethra). The anterior part is in contact with the pubic symphysis and the posterior one with the rectum. The side parts come in contact with the levator ani muscles (Yucel and Baskin, 2004). The normal weight of the prostate in an adult is 25–30 g, and the dimensions are approximately 4/3.5/2.5 cm.

From an embryological and clinical point of view, five prostatic lobes are macroscopically described (McConnell, 1998): posterior lobe, two lateral lobes, median lobe, and anterior lobe.

The anterior lobe is poorly developed, being described as a fibromuscular septum connecting the two lateral lobes.

The lateral lobes, which are located below the plane passing inferior to the ejaculatory ducts, have their origin in the posterolateral buds and can develop symmetrically or not (Fig. 1.1). The posterior lobe represents the peripheral part of the prostate and can be felt during a rectal exam. The median lobe is located toward the bladder neck, and its lower limit reaches the plane that passes through the ejaculatory ducts (Fig. 1.2).

McNeal divides the prostate into three zones: peripheral, central, and transitional (McNeal, 1981). Approximately 75% of the entire glandular tissue is located posteriorly in the peripheral zone (McNeal, 1978). Most prostate cancers develop from this region. The central zone is located around the ejaculatory ducts. The transitional zone is usually the smallest. Two distinct lobes are described, on each side of the urethra. The transitional zone represents 5% of the prostatic volume in males under 30 years of age and is considered to be at the origin of benign prostatic hyperplasia. It usually contains a small batch of tissue with canaliculi located near the prostatic urethra (close to the internal sphincter). As the transitional zone grows, it may represent up to 95% of the prostatic volume (McNeal, 1978). During endoscopic interventions, the two transitional zone lobes can be seen obstructing the prostatic urethra (Fig. 1.3).

The periurethral glands are usually less involved in benign prostatic hyperplasia but through enlargement, they can create the median lobe (a tear-shaped structure located in the posterior part of the bladder neck) (Fig. 1.4). This can compress the urethra, acting like a valve when the pressure inside the bladder rises, causing severe obstructive symptoms.

The transitional zone and the periurethral region have been named the central gland. Prostatic stones develop at the border between the transitional and the peripheral zones (Fig. 1.5). In fact, these can be used as a landmark between these two zones. They are usually made from calcium phosphate and are not clinically relevant. Chemical analysis is not required.

Prostatic stones appear due to calcification of the amyloid bodies and through precipitation of the prostatic secretion. They can occur either spontaneously, in response to an inflammatory reaction, or as a consequence of another disease, creating an acinar obstruction. Some authors state that these calcifications, which appear in response to bacterial prostatitis, may harbor bacteria that grow periodically, thus causing recurrent prostatitis (Klimas et al., 1985).

During transurethral resection of a prostatic adenoma, it is possible to evacuate these stones using a loop (without power) to press the prostatic tissue, thus extracting the stones in the prostatic lodge (Fig. 1.6).

The anterior part of the prostate is the thinnest and narrowest (12 o'clock at cystoscopy) (Fig. 1.7). Transurethral resection must be performed very carefully in this region to avoid perforation of the prostatic capsule, especially if this part of the prostate is approached at the beginning of the intervention.

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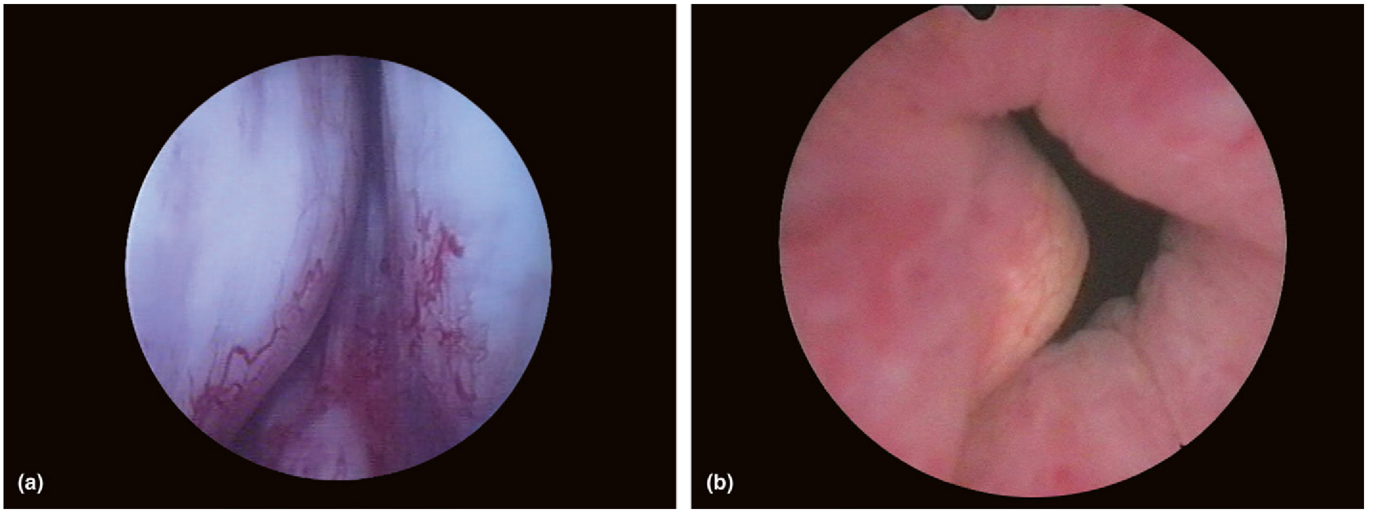


FIGURE 1.1 **Lateral prostatic lobes.** (a) Symmetric, (b) asymmetric.

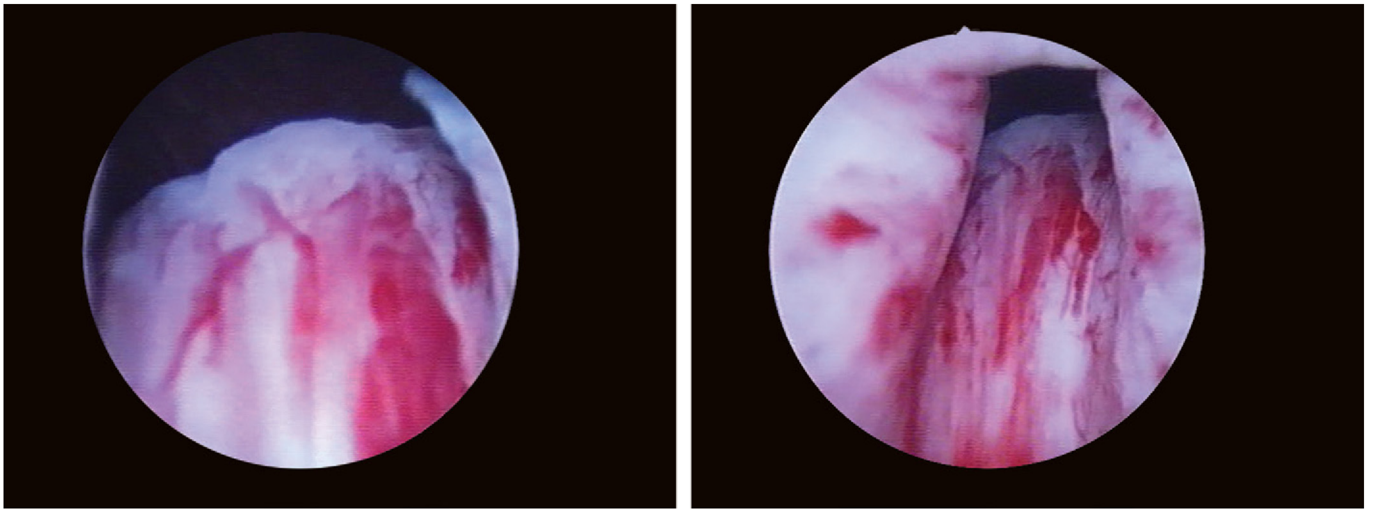


FIGURE 1.2 **Endoscopic aspect of the median lobe.**

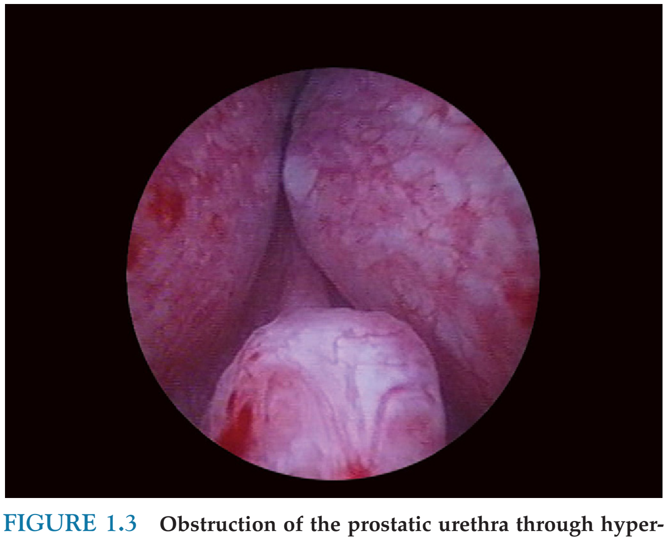


FIGURE 1.3 **Obstruction of the prostatic urethra through hypertrophy of the transitional zone lateral lobes.**

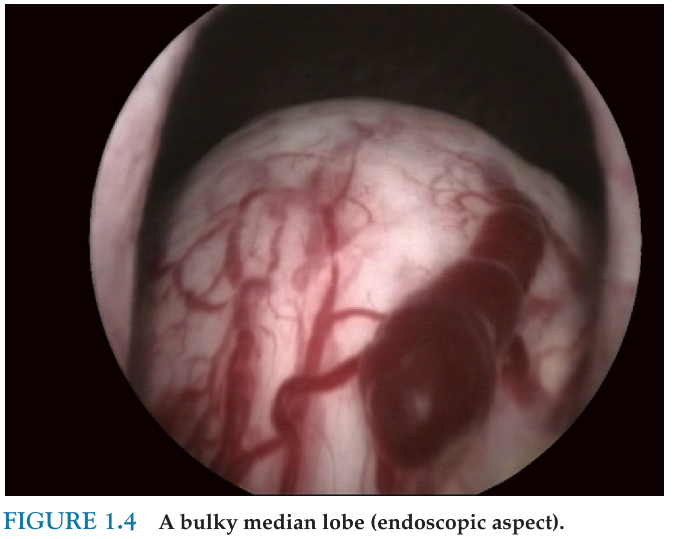


FIGURE 1.4 **A bulky median lobe (endoscopic aspect).**

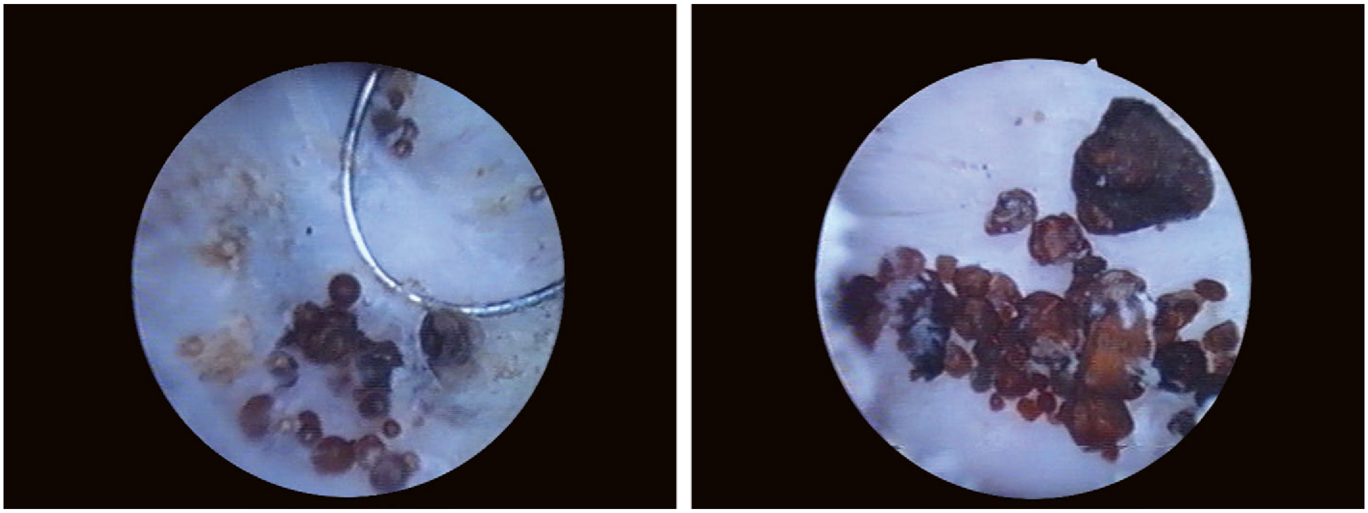


FIGURE 1.5 **Multiple prostatic stones in a patient with benign prostatic hyperplasia.**

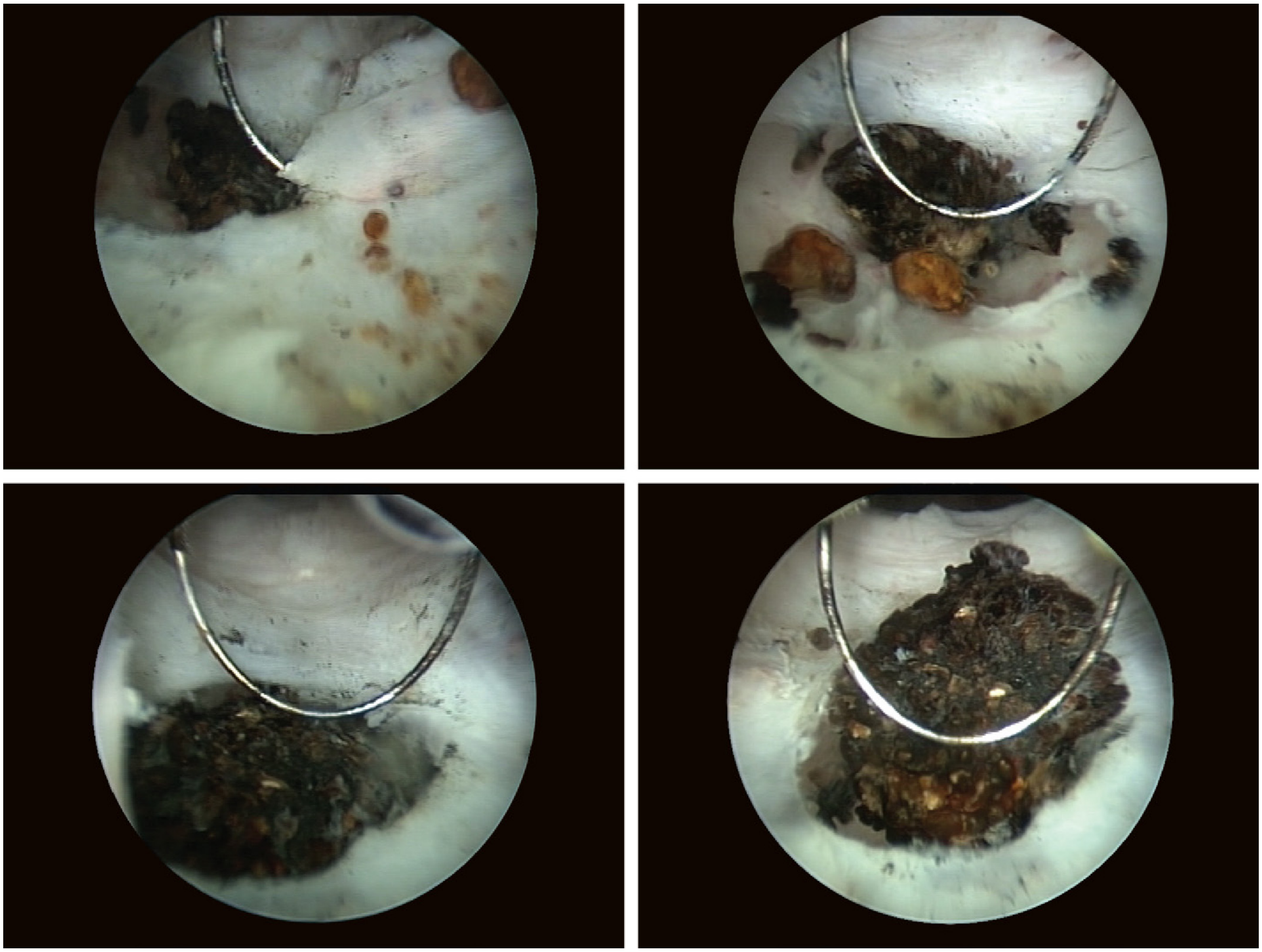


FIGURE 1.6 **Extraction of prostatic stones during transurethral resection.**

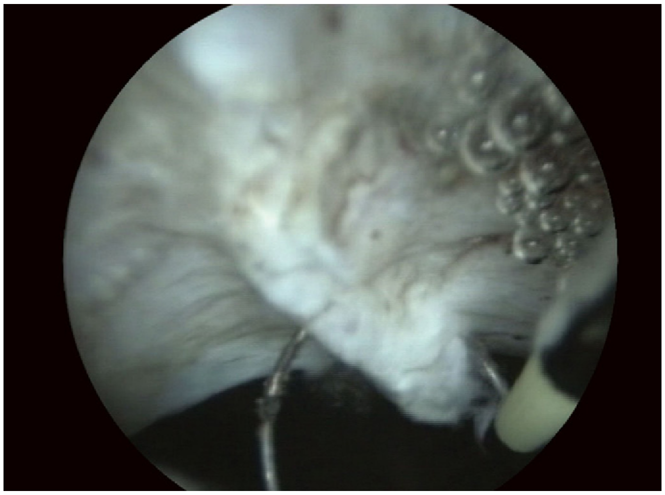


FIGURE 1.7 **The anterior part of the prostate (intraoperative aspect).**

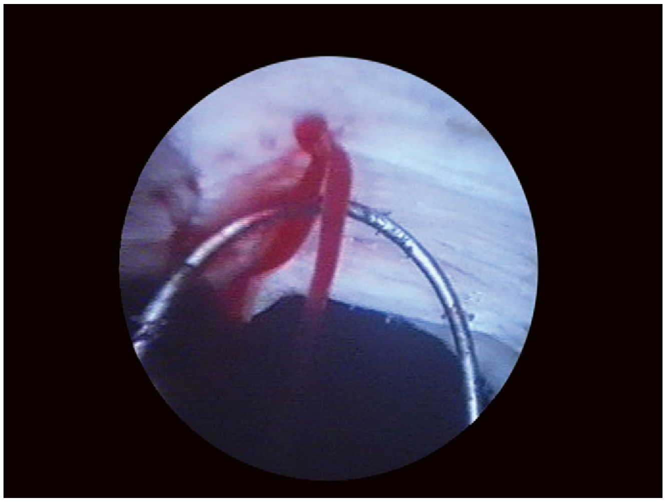


FIGURE 1.8 **Bleeding from the anterior part of the prostate (intraoperative aspect).**

Many blood vessels are found in this region, immediately anterior to the prostatic capsule, which can cause significant bleeding that can be difficult to control (Fig. 1.8).

One of the most important anatomical landmarks used during transurethral prostate surgery is the verumontanum, a structure located on the midline, next to the external sphincter. During endoscopy, it appears as a small, round bump located at 6 o'clock and is best seen during the telescope's withdrawal (Fig. 1.9).

The orifices of the ejaculatory ducts merge in the verumontanum. Intraoperative importance is determined by its position in the immediate vicinity of the external sphincter (Dyson, 1995). This allows it to be used as a landmark for the lower resection limit (Fig. 1.10). The distance between the verumontanum and the external sphincter has individual variations, requiring visual control before starting the resection and during surgery.

Although sometimes up to 10% of the prostate may extend beyond the verumontanum (Fig. 1.11), especially in bulky adenomas, it still represents the lower limit of resection in most situations.

In very large prostates, some experienced urologists resect the apical tissue located on the lateral side, very close or at a small distance from the verumontanum (Fig. 1.12); leaving this tissue in place can cause an incomplete resection and unsatisfactory postoperative results. However, the risk of damage to the external sphincter is high, requiring caution on the part of the surgeon.

Resection or cauterization of the verumontanum should be avoided, since these maneuvers can cause pain during ejaculation. Without this anatomical landmark, orientation can easily be lost, with an increased risk of an external sphincter injury followed by urinary incontinence.

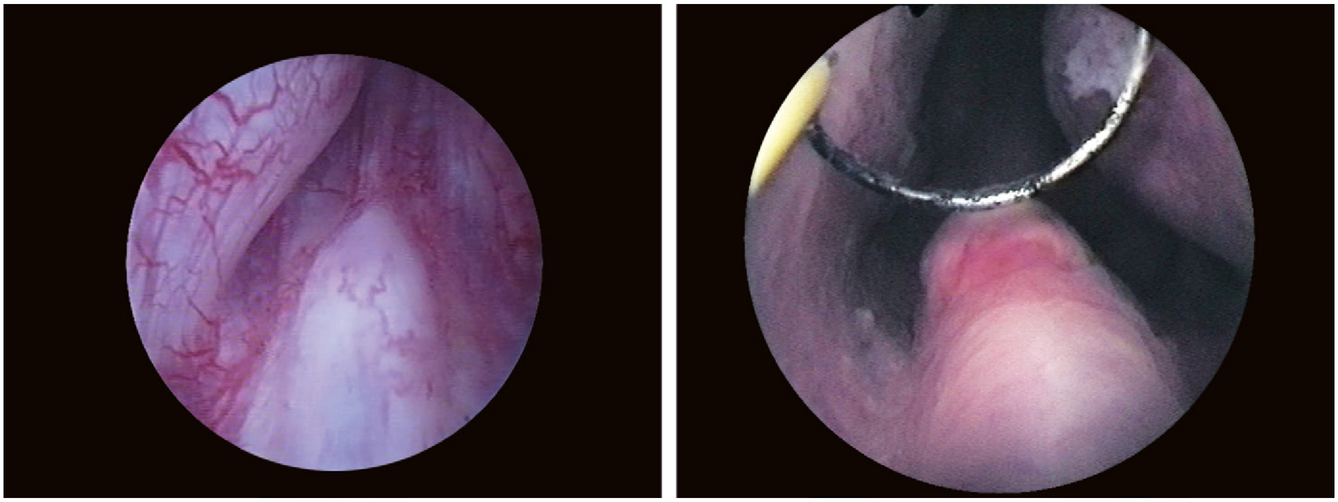


FIGURE 1.9 **Endoscopic aspects of the verumontanum.**

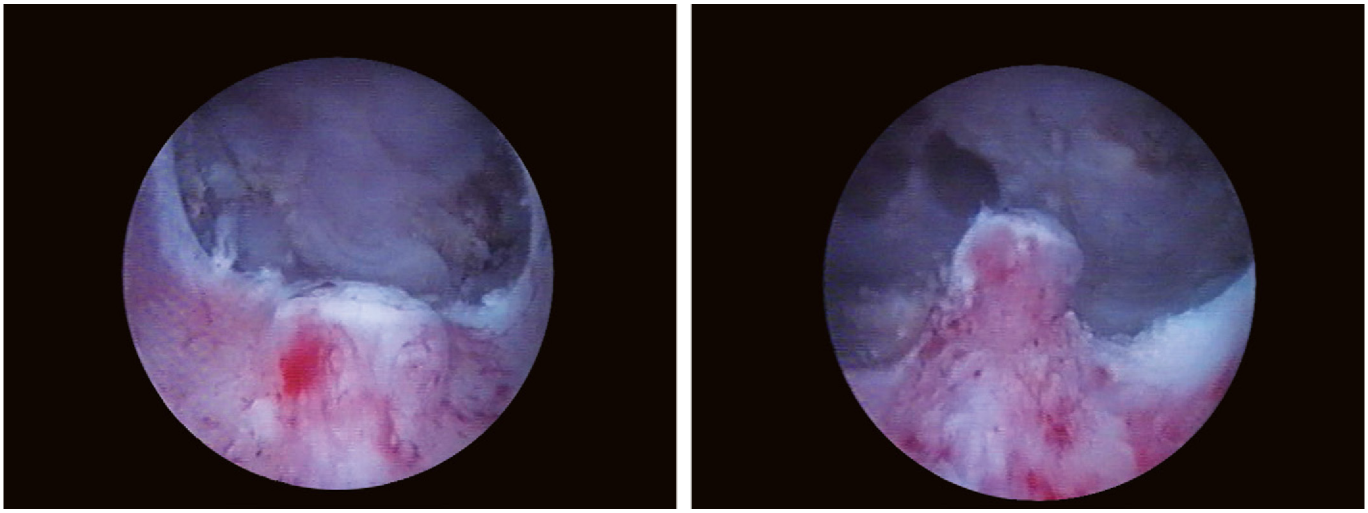


FIGURE 1.10 **The verumontanum as a landmark for the lower limit of endoscopic resection for benign prostatic hyperplasia.**

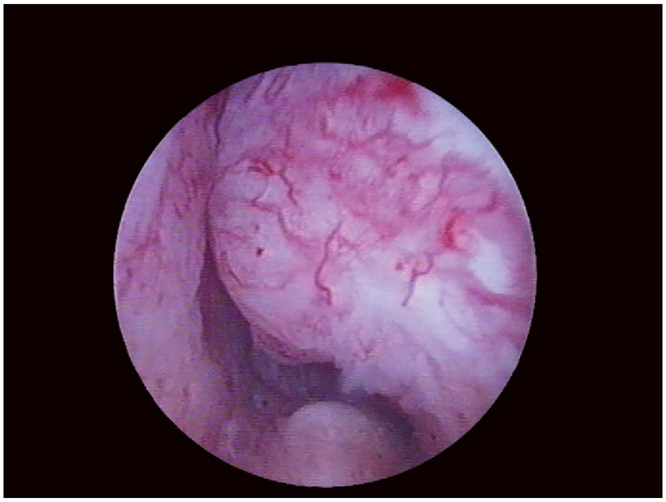


FIGURE 1.11 **A bulky asymmetric benign prostatic hyperplasia, expanded distal to the verumontanum.**

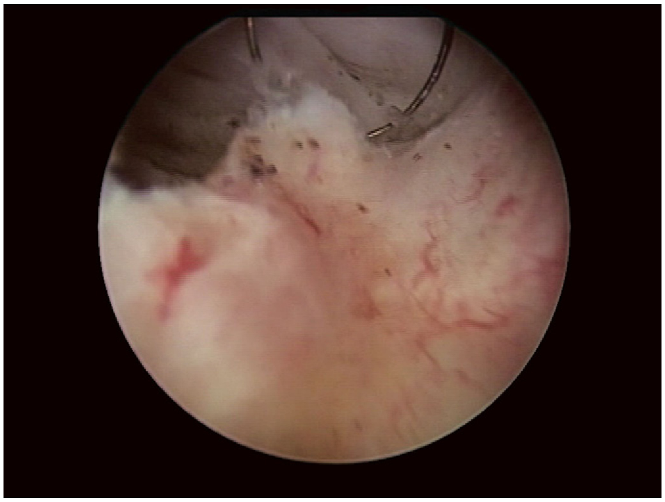


FIGURE 1.12 **Resection lateral to the verumontanum.**

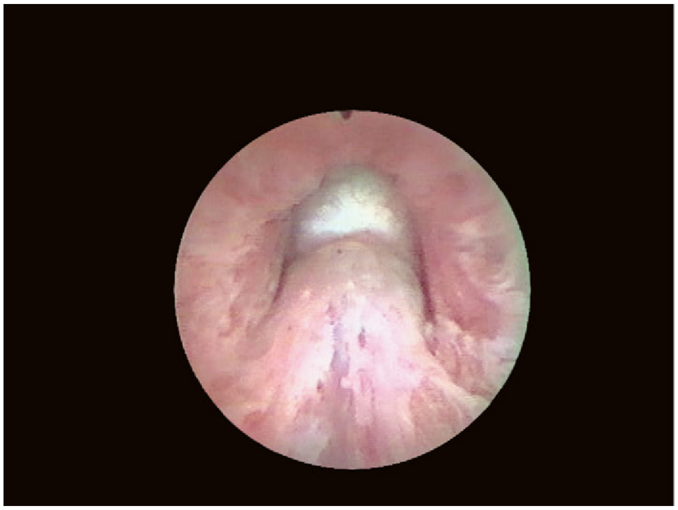
The striated sphincter is located around the membranous urethra, completely surrounding the tip of the prostate, with a slightly inclined position. Due to the increased volume of the gland, the cross-section fiber disposition is similar to the Greek letter "Ω" (Myers et al., 1987; Cockett and Koshiba, 1996).

The external sphincter can be identified during cystoscopy, having the appearance of wrinkles and contracting when the resectoscope is withdrawn (Fig. 1.13). When the instrument is inserted again, the superficial mucosa in front of the telescope has the tendency to gather in a bundle; this occurs because the external sphincter is wrapped inside the urogenital diaphragm, which has a relatively fixed position, while the prostate is characterized by certain mobility (Myers, 1991).

The location of the ureteral orifices in the proximity of the edge of the hypertrophied prostate is variable, especially in patients with a bulky median lobe (Fig. 1.14). This distance should be checked regularly during surgery.

It is important to mention that any endoscopic procedure for treating a prostatic condition usually starts with visualization of the external sphincter, verumontanum, prostatic urethra, bladder neck, median prostatic lobe, trigone, ureteral orifices, and the rest of the urinary bladder. This should be performed very carefully, avoiding as much as possible any urethral and prostatic lobe injuries. These frequently have a hyperemic, easily bleeding mucosa (Fig. 1.15), which may alter intraoperative visibility.

Prostatic vascularization was accurately described by Rubin Flocks (1937). Blood is supplied to the prostate mainly through branches of the inferior vesical artery (prostatic arteries), which originates from the internal iliac artery.



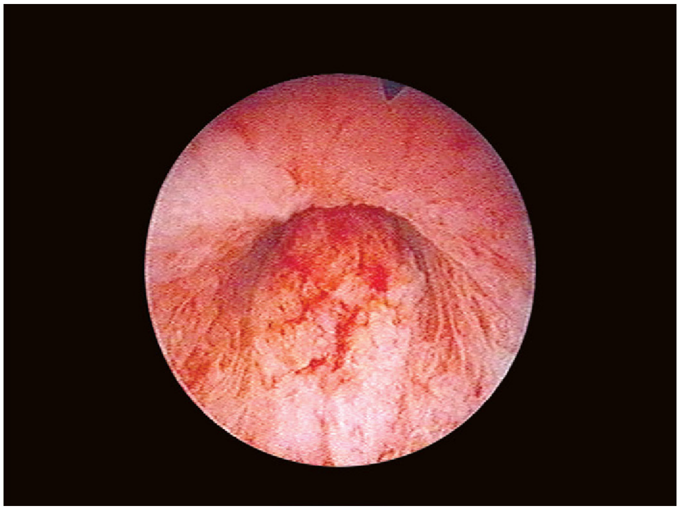


FIGURE 1.13 **Aspect of the external urethral sphincter.**

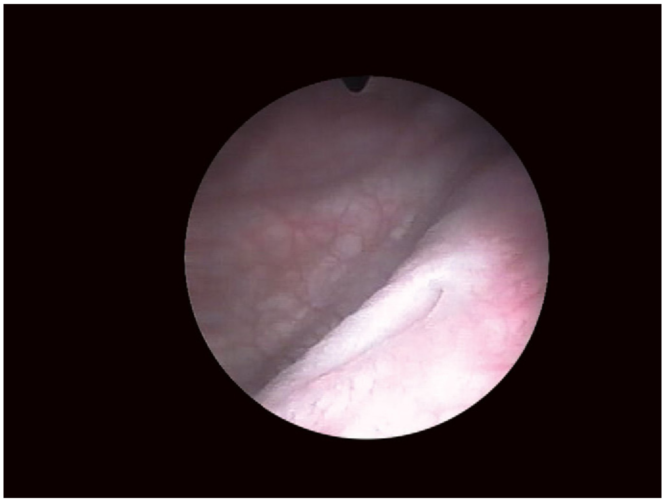


FIGURE 1.14 **Visualization of the ureteral orifice in a patient with median lobe adenoma.**

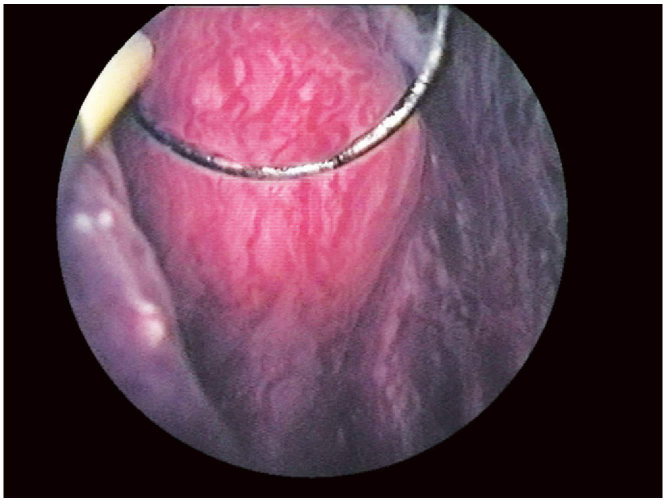


FIGURE 1.15 **Hyperemic, easily bleeding mucosa in a three-lobed prostate adenoma.**

The inferior vesical artery divides into two groups at the junction between the bladder and the prostate. One passes straight through the prostate toward the bladder neck; when entering inside the prostate next to the urethra, most of these ramifications become parallel to the prostatic urethra (urethral arteries), while others supply the median lobe. The vessels, which are parallel to the prostatic urethra, provide most of the blood of the hypertrophied lateral lobes. The second large group of arteries heads posterolaterally toward the prostatic capsule (capsular arteries) and generates perforating vessels distributed to the surface around the verumontanum.

The most important intraoperative bleeding comes from the posterolateral urethral arteries (5 and 7 o'clock) (Fig. 1.16), which are significantly enlarged in benign prostatic hyperplasia, while the capsular arteries do not suffer significant changes (Walsh and Retik, 2002).

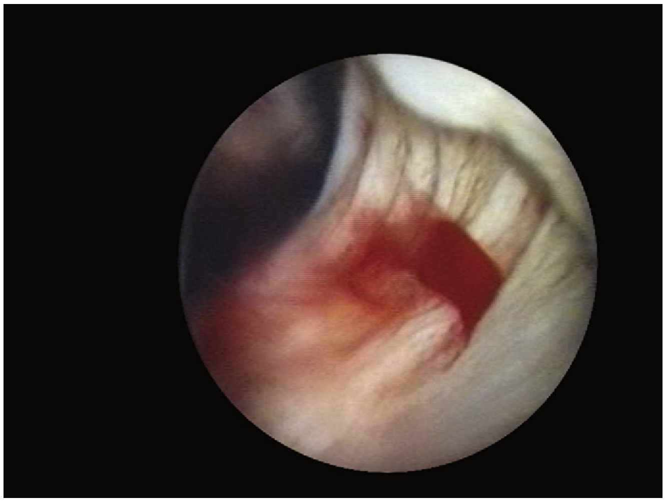


FIGURE 1.16 **Five o'clock intraoperative bleeding.**

Venous drainage is carried out through the prostatic plexus, in which the dorsal vein of the penis also empties, forming the Santorini pudendal plexus. This anastomoses with the bladder plexus and drains into the internal pudendal vein, the internal iliac veins, and the external vertebral plexus (Batson veins), thus explaining the frequent vertebral metastases in prostate cancer.

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C H A P T E R

2

Endoscopic Electroresection of Benign Prostatic Adenoma (TURP)

Petrişor Geavlete, Gheorghe Niţă, Bogdan Geavlete

2.1 HISTORY

Although urinary retention secondary to benign prostate hyperplasia (BPH) has been known since ancient times, with various procedures for urethral catheterization being described, modern surgical procedures are based on advances made in the last 100 years. Urinary retention was first reported by the Egyptians in the fifteenth century BC. Although Galen attributed the term "prostate" to Herophilus (around 300 BC), there are few references up to the middle of the sixteenth century. The word comes from the Greek "prostat," which translates to "something which stands before or in front of …" (it stands in front of the bladder). The first anatomical description belongs to Vesalius (1538), while Jean Riolan (1649) suggested that the hypertrophy of this gland may induce urinary retention. Urinary retention was treated by Celsus and Galen by the insertion of a catheter during the first century of our era. The oldest description of a flexible catheter belongs to Avicenna from Persia in 1036. Different urethral catheters made from a wide variety of materials (*Allium fistulosum* leaves, bamboo, wood, metal, and rubber) were described by the beginning of the twentieth century.

Ambroise Paré was the first to perform an intervention with a curative intent in a patient with prostate adenoma in 1575, using a punch-type instrument (Fig. 2.1) (Shelley, 1969). The modern endoscopic procedures for the treatment of BPH are based on the procedure imagined by Paré, using a cold knife or other power sources inserted in the urethra in order to remove or to incise the prostatic tissue. There are no other descriptions of interventions concerning the prostate in the sixteenth and seventeenth centuries, excepting those described by Paré.

At the end of the eighteenth century, with increasing life expectancy, many authors became interested in prostate pathology. Thus, Morgagni (1761) described BPH and its consequences on the bladder while performing an autopsy on a 73-year-old patient that died because of uremia. La Faye from Paris (1726) developed the surgical technique that was most frequently used in the eighteenth and early nineteenth century. During this procedure, an arched metal catheter with a sharp tip was forced upward through the prostate and inside the bladder using the rectal exam for orientation. This instrument was left in place for several days to allow healing. Minimal suprapubic cystostomy was also described (Heister) in the same period of time, as an alternative for temporary or permanent bladder drainage in case of urinary retention. Yet, the most important therapeutical alternative for those years was represented by self-catheterization; male patients were admitted to the hospital to learn how to perform this maneuver. However, the mortality rate was high, reaching up to 20% during the first 6 months at the middle of the nineteenth century.

The balloon dilation technique for BPH has its origins in the early nineteenth century, being described by Philip Syng (1815), who was known as "the father of American surgery." He used a metal catheter covered by a "balloon" at the proximal end (Fig. 2.2). The balloon was inflated (thus exerting pressure on the prostatic lobes) for approximately 15 min. The technique was repeated every 2–3 days but with poor results, as was confirmed by studies published in the 1880s.

Two decades later, the French surgeon Louis Auguste Mercier described a curved metal catheter equipped with a straight mandrin (Fig. 2.3), which was used to exert pressure on the prostate, especially on its median lobe. In 1830, Sir William Ferguson described for the first time the possibility of treating BPH by removing the obstructive tissue.

The development of anesthetic techniques and the concept of antiseptic surgery gradually led to the development of the suprapubic approach (at the expense of the perineal one) for the removal of bladder stones and subsequently

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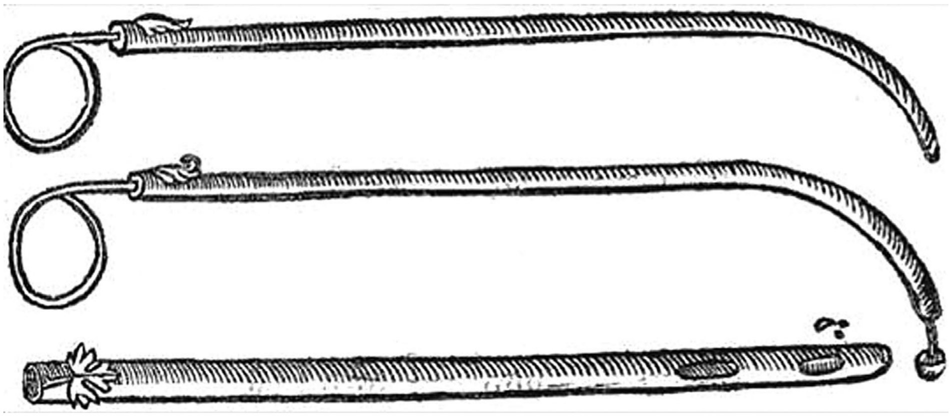

FIGURE 2.1 **Instruments developed by Paré.** *Source: Shelley (1969)*

FIGURE 2.2 **The instrument imagined by Philip Syng for prostate dilation.** *Source: Shelley (1969)*

FIGURE 2.3 **The catheter described by Mercier for prostate "compression."** *Source: Shelley (1969)*

for the partial removal of obstructive prostatic tissue. Many authors described such procedures, for example, Von Dittel (Vienna, 1885), Belfield (Chicago, 1886), and McGill (Leeds, 1887). The first transvesical prostatic adenomectomy with enucleation of both lateral lobes and the median lobe was performed by Goodfellow G. (Tombstone, Arizona) in 1891 but was not published until 1902 (Herr, 2006). The first six cases of suprapubic "prostatectomy" were published by Fuller E. (New York) in 1895. He described the incision of the bladder neck to find the plane between the adenoma and the capsule, followed by digital enucleation of the lateral lobes, while at the same time exerting pressure on the perineum in order to facilitate the intervention. The rectal control of the enucleation was suggested by Guiteras R. The procedure became popular thanks to Peter Freyer (London) and was widely used after 1912 (Fig. 2.4). The perineal approach was described by Von Stockum in 1909. However, this technique was rarely used until the 1940s, being developed and popularized by Terence Millin (London) beginning in 1945.

The first endoscope was developed by Phillip Bozzini, a German, in 1805. It was called the "lightleiter" and was a tubular system with a special support for a wax candle, which provided light. The instrument allowed for the visualization of different cavitary organs, including the bladder. Unfortunately, the device was not taken seriously by Bozzini's contemporary medical community, causing a delay in the development of endoscopes of almost 50 years. In 1853, the French surgeon Antoin Jean Desormeaux added a system of mirrors and lenses, thus improving visualization. The wax candle was replaced by a lamp with alcohol and turpentine. The first endoscope with an electric light source was manufactured by Gustave Trouve in 1869.

The German doctor Maximilian Nitze (1877), known as the father of cystoscopy, designed the precursor of modern cystoscopes (Leslie, 2006). The device was manufactured in Vienna by Josef Leiter and was used exclusively for the examination of the bladder. It used incandescent light generated by an electrically heated platinum cable and was equipped with a water cooling system and telescopic lenses.

FIGURE 2.4 Peter Freyer.

In 1909, Hugh Hampton Young developed the "cold-cut" procedure (cold resection). The instrument had an orifice located close to its proximal end, which allowed for catching the prostatic tissue. The prostatic tissue was cut using the sharp edge of the inner cylinder. Intraoperative bleeding was difficult to control. The technique was improved (1911) with diathermy hemostasis. In 1931, Thomas J. Kirwin designed a modified version of the device for cold resection (performing coagulation before the resection), thus reducing intraoperative bleeding with superior postoperative results (Leslie, 2006).

The discovery of high-frequency direct current (Lee de Forest, 1906) allowed its use for cutting prostatic tissue. The introduction of power generators was made possible by the improvements brought by Wappler R. and Wyeth G. in 1924. However, loop resection became possible only after 1926, when Maximilian Stern designed the resectoscope. It was made from a mobile loop of tungsten and could cut a cylinder from the prostatic tissue using high-frequency power (Blandy et al., 2005). Stern described the mechanism of action for this instrument: rapid destruction of the cells in the path of the loop, leaving a space in which the cutting loop could easily advance without tissue carbonization on the loop's surface. His instrument had a caliber of 27 F and allowed for a satisfactory incision of the prostatic tissue. However, hemostasis was poor and for this reason, for a while, two devices were used by urologists: Wappler's generator for cutting and the old instrument with diathermy for hemostasis.

McCarthy modified Stern's resectoscope to cut from the bladder toward the surgeon and incorporated the working element, which had to be handled with both hands, into a sheath of bakelite (used for the first time in England). The Stern–McCarthy resectoscope, developed by adding the telescope described by McCarthy, became the prototype for all modern resectoscopes. The initial standard resection consisted of the evacuation of a limited number of prostatic fragments (3 or 5) from the median lobe or from the lateral lobes. The mortality rate was significant, up to 25%. Common complications were represented by rectourethral fistulas, urinary incontinence, sepsis, bladder dilacerations, uncontrollable bleeding, and even electrocution. In 1931, Theodore M. Davis combined both generators into a single box with alternative power, allowing the surgeon to cut or to coagulate whenever necessary. Davis also introduced the foot switch with double action (still used in the present), allowing for direct control of both the cutting and the coagulation power (Herr, 2006) (Fig. 2.5).

In the 1930s the interest in transurethral resection grew tremendously, but the morbidity of the procedure remained high. Reed Nesbit later introduced the resectoscope that could be used with one hand, but his instrument did not become popular due to the poor mechanics of the working element. In 1948, Iglesias de la Torre from Havana (a student of McCarthy) developed a mechanism that allowed for total control of the electrode's movement (forward) with one hand, while the backward movement was passively controlled by a spring. Therefore, while for the Stern–McCarthy resectoscope the movement was achieved using the thumb and the first two fingers, the Iglesias model used the thumb and the spring. Most urologists use the Iglesias model (Fig. 2.6), and very few use the original Stern–McCarthy resectoscope.

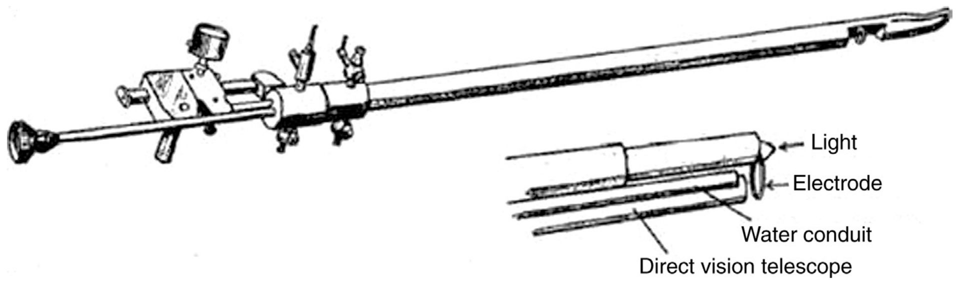

FIGURE 2.5 **Stern–McCarthy resectoscope.** *Source: Shelley (1969)*

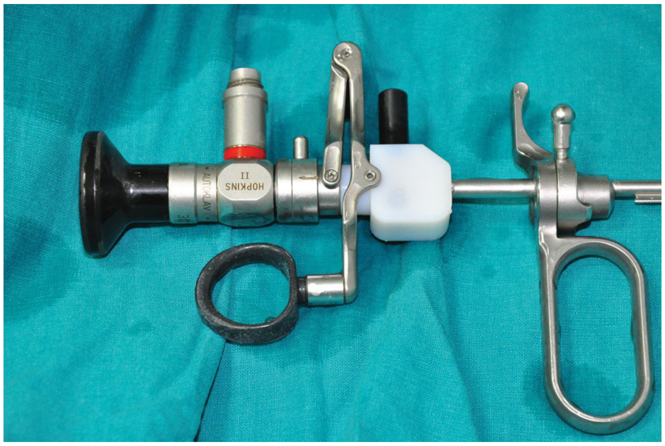

FIGURE 2.6 **Iglesias model modern resectoscope.**

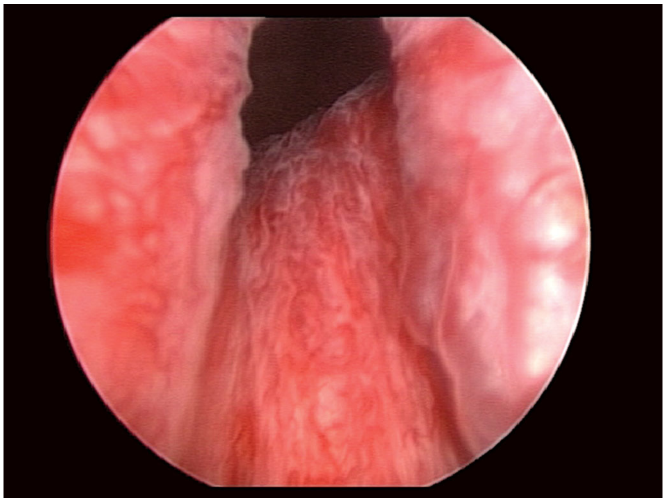

FIGURE 2.7 **Narrowing of the prostatic urethra and bladder neck secondary to BPH.**

Further progress in terms of optical systems (incorporation of bundles of glass fibers, the Hopkins lens system) and high-intensity external light sources, together with the development of anesthetic techniques and antibiotic therapy, contributed substantially to the modern role of transurethral resection of the prostate (TURP).

2.2 GENERALITIES

Prostate adenoma or BPH is the most frequent benign tumor occurring in elderly male patients, developed from the transitional zone of the prostate through proliferation of the glandular, smooth muscle, and stromal components. Prostate enlargement together with the narrowing of the prostatic urethra and bladder neck (Fig. 2.7) increase urinary flow resistance with a consequent decrease in urine output.

This may also be negatively influenced by the hypertonicity of the prostatic capsule and of the smooth muscle fibers found in the structure of BPH (Caine, 1986). Compensatory bladder modifications secondary to obstruction caused by BPH consist of detrusor hypertrophy (Fig. 2.8) and increased bladder pressure (Levin et al., 1995).

Subsequently, the detrusor becomes unstable with decreased compliance, which may cause voiding urgency. The persistence of the subvesical obstacle causes detrusor decompensation, with a significant reduction of the urinary flow rate and the occurrence of postvoiding residue and even of secondary bladder diverticula (Fig. 2.9), which may lead to bilateral ureterohydronephrosis with obstructive renal failure.

The symptoms of BPH patients, also modernly called lower urinary tract symptoms (LUTS), are the result of the interaction between the compensatory mechanisms of the bladder and the subvesical obstacle (Abrams et al., 2002). Usually, the symptoms can be divided into irritative (pollakiuria, voiding urgency, urinary pseudoincontinence) and obstructive symptoms (dysuria, weak and interrupted urinary flow, etc.). According to the European Association of Urology (EAU) 2010 guidelines, the alternatives for medical treatment in the case of patients with LUTS are summarized in Table 2.1 (Oelke et al., 2010).

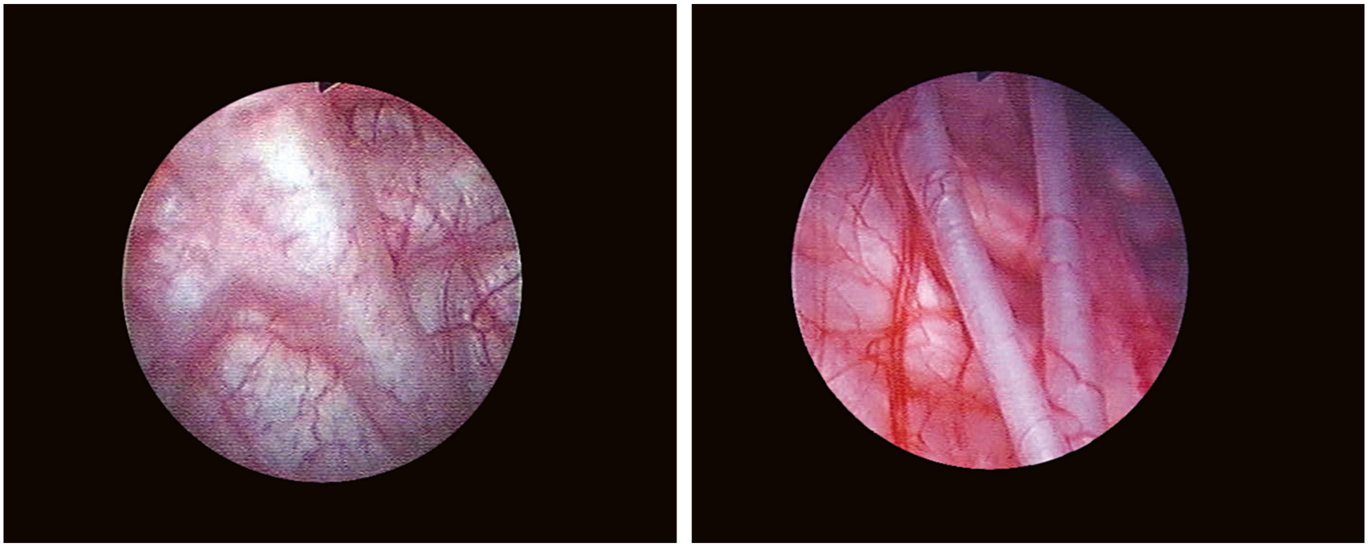

FIGURE 2.8 **Compensatory changes of the detrusor muscle ("cells and columns" in patients with BPH).**

FIGURE 2.9 **Bladder diverticulum secondary to BPH (endoscopic and radiologic aspect).**

Regarding surgical alternatives, as in the case of other urological conditions, the treatment of BPH has seen numerous improvements over the last decade, with a major impact on the incidence of intraoperative and postoperative complications. These improvements are the result of the evolution of existing technology as well as the introduction of novel, minimally invasive techniques. TURP has been the "gold standard" treatment for patients with obstructive BPH for more than 60 years. However, in the last 20 years, extended recommendations for medical treatment and the development of minimally invasive alternatives (laser procedures, thermotherapy, etc.) have led to a reduction in the number of TURPs, both in the United States and in Europe (Madersbacher and Marberger, 1999). Thus, the number of TURPs performed in 1993 in the United States was 227,000, with a decrease to 119,000 procedures in 2000 and a further decrease in 2009 to under 100,000 (Agency for Healthcare Research and Quality, 2003). Despite therapeutical alternatives such as microwave therapy, thermotherapy, and different types of lasers available for the treatment of BPH, TURP still remains the most frequently used procedure for subvesical obstruction due to prostate adenoma. Medical and technological advances have improved the results of TURP. Moreover, the development of

TABLE 2.1 Alternatives for Medical Treatment of Patients with LUTS

Treatment	Indication	Level of evidence
Watchful waiting	Patients with mild symptoms	1b
Alpha blockers	Patients with moderate or severe symptoms	1a
5-Alpha reductase inhibitors	Patients with moderate or severe symptoms and large prostate adenomas; 5-alpha reductase inhibitors may prevent disease progression	1b
Muscarinic receptor antagonists	Patients with predominance of irritative symptoms (moderate or severe)	1b
Phytotherapy	No specific recommendations due to heterogeneity of products	
Combined therapy		
Alpha blockers with 5-alpha reductase inhibitors	Patients with moderate or severe symptoms, large prostate adenomas, and reduced urinary flow; combined treatment is not recommended over short periods of time (<1 year)	1b
Alpha blockers with muscarinic receptor antagonists	Patients with moderate or severe symptoms refractory to monotherapy (using any of the pharmacological agents)	1b

bipolar resection has enabled surgeons to perform this type of procedure in patients with large prostatic adenomas with volumes over 80–100 cm^3 (these patients previously had an indication for open surgery).

2.3 INDICATIONS AND CONTRAINDICATIONS

Proper surgical indication in patients with BPH is important for the postoperative outcome. Usually, the recommendation for surgical treatment is made while considering the patient's age and symptom severity. In the absence of complications, most guidelines usually recommend medical treatment as the first option. In patients with persistent symptoms, refractory to medical treatment, the next option is surgery, representing the most frequent indication (50–60%) for TURP (Marszalek et al., 2009).

However, the absolute indications for surgical treatment in patients with BPH are represented by the following (Oelke et al., 2009):

- urinary retention refractory to medical treatment
- recurrent urinary tract infection due to BPH
- recurrent macroscopic hematuria (refractory to treatment with 5-alpha reductase inhibitors)
- renal failure due to BPH
- bladder stones (Fig. 2.10)

Regarding urinary retention refractory to medical treatment, approximately 20% of patients with retention episodes in the past (despite treatment with alpha blockers) will require surgery in the next 6–12 months (Shah et al., 2002).

Randomized trials have shown that 5-alpha reductase inhibitors have an impact on angiogenesis, with implications for the treatment of patients with adenomas greater than 40 cm^3 and recurrent hematuric episodes (Memis et al., 2008). Recurrent hematuria in patients with BPH may originate from the varicose veins of the prostatic urethra, bladder neck, or median lobe (Fig. 2.11). However, the entire bladder, including the ureteral orifices, must be carefully explored to exclude potential associated tumors of the urothelium. TURP may be performed only after excluding other conditions.

Renal failure secondary to BPH requires drainage of the bladder as a first step (suprapubic cystostomy or urethrovesical catheter) until normalization of the blood biochemistry. Bladder stones are an absolute indication for surgical treatment: TURP and lithotripsy of the stones. The first step of the intervention consists of endoscopic lithotripsy of the stones (Fig. 2.12). A minimal cystostomy with extraction of the stones is the method of choice for large, multiple, rough stones, which require a long operating time with possible trauma of the bladder, which can complicate the endoscopic intervention. In patients with a high surgical risk and reduced life expectancy, some authors recommend only lithotripsy (without TURP) followed by medical treatment for BPH (O'Connor et al., 2002).

FIGURE 2.10 **Stone in a bladder diverticulum in a patient with BPH (endoscopic aspect).**

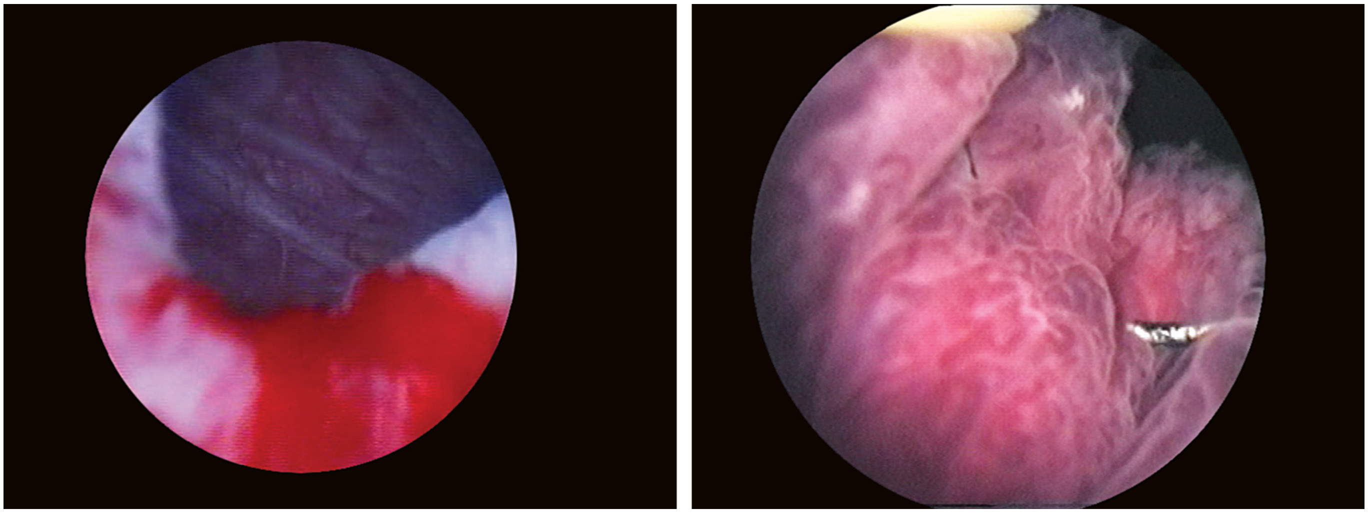

FIGURE 2.11 **Intraoperative aspects in patients with BPH and recurrent hematuria.**

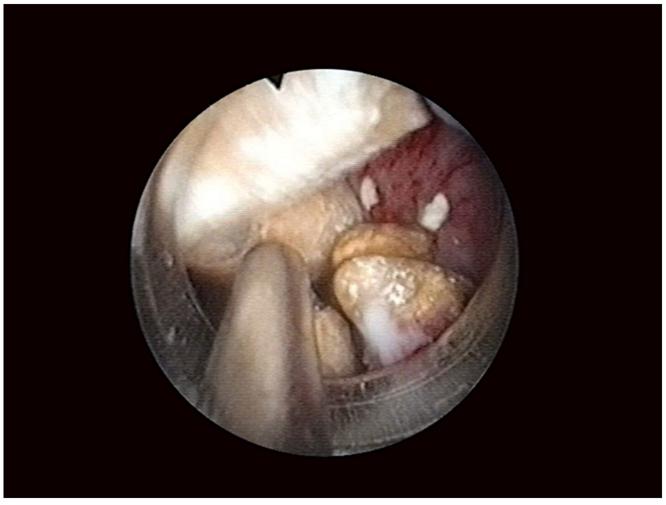

FIGURE 2.12 **Lithotripsy of bladder stones as a first operative step in a patient with BPH.**

Changes in bladder morphology (bladder diverticula) as well as a gradual increase in the postvoid residual volume are relative indications for surgery. Choosing the right moment for the surgical intervention is still controversial. In long-term studies, patients with TURP at the moment of diagnosis have a better outcome as compared to patients with initial follow-up and then TURP (Flanigan et al., 1998), probably because of progressive detrusor decompensation secondary to BPH in the absence of adequate treatment.

Classically, open surgery rather than TURP is preferred in patients with adenomas greater than 50 cm^3, requiring an operating time longer than 90 min (due to the increased risk of intraoperative and postoperative complications). However, many experienced urologists consider this limit to be arbitrary, since they are able to safely resect prostate adenomas of up to 100–150 cm^3 (Muzzonigro et al., 2004). The use of bipolar energy allows for a safe resection of prostate adenomas regardless of their dimensions, since the surgeon is not pressured by the operating time to safely perform the procedure.

Although TURP is the "gold standard" treatment for BPH, there are some patients in whom the procedure is not recommended. The only absolute contraindication is represented by severe coagulopathies (Rassweiler et al., 2006). Most contraindications are relative and are usually due to comorbidities: cardiovascular and pulmonary diseases, conditions with contraindications for the lithotomy position, and severe neurological disorders. For patients with recent myocardial infarction, the procedure should be postponed for at least 3 months (due to the increased risk of complications).

Patients with myasthenia gravis, multiple sclerosis, or Parkinson's disease must be carefully evaluated for a possible recommendation of TURP. Thus, postoperative urinary incontinence may occur due to a dysfunctional sphincter or increased bladder tone (which appear in these diseases). This complication may also occur in patients with severe pelvic fractures (with possible injury of the external sphincter). TURP should be postponed at least 6 months after radiotherapy for prostate cancers (because of the increased risk of postoperative urinary incontinence) (Liu et al., 2005; Flam et al., 2004). Urinary infections are a contraindication for TURP; the procedure is usually rescheduled after adequate treatment with antibiotics.

2.4 PREOPERATIVE PREPARATION

2.4.1 Anticoagulant Therapy

Unlike other surgical interventions, normal coagulation is a prerequisite for TURP for efficient control of intraoperative and postoperative bleeding. It is generally recommended to stop any oral anticoagulant before the intervention. Warfarin should be stopped 3–4 days before the procedure, and PT and APTT are checked before the intervention. For clopidogrel (Plavix) up to 7 days without medication is recommended before TURP. Platelet transfusions are sometimes required to correct the anticoagulant effects of clopidogrel.

Low molecular weight heparin is administered before the intervention (at the same time interrupting oral anticoagulants) in patients in whom anticoagulant therapy cannot be permanently stopped (Dotan et al., 2002). This usually requires hospitalization and close monitoring. For these cases with a high risk of bleeding, another therapeutic alternative may be taken into consideration (interstitial coagulation, KTP laser vaporization, prostatic stenting, etc.).

Aspirin, even in low doses, may increase postoperative bleeding. In a double-blind placebo-controlled study, Nielsen et al. (2000) showed that postoperative bleeding was significantly higher in patients receiving aspirin (compared to placebo), without significant differences regarding the weight of the resected tissue, operative time, or intraoperative bleeding (Nielsen et al., 2000). Therefore, it is recommended to stop aspirin 10 days before the intervention.

The optimal timing of resumption of anticoagulant therapy after TURP is still a matter of debate. This is variable and depends on several factors: the disease requiring anticoagulation, the condition of the patient, the difficulty of the surgical intervention, and the extent of postoperative bleeding (Chakravarti and MacDermott, 1998). It is usually recommended to wait until the urine is clear for 24 h before resuming warfarin (Coumadin), extending up to 48 h when administering Plavix or aspirin (due to the longer half-life of these agents).

2.4.2 Preoperative Antibiotic Prophylaxis

There is some controversy regarding the preoperative use of systemic antibiotics. Most studies have demonstrated their usefulness, and most urologists indicate broad spectrum cephalosporins or fluoroquinolones (Berry and Barratt, 2002), especially since approximately 25% of BPH patients have a history of urinary infections. Furthermore, patients with Foley catheters are prone to infections, requiring a broad spectrum antibiotic prior to surgery. Preferably, the antibiotics will be administered according to the results of the urine culture.

Regarding the duration of postoperative antibiotic therapy, although there are studies showing that 2 weeks of antibiotics can reduce the rate of urethral strictures after TURP, this duration is not precisely defined (Hammarsten and Lindqvist, 1993). After the removal of the urethro-vesical catheter, fluoroquinolones or urinary antiseptics (nitrofurantoin) are usually preferred. Necrosed, partially devascularized prostate tissue offers perfect conditions for bacterial growth, thus explaining the usefulness of antibacterial prophylaxis for approximately 15 days after TURP.

2.4.3 Irrigation Fluid

Different types of irrigation fluids can be used: sterile water, glycine, mannitol, and sorbitol. The ideal irrigation fluid for TURP should be isotonic, sterile, nonhemolytic, clear, nonpyrogenic, inexpensive, and not electrically conductive (Hahn, 2006). Saline solution cannot be used for monopolar resection because it is a good conductor of electricity, diffuses power, and does not allow cutting or cauterization of tissue. Also, the power can pass into the resectoscope's sheath, affecting the surgeon (by electrocution). The monopolar electrosurgical unit normally does not work when using saline solution. Therefore, if this happens, it is necessary to check whether isotonic sodium chloride was not used for lavage (by error) and only after that to check the machine's pedals, power switch, and cable connections.

Liquids that do not conduct electricity (sterile water, glycine, mannitol, and sorbitol) are used for monopolar resection. Sterile water has the lowest cost and is used by most urological departments in our country. However, when it is absorbed in large amounts during the procedure, hyponatremia, intravascular hemolysis, and hyperkalemia may occur (Hahn, 2006). Therefore, nonhemolytic solutions of sorbitol, mannitol, or glycine are recommended. These relatively isotonic agents protect against hemolysis but do not prevent dilutional hyponatremia because their intravascular absorption increases fluid volume. The nonhemolytic irrigating fluid recommended by Creevy in 1947 was a 4% glucose solution. Although not widely used, it may be a reasonable and inexpensive substitute for glycine, since it is safer and induces less hemolysis than sterile water (Collins et al., 2005).

Glycine is probably the most frequently used irrigating fluid for TURP, having an osmolarity of approximately 200 mOsm/kg as compared to the normal plasma osmolarity of 290 mOsm/kg. Although it is not a truly isotonic solution, it does not induce hemolysis. Glycine metabolism into glycolic acid and ammonia may be a contributing factor for TURP syndrome. Glycine inhibits neurotransmission and can rarely cause vision disturbances if absorbed in large quantities (Hahn et al., 1998). If more than 1000 mL of glycine are absorbed, stinging, nausea, hypotension, bradycardia, and confusion may occur. Adverse effects may become severe when more than 3000 mL are absorbed. However, they rarely occur in practice. Glycine toxicity can exceptionally cause death. These problems can be avoided by using a solution of sorbitol/mannitol (Dimberg et al., 1992).

Bipolar resection can be performed safely using saline solution for irrigation (isotonic sodium chloride solution). The advantages of this system, which will be discussed in detail in Chapter 3, include avoiding hyponatremia (TURP syndrome) because normal saline solution is used for irrigation.

2.4.3.1 Hypothermia

Hypothermia is defined as a decrease of the body's temperature to 36°C or less and can lead to shivering (increasing oxygen demand by 500%). Irrigating fluid at room temperature may significantly decrease the body temperature of the patient, especially when using continuous flow irrigation. Other factors that may increase the risk of hypothermia include a longer duration of intervention, an increased amount of fluid absorbed, a large prostate, asthenic constitution, and low weight of the patient (Pit et al., 1996). An important factor is represented by the temperature of the operating room. Beside chills, hypothermia determines cardiovascular changes: bradycardia, reduced heart contractility, increase of mean arterial pressure, and vascular resistance (Slotman et al., 1985). A decrease of body temperature below 35°C causes angina, cardiac arrhythmias, and myocardial infarction (Frank et al., 1993). Therefore, it is recommended to use irrigating fluid at body temperature as well as using other suitable means for heating. No significant changes regarding intraoperative bleeding were noticed when using irrigation fluid heated to body temperature. However, heating the saline solution can improve the performance of bipolar resection.

2.4.4 Surgical Instruments and Patient Positioning

The equipment necessary for TURP consists of the following (Fig. 2.13):

- high-frequency generator
- resectoscope with continuous irrigation
- telescope of 0°, 15°, or 30°

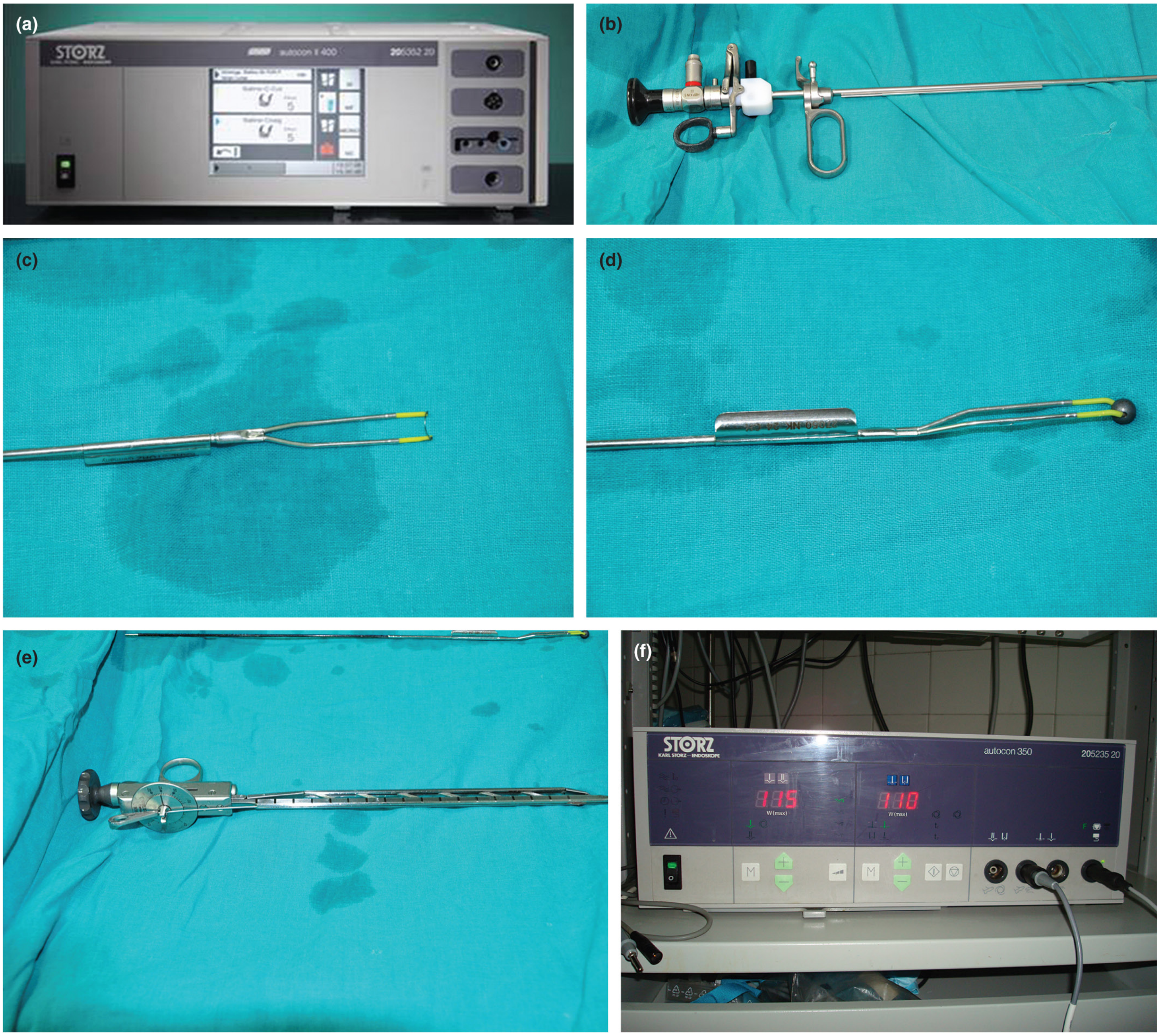

FIGURE 2.13 **TURP equipment (a) high frequency generator; (b) resectoscope; (c) loop; (d) roller; (e) Ottis urethrotome; (f) generator.**

- video camera
- electrodes for resection (loop) and coagulation (roller)
- Ottis urethrotome
- sterile lubricating solution (anesthetic gel or oil)
- 3-way urethral catheter with a 50, 80, or 100 mL balloon
- 100 mL syringe
- suprapubic catheter (optional)

The design and use of the continuous flow resectoscope has eliminated the need for intermittent bladder drainage during resection, thus saving valuable time. It is also possible to maintain a low pressure of the irrigating fluid, both in the prostatic lodge and in the bladder, thereby reducing intravascular absorption.

The main disadvantages are represented by crowding of the resected fragments toward the telescope, thus preventing visibility (Fig. 2.14); the small size of the available loop; and the lack of studies proving the time saved, the

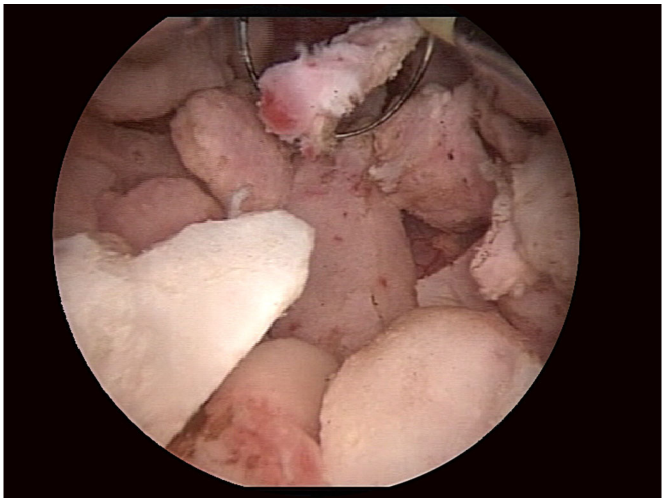

FIGURE 2.14 **Crowding of the resected chips toward the telescope (affecting visibility) in continuous flow resection.**

reduction of intraoperative bleeding, or the decrease of irrigating fluid absorption. However, most urologists prefer using the continuous flow resectoscope.

A suprapubic trocar can be used to provide continuous flow irrigation. Some authors believe that a minimal cystostomy has some advantages (as compared to continuous flow coaxial resectoscopes): chips and irrigation flow are directed toward the drainage tube (increasing visibility); a larger loop may be used; and pressure inside the bladder is maintained below the pelvic venous pressure (reducing the absorption of the irrigation fluid) (Holmquist et al., 1979). The use of a suprapubic trocar is described by some authors in the case of large adenomas (over 100 cm^3) (Madsen and Frimodt-Moller, 1984). The suprapubic trocar is extracted at the end of surgery, without requiring sutures. The intervention is carried out with the patient in the lithotomy position (Fig. 2.15). Isolation and skin disinfection are done while maintaining access to the hypogastric and anal regions.

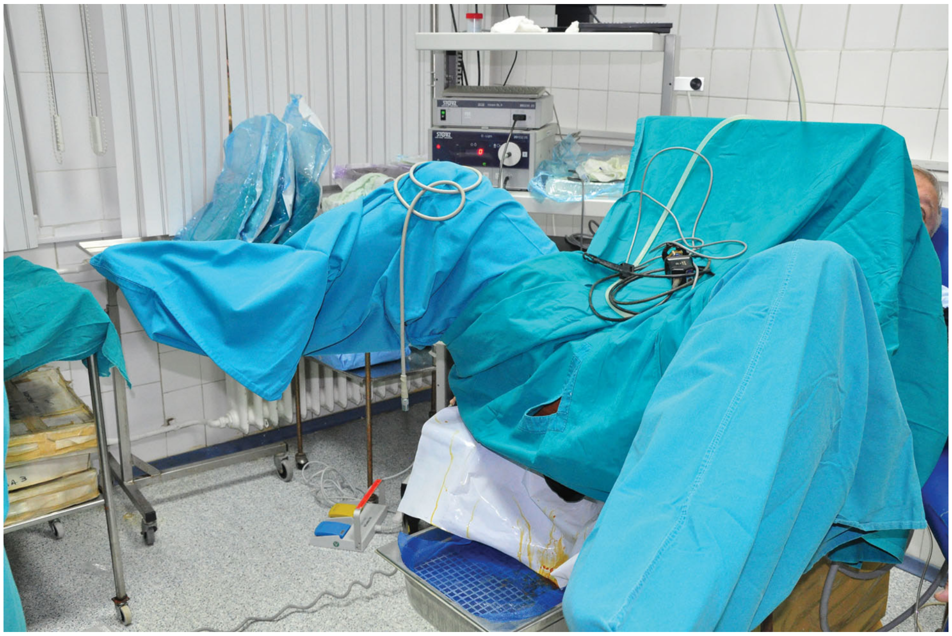

FIGURE 2.15 **Patient positioning for TURP.**

2.5 TECHNIQUE

2.5.1 Anesthesia

TURP may be performed under regional or general anesthesia. Occasionally, high-risk patients require a multidisciplinary preoperative evaluation in order to determine whether the intervention can take place safely. Spinal anesthesia is usually preferred and is used in over 80% of the procedures, for several reasons (Mebust et al., 1989):

- it is possible to communicate with the patient during surgery
- it allows for evaluation of symptoms of dilutional hyponatremia (TURP syndrome)
- recovery is faster (no increase in pulmonary pressure, unlike patients with general anesthesia who often cough, increasing the risk of postoperative hematuria)

However, there are studies that demonstrate the usefulness and comfort of general anesthesia with propofol or desflurane in patients over 60 years, with small prostates (short intervention) (Fredman et al., 1998).

The obturator nerve passes close to the prostate and can be electrically stimulated during monopolar resection, resulting in violent motion of the lower limb (obturator nerve reflex), a phenomenon that does not occur when using bipolar resection (Shiozawa et al., 2002). Although rarely noticed during TURP (it occurs especially during resection of urothelial tumors located on the lateral walls of the bladder), this reflex can cause intraoperative accidents. It can be prevented by injecting a local anesthetic or by general anesthesia.

2.5.2 Basic Principles of Transurethral Resection

There are some basic elements that a beginner should learn in transurethral surgery. Just as in general surgery, it is required to learn how to perform an incision with a scalpel, a correct anastomosis, and an effective hemostasis with minimal trauma. Many of these elements can be understood by following a more experienced surgeon while operating, while others can only be learned in time with experience.

2.5.2.1 Cutting a Chip

The loop of the resectoscope cuts effortlessly, like a knife through butter, requiring a short period of time to achieve this. The cut is made by a halo produced between the electrode and the tissues (Fig. 2.16).

Cutting is done without contact or any effort on the part of the urologist. The working rate is limited only by the rate of tissue displacement. The chip has the shape of a canoe (Fig. 2.17). It is as wide and deep as the loop, and its length is determined by the loop's movement plus the length obtained by moving the sheath in and out.

There are two methods for cutting a chip: one in which the loop's movement ends at the margins of the resectoscope (Barnes, 1951) and another in which the chip is cut before the loop reaches the edge of the sheath, thus preventing any damage to the telescope (Nesbit, 1943). The telescope's lenses may be affected if the loop enters too much inside the sheath. Therefore, loops that cannot enter inside the sheath are now produced.

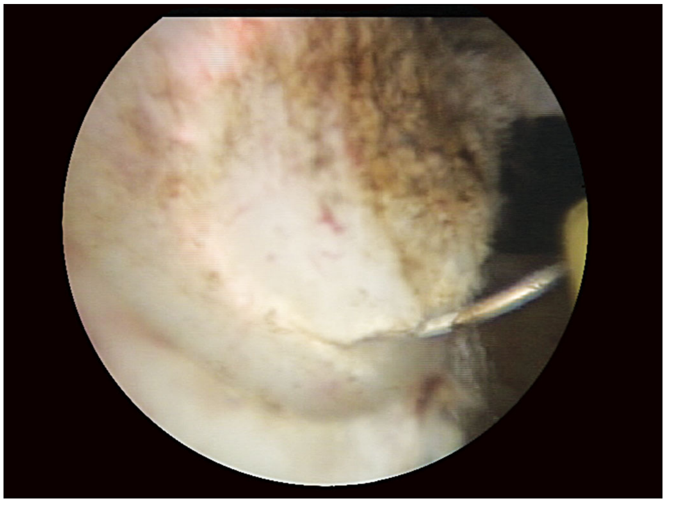

FIGURE 2.16 **The halo between the loop and the tissue (which makes the cut).**

FIGURE 2.17 **The aspect of the chips after resection.**

In practice, most urologists use Barnes' technique and bend the loop: this is perfectly safe as long as there is still a gap between the loop and the lenses. Cutting a chip has three steps (Fig. 2.18): (1) the loop is inserted into the tissue to its maximum depth, (2) it is pulled toward the surgeon, and (3) it cuts the tissue before it enters the sheath.

2.5.2.2 Keeping the Working Rhythm

Transurethral resection is performed methodically, requiring a smooth but continuous rhythm. It is done in successive levels, without opening multiple work fronts, permanently following anatomical landmarks. Cutting a chip begins with the raising of the working element (to let the loop get inside before starting the movement) and ends by lowering it (to raise the loop) (Fig. 2.19).

Once the landmarks have been established, the maximum amount of tissue should be removed during each movement of the loop in order to save time when resecting the lateral lobes of the prostate (the depth of the chip should be equal to that of the loop, and the length should be equal to that of the lateral lobe), even if this means moving the sheath toward the verumontanum (Fig. 2.20).

The cutting effectiveness may decrease if the electrode is covered by a crust of burnt tissue (especially if coagulation with tissue necrosis occurs), requiring cleaning. Several aspects should be checked if the loop is not cutting: fixing and integrity of the loop, the power cable, and the use of adequate irrigation fluid.

2.5.2.3 Hemostasis

In most cases, the mild bleeding that occurs during TURP comes from small veins that are cut as the adenoma is resected (Fig. 2.21). This type of bleeding is reduced by using continuous irrigation (Iglesias type resectoscope).

Any arterial bleeding must be immediately stopped as soon as it is observed. This is achieved by a short application (by means of the loop) of a coagulation energy (Fig. 2.22). The surgeon perceives the change of the sound made by the coagulation energy. The bleeding stops and the tissue becomes white at the level of the application, without its carbonization.

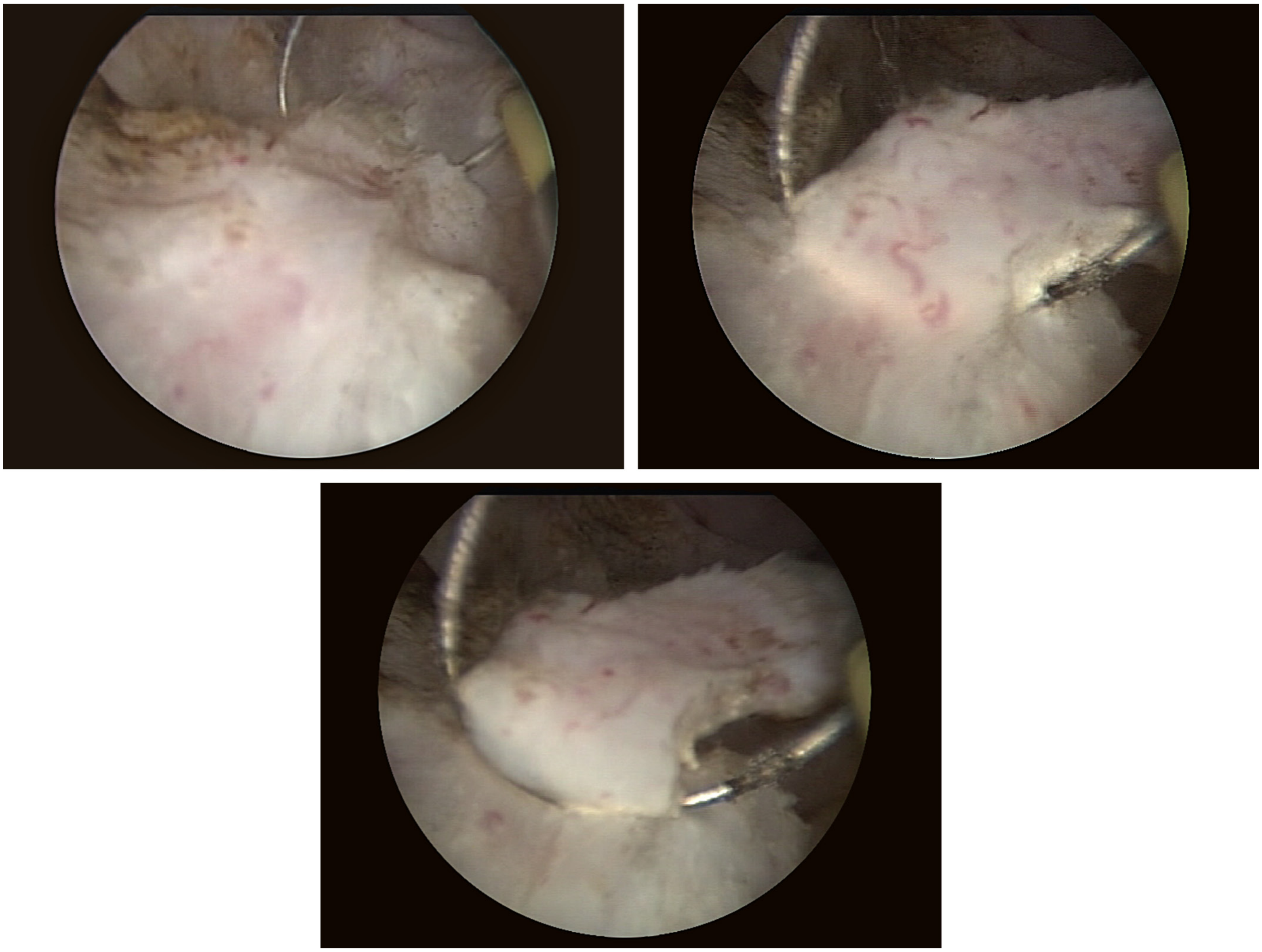

FIGURE 2.18 **Cutting a chip.**

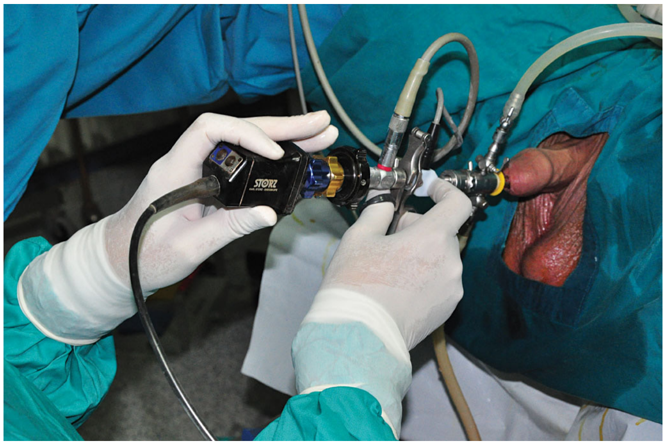

FIGURE 2.19 **Raising the working element to start cutting a chip.**

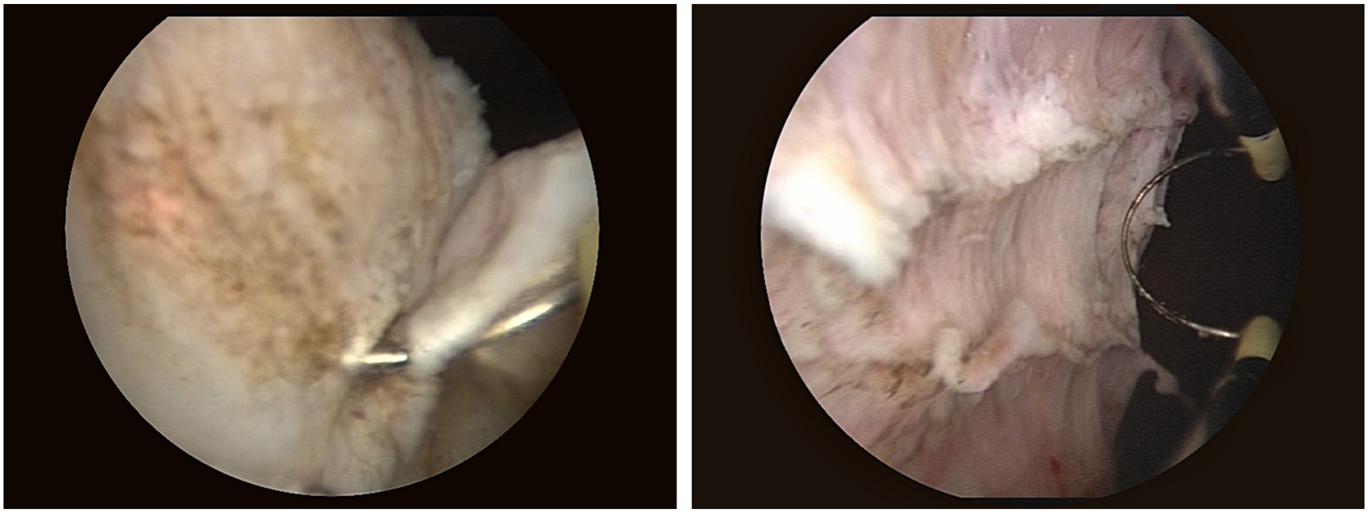

FIGURE 2.20 **Resection of a maximum amount of tissue from the lateral lobes.**

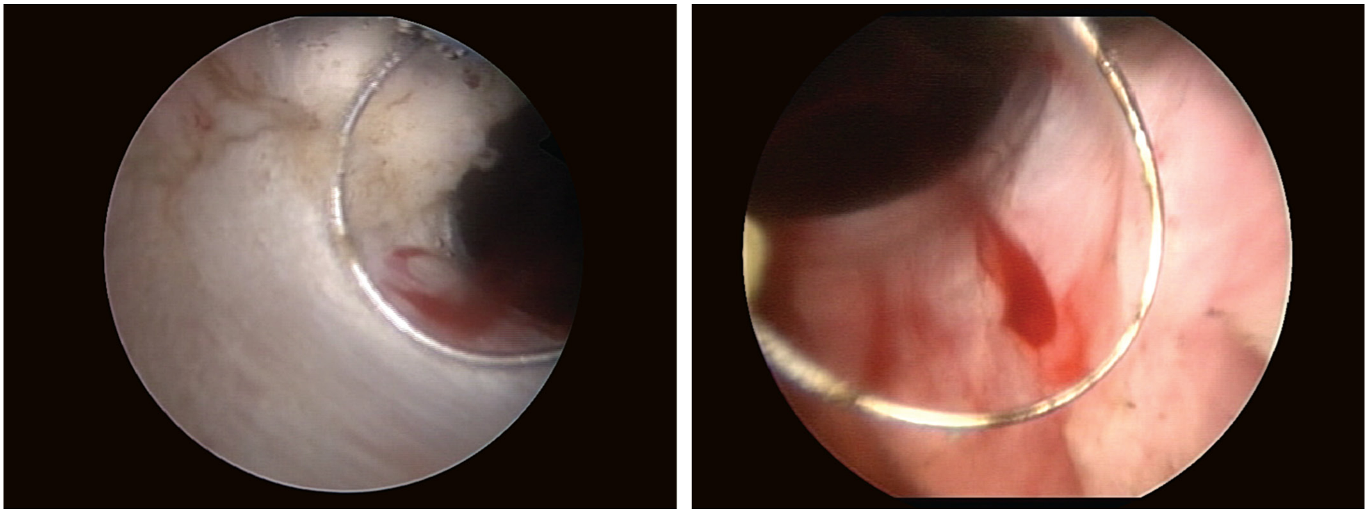

FIGURE 2.21 **Mild venous bleeding during TURP.**

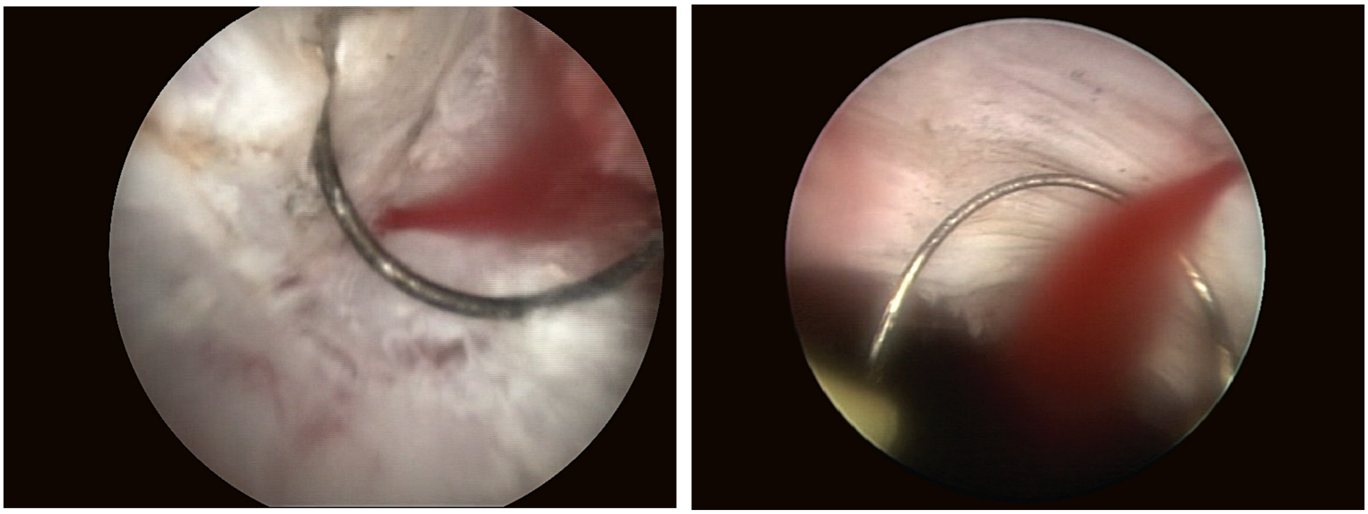

FIGURE 2.22 **Hemostasis of arterial bleeding using the loop.**

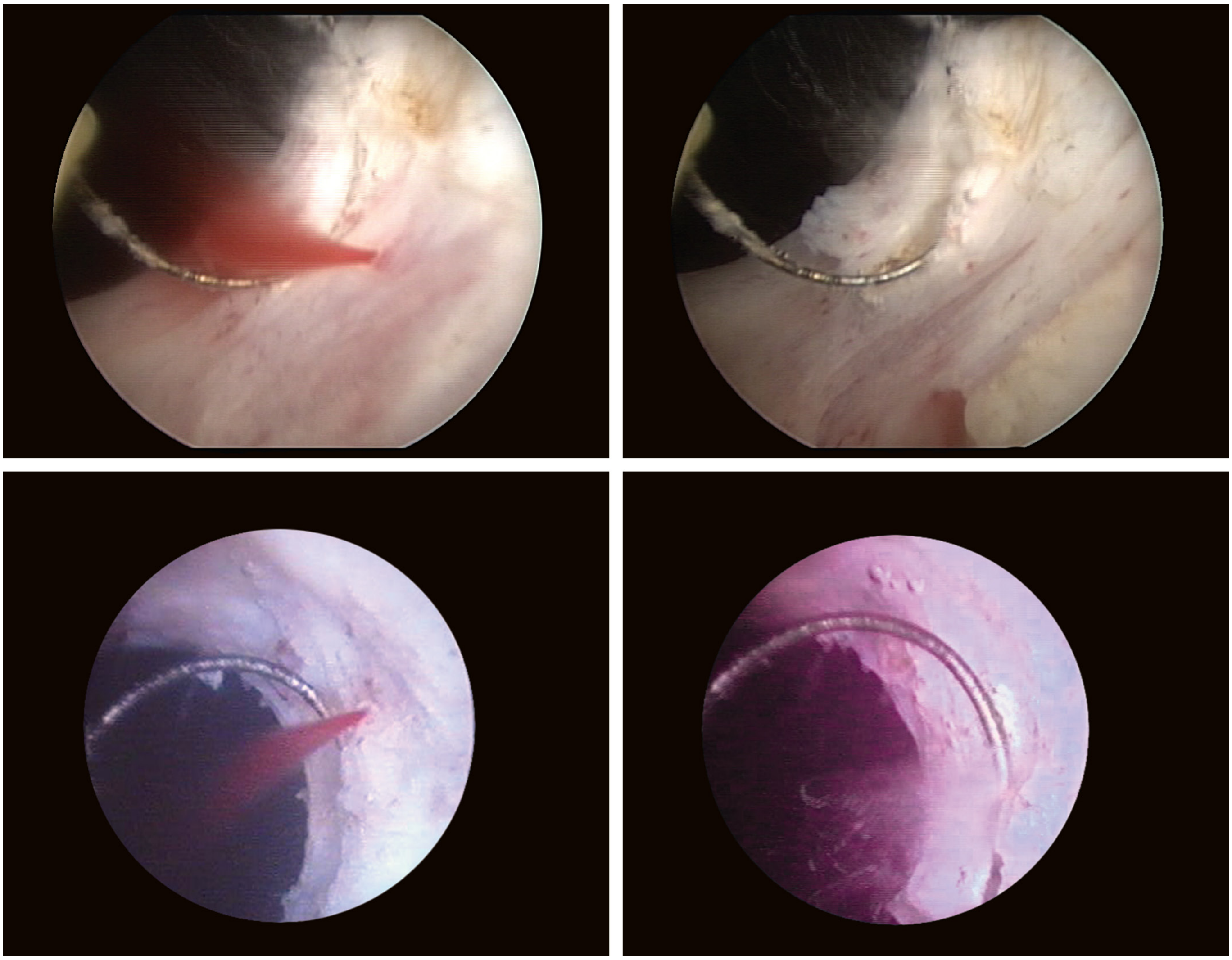

FIGURE 2.23 **Compression (with the loop) lateral to the arterial orifice for an efficient control of bleeding.**

Hemostasis of bigger arteries is more difficult. It is possible to compress the tissue on either side of the arterial orifice so that the arterial walls come close and allow the coagulation energy to close the orifice (Fig. 2.23).

Sometimes the urologist may be misled by a bleeding "by rebound": a powerful stream of blood bounces off the opposite wall of the prostatic lodge. With increasing experience he or she will quickly turn attention to the opposite wall of the prostatic lodge to search for the real source of bleeding. Another confusion may occur if an artery bleeds directly toward the telescope, completely obscuring the image. In this case, the resectoscope should be pushed beyond the bleeding vessel, then angled to compress the vessel, after which the sheath will be slightly withdrawn until the opened artery is identified through the appearance of a blood stream (Fig. 2.24). Coagulation is performed immediately above the artery.

Coagulation using the loop can be difficult when large veins or multiple vessels are involved, and sometimes it is necessary to change the loop with the roller in order to stop the bleeding (Fig. 2.25). It is advisable not to exaggerate with this type of coagulation during resection.

Venous bleeding is more difficult to identify than arterial bleeding, especially when the pressure of the irrigation fluid is equal or higher than the venous pressure. For this reason, venous bleeding may be missed during resection but becomes apparent immediately after the intervention is finished. To identify small-caliber veins, the irrigation flow is decreased (by partial closure of the inlet valve or pressure on the irrigation tube) until the sources of bleeding are seen (Fig. 2.26).

The veins covering the entire inner surface of the capsule have to be coagulated at the end of the procedure (Fig. 2.27).

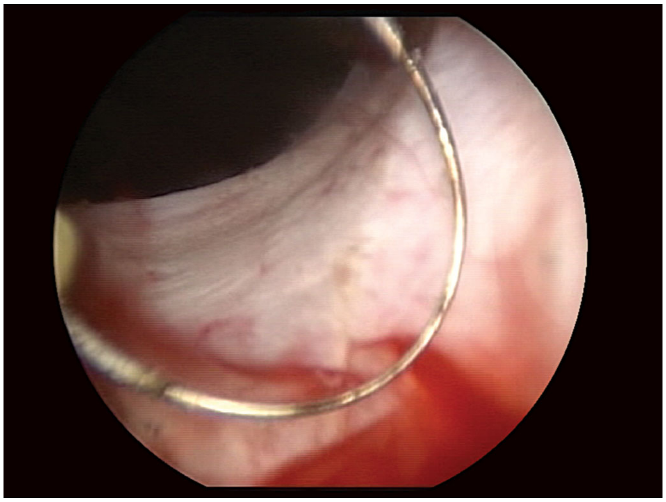

FIGURE 2.24 An artery that bleeds directly toward the telescope is identified (after the resectoscope is angled and the sheath is withdrawn).

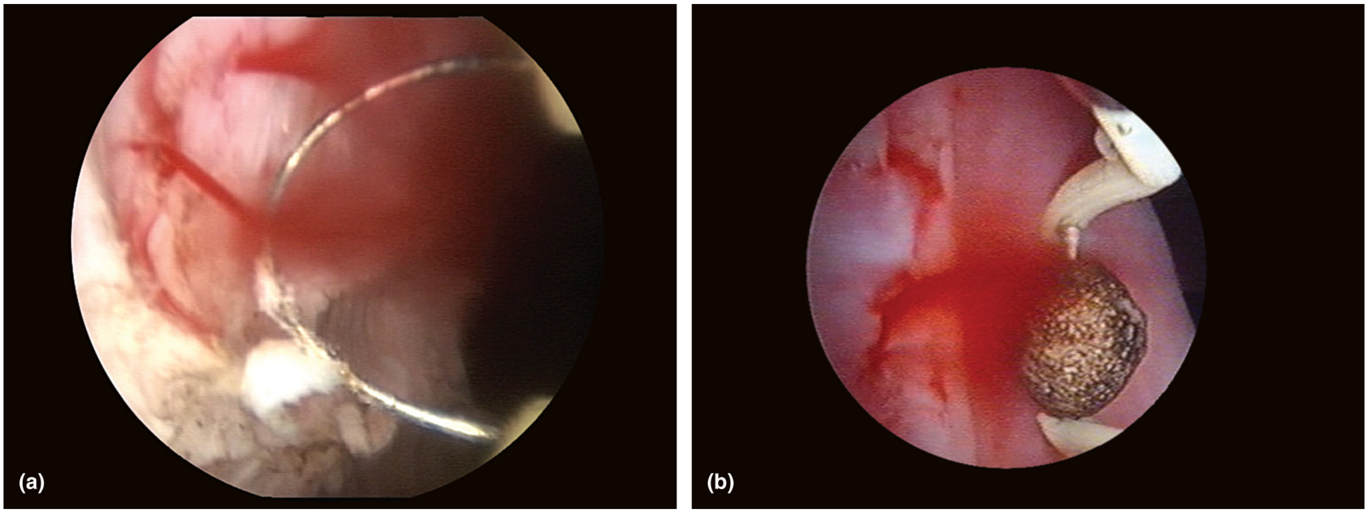

FIGURE 2.25 Bleeding from multiple vessels may be difficult to stop with the loop (a), requiring the roller instead (b).

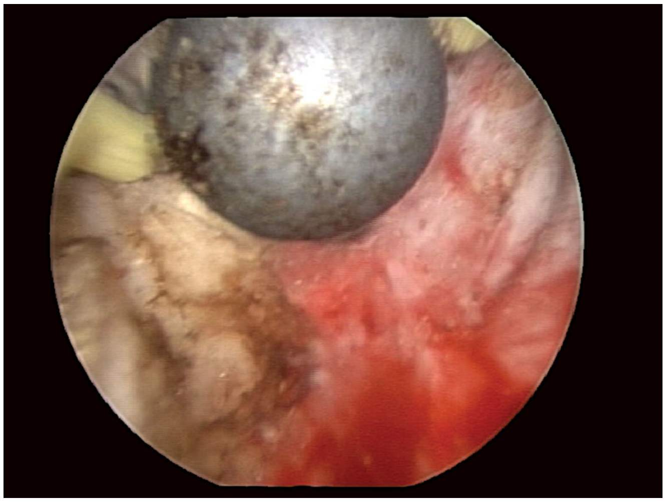

FIGURE 2.26 The flow of the irrigation fluid is decreased to identify the small-caliber veins.

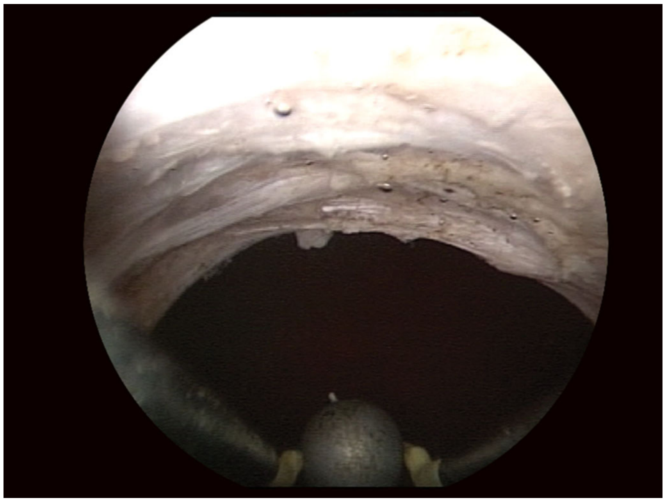

FIGURE 2.27 **Coagulation of the entire inner surface of the capsule.**

Even so, there are patients who still have profuse bleeding despite prolonged hemostasis. In these cases, traction (tamponade) is necessary using an urethro-vesical catheter (Salvaris maneuver). The catheter is inserted using a curved mandrin (to be sure that it does not enter below the bladder neck) and the balloon is filled with approximately 40 mL and is pulled (to compress the bladder neck). Frequently, this maneuver effectively controls bleeding. Otherwise, the resectoscope must be reinserted to check the hemostasis.

2.5.2.4 Maintaining Intraoperative Visibility

Nothing is more important during TURP than visibility and orientation. There are many causes of decreased visibility:

- A dirty telescope or camera due to water or lubricant (oil, gel); these must be cleaned in order to continue the procedure.
- Obstruction of the irrigation flow when there is no more irrigation fluid (requires careful nurses to prevent this incident) or when intravesical pressure increases (secondary to its filling). Excessive filling of the bladder should generally be avoided by repeated bladder emptying.
- Hydrolysis of water or improper connections of the irrigating hose can generate bubbles, impairing visibility. The irrigation has to be stopped and the irrigation fluid discharged. Persistence of the bubbles may require withdrawal and reinsertion of the telescope several times.
- A resected fragment may be blocked between the loop and the sheath or on the lens, requiring removal of the working element and cleaning of the lens.
- Gradual degradation of the telescope and alteration of the optical system require their replacement.

2.5.2.5 Chips Evacuation

Precious time is lost each time resection is stopped to evacuate the chips, so the number of discharges should be as low as possible and should be done, for example, only when the chips start to fall into the prostatic lodge and come in the way of the loop. Usually they are extracted with the Milo Ellik device (Fig. 2.28) or with a high-capacity Guyon syringe adapted to the resectoscope (Fig. 2.29). Both should be used gently to avoid secondary injuries.

2.5.3 Techniques

Although several types of transurethral resection have been described (Barnes, Mitchel, Mauermayer, Nesbit, Segura), they all have the same aim, that is, to remove the adenomatous tissue while leaving in place the compressed external area, the so-called "surgical capsule" (Fig. 2.30). The tissue removed during transurethral resection is, at least in theory, identical to the tissue removed during an open surgery (Green et al., 1996; Blandy and Fowler, 1996). The differences between the transurethral resection techniques arise from the order in which the tissue is removed.

FIGURE 2.28 **Milo Ellik device.**

FIGURE 2.29 **Evacuation of chips with a Guyon syringe.**

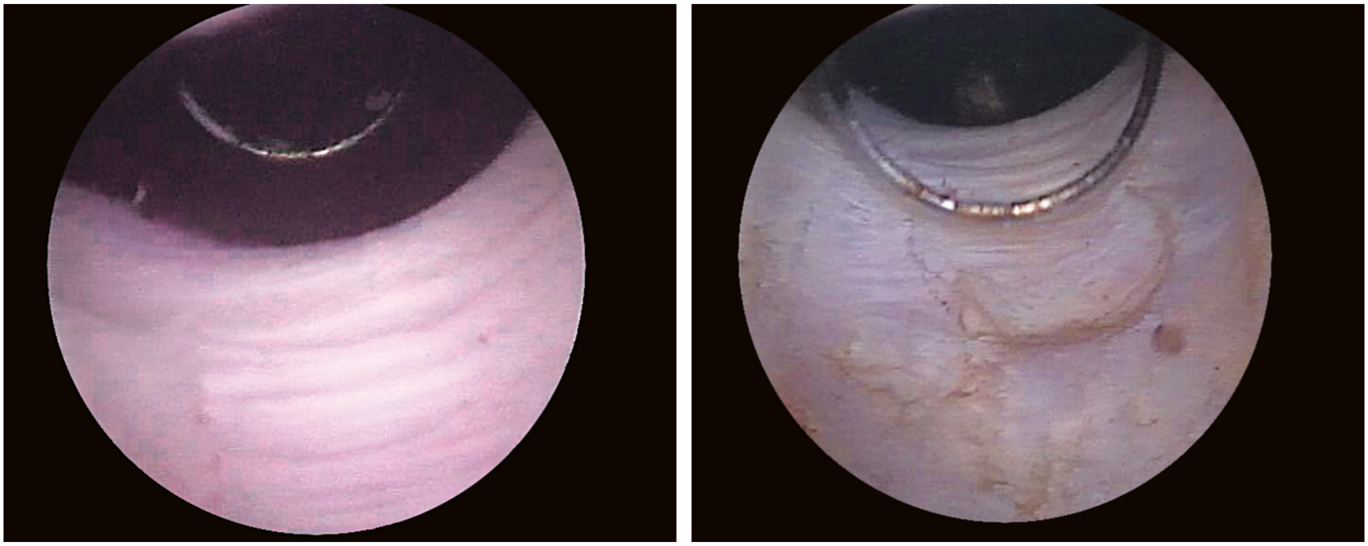

FIGURE 2.30 **Removal of the adenomatous tissue up to the surgical capsule.**

It is very important to perform the procedure following well-established operative steps, known by the urologist. Transurethral resection mainly has three steps:

- establishing the landmarks
- removal of the adenoma
- control of resection and hemostasis

The resection always starts with a preliminary urethrocystoscopy. Urethral calibration with an Ottis urethrotome or with dilators is sometimes necessary to insert the resectoscope. The resectoscope should be easily inserted inside the bladder to prevent postoperative urethral strictures. Most urologists prefer ventral meatotomy using the Ottis urethrotome (Bailey and Shearer, 1979). This is inserted closed into the distal urethra, after which the mechanism is opened up to the 24–28 Ch mark and the blade is retracted. A uniform section of the urethra is achieved, with minimal urethroragia that does not require additional treatment.

The metallic sheath of the resectoscope is well lubricated (with anesthetic gel or sterile oil) and the shutter is attached and gently inserted. The device must pass easily through the urethra, by its own weight, for the insertion to be as least traumatic as possible. In the prostatic urethra the sheath of the resectoscope is swung down to enter inside the bladder. It should not be forced if it meets resistance, and sometimes the insertion of a Sachse urethrotome is necessary to treat an associated urethral stricture. In these situations it is recommended to insert the resectoscope under visual control (Fig. 2.31) in order to avoid possible false passages (Fig. 2.32). The bulbous urethra, external sphincter, prostatic urethra with prostatic lobes, and verumontanum are visualized. This is followed by a mandatory systematic evaluation of the entire bladder.

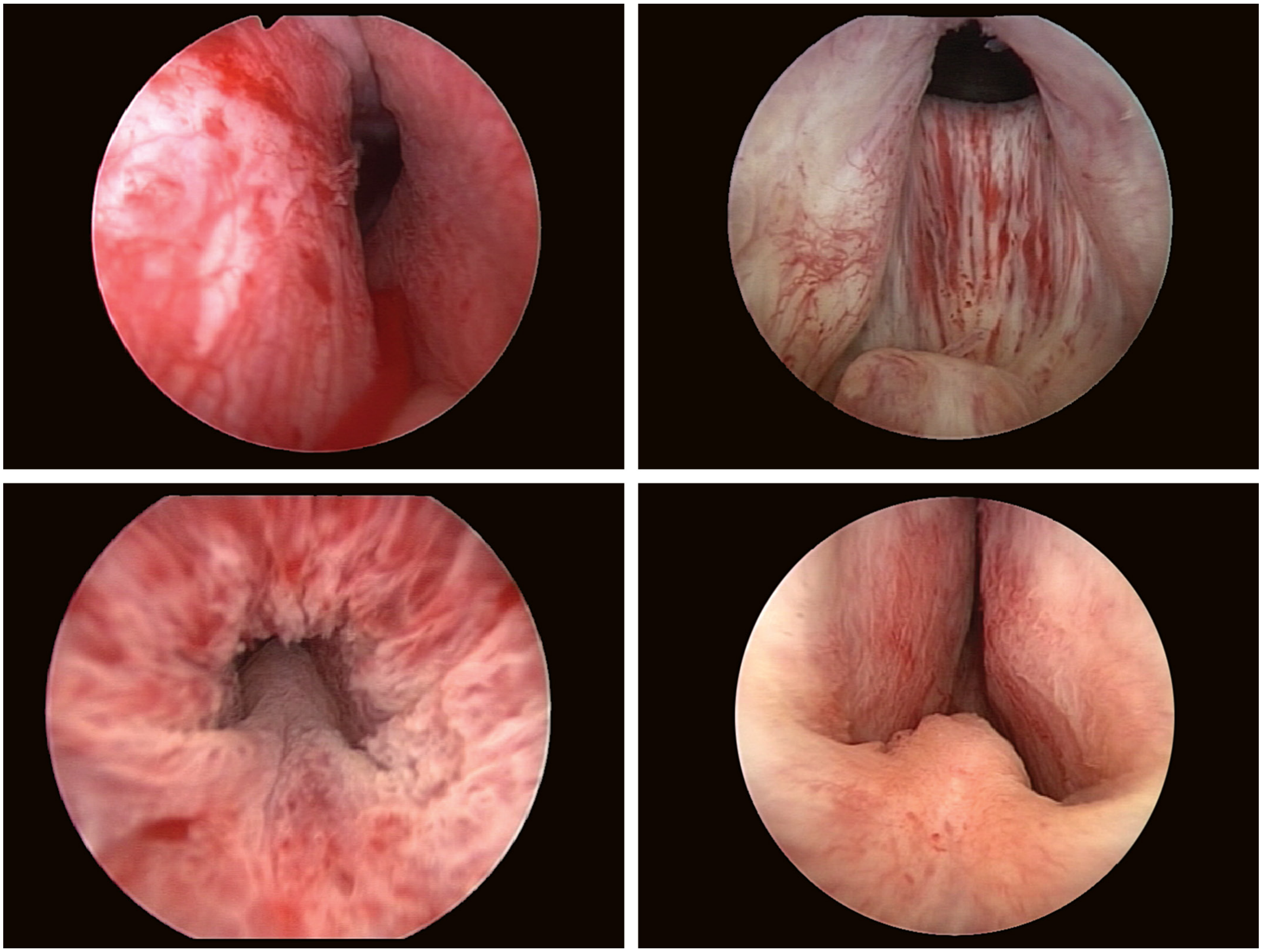

FIGURE 2.31 **The electroresectoscope is inserted under visual control.**

FIGURE 2.32 **False passage in the prostatic urethra after an attempt to insert the resectoscope blindly.**

Some patients have a very narrow urethral lumen in which instruments with a caliber larger than 22 Ch cannot be inserted, forcing the urologist to use resectoscopes of appropriate sizes. In the case of a postanesthetic erection (approximately 4% of cases), 2–3 mL of phenylephrine (1 mL diluted in 49 mL saline solution) or ephedrine (1 vial 0.5% dissolved in 3 mL saline solution) are injected inside the corpus cavernosum, with the erection disappearing in 2–3 min (Lee et al., 1995). If necessary, the procedure may be repeated every 10–15 min.

2.5.3.1 Establishing the Landmarks

The bladder is distended with approximately 100–200 mL of fluid for an adequate identification of anatomical landmarks. These are the same regardless of the dimensions of the prostate adenoma:

- the verumontanum and the external sphincter (representing the distal limit of resection)
- the bladder neck (representing the proximal limit)

The distance between these two limits is variable and is large in voluminous adenomas. The importance of the verumontanum as a landmark is well recognized by all urologists with experience. It is positioned ("as a lighthouse") in the prostatic urethra, just above the external sphincter (Fig. 2.33). The sphincter has an internal part (with smooth muscle fibers) and an external one (with striated muscle fibers, under voluntary control) (Gosling et al., 1982). It is an essential part of the mechanism of continence and should not be injured.

Identification of the external sphincter is very important: the resectoscope is withdrawn distal to the sphincter, the water flow is stopped, and the characteristic contractions are noticed (similar to an anus). The sphincter opens when the irrigation flow starts again (Fig. 2.34). As the sheath of the resectoscope is withdrawn beyond the sphincter, the instrument acquires a greater degree of freedom. It is very important to recognize this feeling during resection because it warns the operator that he or she is beyond the safety limit.

After the verumontanum and the external sphincter have been identified, the next step is represented by cystoscopy and identification of the bladder neck (Fig. 2.35); the proximal limit of resection is the muscular ring from this level. The trigone, ureteral orifices, and lateral walls are examined during cystoscopy.

Normal bladder mucosa has a white-pearly appearance with blood vessels visible by transparency. Subvesical obstruction causes detrusor hypertrophy, with a trabeculated and pseudodiverticular appearance (Fig. 2.36). In these cases, the bladder mucosa may appear congestive and hyperemic.

Bladder stones may sometimes be seen and have to be treated by lithotripsy before TURP. They will be fragmented on sight (Fig. 2.37) to avoid bladder injuries (using pneumatic, ultrasonic, or laser lithotripsy).

Identification of the bladder neck (the proximal limit of TURP) is important to avoid injuries of the trigone and ureteral orifices. In some patients there is no adenoma in the region of the median lobe and the first loop, which removes tissue, reveals muscle fibers just beneath the urothelium (Fig. 2.38).

In other patients, a considerable volume has to be resected before fibers of the bladder neck are observed. In a first step, after exposing the fibers of the bladder neck, resection is abandoned at this level (and will be completed

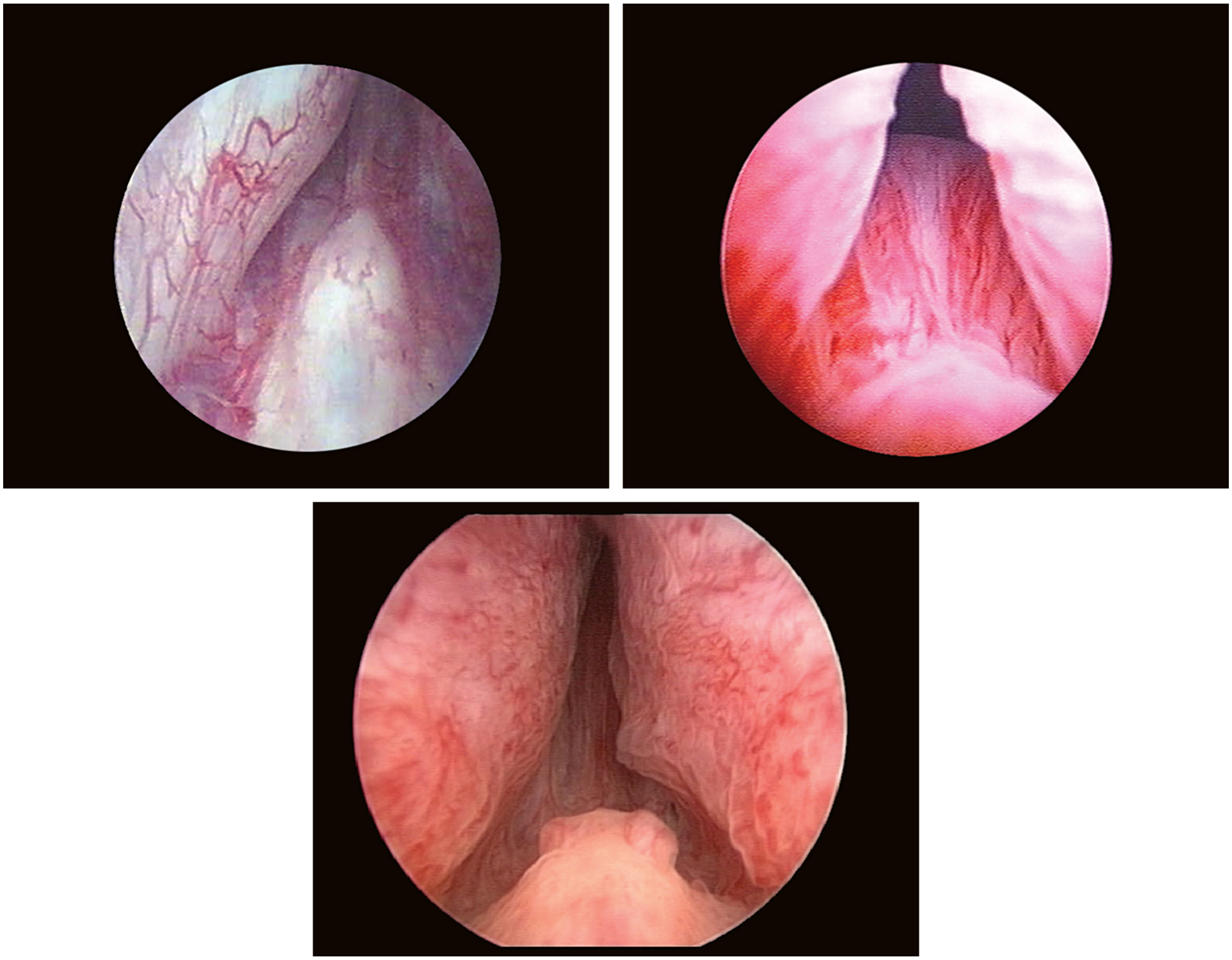

FIGURE 2.33 **Identification of the verumontanum.**

toward the end of resection). The median lobe is then removed until just above the verumontanum so that both the verumontanum and the bladder neck can be seen in the visual field (Fig. 2.39).

Perforations under the edge of the trigone may occur during resection at the level of the bladder neck (looking like a spider web and sometimes a break in the connective tissue beneath the bladder neck) (Fig. 2.40). These are not significant complications (if the resectoscope is not forcibly inserted beneath the trigone).

Additional coagulation of the arteries at 5 and 7 o'clock may be necessary after resection performed on the midline (Fig. 2.41).

In the case of large adenomas, the anatomical changes may complicate an endoscopic intervention. Thus, the lateral lobes can extend distal to the verumontanum (Fig. 2.42), requiring special attention during resection in order to avoid damaging the external sphincter.

2.5.3.2 The Removal of Adenomatous Tissue

The next operative step after establishing the landmarks is removal of the adenomatous tissue. As previously mentioned, it is very important that the procedure be performed methodically, following a plan well known by the surgeon. Mobility in terms of intraoperative decisions as well as adaptation to local conditions are very important for the success of the intervention. This is more important than the place where the resection starts or the specific features of the technique. Resection can start at 6 o'clock (Fig. 2.43) or at 12 o'clock, depending on the surgeon's routine. Both methods are used with similar results.

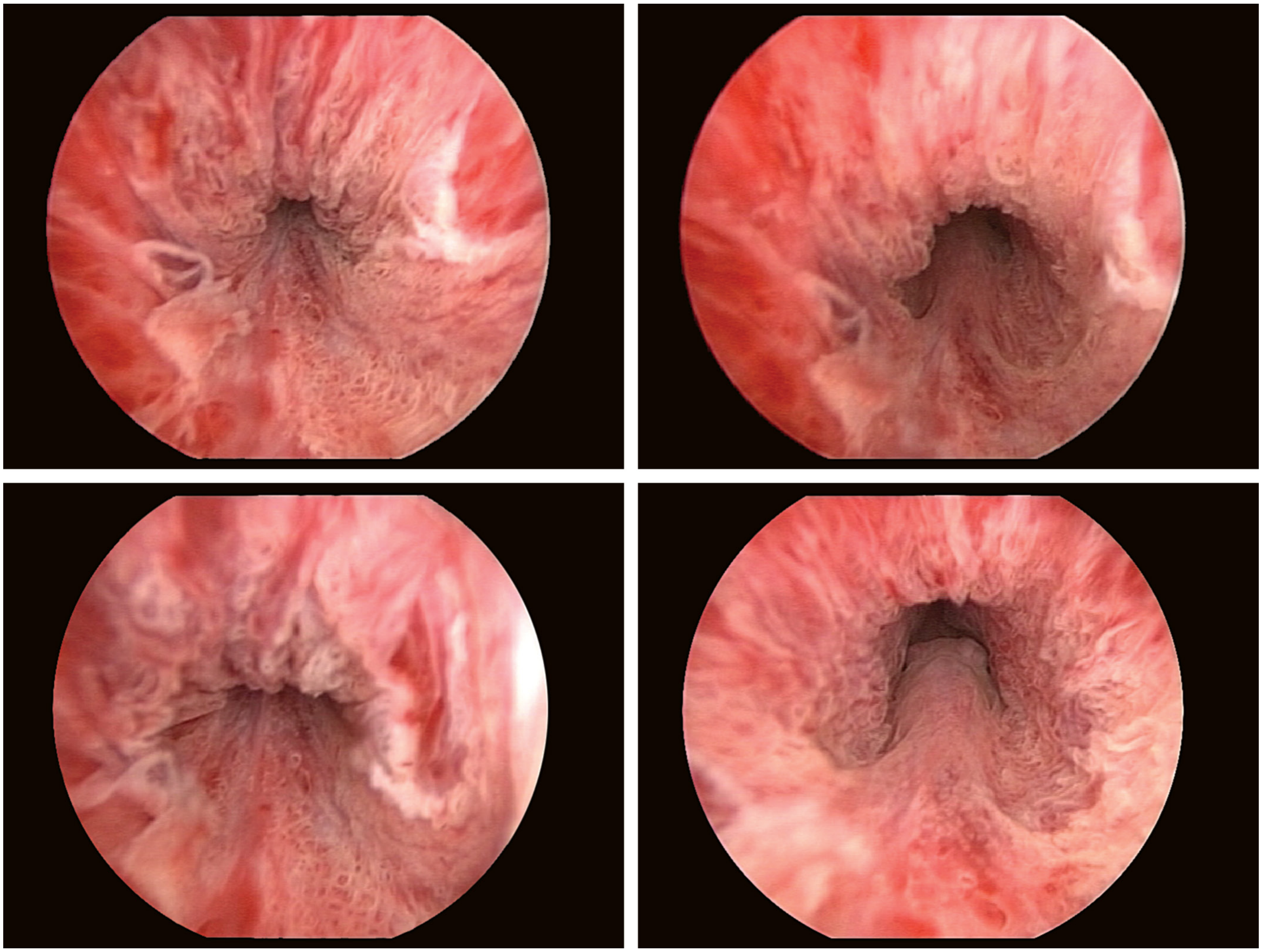

FIGURE 2.34 **Identification of the external urethral sphincter.**

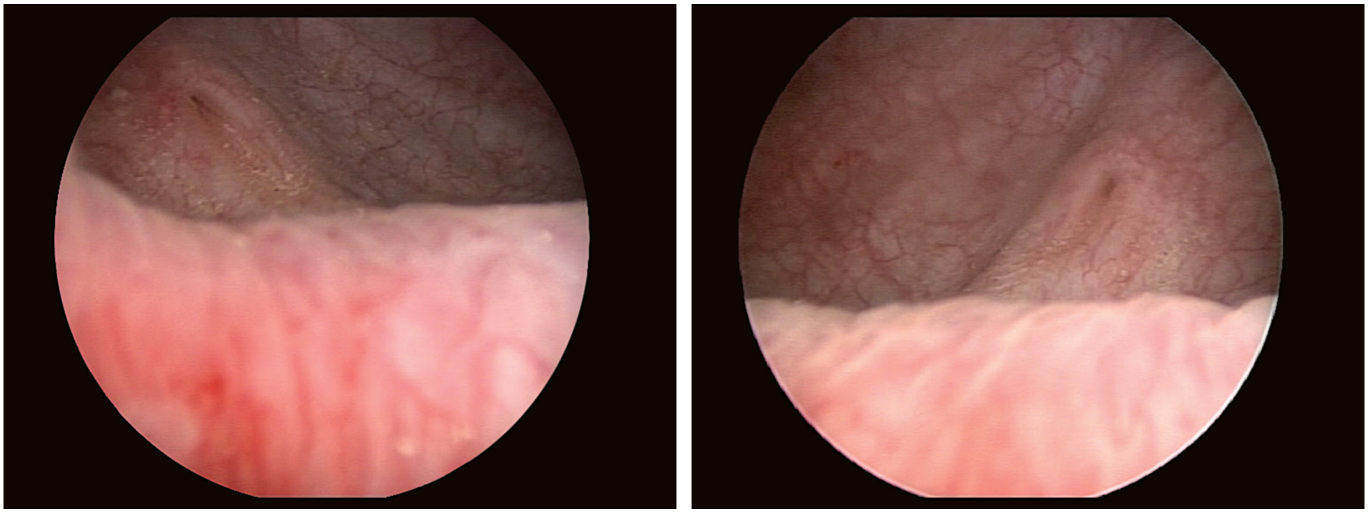

FIGURE 2.35 **Identification of the bladder neck and ureteral orifices.**

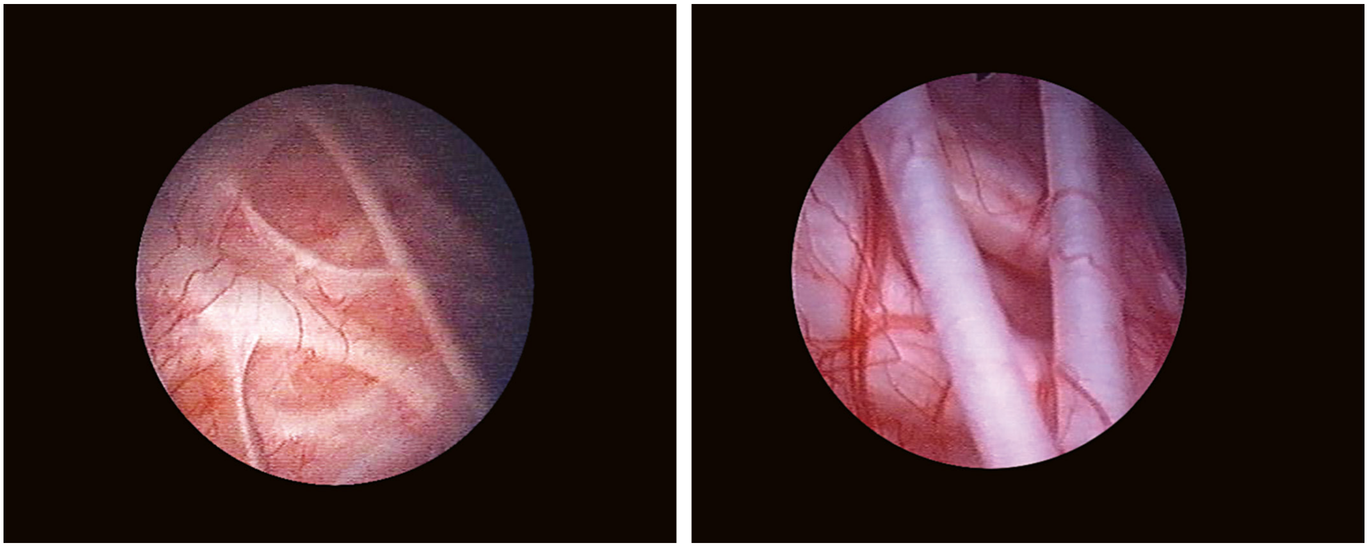

FIGURE 2.36 **Detrusor hypertrophy.**

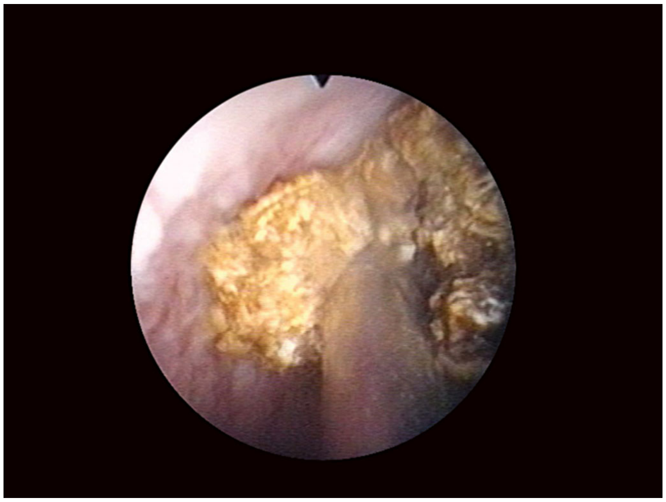

FIGURE 2.37 **Ballistic lithotripsy of a bladder stone (before TURP).**

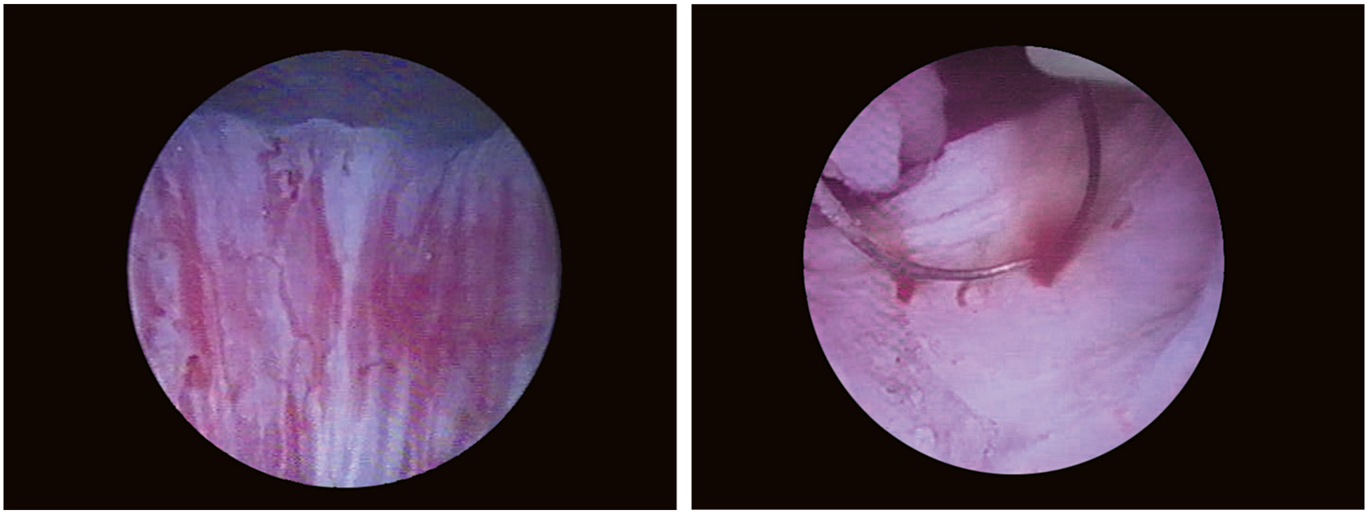

FIGURE 2.38 **Identification of the bladder neck (in a patient without median lobe) and of the muscle fibers after the first resection loop.**

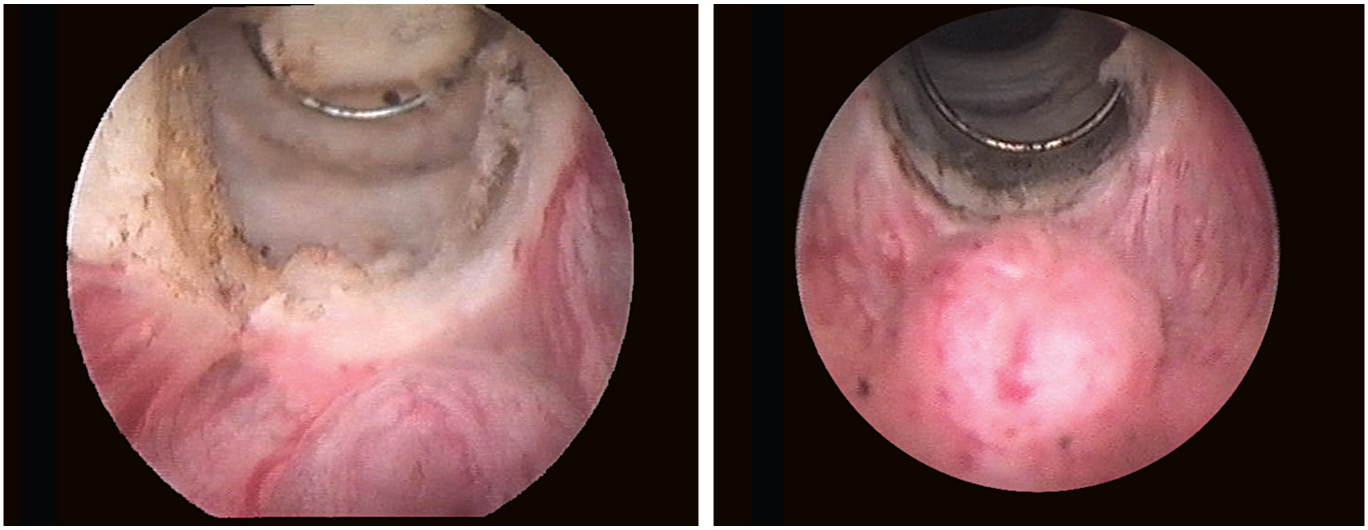

FIGURE 2.39 Resection of the median lobe from the bladder neck until above the verumontanum.

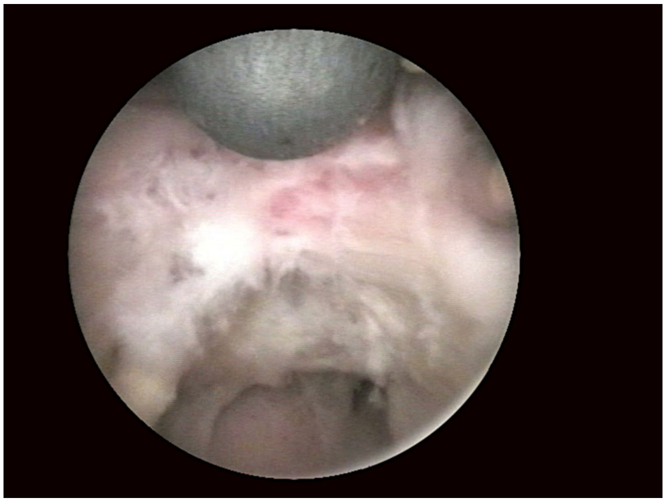

FIGURE 2.40 Perforation under the trigone.

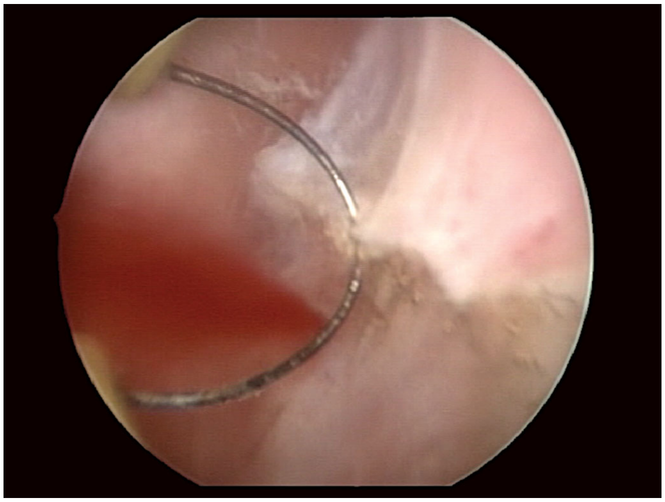

FIGURE 2.41 Coagulation of arteries at 5 o’clock.

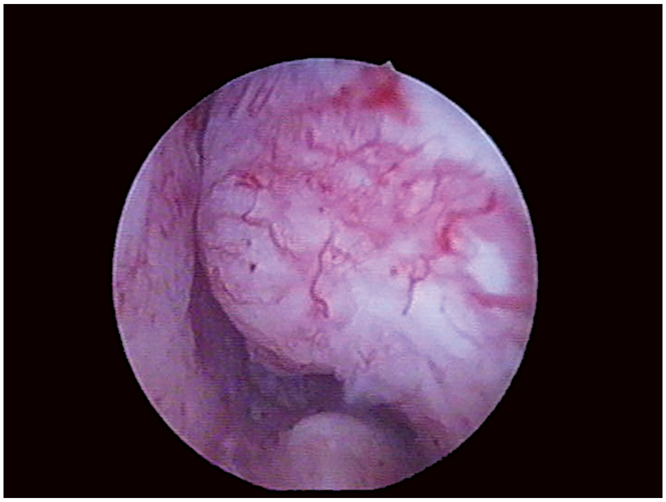

FIGURE 2.42 Lateral lobe extended distal to the verumontanum.

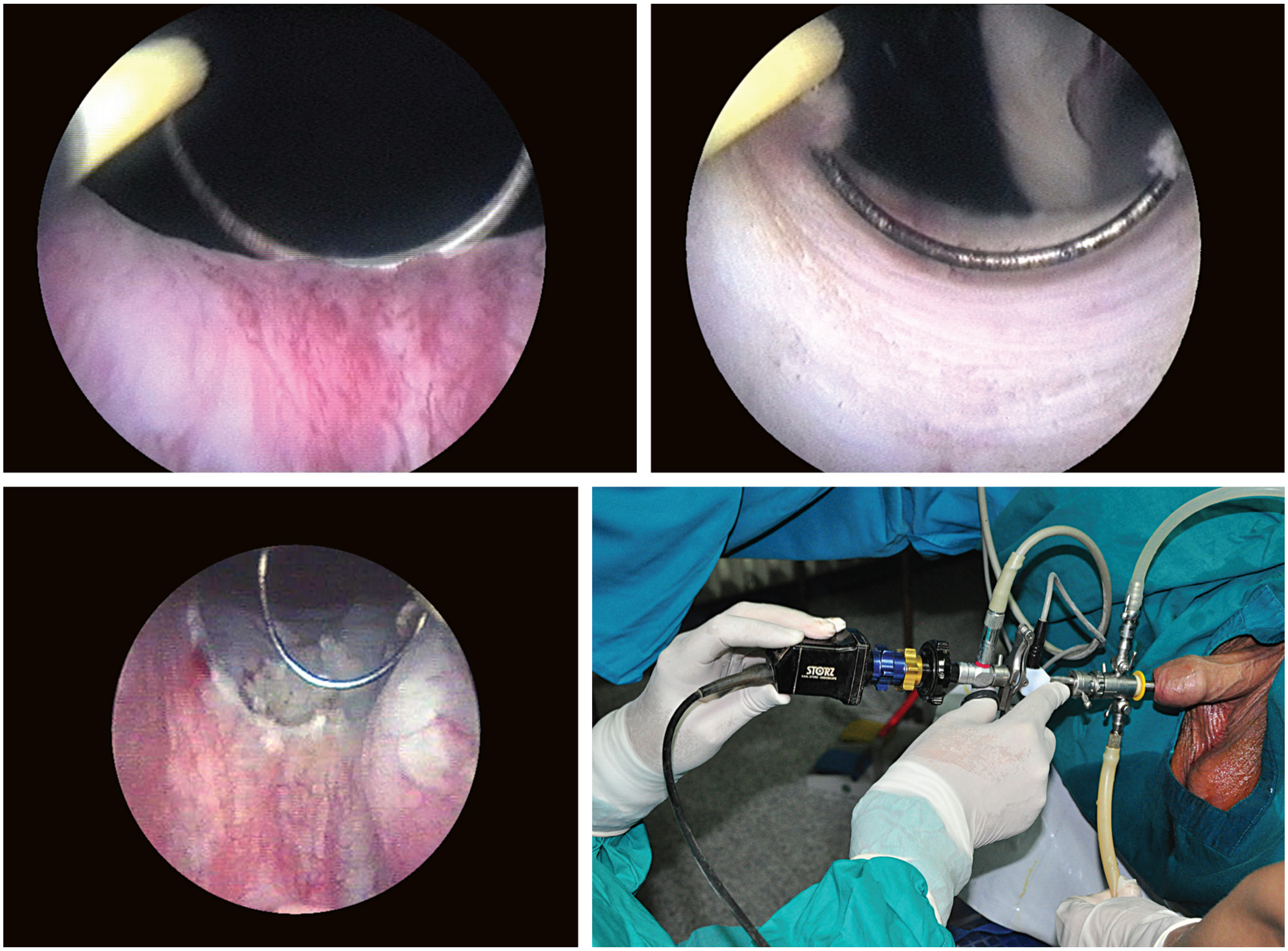

FIGURE 2.43 **Starting the resection at 6 o'clock.**

Usually, in the case of median lobe adenomas, the surgeon starts with this lobe and then continues with the lateral lobes. When these are asymmetric (Fig. 2.44), the bigger one will be resected first.

Resection of the median lobe creates a workspace (Fig. 2.45), allowing an efficient irrigation and a proper passage of the resected chips into the bladder. Identification of the ureteral orifices is sometimes impossible at the beginning. They become visible only after partial resection of the median lobe. These situations require special attention to avoid accidental resection of the ureteral orifices.

Some authors perform incisions at the limit between the median and the two lateral lobes, with coagulation of the perforating vessels at this level. Intraoperative bleeding can be reduced in this way by decreasing the blood supply to the median lobe (Blandy et al., 2005). The median lobe is resected from the top to the bottom, with the resectoscope placed at the bladder neck to avoid perforation beneath the trigone and of the bladder neck (Fig. 2.46). When the median lobe is too close to the bladder wall, it can be removed with a loop (which raises the tissue, pushing it away from the trigone) to be cut safely. It is important for the cutting movements to be short in the area of the bladder neck in order to prevent accidental resection of the trigone and ureteral orifices.

On the other hand, the lower limit of the resection should not exceed the verumontanum to avoid damaging the sphincter.

As adenomatous tissue is removed, the prostatic capsule appears. It has a fibrous structure, different from the granular appearance of adenomatous tissue, and is more evident in the cranial region and less represented in the apical part (Fig. 2.47).

The capsular fibers are rare in the periphery, intersecting the fat around the prostate (Fig. 2.48). When this fat is observed during resection, it is a warning for the surgeon that he or she has reached the capsule (continuing the procedure can lead to complications).

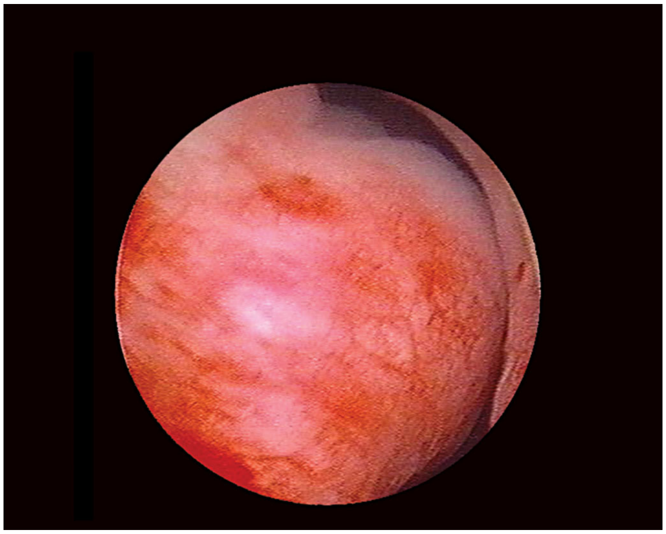

FIGURE 2.44 **Asymmetric lateral lobe (resection starts at this level).**

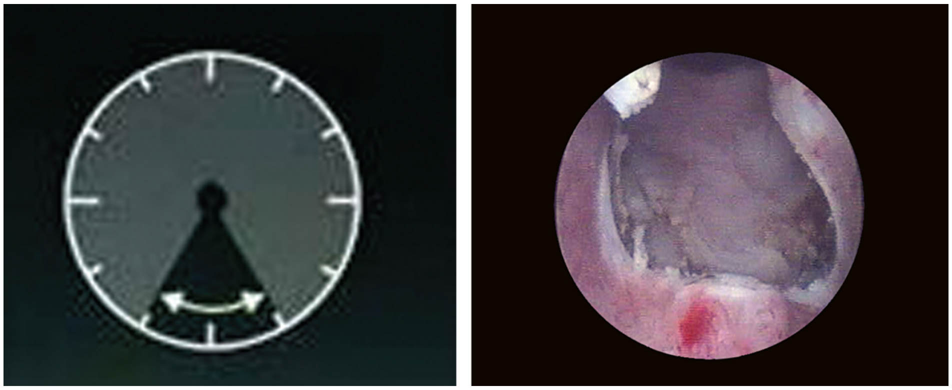

FIGURE 2.45 **Initial resection of the median lobe creates a workspace.**

The procedure continues with the resection of the lateral lobes. It is up to the surgeon if he or she starts with the left or right lobe. For the left lobe, the direction of resection is from 5 o'clock toward 2 o'clock (Fig. 2.49). Successive cuts are indicated in order to obtain a smooth surface. Resection starts from proximal to apical, without insisting during this operative step on the bladder neck or on the sphincter (resection of these areas will be performed later).

While advancing toward the prostatic capsule, temporary hemostasis of the important blood vessels is done to maintain acceptable intraoperative visibility (Fig. 2.50).

In the case of large lateral lobes, some surgeons perform incisions at 3 o'clock (for the left lateral lobe) and 9 o'clock (for the right lobe), respectively, with coagulation of the arteries entering the prostate at this level (May and Hartung, 2006). The tissue between 6 o'clock and 3 o'clock (on the left side) and between 6 o'clock and 9 o'clock (on the right side), respectively, is resected afterward.

Right lobe resection is similar to the left, starting at 7 o'clock and continuing toward 10 o'clock (Fig. 2.51). Two or three successive resections may be necessary for large adenomas in order to cover the distance between the bladder neck and the verumontanum. In general, the excursion of the loop toward the resectoscope's sheath must be accompanied by a movement of the device in order to achieve an "excavation" into the adenomatous tissue.

After resection of the lateral lobes, the next operative step is represented by removal of the tissue located anteriorly. The resectoscope is placed at the level of the verumontanum, rotated 180°, and the tissue between 10 o'clock and 2 o'clock is resected (Fig. 2.52).

Resection of the apical tissue, close to the verumontanum, represents the next operative step. The resectoscope is placed at the level of the verumontanum and short and successive incisions are performed circumferentially (clockwise) (Fig. 2.53).

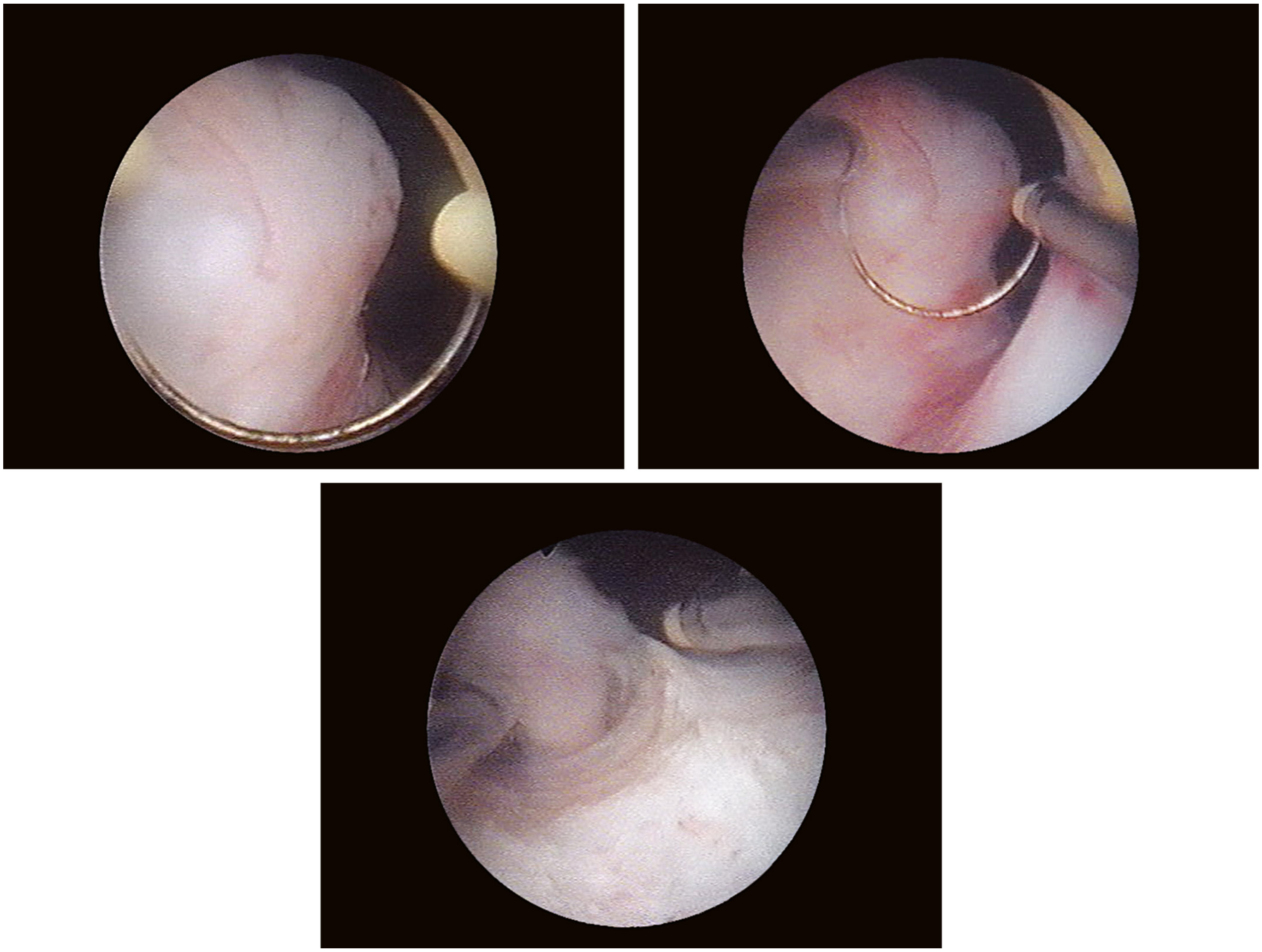

FIGURE 2.46 **Resection of the median lobe from the top to the bottom with the resectoscope placed at the bladder neck.**

Full control over each excursion of the loop is mandatory in order to strictly limit the resection to the residual apical tissue without sphincter injury. The resection continues next to the verumontanum, creating a groove on both sides of it (without damaging it) (Fig. 2.54). Superficial incisions are recommended to avoid perforations.

2.5.3.3 Control of Resection and Hemostasis

The remaining apical tissue becomes quite mobile (like folding doors). This remaining tissue can be identified by lowering the flow of irrigating fluid after withdrawing the resectoscope into the membranous urethra (Fig. 2.55).

A rectal exam is considered very useful by some authors, especially for the apical tissue (May and Hartung, 2006). Complete resection of this tissue can thus be managed properly and a good hemostasis is achieved. Removal of this tissue is also recommended for very large prostates, where the apical tissue extends beyond the verumontanum.

When needed, especially for small adenomas (with a "tall" bladder neck), additional bilateral incisions of the bladder neck at 5 and 7 o'clock are sometimes required in order to reduce the incidence of postoperative bladder neck sclerosis. Usually, after incision, the bladder neck opens wide. The final result of the procedure should be a broad, nonobstructive, and smooth prostatic lodge (Fig. 2.56).

All the chips are extracted from the bladder at the end of the resection, taking care that no debris remain to obstruct the urethro-vesical catheter (Fig. 2.57).

The resection loop is changed with the roller in order to achieve circumferential hemostasis of the entire prostatic lodge (Fig. 2.58). However, excessive coagulation should be avoided because areas of necrosis may appear, thereby delaying healing. Sometimes the venous sinuses are not easily controlled with regard to hemostasis using the roller. In general, a clear irrigating fluid from the bladder is a sign of proper hemostasis.

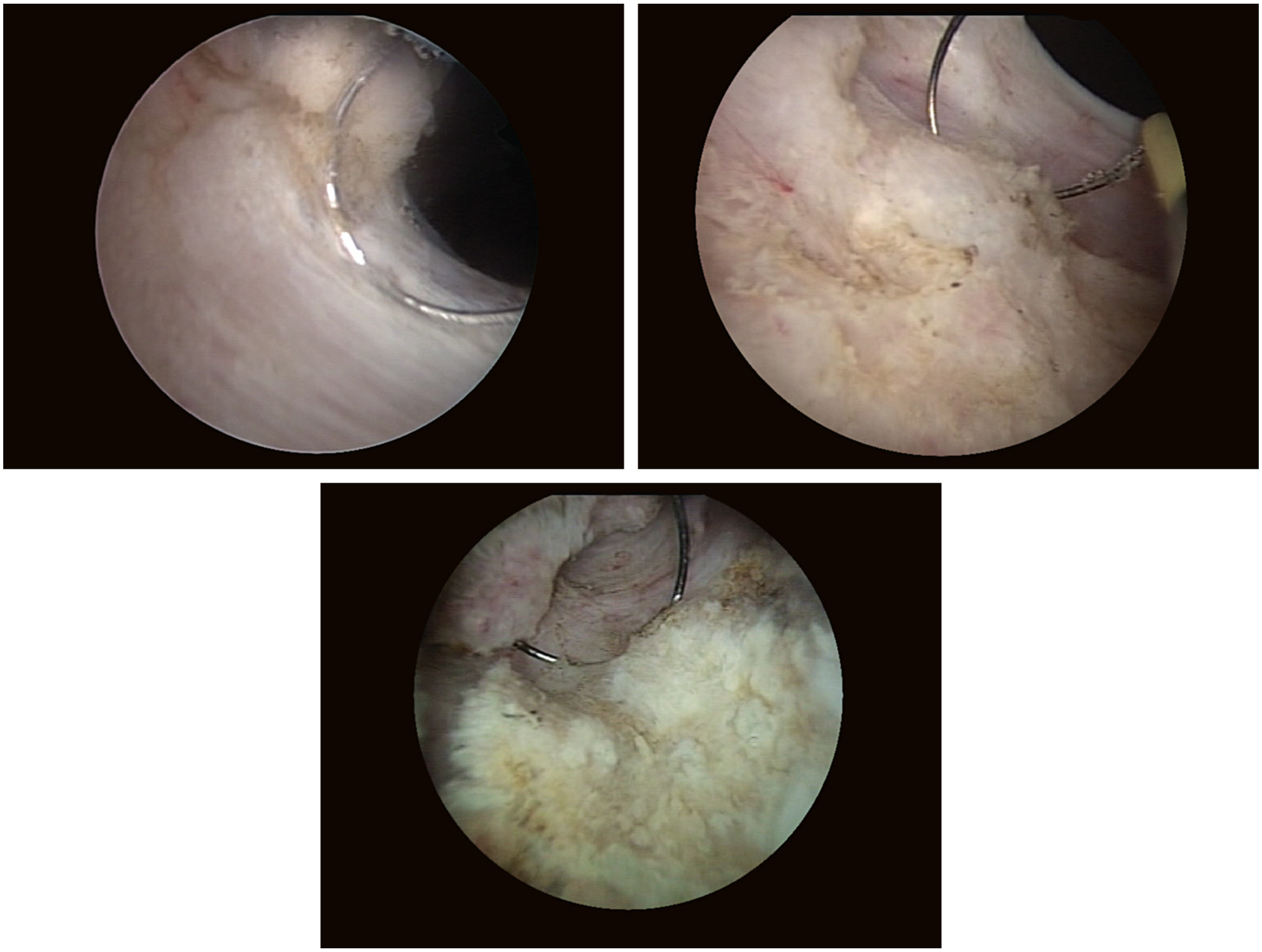

FIGURE 2.47 **The prostatic capsule is observed.**

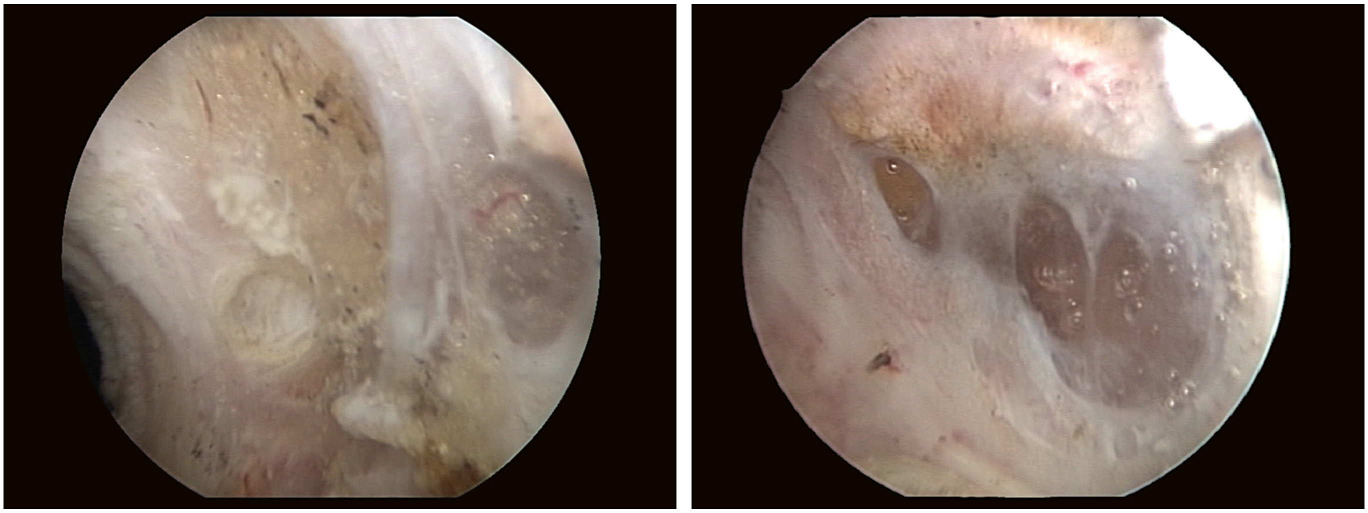

FIGURE 2.48 **Highlighting of the fat around the prostate (border of the surgical capsule).**

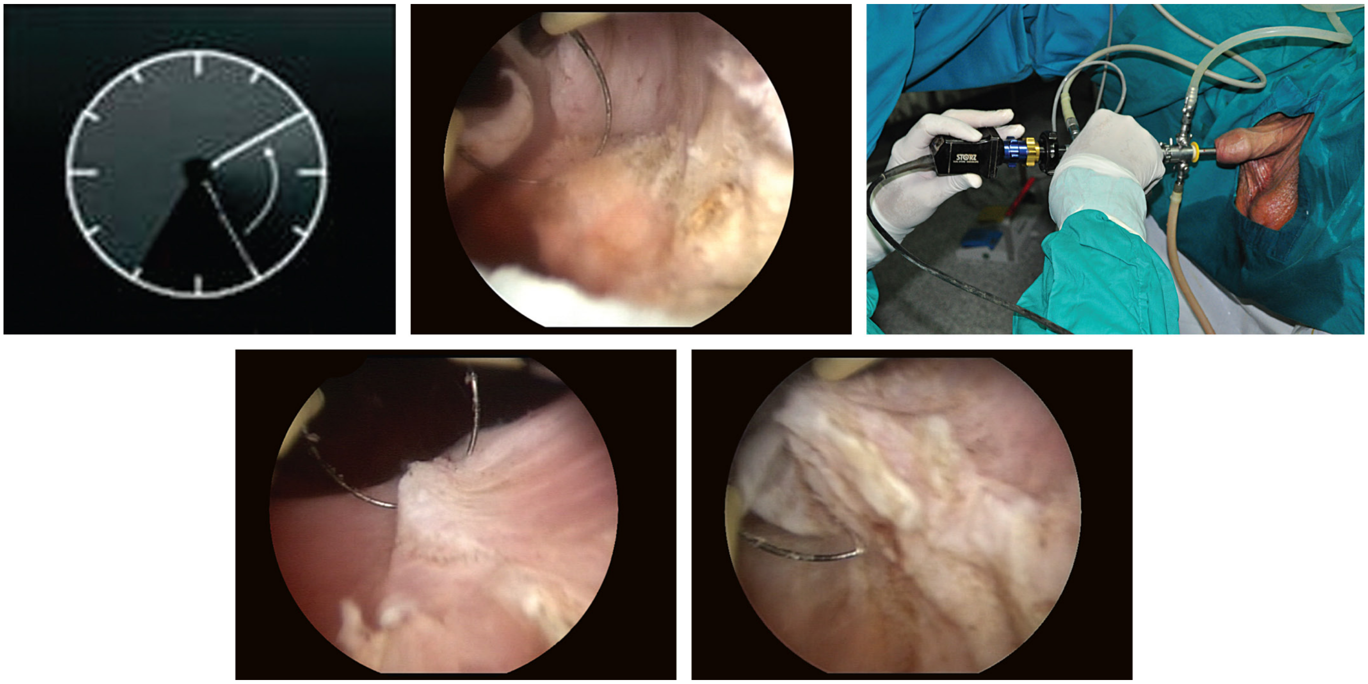

FIGURE 2.49 **Left lobe resection between 5 o'clock and 2 o'clock.**

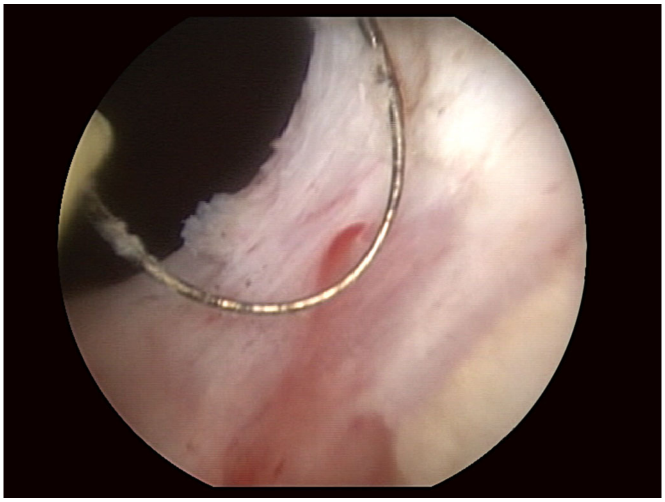

FIGURE 2.50 **Temporary hemostasis of blood vessels to maintain intraoperative visibility.**

After hemostasis is completed, the resectoscope is reinserted into the bladder to check for a complete evacuation of all the chips and clots. Bladder diverticula must be checked carefully. The bladder is partially filled (for an easier insertion of the urethro-vesical catheter) and the resectoscope is extracted. A Foley catheter is inserted using a curved mandrin. This raises the tip of the catheter, thus avoiding perforation of the prostatic lodge. A difficult irrigation through the catheter may suggest a faulty position, requiring repositioning.

Usually 20–22 F double lumen catheters with a 30–50 mL balloon are used. Some authors consider that the final volume of the balloon should be equal to the weight of resected tissue plus 20 mL. The catheter will be fixed so that the balloon exerts traction on the prostatic lodge. The resectoscope is reinserted (before leaving the operating room) to check the prostatic lodge in case of persistent hematuria with no improvement after continuous irrigation. If bleeding is not controlled in the operating room, it will be even more difficult to control in the intensive care unit or in the ward. Postoperative continuous bladder irrigation with saline solution is usually recommended, especially for large adenomas. Many urologists use mild or moderate prolonged traction for at least 24 h as a means to control bleeding;

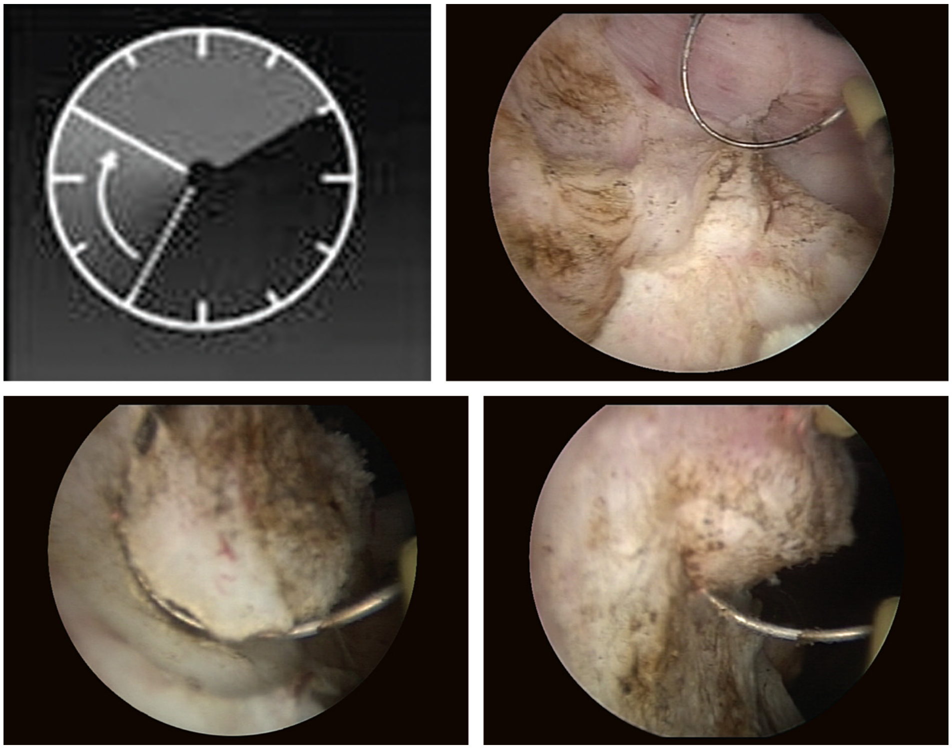

FIGURE 2.51 **Right lobe resection between 7 o'clock and 10 o'clock.**

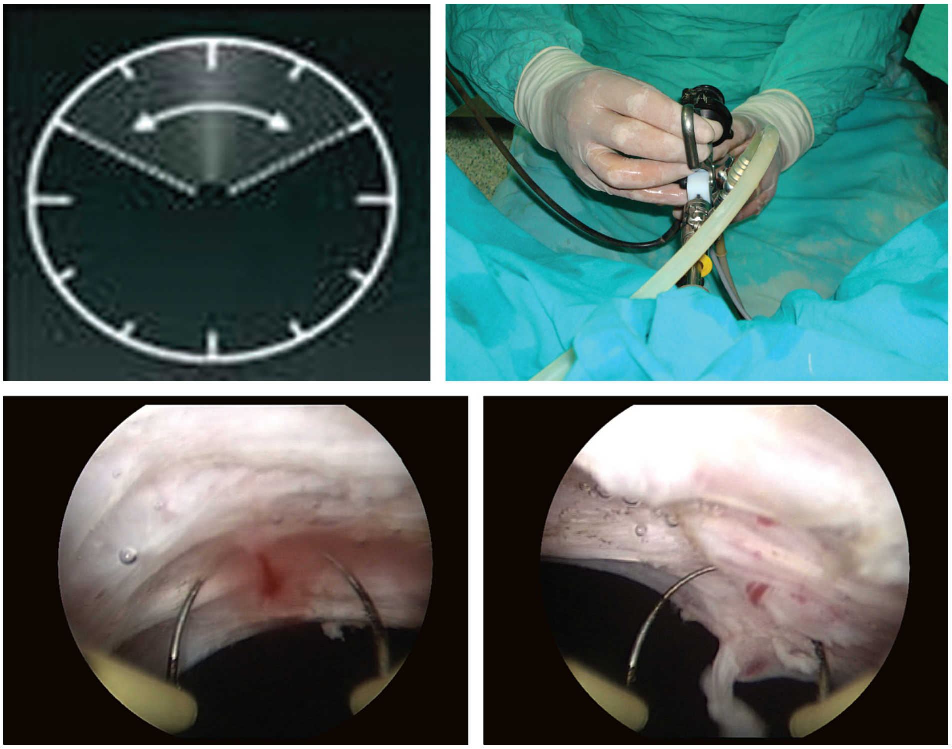

FIGURE 2.52 **Resection between 10 o'clock and 2 o'clock.**

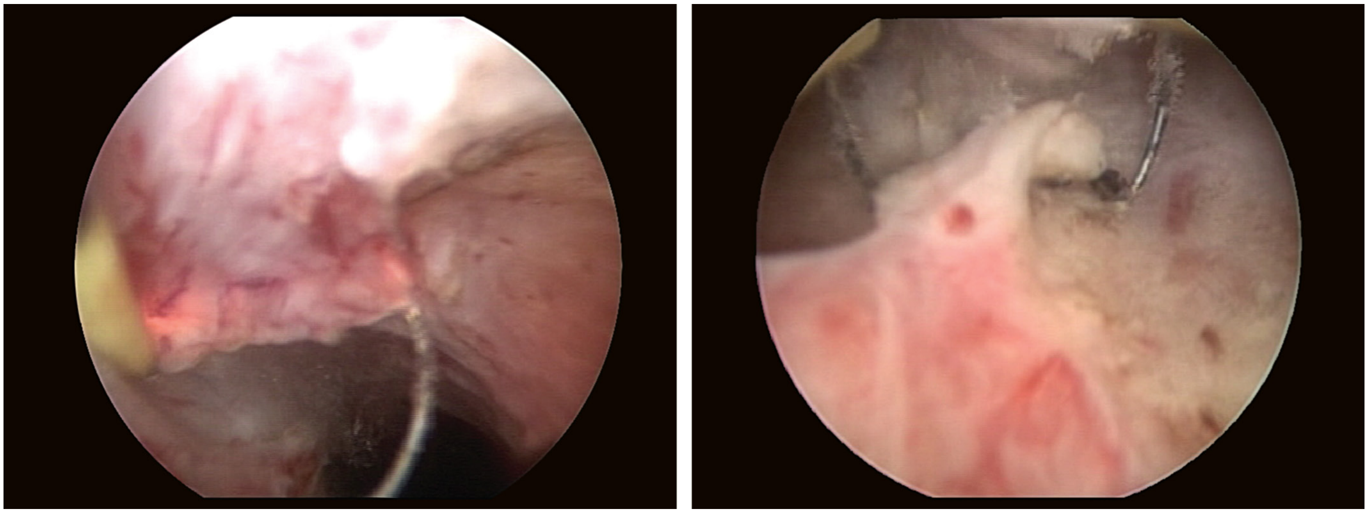

FIGURE 2.53 **Circumferential resection of the apical part.**

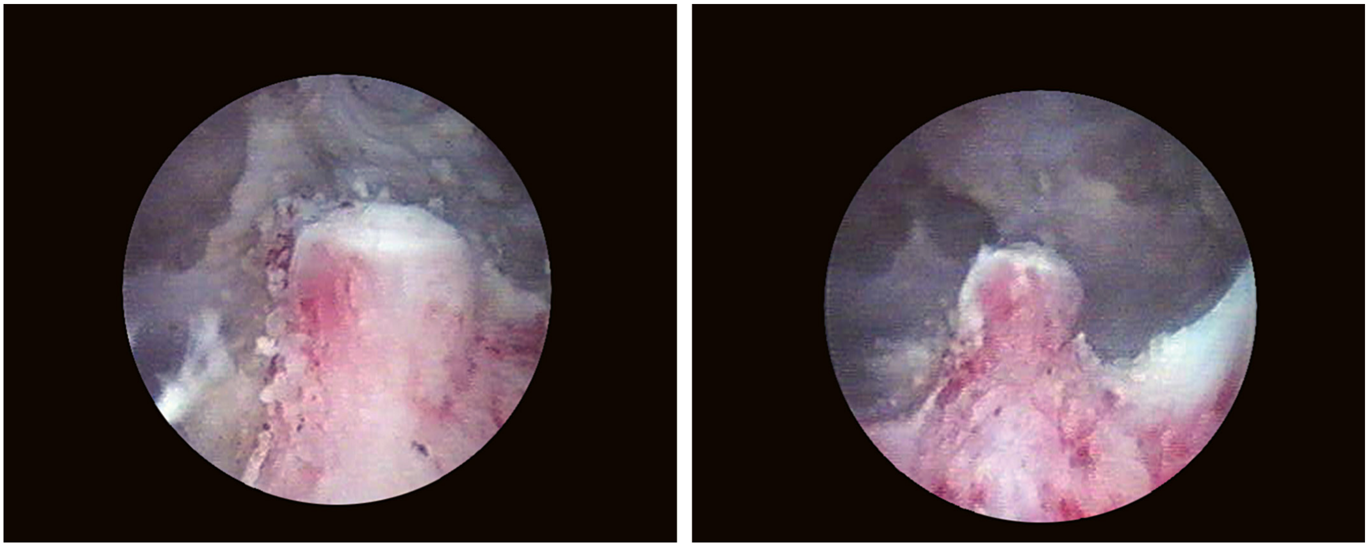

FIGURE 2.54 **Final aspect after resection of tissue next to the verumontanum.**

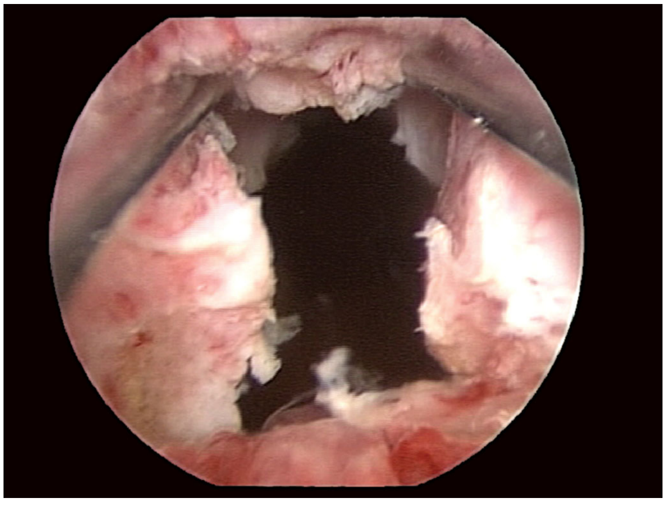

FIGURE 2.55 **Identification of the remaining apical tissue.**

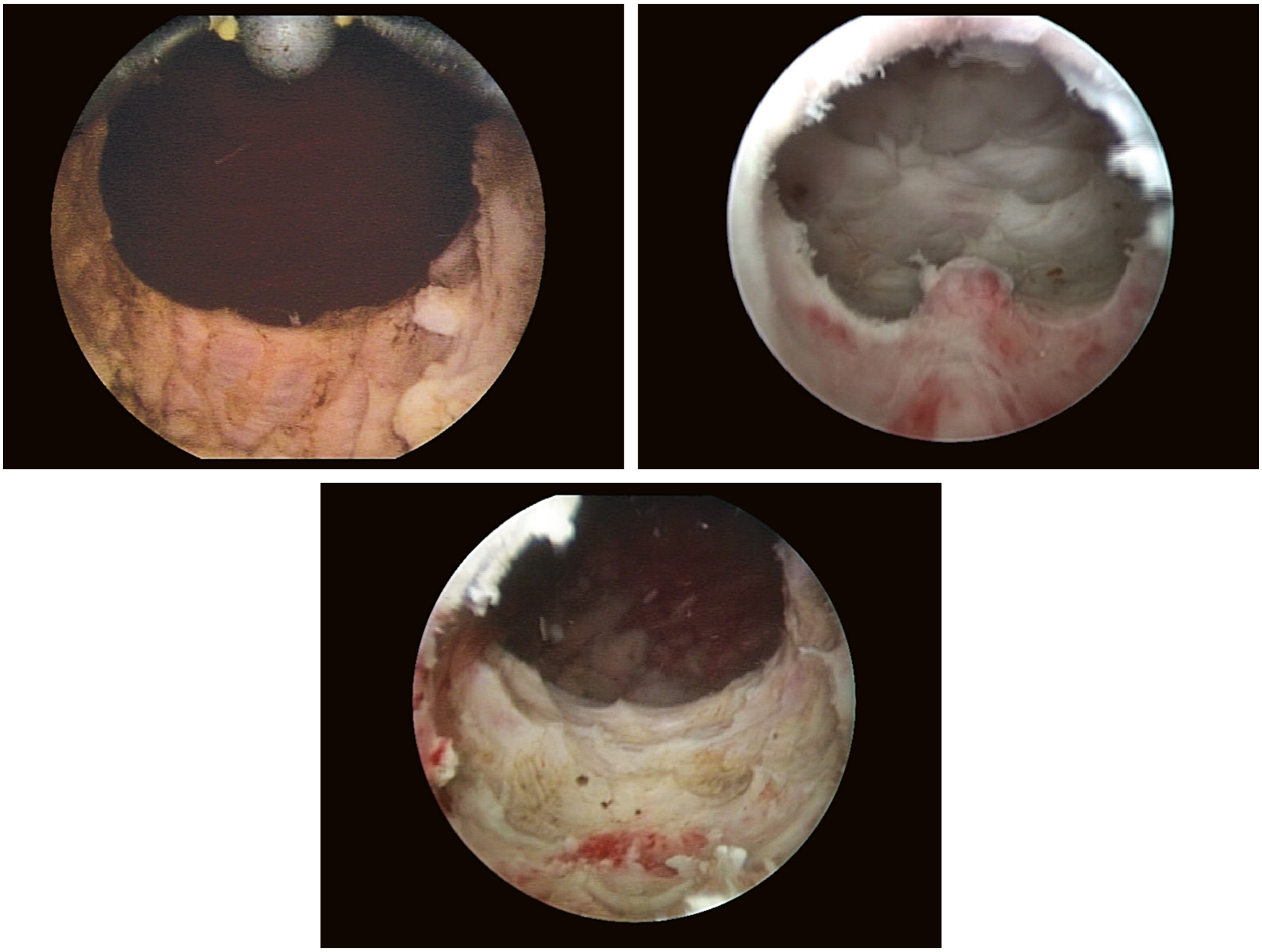

FIGURE 2.56 **Final aspect of the prostatic lodge after TURP.**

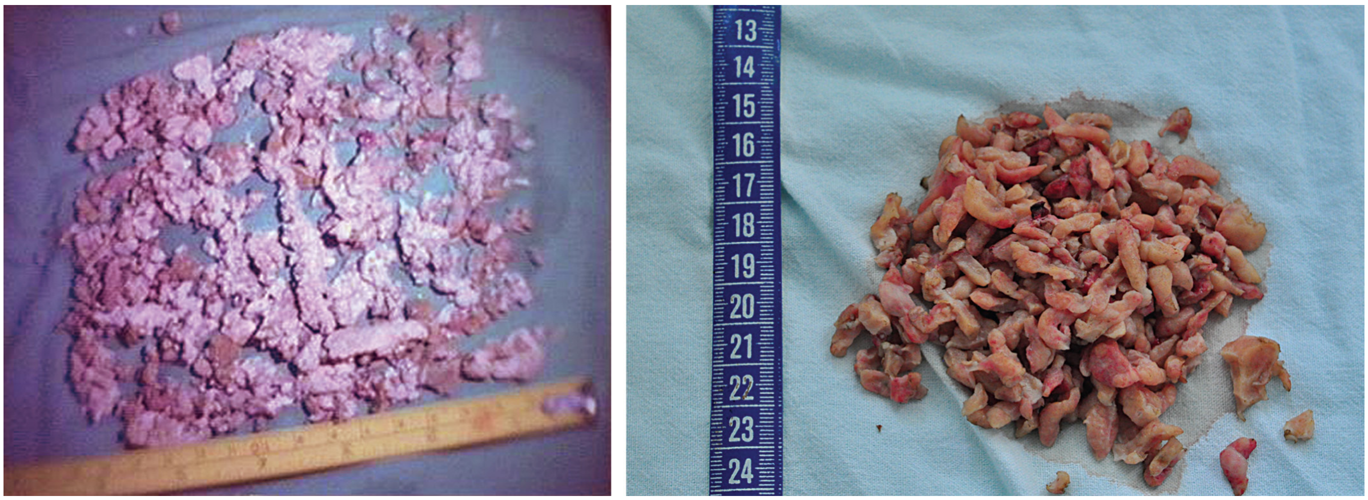

FIGURE 2.57 **Chips removed after TURP.**

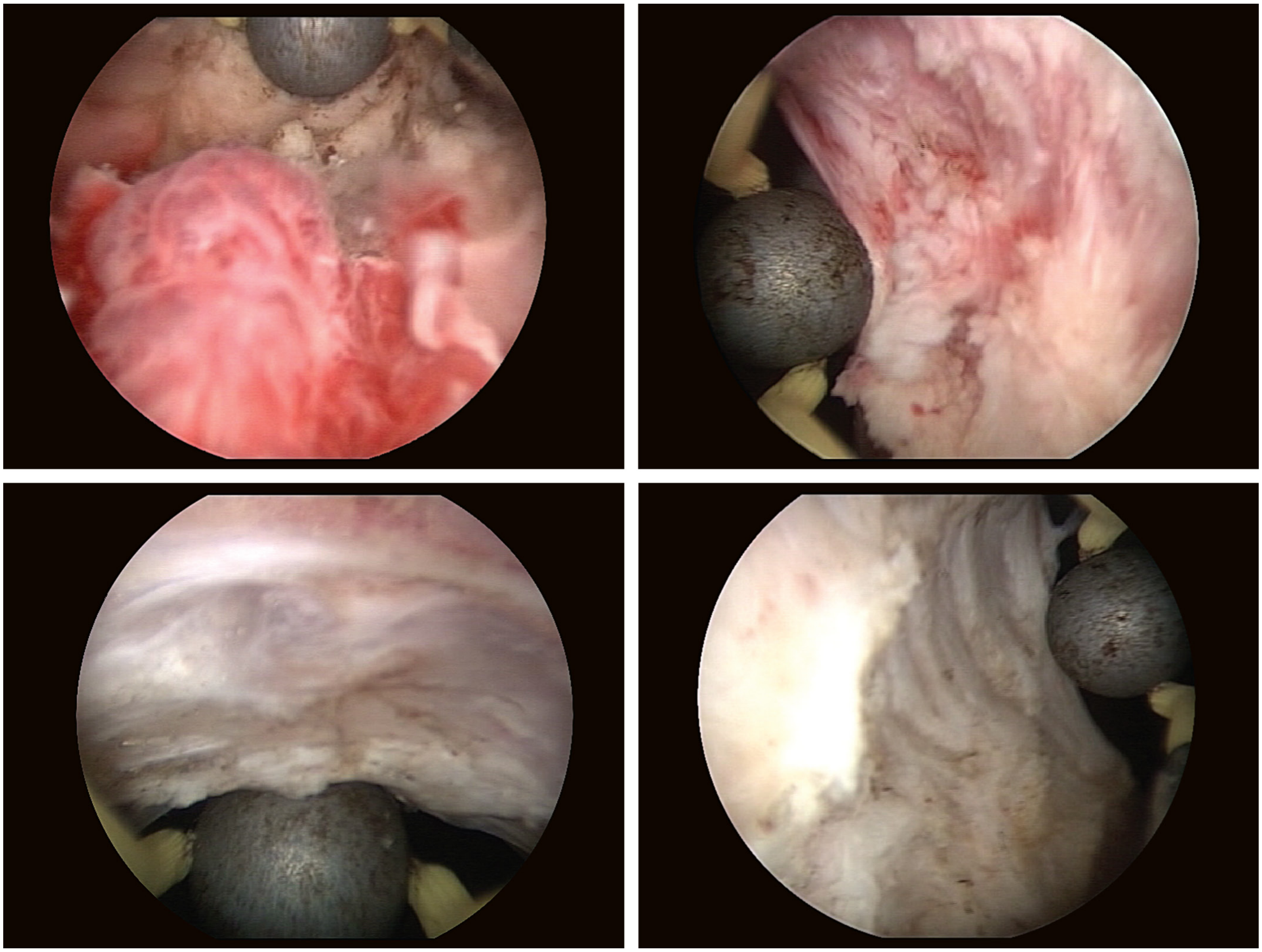

FIGURE 2.58 **Circumferential coagulation with the roller at the end of the procedure.**

others believe that this increases the patient's discomfort and consider the maneuver to be useless as long as hemostasis is properly controlled during surgery (Leslie, 2006).

There is no reason to use glycine solution for bladder irrigation after TURP. Glycine is much more expensive than saline solution and does not contain sodium or electrolytes (and thus does not contribute to the correction of hyponatremia).

2.5.3.3 Other Techniques

As previously mentioned, there are several methods for performing resection. The previous technique, described by Mauermayer (1981), is one of them. Two other techniques, described by Nesbit and Milner, deserve special attention.

The Nesbit technique was first described by Reed M. Nesbit in his book from 1943 (Nesbit, 1943) and is frequently used. As initially described by Nesbit, the procedure is divided into three stages: intravesical (or proximal), extravesical, and apical. The intervention starts by positioning the resectoscope between the bladder neck and the middle of the prostatic urethra, proximal to the verumontanum. The resection begins with removal of the intravesical part of the prostate and the bladder neck tissue, starting from 12 o'clock and moving clockwise. In this stage, the main landmarks are the bladder neck and ureteral orifices. In the extravesical stage, the resectoscope is placed in front of the verumontanum, the intervention continuing from the previously resected margin to the proximity of the verumontanum. The resection starts at 12 o'clock, continuing up to 4 o'clock on the left side and 8 o'clock on the right. The remaining tissue from the posterior lobe is then resected. A rectal exam is recommended to better evaluate the presence of residual tissue. The apical tissue remaining around the verumontanum is resected at the end of the intervention (the apical stage).

The Nesbit technique has some important advantages. By starting the resection at 12 o'clock, the lateral lobes may fall toward the posterior region, thus making their resection easier. This technique also allows for better control of the main bleeding sources. Initial resection of the bladder neck helps to clearly delineate the resection limits and is useful for avoiding perforations under the trigone. The procedure is performed in a relatively comfortable position for the surgeon.

The Nesbit technique has some disadvantages. The procedure has three distinct stages, each performed separately. The initial resection, at the level of the anterior prostate, is performed without any real landmark, in an underdeveloped (thin) region, with increased risk of perforation. An early perforation (at the beginning of resection) leads to bleeding and absorption of the irrigating fluid, which may interrupt the procedure and increase morbidity. Resection is more difficult in the case of large prostates because the lateral lobes cannot fall.

The Milner technique was described in 1941 (Milner and Engster, 1941). Resection starts at 9 o'clock and continues between 11 o'clock and 7 o'clock, from the bladder neck toward the verumontanum, in order to resect the lateral lobe from inside to outside up to the capsule. The resection is then repeated on the opposite side. After the lateral lobes, resection of the posterior and median lobes is performed. The anterior prostate is approached at the end (between 11 o'clock and 1 o'clock).

Although Milner's technique has some important advantages, the initial resection of the lateral lobes may be associated with more significant intraoperative bleeding as compared to the Nesbit technique. On the other hand, starting the resection this way minimizes the risk of perforations (since the adenomatous tissue is thicker on the lateral lobes). It is also possible to resect only one prostatic lobe (while the other will be resected during another intervention). The risk of perforations is decreased by resecting the anterior prostate at the end of the procedure. Unlike the Nesbit technique, where the surgical steps are somewhat arbitrary (proximal or intravesical, extravesical and apical resection), resection is much more methodical during the Milner procedure (right, left, inferior, and superior).

Regardless of the resection technique, the most important aspect is the surgeon's familiarity with it.

2.5.4 Tips and Tricks for Resection of Large Prostates

Technological developments and the continuous improvement of resection techniques have made possible the resection of larger prostates, without any constraints as long as the surgeon maintains spatial orientation, concentration, and patience. However, the urologist must know his or her limits and should not perform TURP in the case of a prostate adenoma of 100 g if he or she does not have enough experience to finish the procedure in optimal conditions. The fact that "experience creates excellence" is well known. It is obvious that an unexperienced urologist will not be able to perform TURP in a patient with a 100 g prostate, even after carefully reading these recommendations several times. Only with experience, a proper technique, and increased self-esteem will the surgeon be able to perform this type of procedure.

Since the intervention lasts approximately 90 min, it is important to adjust the height of the operating table so the surgeon will have a comfortable position. A good resectoscope with continuous flow allows for proper intraoperative visibility, with minimal interruptions, thus shortening the duration of the procedure. Some urologists prefer higher caliber instruments (24–25 F) when resecting large adenomas, even if this increases the risk of postoperative strictures.

A lower intravesical pressure reduces the absorption of the irrigating fluid and decreases the risk of TURP syndrome and hyponatremia.

It is generally recommended to avoid the resection of a high volume of tissue (which cannot be evacuated) and that has to be processed afterward. This is much more difficult to perform when the tissue is mobile inside the bladder.

The aim of the intervention is to excise the obstructive tissue as quickly as possible. This is why the surgeon should focus on the obstructive tissue, without losing valuable time with hemostasis (unless it is necessary) or with resection of small tissue fragments not generating obstruction. The procedure is not a beauty contest and there is no prize for the most beautiful prostate lodge. A safely performed TURP for a large prostate usually requires speed and efficiency. To gain time, hemostasis is recommended when the urologist reaches the level of the capsule.

Cauterization of the venous sinuses is usually avoided, since they cannot be stopped only by cauterization (this means losing valuable time). It is important to know the elapsed time from the beginning of the procedure in order to adapt the operative strategy.

One of the secrets of the intervention consists in the skill of the surgeon in cutting the chips. Larger fragments may be obtained if a withdrawal (removal) movement of the resectoscope is performed simultaneously with the excursion of the loop, thereby reducing the operating time. However, in order to perform this maneuver safely, the surgeon must be aware of the landmarks and limits/edges of resection and of the exact location of the resectoscope. It is forbidden to resect if the exact location is uncertain or if the orientation toward important landmarks is unknown. It is better to lose several minutes for reorientation.

Finasteride can reduce intraoperative bleeding, particularly in patients with large prostates (Geavlete et al., 2004; Crea et al., 2005). Usually 2 months of treatment are recommended, although some authors have reported satisfactory results after only 2 weeks (Ozdal et al., 2005; Donohoe et al., 2005).

Some authors consider it to be very important to coagulate the main prostatic arteries located at 10, 2, 5, and 7 o'clock, using the roller, prior to the actual resection in patients with very large prostates (Blandy et al., 2005).

Complete resection of one lateral lobe is preferred in the case of large adenomas (Fig. 2.59). It is not recommended to open several "working areas" in both lobes. This can lead to uncontrollable bleeding. In addition, surgery can be stopped at any time if the resection is performed in stages (first one and then the other lobe) (Persu et al., 2010).

Thus, hemostasis is performed (using a roller when necessary) after the resection of the first lobe. The procedure can be interrupted at this point if the patient's condition does not allow for continuation or if the remaining time (for continuing the intervention) is too short. Patients usually resume micturition spontaneously (Agrawal et al., 2005). If subvesical obstruction persists, the intervention can be resumed later (a two-step procedure) (Fig. 2.60).

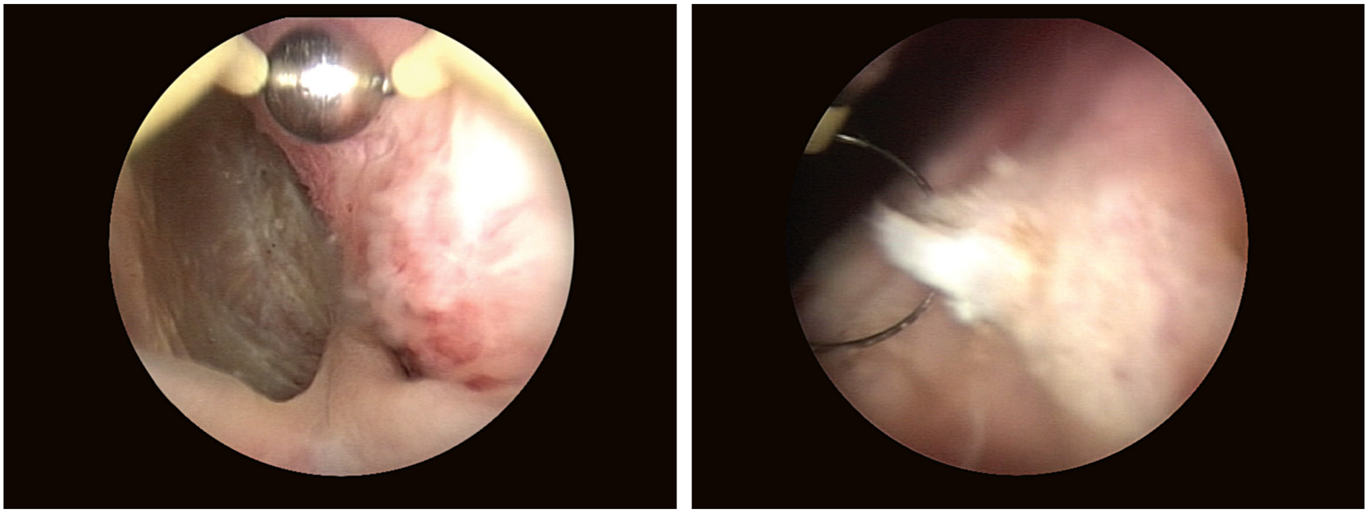

FIGURE 2.59 **Two-step resection of a large prostatic adenoma (remaining left lobe).**

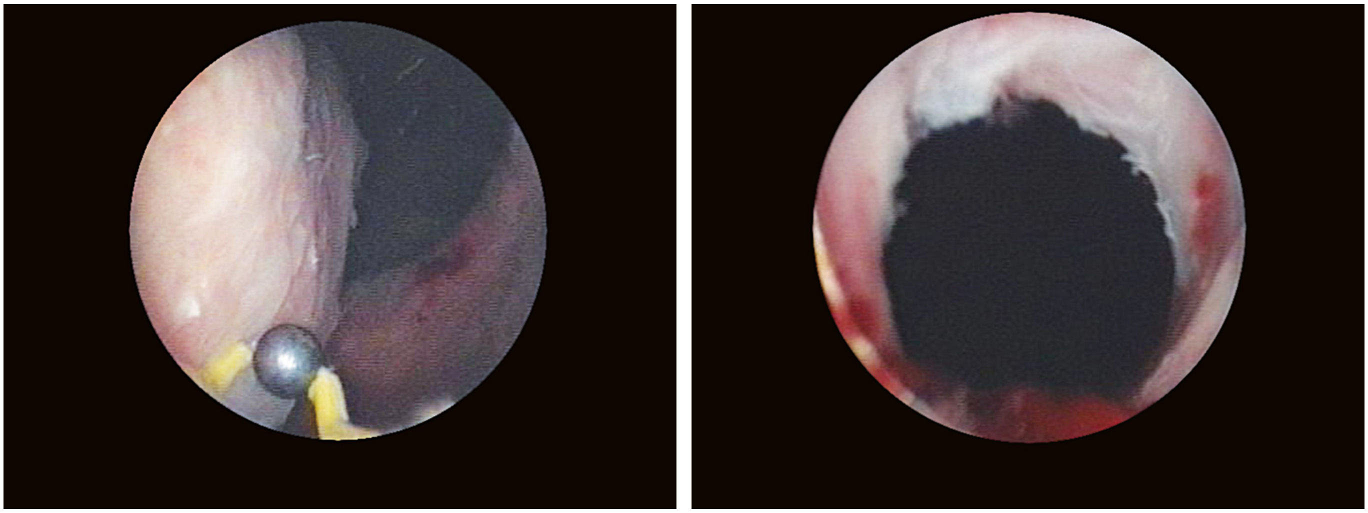

FIGURE 2.60 **Resection of the right prostatic lobe in a patient with a large adenoma operated in two steps.**

2.6 POSTOPERATIVE CARE

Urethro-vesical catheter permeability is an essential factor for postoperative evolution. Its obstruction may occur due to several factors:

- improper positioning
- remaining prostatic chip
- twisting of the connection with the collecting bag
- obstructive clot

An improper positioning of the catheter requires its replacement.

In the case of postoperative bleeding, most authors recommend placing the urethro-vesical catheter with the balloon inside the bladder, exerting traction on the bladder neck. Placing the balloon in the prostatic lodge can prevent its postoperative contraction, thereby worsening bleeding. To prevent accidental entering of the balloon inside the lodge, the balloon is inflated with 30–60 mL liquid. The duration of the traction on the lodge is variable (1–12 h). Basically, it is necessary until the bleeding from the venous sinuses is stopped (by compression) and the prostate capsule contracts. However, it should be kept in mind that the incidence of bladder neck sclerosis increases with the duration of traction (Mebust et al., 1989). This can be explained by ischemia secondary to compression, with vicious scars (Fig. 2.61).

Bladder lavage uses standard saline solution. Most urologists adapt the irrigation flow to the intensity of hematuria. Irrigation may be reduced or stopped the second day after surgery. The urethro-vesical catheter will be extracted

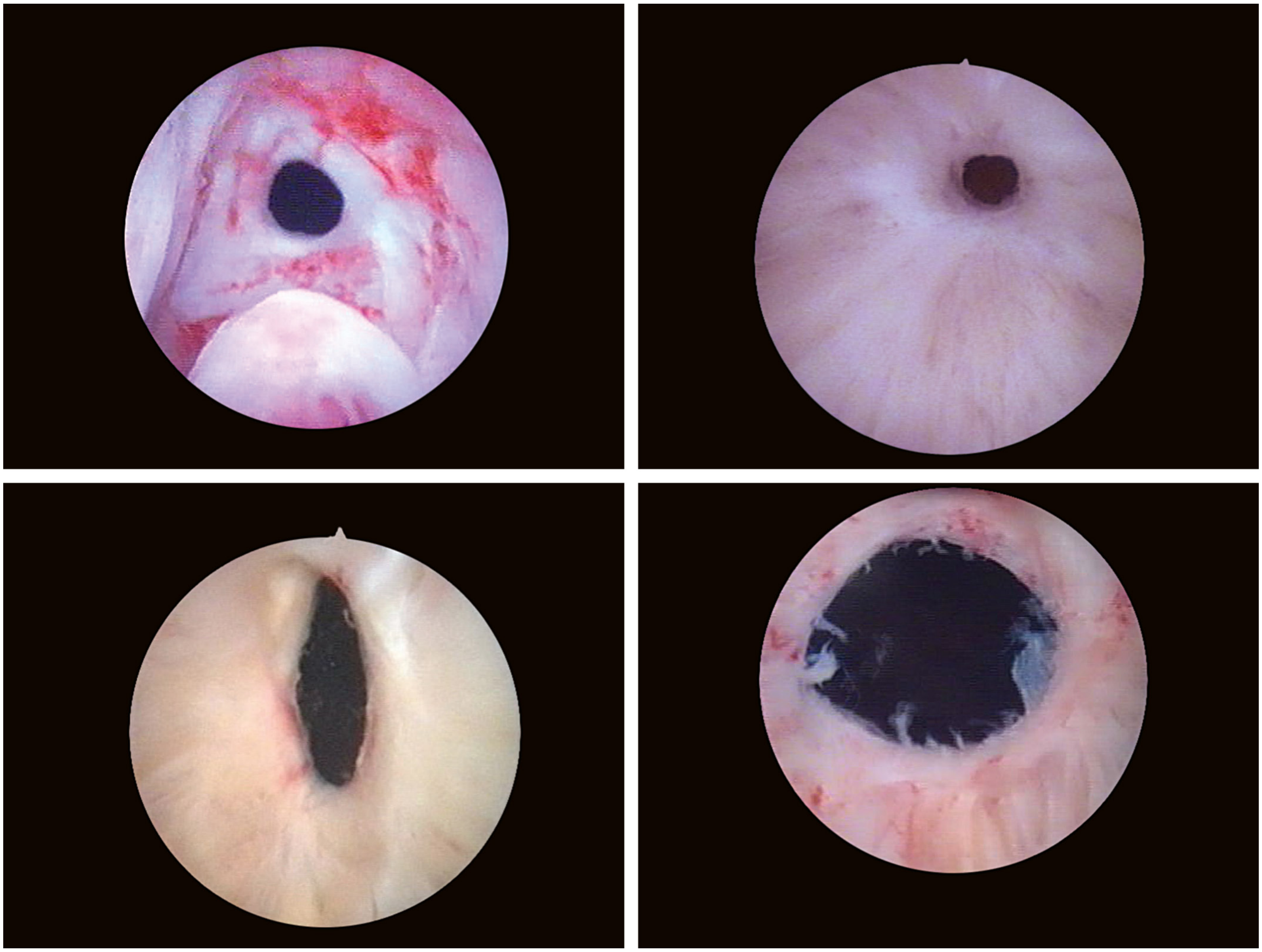

FIGURE 2.61 **Bladder neck sclerosis after TURP.**

2–3 days after surgery. The quality of the urine and the residual bladder volume must be checked after extracting the urethro-vesical catheter. Therefore, to ensure proper voiding of the bladder, an ultrasound exam is mandatory, especially in patients with a decompensated bladder or a history of urinary retention.

If the urethro-vesical catheter is obstructed by clots, additional lavage with a Guyon syringe is required until they are completely evacuated. Irrigation can start again when all clots have been removed from the bladder. In the case of persistent bleeding, with the impossibility to evacuate all the clots, reintervention for hemostasis may be necessary.

2.7 COMPLICATIONS

2.7.1 Intraoperative Complications

2.7.1.1 Bleeding

Bleeding represents the major intraoperative complication. However, the continuous improvement of instruments has resulted in a significant reduction in the rate of blood transfusions (Rassweiler et al., 2006). Thus, while studies conducted in the 1970s–1990s describe a transfusion rate of approximately 20%, those published after 2000 report a decrease to 5–10% (Table 2.2) (Zwergel, 2001; Mebust et al., 1989; Horninger et al., 1996; Borboroglu et al., 1999; Muzzonigro et al., 2004; Kuntz et al., 2004). Also, the introduction of video technology has improved the learning curve of TURP procedures (Faul, 1993) (a less experienced surgeon can comfortably watch every step of the procedure). Furthermore, patients with an increased risk of intraoperative bleeding may benefit from other therapeutic alternatives, such as Holmium laser (Westenberg et al., 2004) or KTP laser (Bachmann et al., 2005).

Arterial bleeding (Fig. 2.62) may be more pronounced in patients with preoperative urinary infections or urinary retention due to glandular congestion.

Preoperative therapy with finasteride or flutamide may reduce the risk of bleeding (Hoffmann, 2005). Venous bleeding is easy to differentiate due to the lack of pulsatile flow, its darker color (as compared to arterial blood), and the fact that it stops with increasing pressure inside the bladder (Fig. 2.63). It is caused by perforation of the capsule or by the opening of venous sinuses. The magnitude of intraoperative bleeding may depend on the size of the prostate (resected volume).

Although the Mauermeyer technique allows for the control of the vessels (from 5 o'clock to 7 o'clock) from the beginning of the intervention, while in the Nesbit technique the capsule is reached first at 11 o'clock and then at 1 o'clock, there are no significant differences regarding the control of intraoperative bleeding. Whatever method is used, hemostasis must be rigorous and properly carried out.

The source of bleeding can be compressed with the resectoscope in the case of large arteries. Afterward, the surgeon must find the optimal viewing angle in order to avoid directing the arterial blood stream toward the optics. Major arteries require circumferential coagulation.

TABLE 2.2 Evolution in the Rate of Blood Transfusions After TURP

Authors	Number of patients	Transfusion rate (%)
INITIAL STUDIES		
Zwergel (1998)	232	21.2
Mebust et al. (1989)	3885	6.4
INTERMEDIATE STUDIES		
Zwergel (1998)	214	14.6
Horninger et al. (1996)	1211	7.6
Borboroglu et al. (1999)	520	0.4
RECENT STUDIES		
Rassweiler (2006)	7707	3.0
Muzzonigro et al. (2004)	113	7.1
Kuntz et al. (2004)	100	2.0

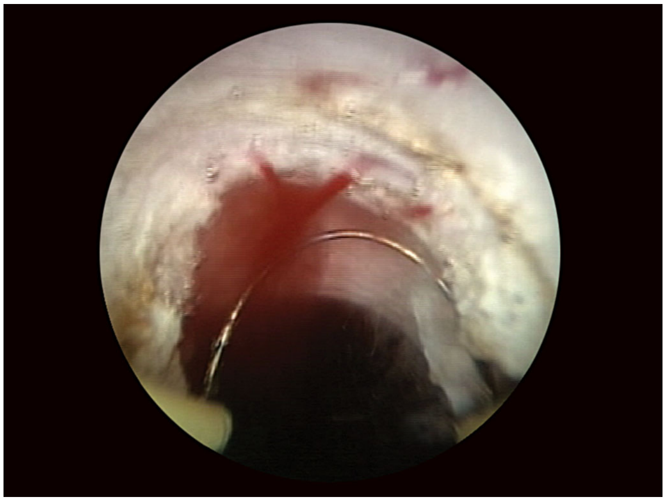

FIGURE 2.62 **Intraoperative arterial bleeding.**

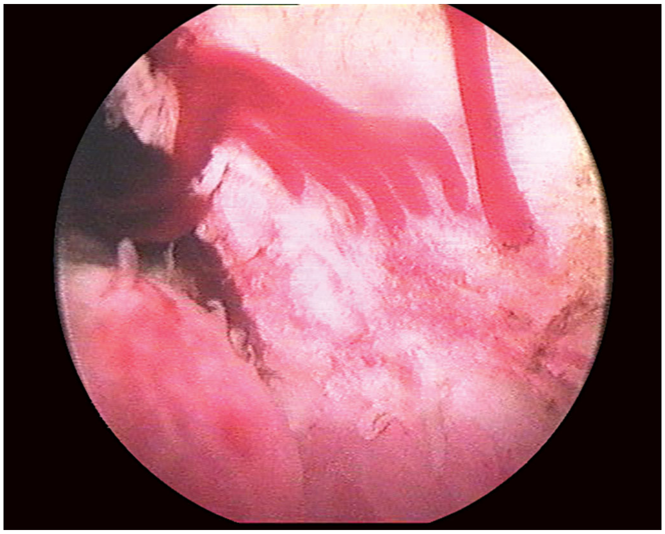

FIGURE 2.63 **Intraoperative venous bleeding.**

At the end of the resection, coagulation is performed while reducing the flow of irrigation in order to view the small bleeding sources. Coagulation of the venous sinuses requires special attention, especially if the capsule is also perforated. In these situations, bleeding cannot often be stopped by electrocoagulation, and a urethro-vesical catheter with the balloon compressing the neck is necessary for hemostasis. Open surgery may even be necessary if the bleeding continues, although some authors recommend selective arterial embolization (Michel et al., 2002).

Patients with bleeding disorders require special attention (liver or hematological diseases, anticoagulants). Knowing these conditions may influence the therapeutic decision, and the intervention is frequently postponed until the coagulation disorders are corrected. Also, bleeding may become apparent after the blood pressure rises to normal values in patients with low blood pressure during surgery. Therefore, it is good for the anesthesiologist to increase the blood pressure to normal values before the end of the procedure; checking the prostate lodge in these conditions can identify the bleeding sources.

2.7.1.2 TURP Syndrome

A significant amount of irrigation fluid may be absorbed during TURP, especially if surgery is prolonged or if many venous sinuses are opened. Approximately 20 mL are absorbed per minute, on average, during an intervention, reaching 1000–1200 mL in the first hour of resection. One third of this fluid is absorbed directly into the venous system, which may lead to dilutional hyponatremia (TURP syndrome), with confusion, nausea, vomiting, visual disturbances, hemolysis, nephropathy, coma, and shock.

The most important hemodynamic changes are represented by

- increased central venous pressure
- hypertension
- bradycardia
- other signs of fluid overload: agitation, tachypnea, and sometimes changes in color of the conjunctiva, the mucous membranes, or nails.

Symptoms usually occur when serum sodium levels drop below 125 mEq.

The incidence of TURP syndrome has significantly decreased from 3% to less than 1% (Rassweiler et al., 2006). The risk is higher in patients with large adenomas, when the duration of the procedure extends over 90 min, especially if the patients have relative hyponatremia before surgery (Doll et al., 1992). Hyponatremia before surgery should be identified and corrected before the procedure. It may appear in adrenal insufficiency, hypothyroidism, psychotropic medication or diuretics, urinary infections, etc.

In general, a flow of 300 mL/min is necessary to maintain adequate visibility during surgery (with positioning of the irrigating fluid at a height of 60 cm above the patient). The absorbed volume is directly proportional to the irrigation fluid pressure (Madsen and Naber, 1973). Thus, an increase of irrigating fluid pressure from 60 cm to 70 cm H_2O determines a doubling of intravesical pressure. Therefore, the use of an irrigating fluid that does not induce hemolysis and a low pressure of the fluid during surgery reduce the risk of TURP syndrome. It is possible to maintain low intravesical pressures using modern resectoscopes with continuous irrigation with absorption of a minimum amount of fluid (Heidler, 1999). The use of a device without continuous flow requires repeated emptying of the bladder.

In mild or moderate forms of the TURP syndrome, administration of furosemide may be sufficient. This reduces overload (because of diuresis), maintaining serum sodium levels. Furosemide administration should be started in the operating room if bleeding is significant, if the intervention is longer than 90 min, or if serum sodium levels drop rapidly. Severe cases are treated by slow intravenous administration of 3% hypertonic saline solution (usually 150–200 mL for 1–2 h) and diuretics (especially in patients at risk of congestive heart failure). Careful monitoring of electrolytes is required.

Usually, an increase in serum sodium levels by 4–6 mEq./L leads to the disappearance of symptoms. Typically, sodium deficiency is corrected by half during the first 12–24 h while avoiding an increase in serum levels by more than 20 mEq./L in 24 h.

Hemodialysis is an option in rare cases of very severe hyponatremia or in patients with severe kidney disease. TURP syndrome is more common in smokers due to vascular changes in the prostate that cause increased absorption of the irrigating fluid (Hahn, 2001).

2.7.1.3 Perforations

Perforations are relatively common intraoperative complications with various degrees of severity, depending on their depth (Mebust et al., 1989). Minor lesions (Fig. 2.64) require no specific treatment but warn the surgeon that he or she has reached the limit of the surgical capsule, while large perforations may require stopping the intervention or converting to open surgery. Perforations of the urethra, prostatic capsule, or bladder may occur. Perforations may occur both during and at the end of the intervention, when the urethro-vesical catheter is inserted. The latter is more difficult to diagnose, so perforation of the prostatic capsule should be taken into consideration whenever the catheter does not drain properly at the end of the procedure.

Urethral injuries may be caused by the resectoscope's sheath, especially when it is inserted. Forcing this maneuver can cause urethral perforation, which can be located proximal or distal to the verumontanum (Fig. 2.65). The resectoscope should not be blindly inserted in order to prevent this complication. False passages may require optical urethrotomy followed by TURP or by insertion of a urethro-vesical catheter and postponement of the intervention.

Minor capsular perforations highlight periprostatic fat, without having to stop the intervention (Fig. 2.66). Lowering the pressure of the irrigating fluid is usually sufficient.

Significant capsular lesions are caused by excessively large incisions or by high pressure during irrigation (Fig. 2.67). They determine extravasation of the irrigation fluid, which in most cases is extraperitoneal. Sometimes irrigating fluid may be found intraperitoneal (by diffusion of large amounts or when the bladder is injured), requiring percutaneous or surgical drainage. The severity of the perforation depends on the volume of extravasated fluid. In

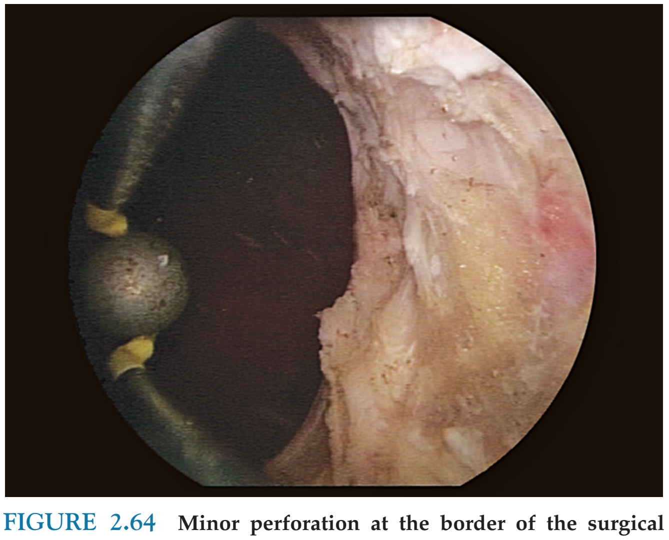

FIGURE 2.64 Minor perforation at the border of the surgical capsule.

FIGURE 2.65 Urethral perforation proximal to the verumontanum after an attempt of blind insertion of the resectoscope.

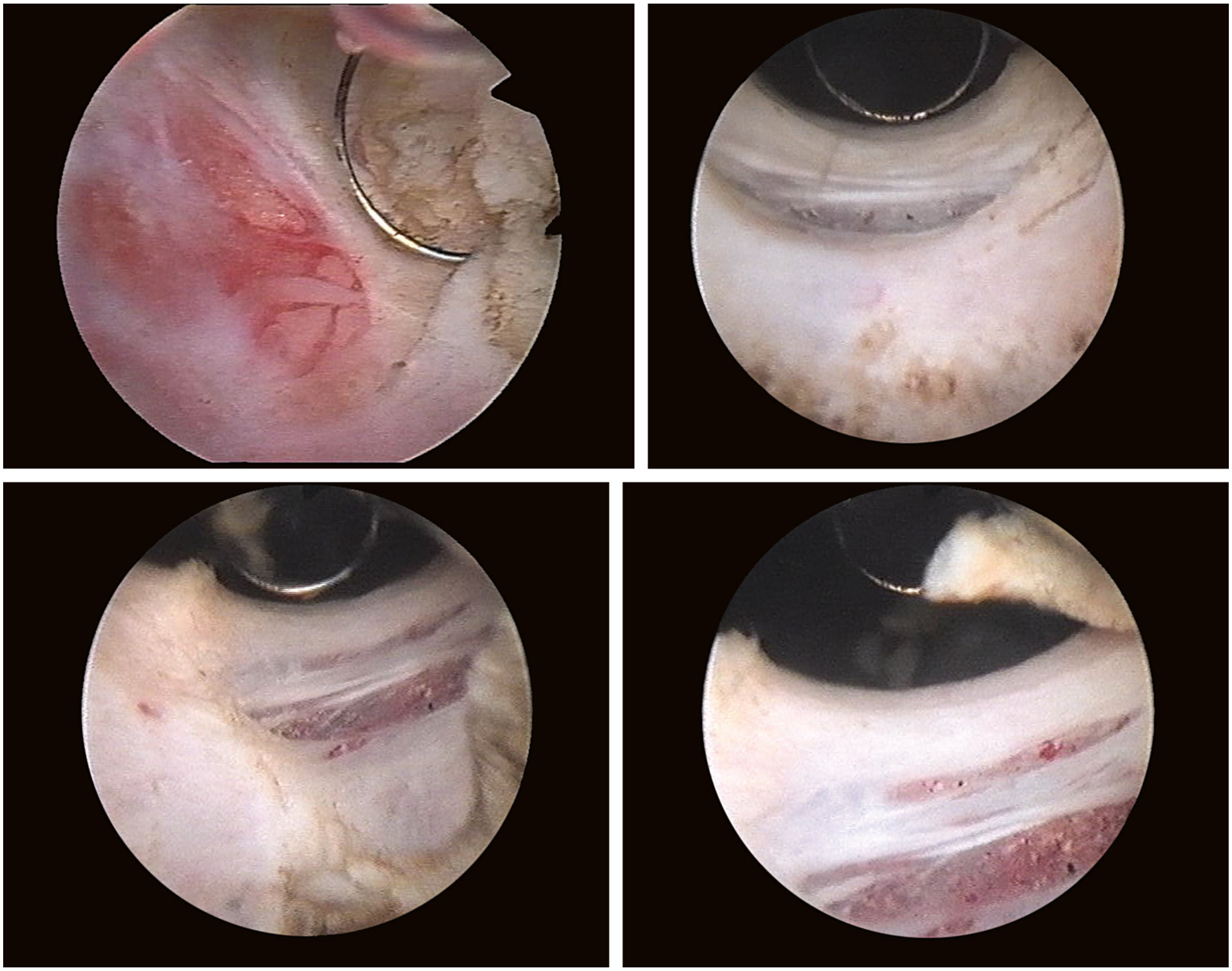

FIGURE 2.66 **Minor perforations of the prostatic capsule.**

mild cases (recognized immediately), interruption of the procedure and insertion of a urethro-vesical catheter followed by treatment with diuretics and antibiotics may be sufficient for a favorable evolution.

The patient becomes symptomatic in the case of significant extravasation: agitation, nausea, vomiting, and pain in the lower abdomen. The bladder and bladder neck can deform due to retroperitoneal fluid accumulation, which compresses these structures. Dilutional hyponatremia may occur (TURP syndrome). Extravasation produces fewer symptoms in the case of bipolar resection (using saline solution). The presence of extravasation usually requires evacuation of the chips, hemostasis, and interruption of the intervention, followed by antibiotics and monitoring of hemoglobin and hematocrit.

Bladder perforation may occur through accidental injury with the resectoscope or through excessive distension (Fig. 2.68).

This should be taken into account when the abdomen becomes rigid during the procedure, in the case of excessive bleeding without an obvious source, or when a patient with spinal anesthesia complains of pain in the shoulder. Shoulder pain can be caused by irritation of the diaphragm by the irrigating fluid found in the peritoneal cavity.

The diagnosis can be confirmed by a simple cystography. The extent of the extravasation, laboratory results, and the clinical status of the patient may require open cystostomy with drainage around the bladder. The vast majority of patients require only bladder drainage. If the patient's condition worsens, open surgery should be considered.

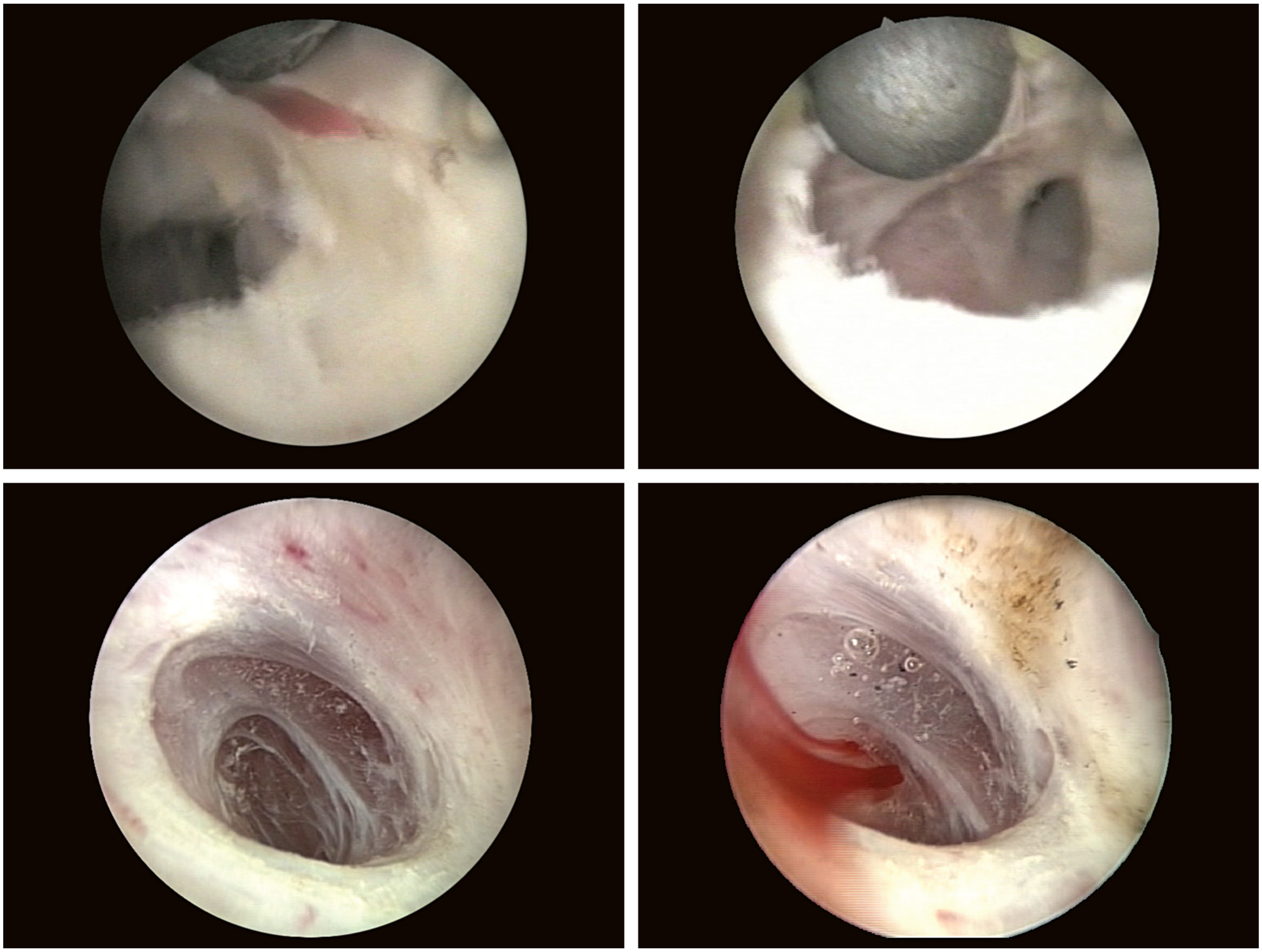

FIGURE 2.67 **Important capsular perforations.**

2.7.1.4 Injuries of the Ureteral Orifices

These may occur in the case of large median lobes with difficult to identify ureteral orifices. As in the case of TURBT (TUR of bladder tumors), treatment depends on the severity of lesions. The insertion of a JJ catheter can be indicated for severe ureteral lesions; otherwise, ultrasound reassessment is sufficient. The stent should be maintained for 2–3 weeks. Ureteral orifices must be identified before starting the resection. If this is not possible due to a large median lobe, TURP must be carefully performed, especially near the bladder neck.

2.7.1.5 External Sphincter Injury

This injury is usually discovered after surgery. Minimal lesions, located at the level of the internal part of the sphincter, are not followed by urinary incontinence. Most injuries are located ventrally (at the 12 o’clock position). Resection of the verumontanum has a high risk of sphincter lesions. For this reason, the exact position of the external sphincter should be repeatedly checked, especially during apical resection (Hartung and May, 2002). The traction of the urethro-vesical catheter should be reduced as much as possible when an injury of the sphincter is suspected. However, most cases of urinary incontinence after TURP are not caused by iatrogenic injuries of the external sphincter.

Some intraoperative complications (especially TURP syndrome) are directly proportional to a prolonged operating time. Despite all the technological improvements, studies show that the speed of resection has not changed significantly over time, between 0.5 g/min and 0.9 g/min (Table 2.3). The average speed of resection is around

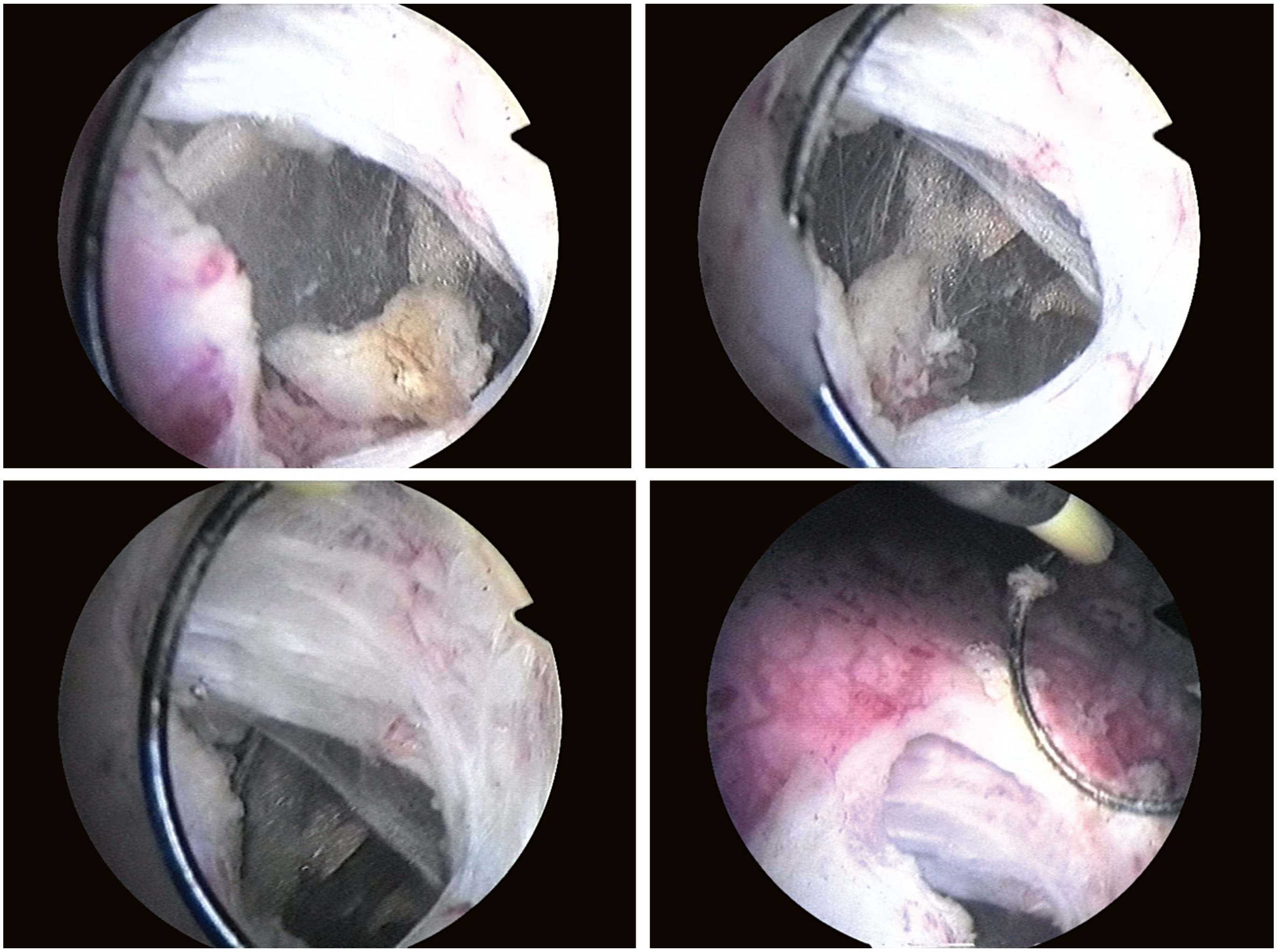

FIGURE 2.68 **Bladder perforation due to increased pressure of the irrigating fluid.**

TABLE 2.3 Evolution of the Resected Tissue and of the Speed of Resection

Authors	Number of patients	Mean weight (g)	Operating time (min)	Speed of resection (g/min)
INITIAL STUDIES				
Doll et al. (1992)	388	23.0	38.0	0.6
INTERMEDIATE STUDIES				
Haupt (1997)	934	29.0	45.0	0.6
Hammadeh (1998)	52	20.1	21.6	0.9
Gilling (1999)	59	14.5	25.3	0.6
Borboroglu et al. (1999)	520	18.8	62.5	0.3
RECENT STUDIES				
Rassweiler (2006)	7707	35.1	52.0	0.7
Kuntz et al. (2004)	271	37.2	73.8	0.5
Muzzonigro et al. (2004)	113	31.0	52.5	0.6

0.6 g/min, far from the speed frequently reported in the literature (1 g/min). Technological breakthroughs such as microprocessor-controlled electrosurgery, intermittent coagulation with cutting, and bipolar resection, which allow cutting and coagulation to be performed simultaneously, are associated with slower movements of the loop. This is the explanation behind the same speed of resection.

2.7.2 Immediate Postoperative Complications

2.7.2.1 Postoperative Bleeding

Immediate postoperative bleeding may be caused by a hypertensive episode, coagulation disorders, or improper hemostasis during surgery. A transient hematuria 7–9 days after surgery is most frequently caused by the separation of an eschar.

Persistent or recurrent bleeding sometimes leads to the formation of clots, which may require reintervention (1.3–5%). Obstructive clots must be evacuated. Traction of the catheter's balloon can be helpful in cases of moderate bleeding. However, this technique is not sufficient in the case of active arterial bleeding.

Immediate reintervention with evacuation of the clots and coagulation of the bleeding sources is necessary if the urine does not become clear in order to lower the risk of future complications. Another alternative is superselective transfemoral embolization (Michel et al., 2002).

2.7.2.2 Urinary Infection

Immediate postoperative evolution can be influenced by different types of urogenital infections: orchiepididymitis, urethritis, prostatitis, etc. The incidence of these infections after TURP is relatively low in most studies (approximately 3.5%) (Table 2.4). However, there are multicenter studies with incidence rates of up to 21% (Colau et al., 2001).

The most frequent risk factors are represented by

- bacteriuria before surgery
- a long procedure (>70 min)
- hospitalization before surgery of more than 2 days
- reintervention

Antibiotic prophylaxis is recommended for patients catheterized for a long time before surgery. Routine vasectomy is not recommended, due to the low incidence of postoperative epididymitis.

2.7.2.3 Urinary Retention

Urinary retention after TURP (3–9%) occurs mainly because of primary detrusor underactivity and less due to incomplete resection (Djavan et al., 1997). Therefore, most authors recommend postponing a potential reintervention (at least until the prostatic lodge heals). Patients with detrusor underactivity may have a postvoiding residue higher than 100 cm^3. On the other hand, the presence of remaining, obstructive adenomatous tissue requires proper resection up to the capsule (Fig. 2.69); the reintervention rate in this case is 3–5% (Table 2.5).

TABLE 2.4 Dynamics of Urinary Infections After TURP

Authors	Number of patients	Incidence (%)
INITIAL STUDIES		
Mebust et al. (1989)	3885	14.0
INTERMEDIATE STUDIES		
Gallucci (1998)	80	5.0
Gilling (1999)	59	8.2
Borboroglu et al. (1999)	520	2.1
RECENT STUDIES		
Rassweiler (2006)	7707	3.5
Kuntz et al. (2004)	100	4.0

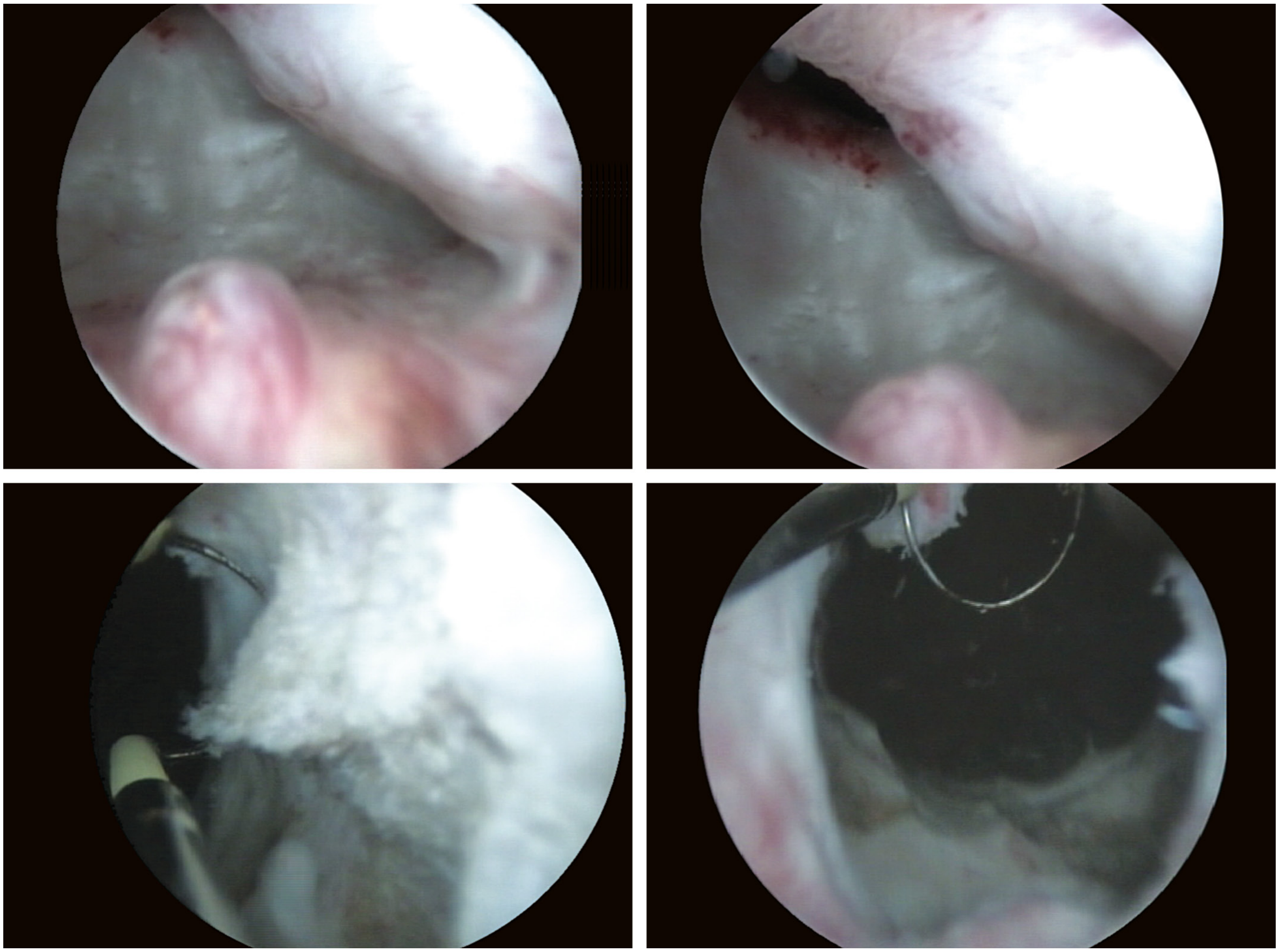

FIGURE 2.69 **Remaining adenomatous tissue in the left lobe for which resection up to the capsule is performed.**

TABLE 2.5 Reintervention Rates After TURP

Authors	Number of patients	Reintervention rate (%)
Gilling (1999)	59	3.3
Rassweiler (2006)	126	4.2
Rassweiler (2006)	7707	5.0
Kuntz et al. (2004)	100	3.0

2.7.2.4 Immediate Urinary Incontinence

Immediate urinary incontinence may occur in 30–40% of cases (Theodorou et al., 1998). It can be secondary to postoperative irritation or to detrusor instability. Treatment consists of administering selective anticholinergic medication and anti-inflammatory drugs.

2.7.3 Delayed Postoperative Complications

2.7.3.1 Urinary Incontinence

Although approximately 3% of patients present different degrees of urinary incontinence for 3 months after TURP, delayed iatrogenic urinary incontinence occurs in approximately 0.5% of cases (Rassweiler et al., 2006). Careful evaluation is needed.

There are three types of urinary incontinence after TURP:

- urgent micturition (associated with the healing process immediately after surgery)
- stress urinary incontinence (due to excessive resection of the apex and around the verumontanum)
- total urinary incontinence following an irreversible injury of the external muscle of the sphincter

The first two types usually subside after 3–6 months. Kegel exercises can be useful for mild to moderate incontinence (Liu et al., 2005). Incontinence lasting for more than 6 months after surgery requires a complete evaluation, including retrograde urethrography, urethrocystoscopy, and urodynamic studies (Zwergel, 2001).

There are several causes of incontinence (Theodorou et al., 1998; Wasson et al., 1995):

- sphincter incompetence (30%)
- detrusor instability (20%)
- mixed incontinence (30%)
- remaining adenoma (5%)
- bladder neck sclerosis (5%)
- urethral stricture (5%)

Corrective interventions address the cause: collagen injection, artificial sphincter implant, repeated TURP, bladder neck incision or resection (Fig. 2.70), etc.

2.7.3.2 Urethral Strictures

The incidence of urethral strictures varies in the literature between 2.2% and 9.8%, with no direct relationship with the time elapsed from the intervention. Meatal strictures usually occur because of a mismatch between the device's gauge and the diameter of the urethral meatus. Bulbous strictures (Fig. 2.71) occur due to an insufficient isolation of the resectoscope's sheath (because of improper lubrication), with the dispersion of electricity in monopolar resections.

Therefore, the surgeon should avoid using high-intensity power. Internal urethrotomy is necessary before TURP in the case of meatal or urethral stenoses. The treatment of this condition was discussed in detail in Chapter 1.

2.7.3.3 Bladder Neck Sclerosis

Secondary bladder neck sclerosis is one of the most frequent long-term complications after prostate surgery. According to the 2009 EAU Guidelines, the risk of developing this condition is 4% after TURP, 1.8% after open surgery for BPH, and 0.5–14.6% after radical prostatectomy for prostate cancer (de la Rossette et al., 2009). Secondary bladder neck sclerosis remains an important issue in modern urology. In a study conducted by Ying-Huei Lee on 1135 patients with standard TURP, bladder neck sclerosis developed in 9.7% of cases after a median follow-up of 37 months. In most cases, patients were initially diagnosed with small prostates (Lee et al., 2004). It seems that this complication occurs more frequently in patients with small prostates initially treated with monopolar TURP, and therefore some authors recommend an incision of the bladder neck for these patients, regardless of its "height" (Al-Singary et al., 2004).

Retrograde endoscopic treatment is the main therapeutic alternative. Open surgery techniques were described, such as Y–V plasty or those using the abdomino-perineal approach, procedures rather of historical value (Kishev, 1975; Theodorou et al., 2000). Treatment of bladder neck sclerosis consists of repeated dilations, incision of the bladder neck, standard monopolar transurethral resection of the fibrous tissue, and different types of laser therapies (Basok et al., 2008). Periodical dilations may be used as the first therapeutic option, but their prolonged repetition can cause traumatic injuries associated with an inflammatory process and hence increasing stenosis.

Incision of the bladder neck with a cold knife (Fig. 2.72) or a Collins loop with the purpose of creating an opening with a 22 Ch diameter (Fig. 2.73) is another method that can be used in the initial management of this type of complication.

Standard monopolar transurethral resection of the fibrous tissue (Fig. 2.74) from the bladder neck is a frequent option in clinical practice but with a significant rate of restenosis (Fig. 2.75) (Sataa et al., 2009).

On the other hand, laser procedures (Neodymium:YAG, Revolix laser) using different techniques for the incision of the bladder neck or vaporization of the fibrous tissue have recently gained ground with satisfactory results (Bach et al., 2007; Silber and Servadio, 1992).

Bipolar technology has been introduced as a promising alternative for secondary bladder neck sclerosis. One of these therapeutic options is bipolar vaporization using the PlasmaKinetic™ system, with satisfactory results

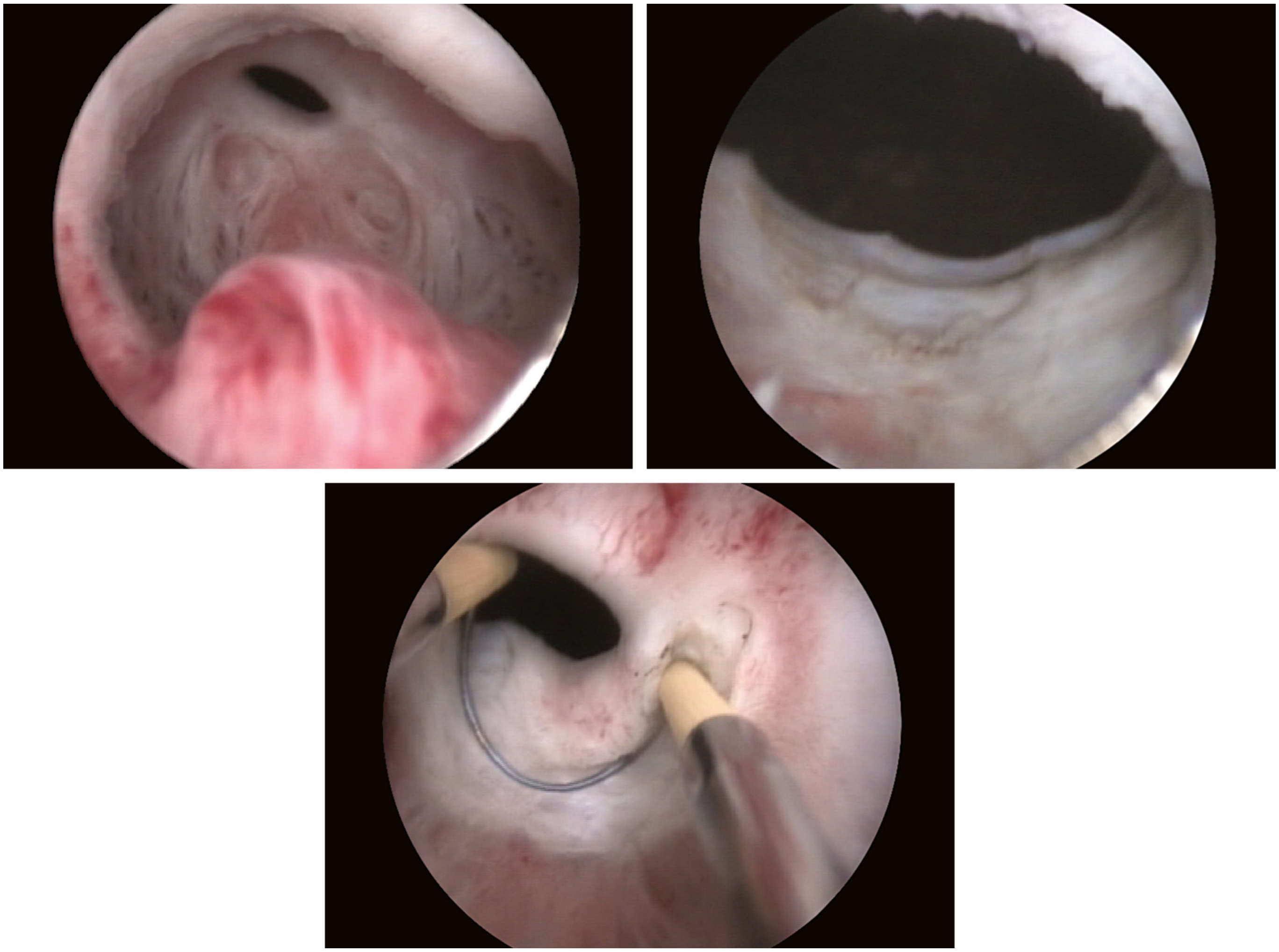

FIGURE 2.70 **Resection of bladder neck sclerosis in a patient with TURP and urinary incontinence.**

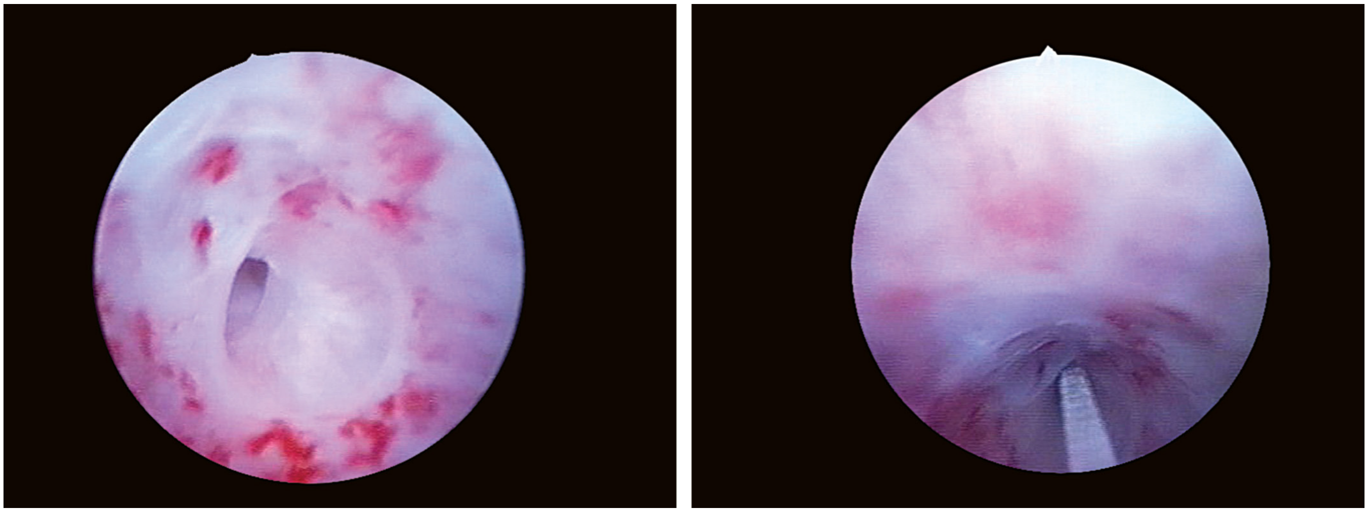

FIGURE 2.71 **Stricture of the bulbous urethra after TURP.**

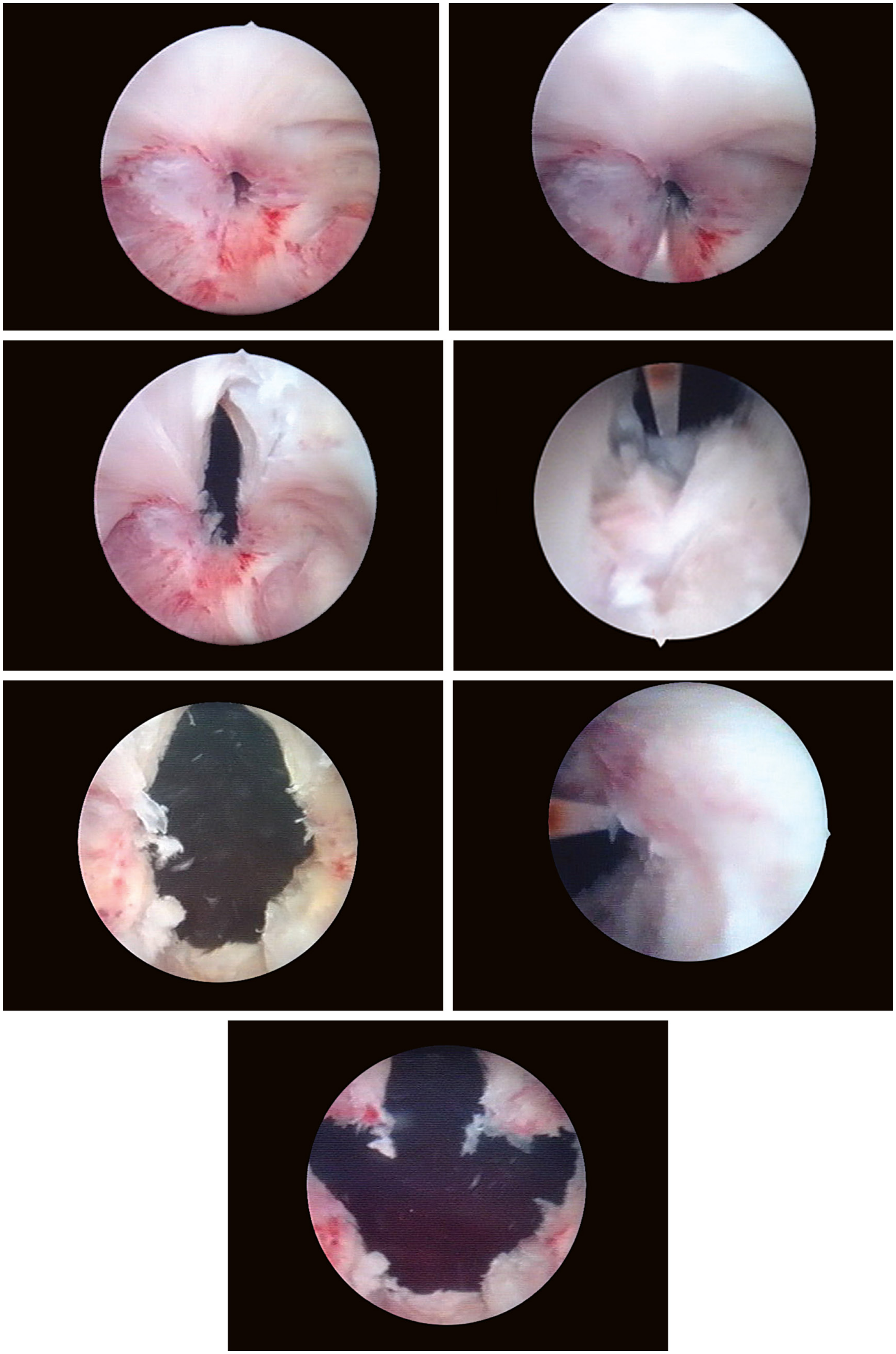

FIGURE 2.72 **Stellate incision with a cold knife for a bladder neck sclerosis.**

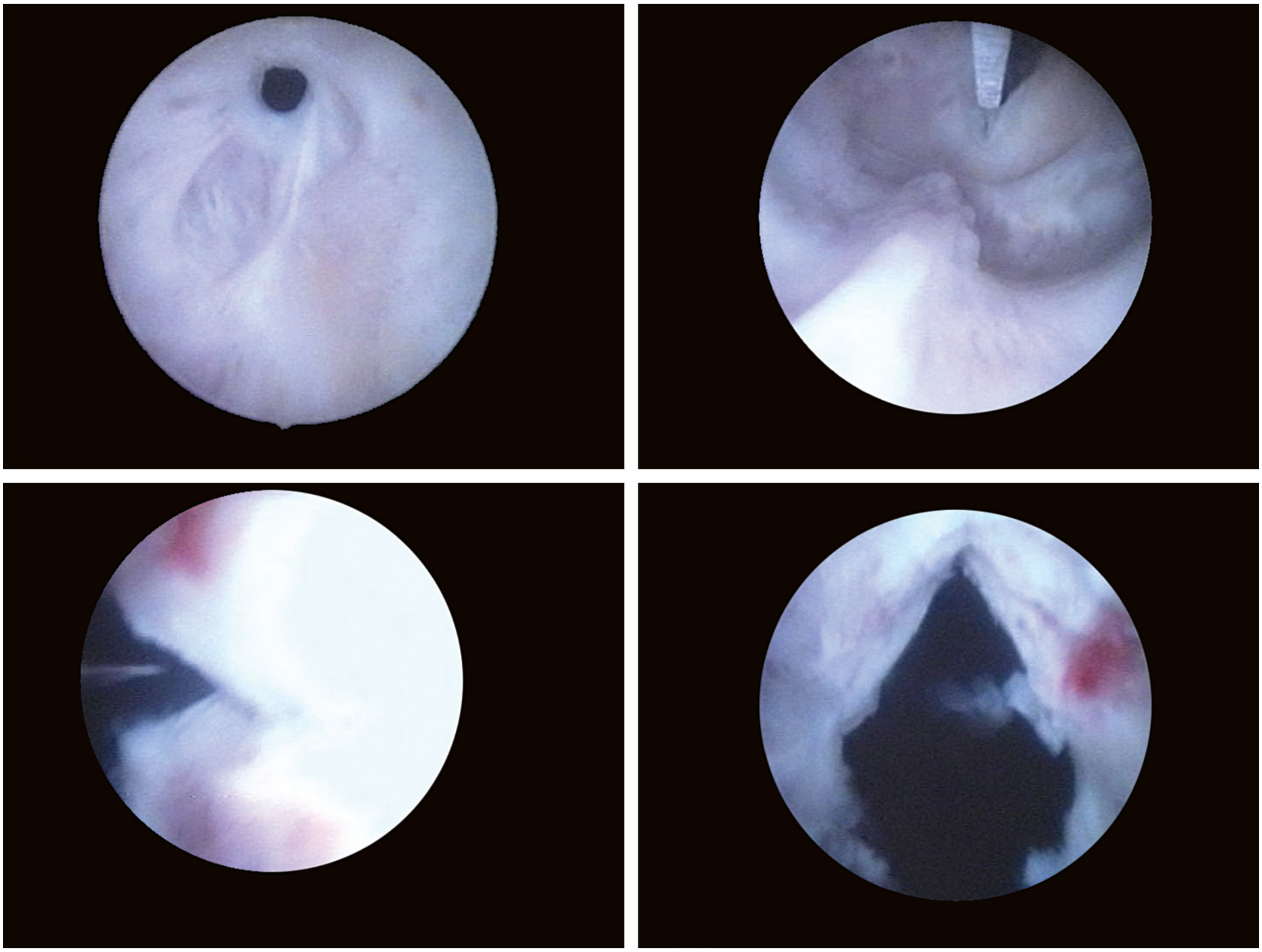

FIGURE 2.73 **Large opening (Ch 22) of the bladder neck after cold knife incision.**

(Basok et al., 2008). A new method derived from this technique is bipolar plasma vaporization using the TURis system (transurethral resection in saline medium), introduced in May 2009 (Geavlete et al., 2009). Bipolar plasma vaporization is used for disorders of the lower urinary tract (Sevriukov et al., 2007). The power of the generator can be adapted to the tissue characteristics and consistency.

Due to the increased consistency of the fibrous tissue, for secondary bladder neck sclerosis a 320 W power is recommended with rapid removal of the areas of fibrosis. From a technical point of view, the intervention consists of the movement of the electrode in direct contact with the fibrous tissue ("hovering" technique), which is instantly vaporized upon contact with the plasma (Fig. 2.76).

Moreover, especially in the case of bladder neck sclerosis after radical prostatectomy for prostate cancer, it is possible to resect fragments for pathological examination (Fig. 2.77).

This type of vaporization does not alter the visual characteristics of the tissues, therefore allowing the surgeon to more accurately differentiate the fibrous tissue from the fibers of the prostatic capsule (Fig. 2.78).

Visibility remains excellent throughout the entire procedure due to the lack of bleeding. The area of vaporization has a smooth surface with well-defined edges, without irregularities or tissue debris, and with no additional thermal damage to the underlying tissue (Fig. 2.79)

The postoperative aspects of the prostatic lodge after TURis for bladder neck sclerosis regularly show a wide area without obstruction (Fig. 2.80).

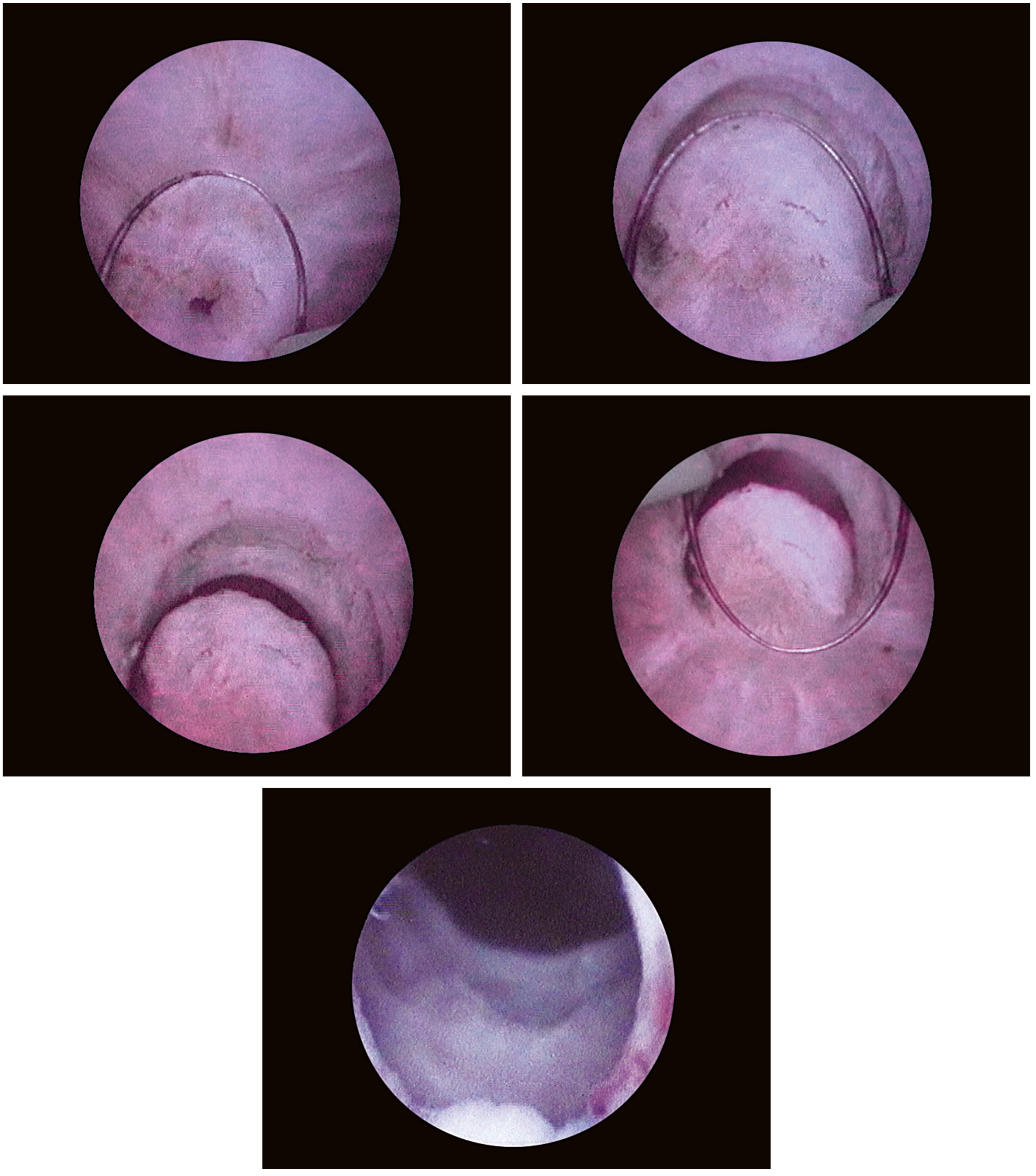

FIGURE 2.74 **Monopolar resection for bladder neck sclerosis.**

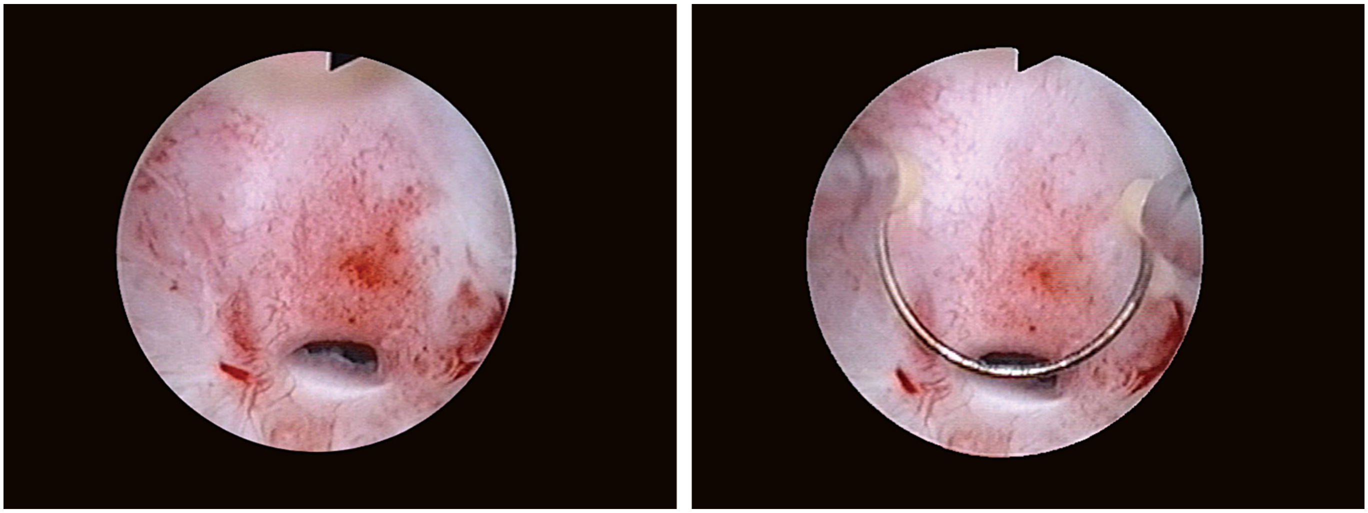

FIGURE 2.75 Relapse of a bladder neck sclerosis after monopolar resection.

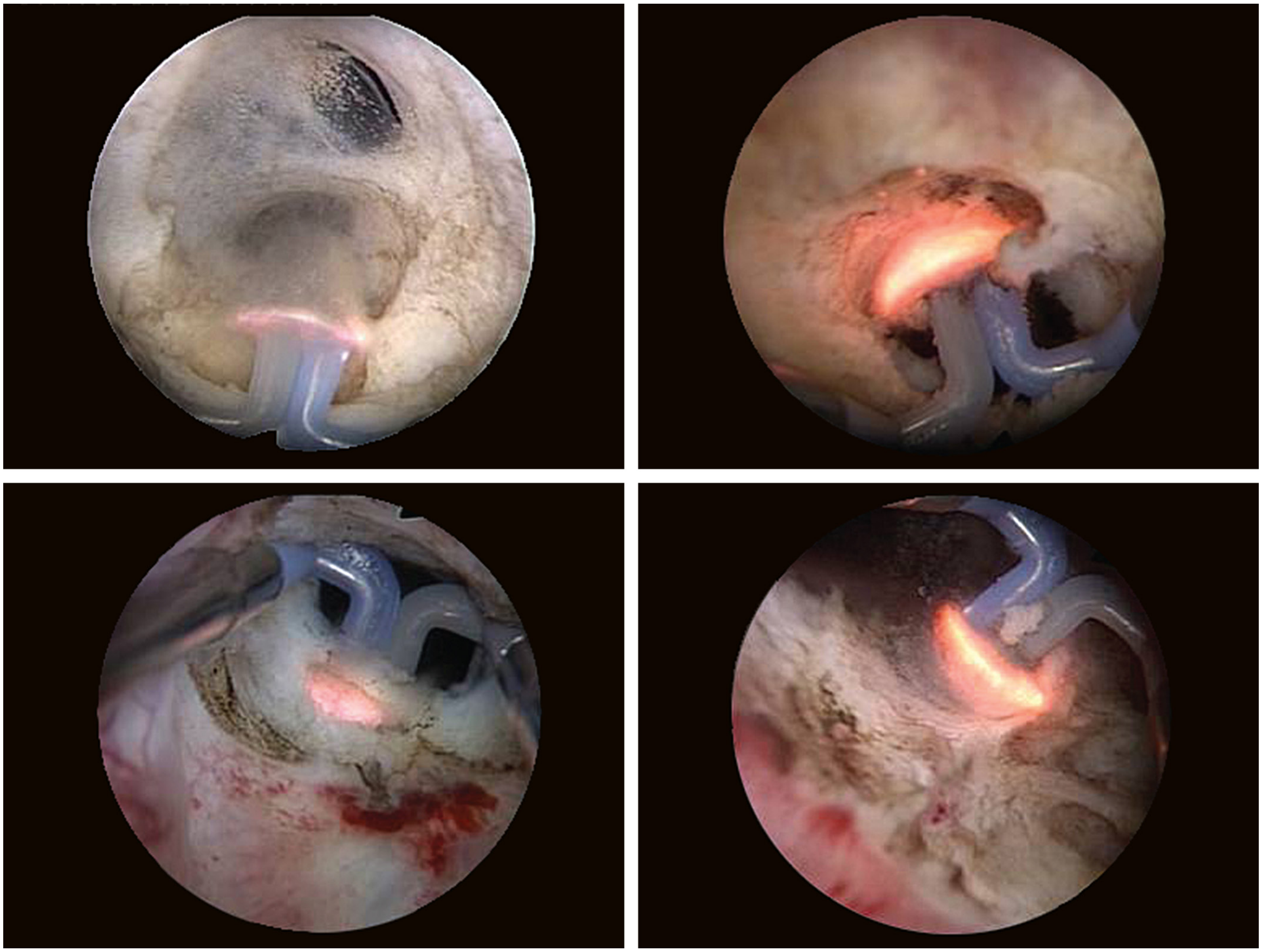

FIGURE 2.76 Intraoperative aspects of fibrous tissue vaporization from the bladder neck.

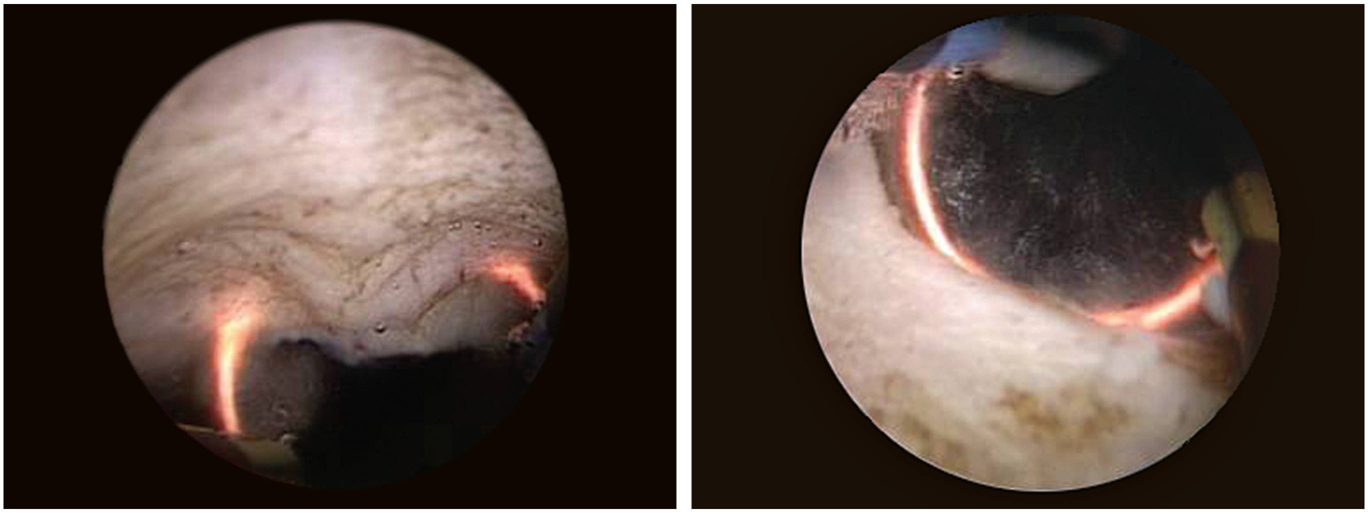

FIGURE 2.77 **Bipolar resection for bladder neck sclerosis after radical prostatectomy.**

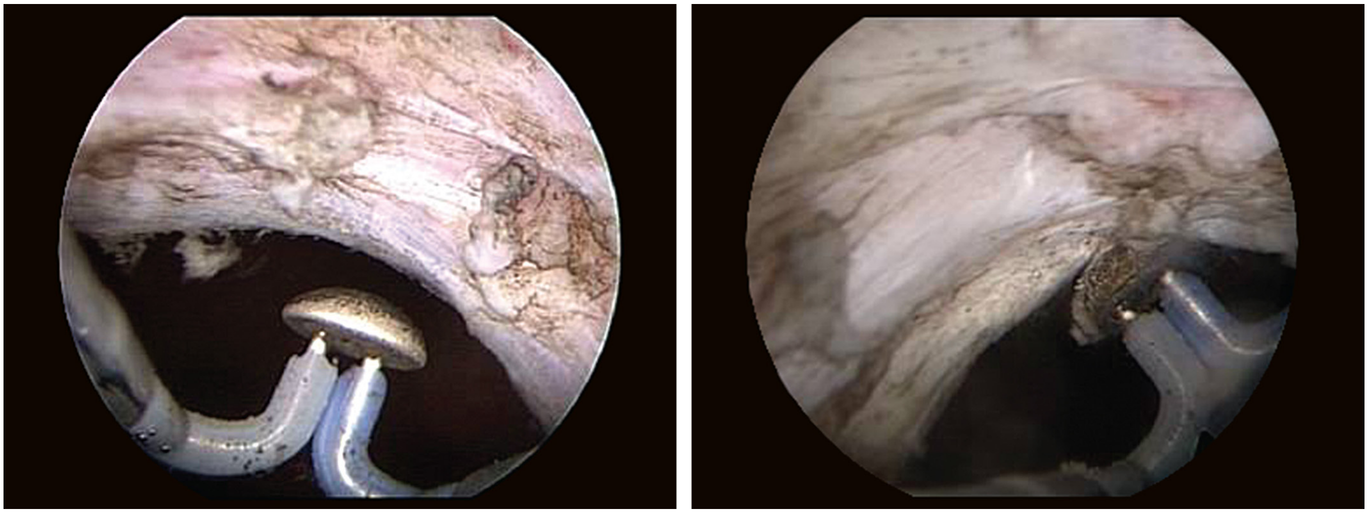

FIGURE 2.78 **Remaining fibrous tissue and the prostatic capsule.**

It is also important to note the low rate of major intraoperative and postoperative complications, confirming the safety of the procedure. From this perspective, we can say that plasma vaporization is a promising application of the TURis system.

Bipolar plasma vaporization seems to be comparable to laser incision (Bach et al., 2007). On the other hand, bipolar technology seems to be more advantageous in terms of costs as compared to laser treatment (Basok et al., 2008). Regarding long-term complications, the rate of restenosis after endoscopic treatment for bladder neck sclerosis is still high, regardless of the technique: 13.7% for resection (Sataa et al., 2009) and 27.5% for incision (Al-Singary et al., 2004). An important advantage of bipolar vaporization of fibrous tissue is the fact that it contributes to the reduction of recurrent scar tissue formation (Basok et al., 2008). Laser vaporization of bladder neck sclerosis may be followed by re-epithelialization without scarring (Silber and Servadio, 1992).

2.7.3.4 Retrograde Ejaculation

Retrograde ejaculation is the most frequent delayed postoperative complication (53–75%) (Rassweiler et al., 2006). It is the result of bladder neck resection. During normal ejaculation the bladder neck closes under sympathetic influence. After TURP the bladder neck cannot close, allowing the sperm to reach the bladder. The tissue surrounding the verumontanum should be protected during resection to avoid retrograde ejaculation. Medical treatment (α-blockers and 5-α reductase inhibitors) or transurethral incision of the prostate (TUIP) may be used in young patients.

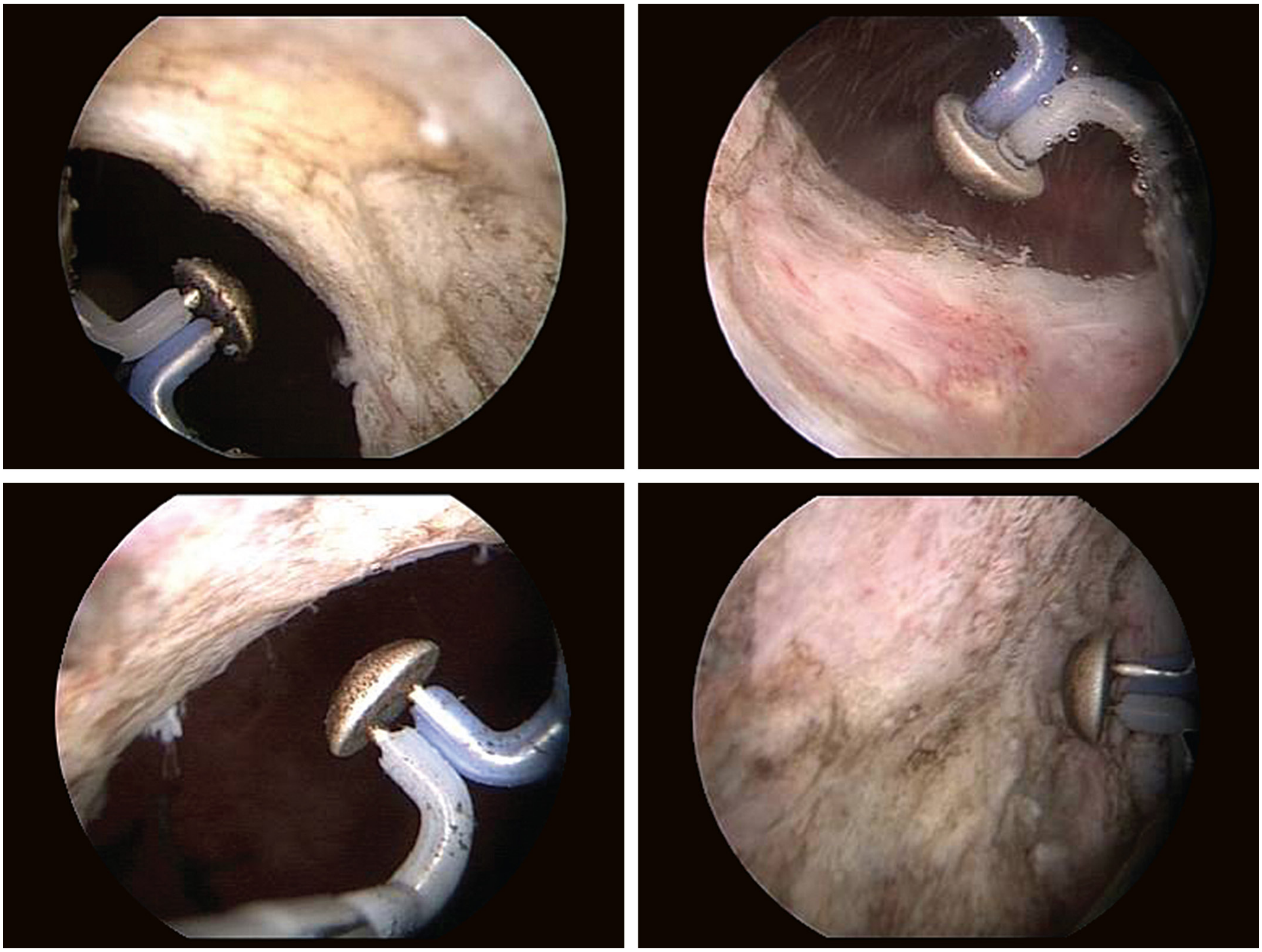

FIGURE 2.79 **Final aspect of the bladder neck after plasma vaporization.**

2.7.3.5 Erectile Dysfunction

Preserving sexual function after TURP depends on several factors:

- status before the intervention
- age
- relationship between the patient and his partner
- the way the couple adapts to the postoperative status

Theoretically, the high-intensity power generated near the capsule can damage the neurovascular bundles. The incidence of this complication ranges between 3.4% and 32% (Wasson et al., 1995). However, there are studies reporting improved sexual function after TURP (Mishviki et al., 2001; Brookes et al., 2002).

2.8 RESULTS AND PROGNOSIS

Despite the high average age (55% of patients are over 70 years of age), morbidity associated with TURP in large studies remains at a low level, below 1%, with a mortality rate of 0–0.25% (Madersbacher et al., 2005) (Table 2.6).

The retreatment rate for TURP is lower (3–14.5% after 5 years) as compared to other therapeutic methods such as TUMT or TUNA (Madersbacher and Marberger, 1999) (Table 2.7). The natural history of the disease as well as inadequate initial resection are the main causes of reTURP.

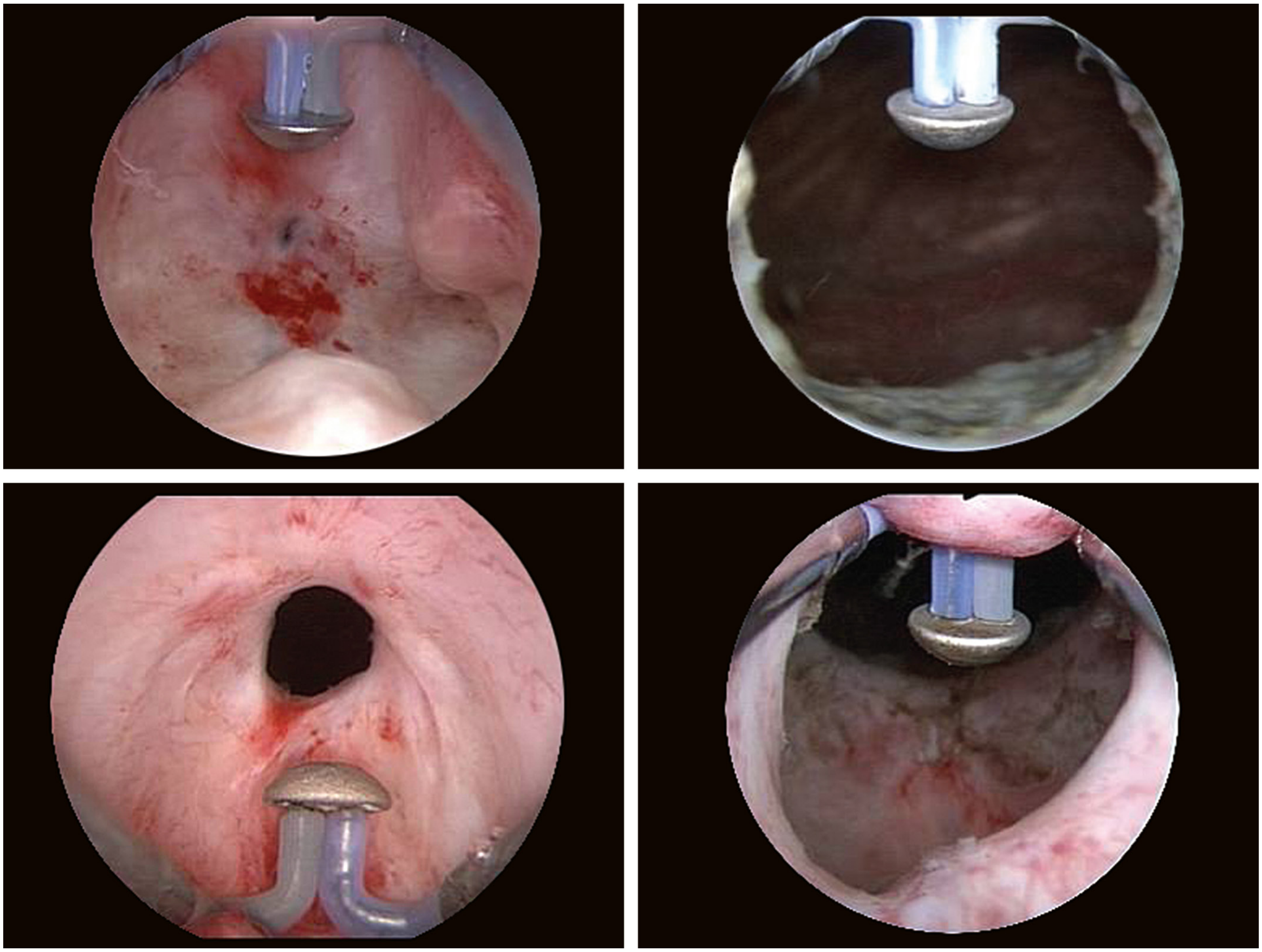

FIGURE 2.80 **TURis aspects before and after surgery in the case of bladder neck sclerosis.**

TABLE 2.6 Mortality After TURP

	Initial studies		Intermediate studies		Recent studies
Associated morbidity	**Mebust et al. (1989)**	**Doll et al. (1992)**	**Haupt (1997)**	**Borboroglu et al. (1999)**	**Kuntz et al. (2004)**
Arrhythmia	1.1	ND	0.4	1.3	ND
Myocardial infarction	0.05	0.5	0.2	0.2	0.0
Pulmonary embolism	ND	ND	0.1	ND	0.0
Pneumonia	ND	ND	0.2	ND	0.0
COPD	0.5	ND	0.1	ND	ND
Mortality	0.23	0.8	0.1	0.0	0.0

ND, no data.

Measuring the postvoid residual volume and the maximum urinary flow are the most commonly used parameters for assessing the results of TURP. However, there are important variations from one test to another (performed on the same patient). In addition, there is no directly proportional relationship between symptoms and postvoid residual volume (an important residual volume is not necessarily associated with a high symptoms score).

Bosch described a comparative analysis of urethral resistance (determined by urodynamics) before and after treatment (Bosch, 1997). It was shown that open surgery is the most effective method for reducing urethral resistance.

TABLE 2.7 Rate of reTURP

Authors	Number of patients	Rate of reTURP (%)
INITIAL STUDIES		
Zwergel (1998)	232	ND
Doll et al. (1992)	388	1.5
INTERMEDIATE STUDIES		
Hammadeh (1998)	52	4.0
Gallucci (1998)	80	0.0
Gilling (1999)	59	6.6
Borboroglu et al. (1999)	520	2.5
RECENT STUDIES		
Kuntz et al. (2004)	100	3.0
Muzzonigro et al. (2004)	113	ND

ND, no data.

TURP is immediately behind. Both procedures were superior to laser treatment, transurethral incision of the prostate (TUIP), α-blocking agents, or other alternative procedures (TUMT, TUNA) (Donovan et al., 2000).

Most studies have demonstrated the effectiveness of TURP in terms of subvesical obstruction secondary to BPH. Effective bladder capacity (the maximum bladder volume minus the postvoid residual volume) increased on average by 45% 6 months after the intervention. This leads to an improvement of symptoms: decreased dysuria and pollakiuria. The rate of detrusor instability decreases from approximately 35% to 16% (Bruskewitz et al., 1986; Flanigan et al., 1998; DeSantostefano et al., 2006).

Improvement of symptoms is the most important parameter for evaluating the long-term results of TURP. Most authors use the AUA score for evaluation. On average, 88% of patients experience significant improvement (in terms of symptoms) after TURP. The maximum urinary flow rate increases by over 100% after TURP, with a mean improvement of urinary flow of approximately 10 mL/s. However, the future of TURP is uncertain. Although this technique remains the "gold standard" for the treatment of BPH, it tends to be replaced by newer therapies.

Although new alternatives are constantly being introduced (e.g., electrovaporization, laser techniques, thermotherapy, bipolar resection, HIFU, urethral stents), they require the test of time to prove their superiority over TURP.

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CHAPTER

3

Bipolar Electroresection of Prostate Adenomas

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3.1 BASIC PRINCIPLES OF BIPOLAR RESECTION

According to the European Association of Urology guidelines (Oelke et al., 2009), monopolar transurethral resection is the "gold standard" treatment for benign prostatic hyperplasia, but this procedure is still associated with relatively high morbidity and mortality rates (Mebust et al., 1989). Therefore, to improve transurethral resection of the prostate (TURP) performance and to reduce complications, new alternative methods have been developed and introduced. Bipolar resection in saline solution appears to be an efficient and safe alternative with a low complication rate compared to standard TURP and with similar functional results.

An innovative feature introduced by this method is that the active and return poles are incorporated within the same electrode (Miki and Loritani, 2004). In contrast to the monopolar technique, the energy used in bipolar surgery does not pass through the patient's body to be absorbed by the neutral plate (which functions as a large return electrode). Therefore, the energy will be localized exclusively in the prostate.

Another difference between the two systems is the smaller amount of energy required for bipolar resection. It is also important to emphasize the low voltage necessary to close the circuit (due to the smaller amount of tissue transited), which implies a lower tissue resistance. Furthermore, some systems are capable of monitoring tissular impedance during the procedure and may modify their power output and voltage (with tissue trauma reduction).

In contrast to the higher energies used in monopolar resection, the lower levels of voltage and of temperature lead to the reduction of carbonization and of tissue necrosis. During standard monopolar interventions, the surgeon will have to devote a significant amount of time to accomplishing hemostasis. In the bipolar technique, the low applied voltages lead to a situation where resection and coagulation coexist and come to represent concurrent processes.

However, it is necessary to reduce the speed with which the loop passes through the tissue. This may have a negative impact on the overall duration of the bipolar intervention.

As noted earlier, monopolar resection uses a nonconducting liquid (glycine, sorbitol, mannitol, or sterile water) as irrigation fluid. In contrast, the bipolar technique is performed in a conductive fluid medium (physiological saline), with a saline impedance of 40 Ω.

Using saline irrigation is one of the most important advantages of the bipolar approach. Thus, during bipolar resection complications, such as hyponatremia or TUR syndrome, caused by hypotonic or hypo-osmolar irrigation, do not occur, which makes the technique safer (Issa et al., 2004). These features allow the surgeon to perform endoscopic interventions in patients with large prostate adenomas with no time limit and with proper hemostasis. Also, within the learning curve, the procedure may be prolonged without the patient's safety being jeopardized.

These characteristics of bipolar resection require instrumental changes in order to allow resection in high conductivity environments (sodium chloride solution or Ringer's solution). Therefore, the bipolar electrode is placed as close to the loop as possible. The use of high conductivity lubricants can reduce the risk of urethral injury caused by the passing current.

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3.2 WORK SYSTEMS

Although the bipolar electrode is, apparently, similar to the monopolar one, the materials used in its production, its operation methods, and circuits are different. Several bipolar resection systems have emerged, each having certain characteristics: the neutral electrode located near the loop (Gyrus), the neutral electrode opposed to the loop (Storz), or the sheath used as a neutral electrode (Olympus). The common link between these systems is their ability to operate in an isosmotic saline environment (Fig. 3.1).

3.2.1 The Vista Coblation® System

The Vista Coblation bipolar system produced by Gyrus-ACMI (Southborough, MA) uses a distal double loop electrode. This system is composed of an active proximal loop and a distal return loop (Fig. 3.2). The electrical circuit is closed when the current runs from the active electrode toward the return one.

This system uses a special generator (Fig. 3.3) that provides a low-frequency current of 100 kHz, in contrast to the one used in the monopolar method, which is a medium-frequency current (300–500 kHz). The manufacturer has replaced this device with the PKTM SuperPulse system that uses a disposable loop with the electrode located proximal to it.

3.2.2 The Autocon System

Introduced in 2007, the Autocon system (Karl Storz Endoscopy, Culver City, CA) generates bipolar energy by incorporating the active and return electrodes into a dual loop (distal type), as in the case of the previously mentioned system. The difference lies in the fact that the two loops are in opposition to each other, thereby creating the "mirror"

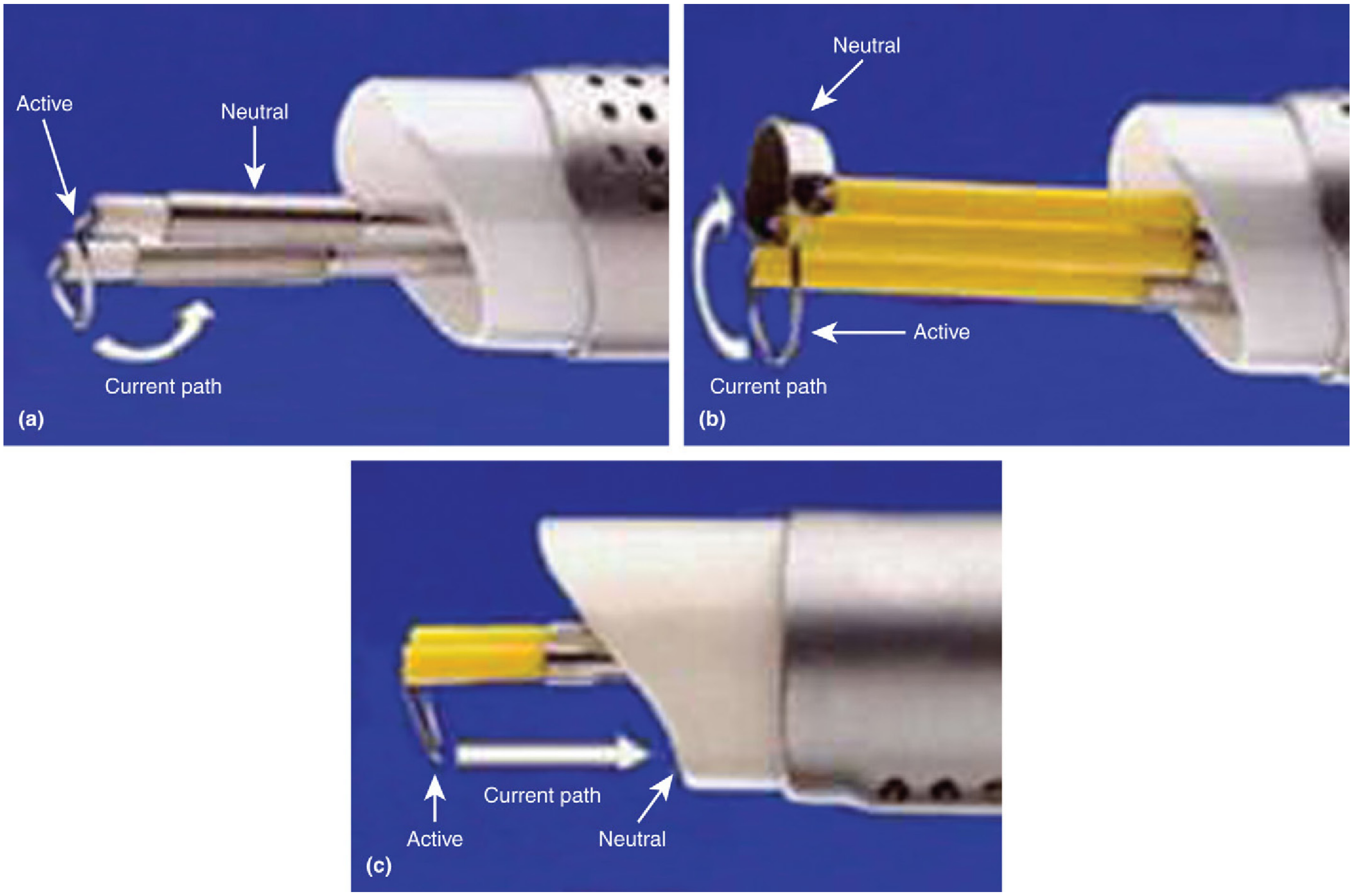

FIGURE 3.1 **Bipolar electroresection systems.** (a) Gyrus, neutral electrode located near the loop; (b) Storz, neutral electrode opposed to the loop; (c) Olympus, sheath used as a neutral electrode.

FIGURE 3.2 The electrode used in the Vista Coblation system.

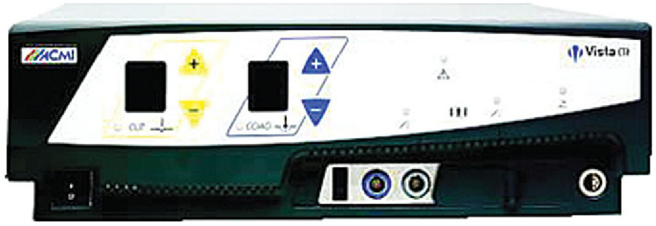

FIGURE 3.3 Vista Coblation generator.

appearance. This system uses a special set of instruments consisting of a particular resectoscope, loops of different sizes, and a generator (Fig. 3.4), which provides default settings for both monopolar and bipolar resection.

3.2.3 The Olympus UES-40 SurgMaster System

The Olympus UES-40 SurgMaster generator (Olympus, Hamburg, Germany) (Fig. 3.5) was introduced into practice in 2008. This system is derived from the classical monopolar one and can be used both in standard mode (monopolar) and in bipolar mode. Like the systems described earlier, it has both electrodes incorporated into the same resectoscope and it uses saline solution as an irrigation fluid.

The most important features of the main systems used for mono- and bipolar resection are summarized in Table 3.1.

3.3 SURGICAL TECHNIQUE

The indications of the procedure overlap with those presented in Chapter 2. The procedures are performed under spinal or general anesthesia. The significant differences consist in the equipment and the liquid used for lavage (saline solution). The working power for the Olympus SurgMaster UES-40 bipolar generator is usually set at 280–320 W.

FIGURE 3.4 Karl Storz Autocon II 400 unit.

FIGURE 3.5 Olympus UES-40 SurgMaster generator.

TABLE 3.1 Main Characteristics of Bipolar Systems Compared to Monopolar TUR

Criterion	Monopolar TURP	Olympus	Gyrus	Storz
Dimensions	24–26 F	24–26 F	26 F	24–26 F
Active loop	Standard dimensions	Reduced size	Double size	Reduced size
Neutral electrode	Skin contact	Resection sheath	Proximal to the loop	Opposite to the loop
Intraoperative visibility	+++	+++	+++	+++

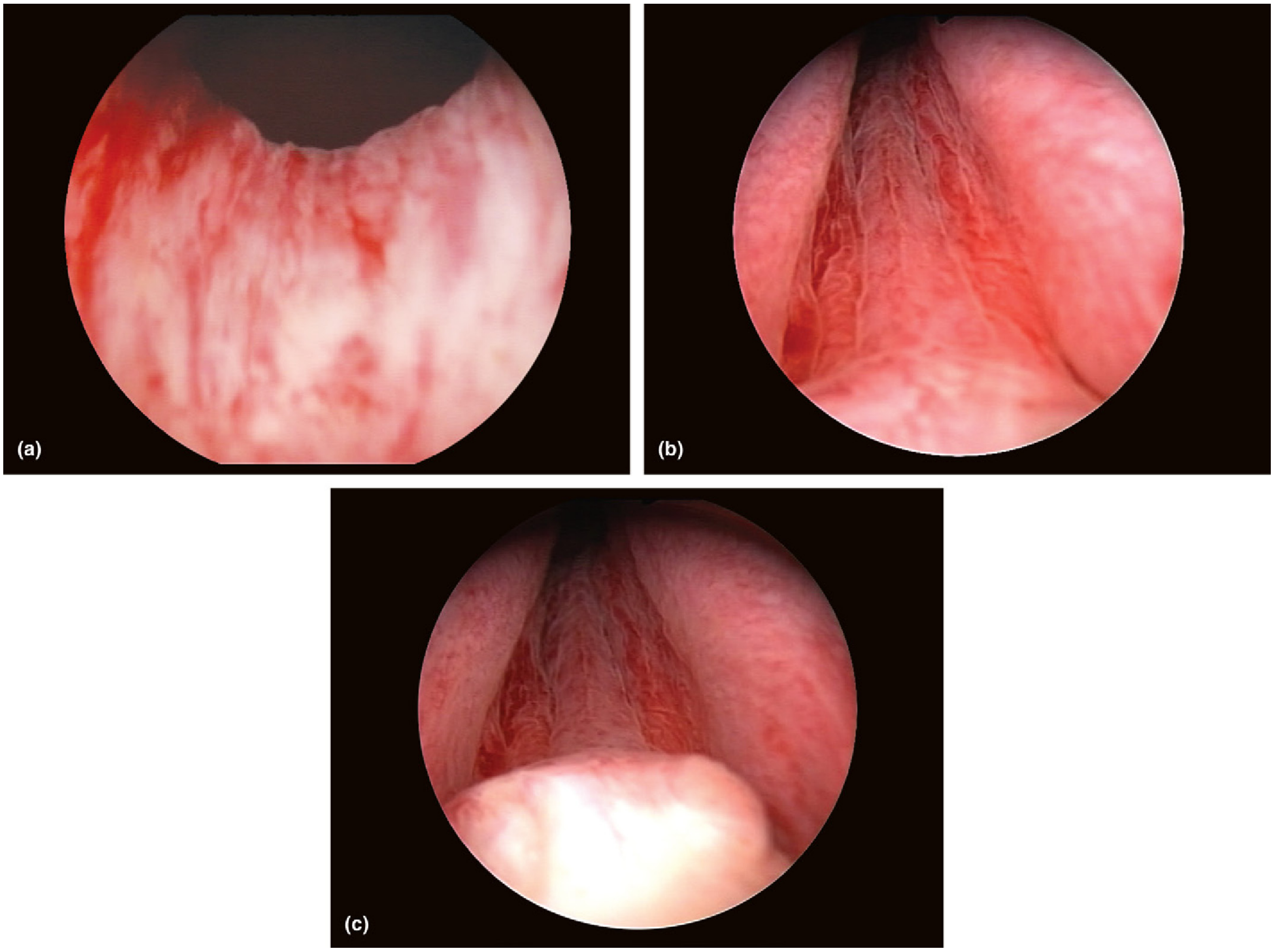

FIGURE 3.6 **Establishing the landmarks for the bipolar resection.** (a) Bladder neck, (b) lateral lobes, (c) verumontanum.

Bipolar transurethral resection in saline solution is carried out by following the same operating steps as in standard monopolar resection:

- benchmarking
- removal of adenomatous tissue
- resection and hemostasis checkup

Before starting the actual resection, a urethrocystoscopy should be performed in order to establish the landmarks (Fig. 3.6): bladder neck, prostatic lobes, and verumontanum.

After establishing the landmarks, the adenomatous tissue is removed, starting with the median lobe (at 6 o'clock) (Fig. 3.7), without distally exceeding the verumontanum.

At the end of this operative step, a workspace will be created (Fig. 3.8) that allows for the irrigation and mobilization of the resected fragments toward the bladder.

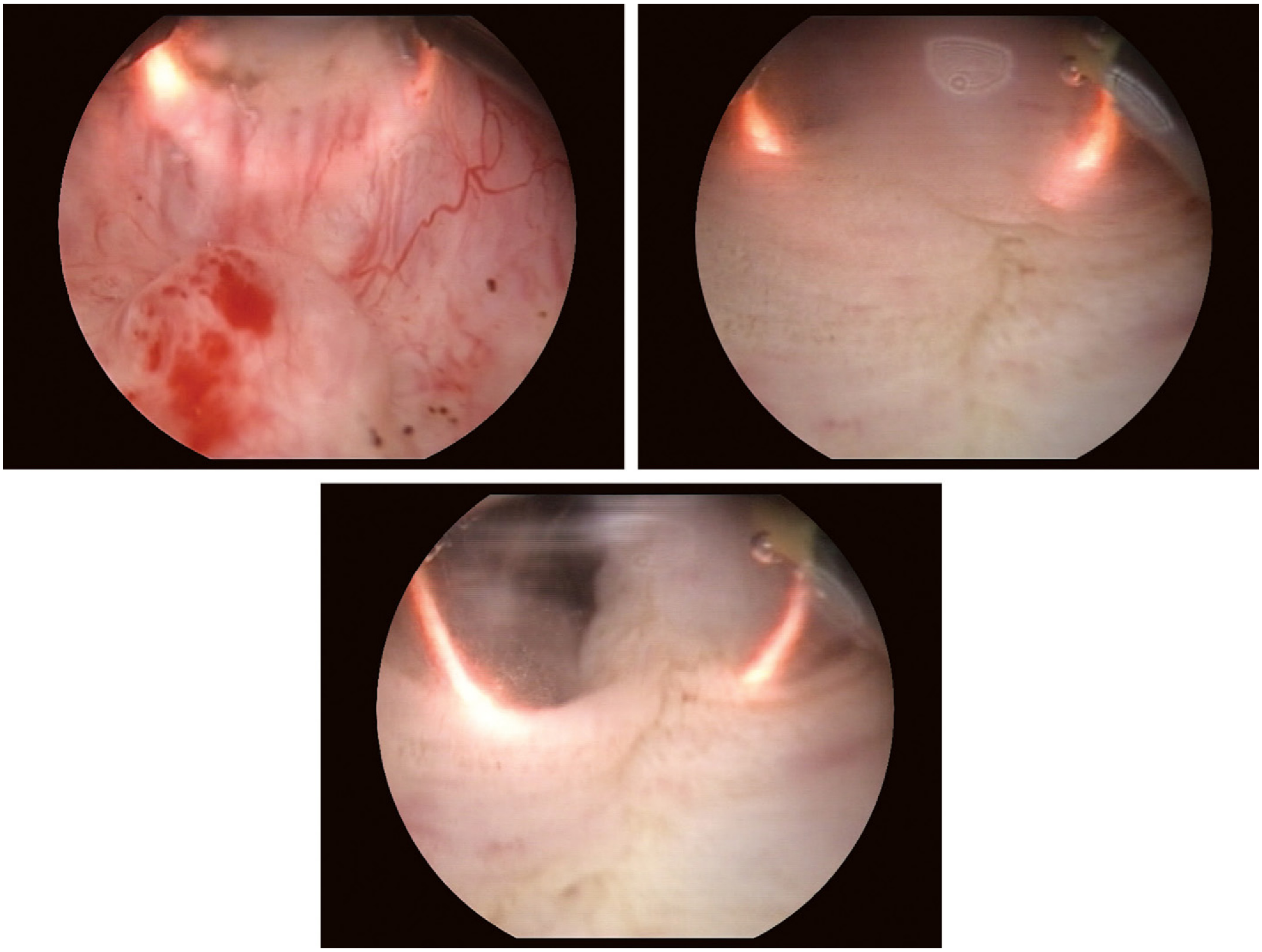

FIGURE 3.7 Initiation of the resection at 6 o'clock.

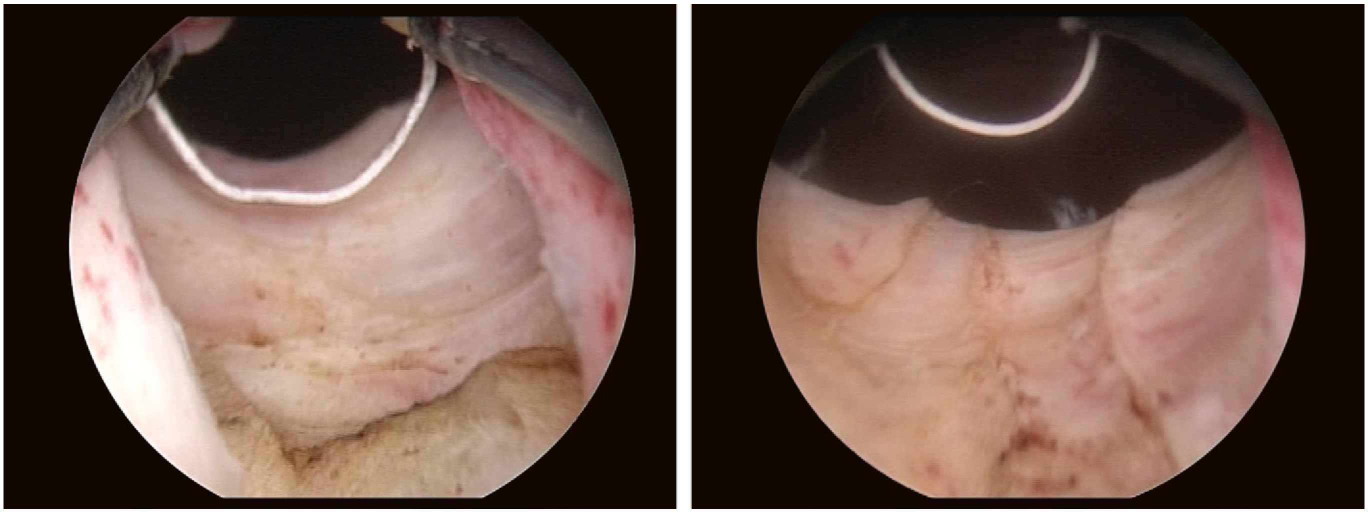

FIGURE 3.8 Creating the median working channel.

The next operative step is the resection of the lateral lobes. As stated in Chapter 2, the right lobe should be resected from 7 o'clock toward 10 o'clock (Fig. 3.9).

Left lobe resection is similar to right lobe resection but starting from 5 o'clock toward 2 o'clock (Fig. 3.10). Visualization of the prostatic capsule demonstrates complete adenomatous tissue resection.

After the lateral lobes, the ventral tissue is resected (Fig. 3.11).

The procedure continues with resection of the apical tissue and of the tissue situated next to the verumontanum (Fig. 3.12).

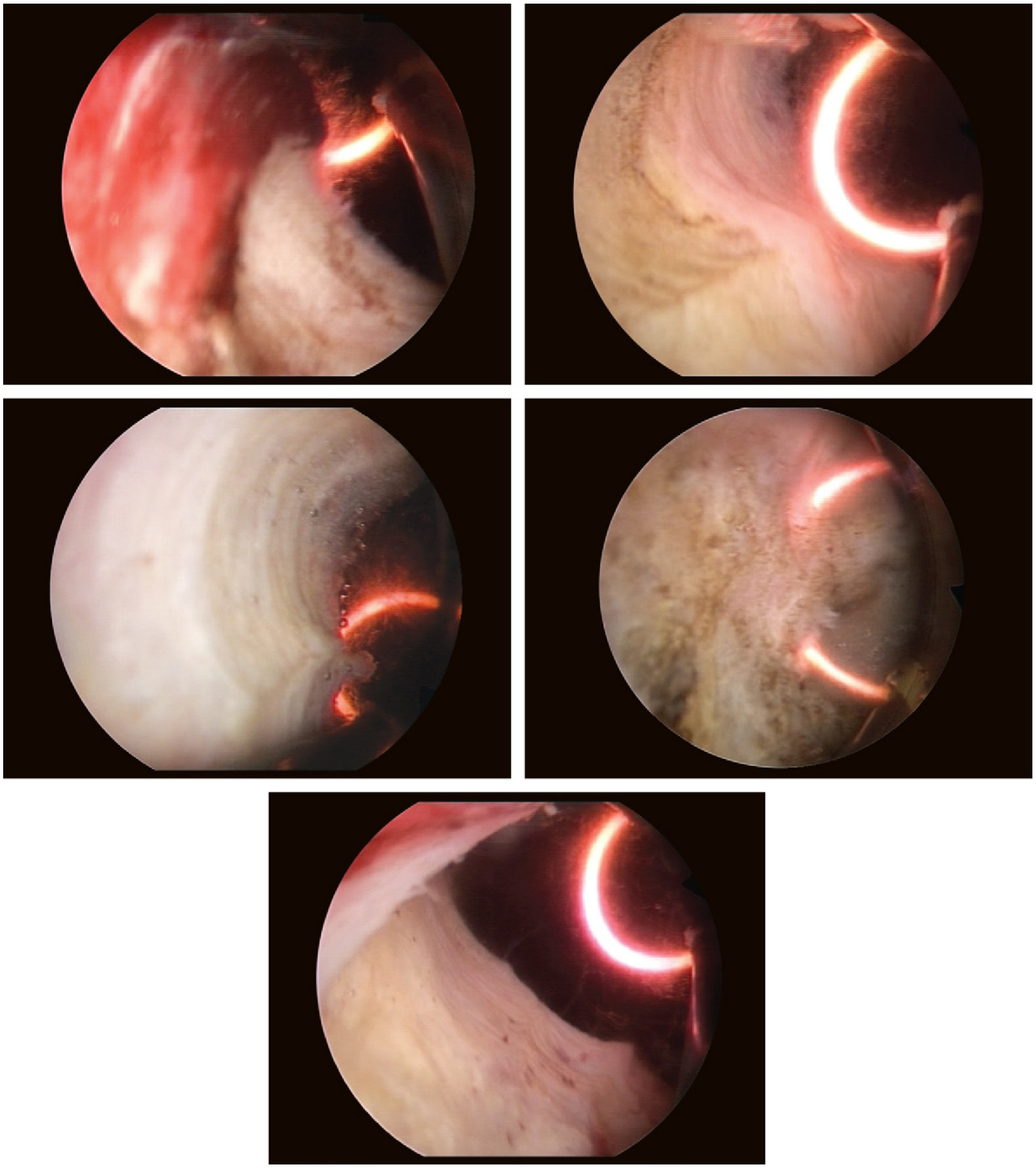

FIGURE 3.9 **Bipolar resection of the right prostatic lobe.**

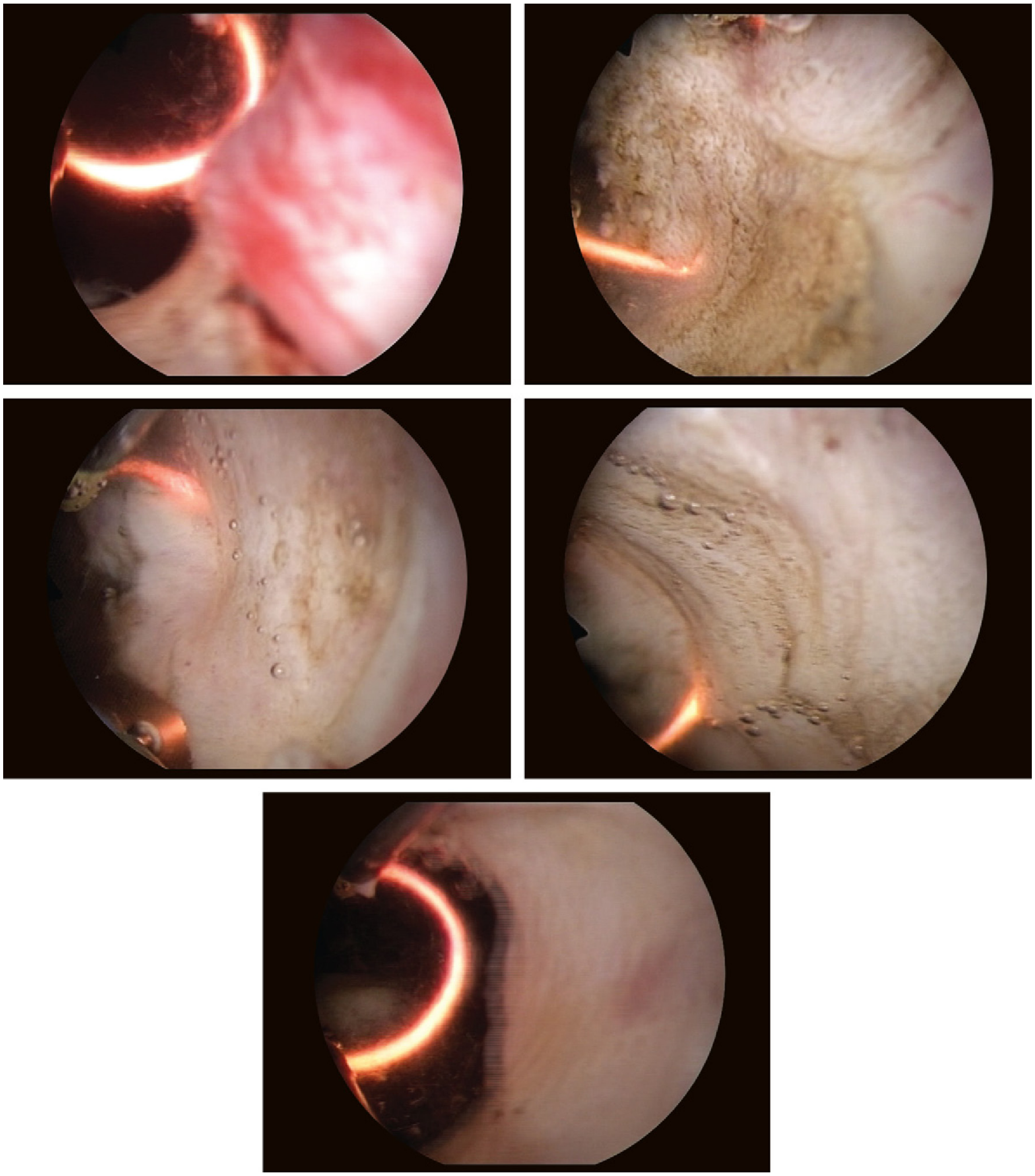

FIGURE 3.10 **Bipolar resection of the left prostatic lobe.**

The final aspect of the prostatic lodge should be broad and as regular as possible (Fig. 3.13).

At the end of the intervention resection is checked and hemostasis is performed, similar to the monopolar technique. Regarding postoperative follow-up, there are no differences between the monopolar and bipolar techniques.

3.4 COMPLICATIONS

Similar to monopolar resection, complications may be intraoperative or early or late postoperative. Regarding intraoperative complications, the use of isotonic saline irrigation solution averts the TURP syndrome (Table 3.2), a formidable complication that can endanger the patient's life.

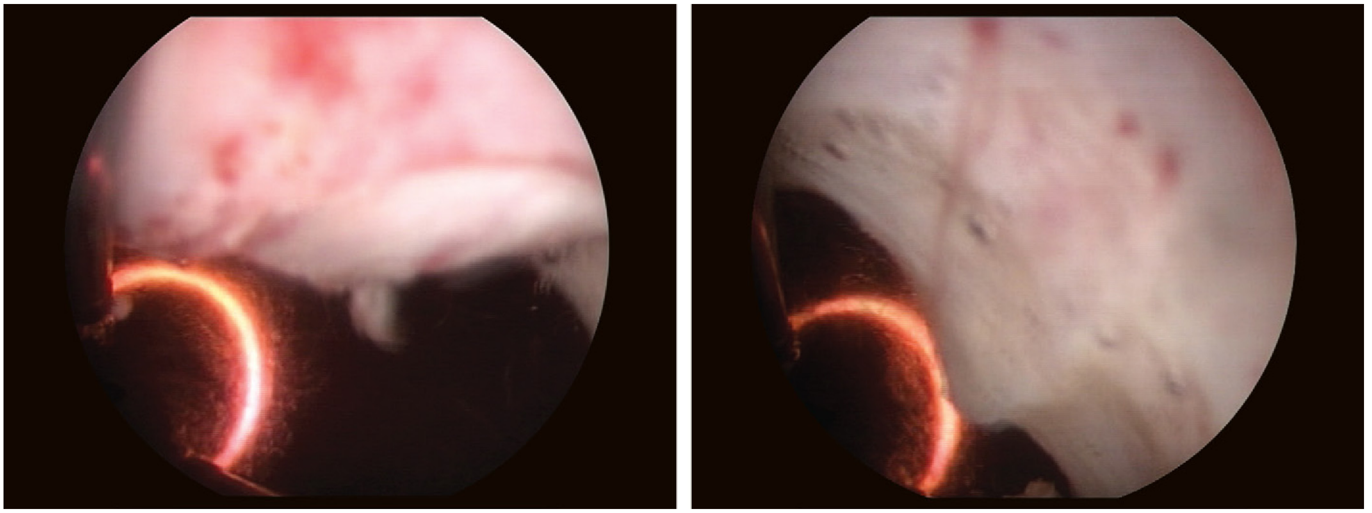

FIGURE 3.11 Bipolar resection of the tissue located ventrally between 10 o'clock and 12 o'clock.

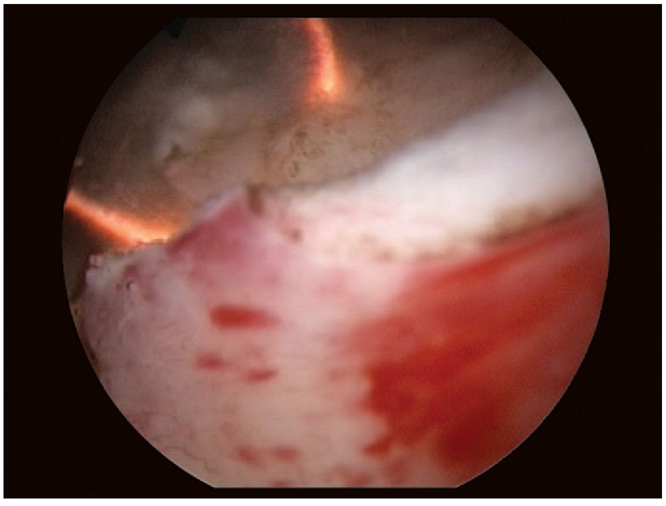

FIGURE 3.12 Bipolar resection near the verumontanum.

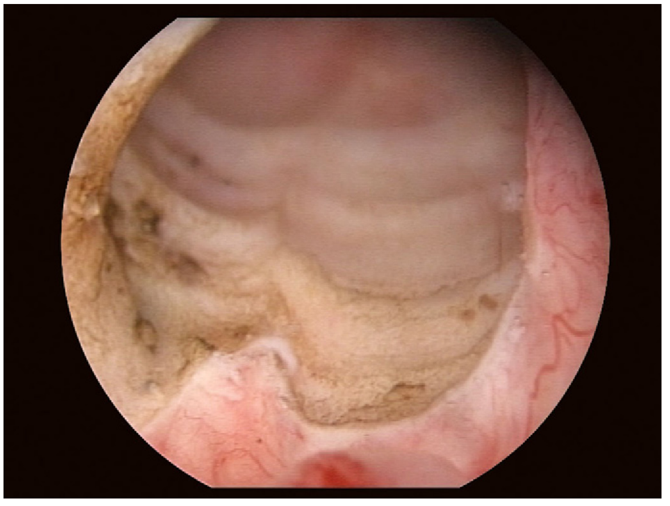

FIGURE 3.13 The final aspect of the prostatic lodge.

Also, as shown in Table 3.2, bleeding occurs at a much lower rate compared to monopolar resection (Tefekli et al., 2005; Hon et al., 2006; Autorino et al., 2009; Ho et al., 2006; Pantankar et al., 2006). This can be explained by the fact that in bipolar resection, cutting and coagulation are virtually simultaneous.

Other complications, such as prostatic capsule perforation or urinary infections, occur in a low percentage of cases.

Regarding late postoperative complications, the bipolar approach faces two problems (frequently encountered when using monopolar systems as well): urethral strictures and bladder neck sclerosis. Studies that have described these complications are relatively recent, as summarized in Table 3.3 (Tefekli et al., 2005; Hon et al., 2006; Autorino et al., 2009; Ho et al., 2006).

Regarding their etiology, several factors are culpable (Tefekli et al., 2005):

- the use of large diameter resectoscopes (27 F), especially if the urethra was not sufficiently dilated in advance
- the use of high work powers (even for short periods of time)
- a prolonged duration of interventions

Some authors (Morishita et al., 1992) consider that both electrical resistance and current leakage from the resectoscope are at the origin of urethral strictures after TURP. In terms of instruments, it has been found that the modern bipolar electrode has a low electrical resistance (0.5 or 0.6 Ω). As it is used, the resistance increases to an average

TABLE 3.2 Comparative Analysis (Bipolar Resection vs. TURP) of the Main Intraoperative Complications

		Intraoperative bleeding (%)		TURP syndrome (%)	
Studies	**Number of patients**	**TURP**	**Bipolar resection**	**TURP**	**Bipolar resection**
Singh (2005)	60	3.3	0.0	0.0	0.0
Tefekli et al. (2005)	96	2.1	2.0	0.0	0.0
Starkman (2005)	43	11.0	0.0	ND	ND
Hon et al. (2006)	160	5.3	1.2	0.0	0.0
De Sio (2006)	70	11.4	5.7	0.0	0.0
Pantankar et al. (2006)	104	3.9	0.0	3.9	0.0
Ho et al. (2006)	100	3.8	6.3	3.8	0.0

ND, no data.

TABLE 3.3 Comparative Analysis of the Incidence of Postoperative Urethral Strictures

		Urethral stricture (%)	
Studies	**Number of patients**	**TURP**	**Bipolar resection**
Singh (2005)	60	0.0	3.3
Tefekli et al. (2005)	96	2.1	6.1
Starkman (2005)	43	5.5	6.6
Hon et al. (2006)	160	1.2	0.0
De Sio (2006)	70	2.8	2.8
Ho et al. (2006)	100	6.3	1.9

of 26 Ω but without associating current leakage. On the other hand, the monopolar electrode presents current leakage from its first use, also having an increased electrical resistance. These observations explain published results showing a declining rate of urethral strictures after bipolar resection.

3.5 RESULTS

With the development of the new bipolar resection systems many authors have compared the results of this technique with those of standard (monopolar) intervention, assessing several parameters:

- intraoperative bleeding
- the amount of intraoperative absorbed liquid
- the need for postoperative lavage
- the duration of postoperative catheterization
- thermal effects on the tissues
- the length of hospital stay

Generally, similar groups were used in terms of age, prostate-specific antigen, and prostate volume (Ibrahim et al., 2006).

Regarding intraoperative bleeding, some studies (Ibrahim et al., 2006) show similar values between the two groups (185 mL in the group treated by bipolar resection vs. 190 mL for TURP). Similar results were also observed regarding the amount of liquid absorbed during surgery (305 mL for bipolar resection vs. 334 mL for TURP) (Hon et al., 2006). Postoperative serum sodium levels were also similar (2.4 mmol/L vs. 2.2 mmol/L).

Bipolar resection was superior to monopolar resection regarding the reduction of the hemoglobin level (1.2 g/dL vs. 1.7 g/dL) (Ibrahim et al., 2006) and the amount of fluid used for postoperative lavage (Table 3.4).

TABLE 3.4 Comparative Analysis of the Amount of Fluid Required for Postoperative Lavage

		Average postoperative lavage (liters or hours)	
Studies	**Number of patients**	**TURP**	**Bipolar resection**
Tefekli et al. (2005)	96	7.8 liters	6.9 liters
Hon et al. (2006)	160	28.3 liters	20.4 liters
De Sio (2006)	70	52 hours	30 hours

TABLE 3.5 Comparative Analysis of the Postoperative Catheterization Duration

		Average postoperative catheterization (days)	
Studies	**Number of patients**	**TURP**	**Bipolar resection**
Singh (2005)	60	3.4	2.5
Tefekli et al. (2005)	96	3.8	2.3
Starkman (2005)	43	3.2	1.8
Hon et al. (2006)	160	2.4	2.0
De Sio (2006)	70	4.1	3.0
Pantankar et al. (2006)	104	1.8	0.8

Most studies objectify a decrease of postoperative bladder catheterization for the bipolar technique (Table 3.5).

Regarding complications, there has been no case of TURP syndrome in patients with bipolar resection. Postoperative bleeding was objectified in approximately 3% of cases (compared to 5% in TURP) (Michielsen et al., 2007).

The thermal effects of transurethral resection have been the subject of numerous studies that compared histological changes that occurred after the two techniques (Akgül et al., 2009).

Recordings of intraprostatic temperatures showed significant differences between the two procedures. Also, the depth of thermal tissue damage was higher in the group exposed to monopolar resection (0.59 mm), in contrast to bipolar systems where the values were 0.07–0.15 mm. These studies show that bipolar resection has a lower degree of invasiveness; the intervention generates less heat than the classic approach while also having a lower degree of histopathological alteration.

Analyses of tissue artifacts (atypical cytological changes) generated by the two methods of resection showed a lower percentage for the bipolar method (Ko et al., 2010).

Most studies conclude that the two procedures have similar efficacy, with certain advantages for the bipolar system. Thus, the advantages of bipolar resection can be observed regarding irrigation (peri- and postoperative), the amount of absorbed fluid, and the decrease of serum sodium levels. The possibility of prolonging the intervention to more than 90 min due to the absence of TURP syndrome is a clear advantage for bipolar resection.

3.5.1 Bipolar Approach in Large Adenomas

The development of instruments and techniques for bipolar resection and its increasingly frequent use has allowed the approach to be used in large prostate adenomas. Prospective clinical studies performed on cases of large prostates (over 50 cm^3) compared the advantages of the bipolar system over monopolar resection (Chen et al., 2009; Bhansali et al., 2009). The differences between the two techniques are obvious in terms of

- decrease of serum sodium levels, which is lower in the bipolar resection group (6.9 mM) compared to the standard group (14.8 mM)
- decrease of hemoglobin levels (by 1.4 g/dL for bipolar resection compared to 2.5 g/dL in the TURP group)

In these cases, the resection speed was higher for the bipolar technique compared to the standard group (0.64 g/min vs. 0.52 g/min) while the overall rate of acute complications was higher in patients with TURP compared to bipolar resection (42% vs. 19%). The results of these studies demonstrated the high efficiency of the new therapeutic method, so that the bipolar resection system can be taken into consideration for the treatment of large prostates.

Regarding comparisons with other therapeutic options (holmium laser enucleation), the results are superior for the laser technique: lower intraoperative bleeding and lower postoperative lavage (Zhu et al., 2008). On the other hand, the bladder catheter was maintained for a shorter period of time in the cases in which bipolar vaporization was used. Also, IPSS, Qmax, and residual volume showed significant improvements at 1 and 3 months after the procedure, with no significant differences between the two groups.

Both bipolar vaporization and laser interventions are effective and safe therapies, with the mention that the growing popularity of bipolar resection and of the techniques derived from it, combined with the lower costs per procedure, might make this method a new "gold standard" for the endoscopic treatment of prostate adenoma. On the other hand, overall viability and long-term outcomes of these procedures require additional studies conducted over long periods of time in order to define the stability of the functional improvements, which appear to be very promising.

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CHAPTER

4

Electrovaporization of Prostate Adenoma

Bogdan Geavlete, Gheorghe Niţă, Marian Jecu, Florin Stănescu, Petrişor Geavlete

4.1 GENERALITIES

Transurethral resection of the prostate (TURP) has seen significant technical improvements, which have had a strong impact on the incidence of intra- and postoperative complications. The introduction of bipolar resection was an important step in developing electrovaporization techniques, especially after the appearance of the Gyrus® PlasmaKinetic® Tissue Management System (Gyrus Medical Ltd, Bucks, UK). This new alternative therapy proved to be as effective as TURP, showing very good long-term results with minimum immediate postoperative complications (Hon et al., 2006).

A new variant of this technique, bipolar plasma vaporization using the transurethral resection in saline (TURis) system, was introduced in clinical practice with favorable results. While monopolar resection achieves prostate ablation by tissue resection and hemostasis by fulguration, transurethral vaporization is based on the combination of vaporization and tissue desiccation.

Fulguration is a superficial carbonization of the tissue achieved by intermittently applying a current that causes dissipation of the resulted heat over large areas, the effect being limited to a superficial level. In this way, cells dehydrate quickly but do not vaporize, obtaining superficial carbonization and hemostasis. Cutting or vaporization occur when tissues are rapidly heated and the cells "explode," producing steam. This is done by applying a high intensity current with an instantaneous release of energy. Desiccation produces extraction of water from the tissular level. Mebust et al., (1972, 1977) introduced this concept, using a transurethral probe that had the capacity to heat and desiccate the prostate. Prostate vaporization was first described in 1995 by Kaplan and Te (1995a, b).

Vaporization produces strong tissue heating (because of the high temperatures it achieves). The release of electrical energy can be influenced by certain factors such as (Kaplan et al., 1998)

- generator-produced voltage
- density of the current at the electrode's contact surface
- electrical resistance of the tissue on which the current is applied

Generally, vaporization requires 75% of the power used for standard resection (Van Swol et al., 1999).

4.2 WORK SYSTEMS

4.2.1 The PlasmaKinetic System

The PlasmaKinetic Tissue Management System (PKTM) (Gyrus-ACMI, Southborough, MA) was the first to use saline solution as an irrigation fluid (Fig. 4.1).

The first generation was developed in the mid-1990s by producing a vaporization electrode, which was later improved (Fig. 4.2).

Plasmakinetic technology uses the energy transmitted from the electrode into the saline solution. The solution is evaporated, thereby forming a gas layer around the loop. By increasing the voltage, the layer of gas determines excitation of the sodium ions, resulting in the formation of plasma. This surrounds the loop and gives it its particular incandescent aspect (orange).

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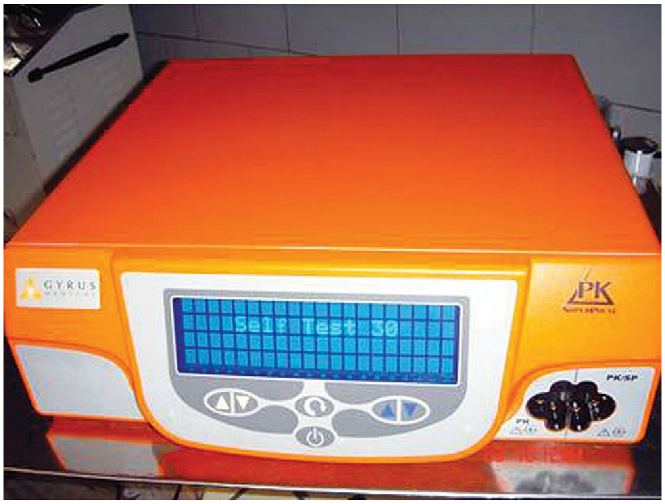

FIGURE 4.1 **Gyrus PlasmaKinetic system.**

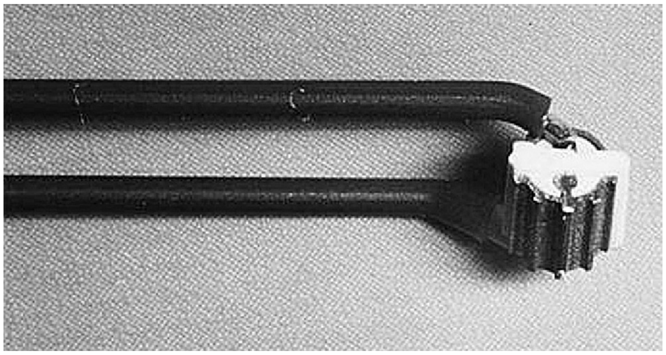

FIGURE 4.2 **Gyrus electrode for bipolar vaporization.**

Plasma is a state of matter (highly energized) that consists of charged particles that are in free motion. The molecules that compose the plasma can be easily cleaved at low voltage energies, leading to tissue vaporization. Plasma causes tissue destruction at a molecular level.

4.2.2 The TURis System

The TURis system includes the Olympus UES-40 SurgMaster generator (Olympus, Hamburg, Germany) and the OES Pro resectoscope (Fig. 4.3).

A novelty is its "mushroom"-type loop, which determines effective tissue vaporization with proper intraoperative control (Fig. 4.4).

The plasma crown from the electrode's surface is created by applying a current with a power of 300 W. This produces minimal tissue alterations (in the absence of carbonization). After vaporization, the prostatic lodge presents smooth walls with no irregularities, which determines uniform scarring, thus avoiding the occurrence of postoperative complications such as bladder neck sclerosis.

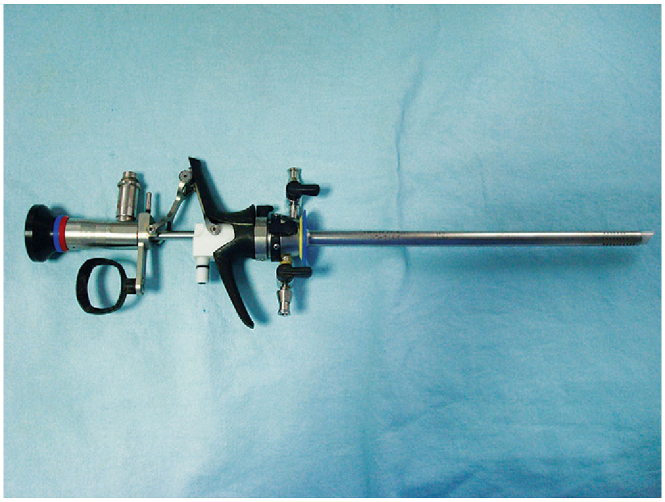

FIGURE 4.3 **OES Pro resectoscope.**

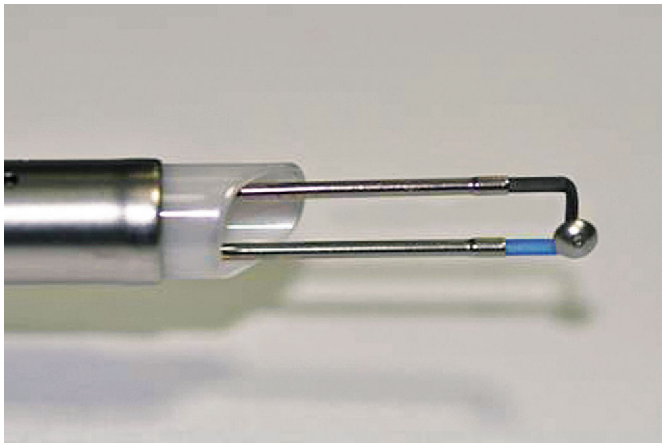

FIGURE 4.4 **Olympus UES-40 system "mushroom"-type electrode.**

4.3 SURGICAL TECHNIQUE

The indications of the procedure are similar to those for mono- or bipolar resection. Transurethral vaporization follows the same surgical steps as in standard resection. Technically, the hemispherical "mushroom"-type electrode develops a plasma crown on its surface. This produces an instantaneous vaporization with almost no prostatic tissue bleeding through direct contact with it (the "hovering" technique). The electrode is gradually moved, removing the adenomatous tissue layer by layer, up to the prostatic capsule.

The working power for the Olympus SurgMaster UES-40 bipolar generator is usually set at 280–320 W for vaporization (varying according to the tissue's consistency) and at 120–140 W to perform hemostasis.

Before starting the actual intervention, a systematic urethrocystoscopic examination should be performed. This will provide information on the prostate size, length of the prostatic urethra, and the location of the bladder neck and ureteral orifices.

The first step of the intervention is represented by the creation of the median work channel by orienting the vaporization at 6 o'clock (Fig. 4.5). This channel will determine a good orientation and will ensure optimal irrigation, which is an essential aspect in terms of visibility during surgery. During the procedure, excessive bladder distention with lavage fluid should be avoided. This surgical step is performed respecting two fundamental reference points: the bladder neck (distal limit) and the verumontanum (proximal limit) (Fig. 4.6).

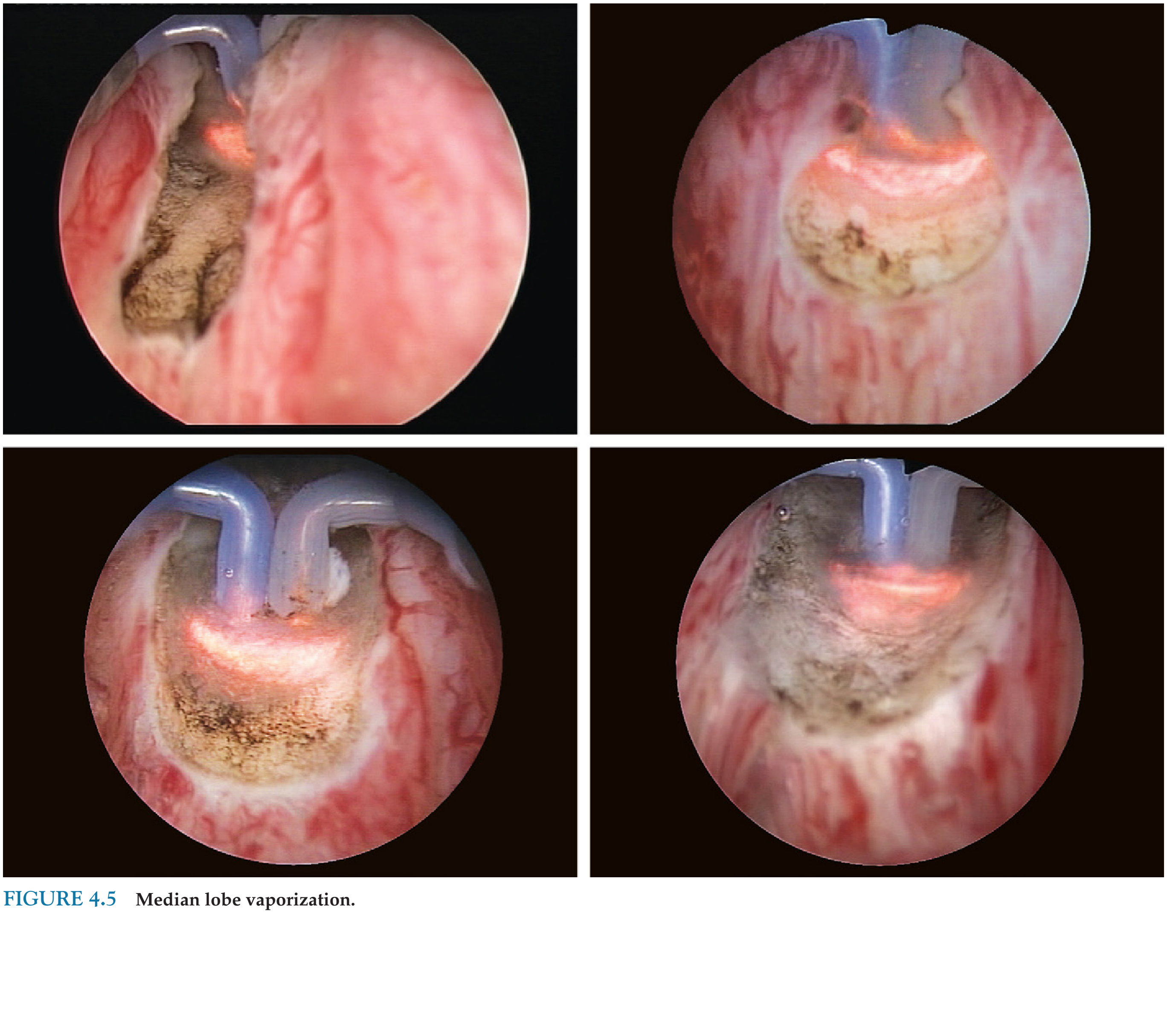

FIGURE 4.5 **Median lobe vaporization.**

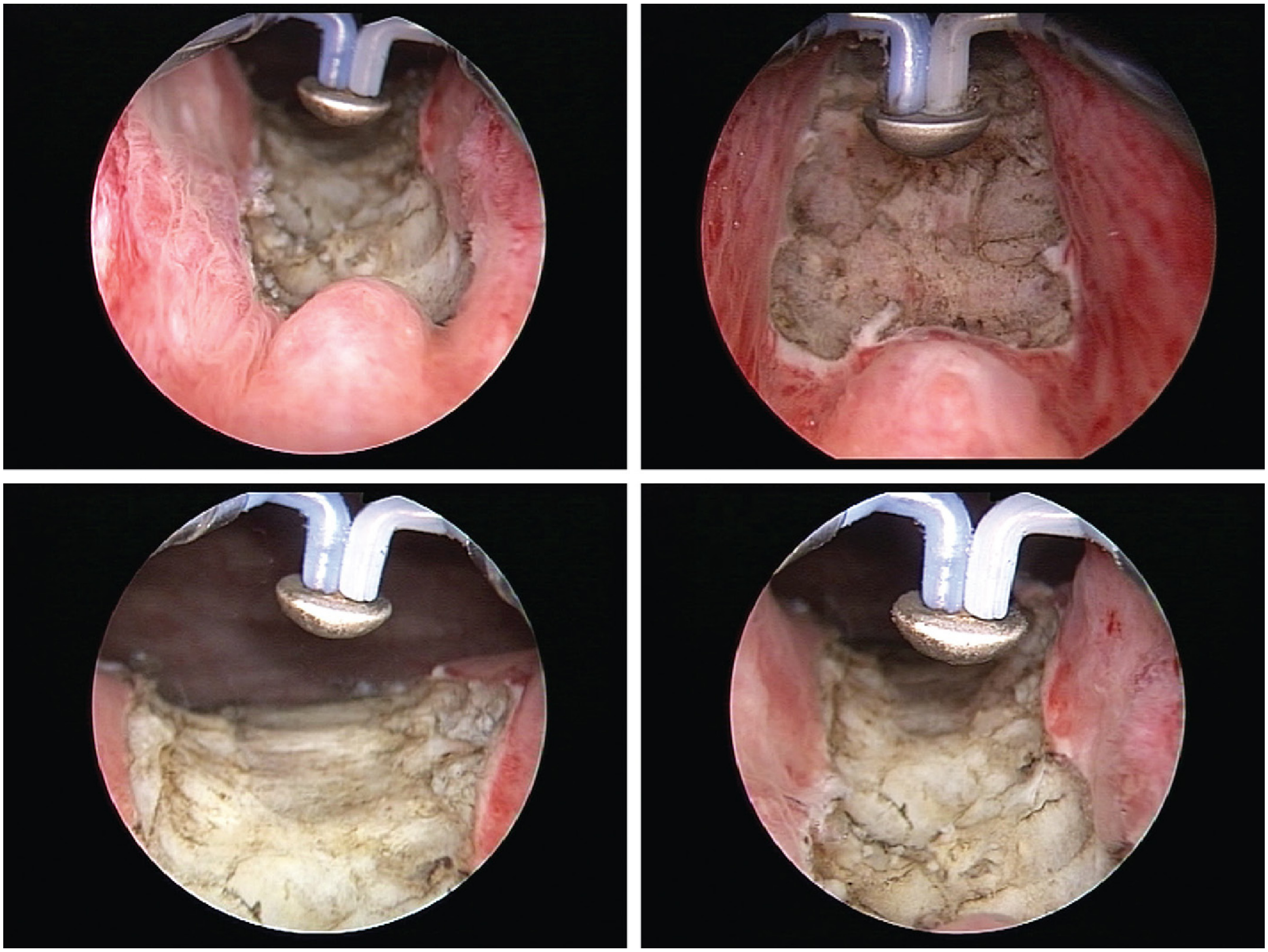

FIGURE 4.6 **Limits of the vaporization: verumontanum (up) and bladder neck (down).**

The lateral lobes are symmetrically vaporized, layer by layer, with the aim of obtaining a smooth surface and the complete removal of the adenomatous tissue (Fig. 4.7).

The objective of this surgical step is to obtain a concave area within each lateral lobe (Fig. 4.8). One of the benefits of a regular surface at the end of the intervention is the control of bleeding, which is more difficult to achieve in the case of an irregular surface.

Prostatic apex vaporization must be very precise so as not to cause sphincter lesions. The aim is to vaporize the entire adenomatous tissue on both sides of the verumontanum. All apical tissue must be removed at the end of this surgical step, obtaining the typical appearance of "lone veru" (Fig. 4.9).

Generally, duration of the intervention is shortened due to minimal intraoperative bleeding and excellent intraoperative visibility. The loop-type electrode can be used for the resection of several peripheral prostate tissue fragments (most commonly affected by prostate cancer), which will be sent for histopathological examination (Fig. 4.10).

The bladder neck tissue will be vaporized until a large, unobstructed area is obtained.

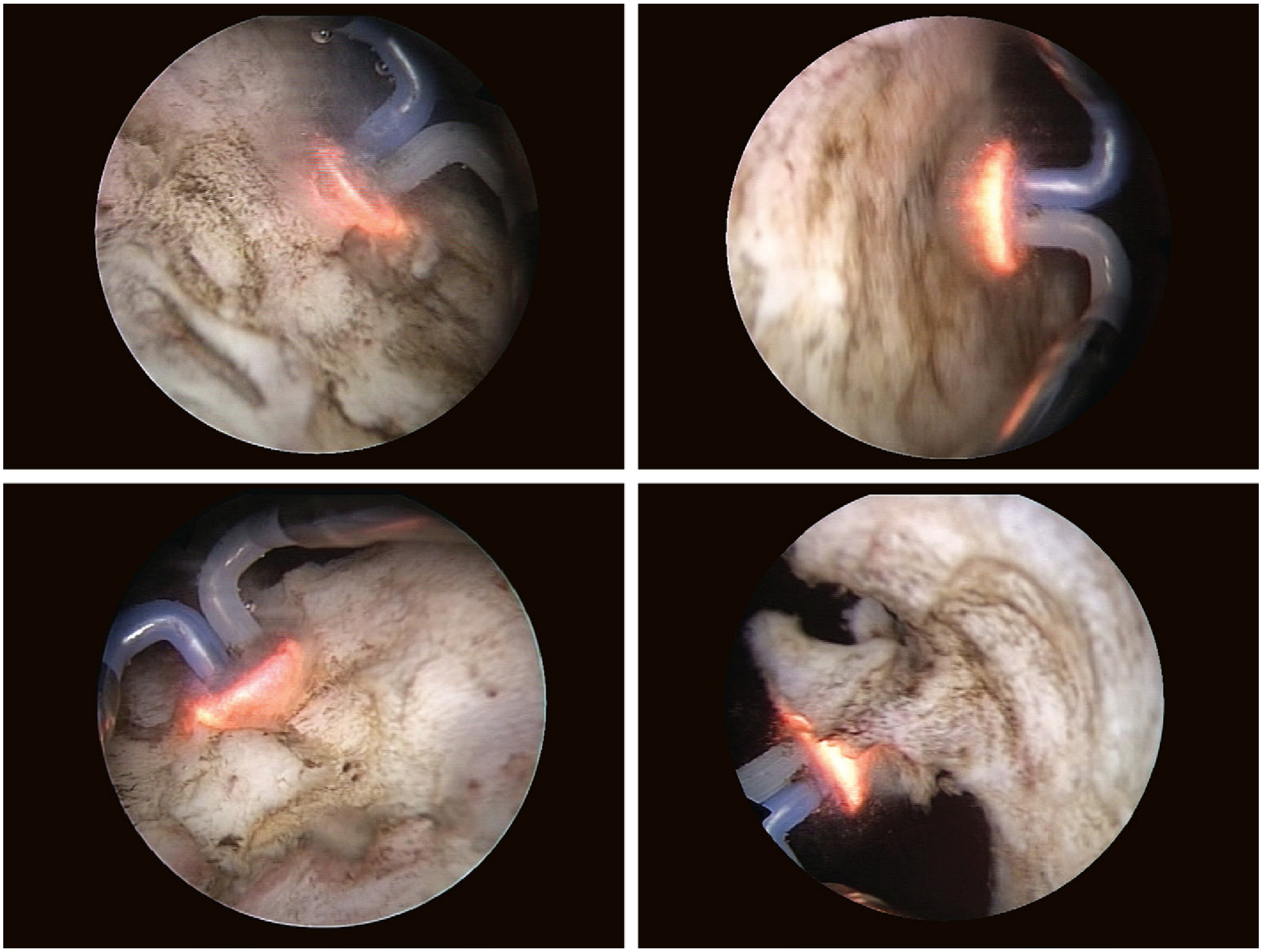

FIGURE 4.7 **Vaporization of the lateral lobes.**

An important issue at this stage is represented by the evacuation of the bladder to check for migrated tissue fragments. Any bleeding source should be identified and coagulated (Fig. 4.11). Coagulation of bleeding sources can be performed simultaneously with the vaporization, while larger vessels may require modifying the power of the generator.

At the end of the intervention, the prostatic lodge should be in the shape of a concave, large, open cavity, with a smooth and regular surface, without damage to the urethral sphincter or to the verumontanum (Fig. 4.12).

Due to the high power of penetration (secondary to the high temperatures created on the surface), the handling of the electrode should be carried out carefully in order to avoid prostate capsule perforation. This can easily be highlighted due to the preservation of the visual characteristics of the adenomatous tissue and capsular fibers (Fig. 4.13).

Comparison of pre- and postoperative aspects highlights the outstanding efficiency of plasma vaporization. The wide prostatic lodge highlighted at the end of the intervention, completely free of irregularities (or any other form of obstruction), anticipates favorable postoperative results, which translate into the improvement of functional parameters (Fig. 4.14).

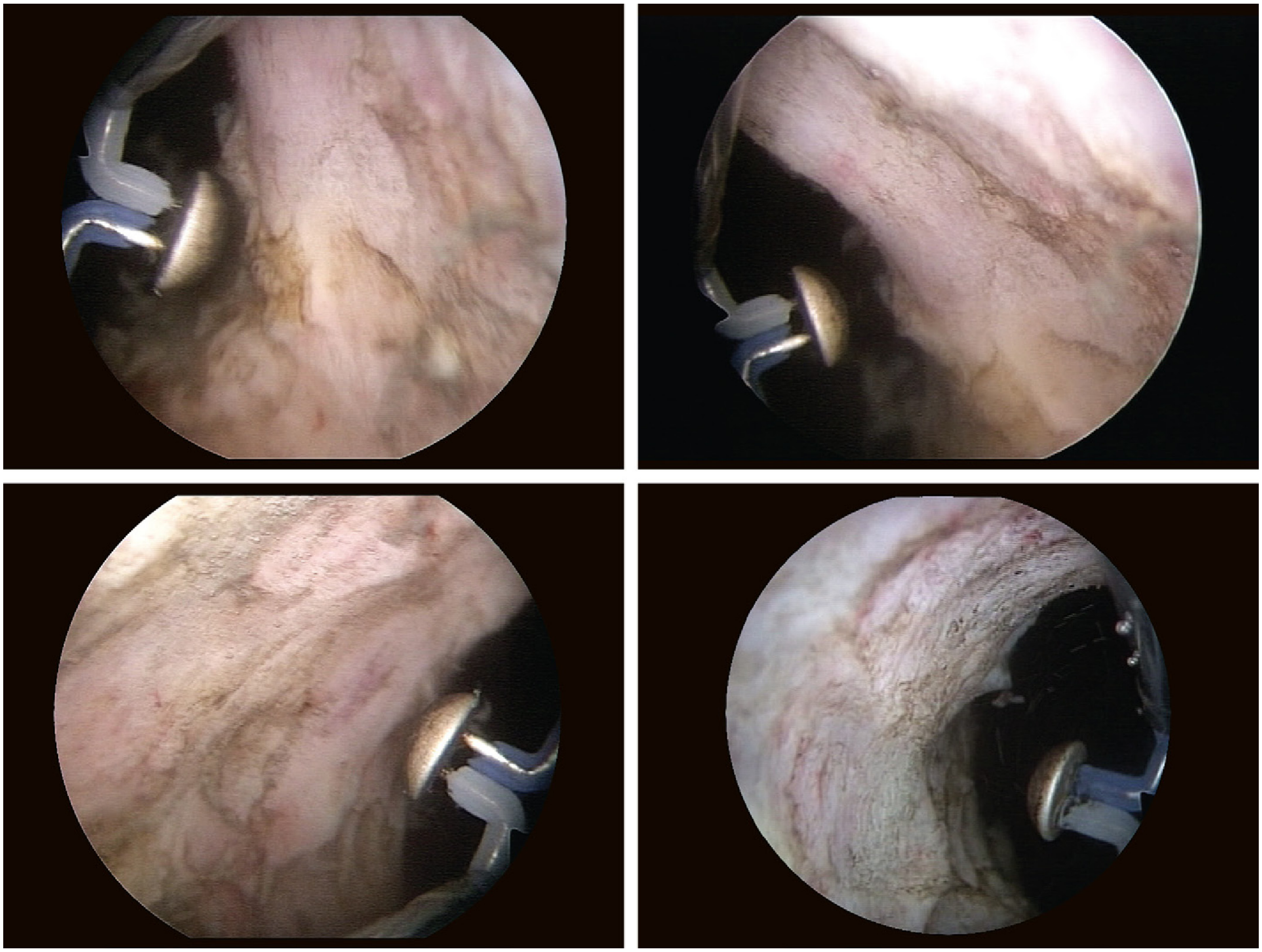

FIGURE 4.8 **Final aspect after vaporization of the lateral lobes.**

4.4 RESULTS

4.4.1 The PlasmaKinetic System

Prospective, randomized studies have been conducted analyzing plasma vaporization using the PlasmaKinetic Tissue Management System (PKTM) compared to standard TURP. In one study (Karaman et al., 2005), several important parameters were assessed by comparison (vaporization vs. TURP):

- the average operative time (40.3 min vs. 55 min)
- the average time for maintaining postoperative bladder infusion (6 h vs. 20 h)
- the need for blood transfusions (0 patients vs. 2 cases)
- the average time period for maintaining the urethro-vesical catheter (35 h vs. 68 h)
- the evolution of Qmax and IPSS (no significant differences)

An interesting aspect noted after analyzing biopsy specimens is that in the case of monopolar transurethral resection, thermal tissue damage spreads up to 3 mm, while in the case of bipolar vaporization, this was only 0.5 mm.

Patankar's randomized study (Patankar et al., 2006) (PKVP vs. TURP) also demonstrated the superiority of vaporization (Table 4.1).

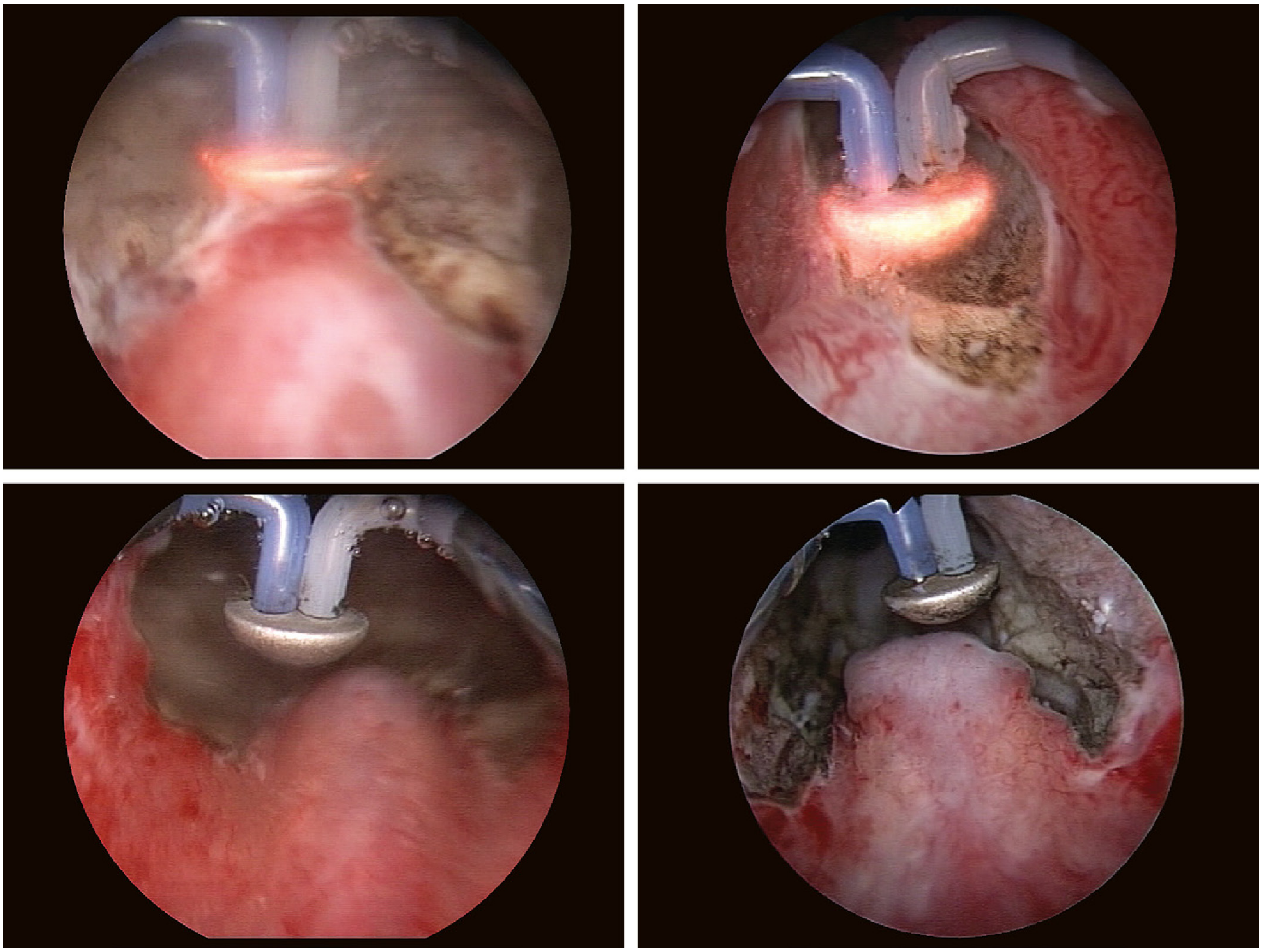

FIGURE 4.9 **Adenomatous tissue vaporization lateral to the verumontanum.**

TABLE 4.1 The Results of the Randomized Study Published by Patankar

Criterion	PKVP	TURP
Operating time (min)	49.9	57.8
Mean catheterization period (h)	18.4	42.4
Intraoperative bleeding (mL)	140.6	282.6
Postoperative hematuria (%)	5.7	17.6
Urinary tract infections (%)	13.7	11.5
TURP syndrome (%)	0	1

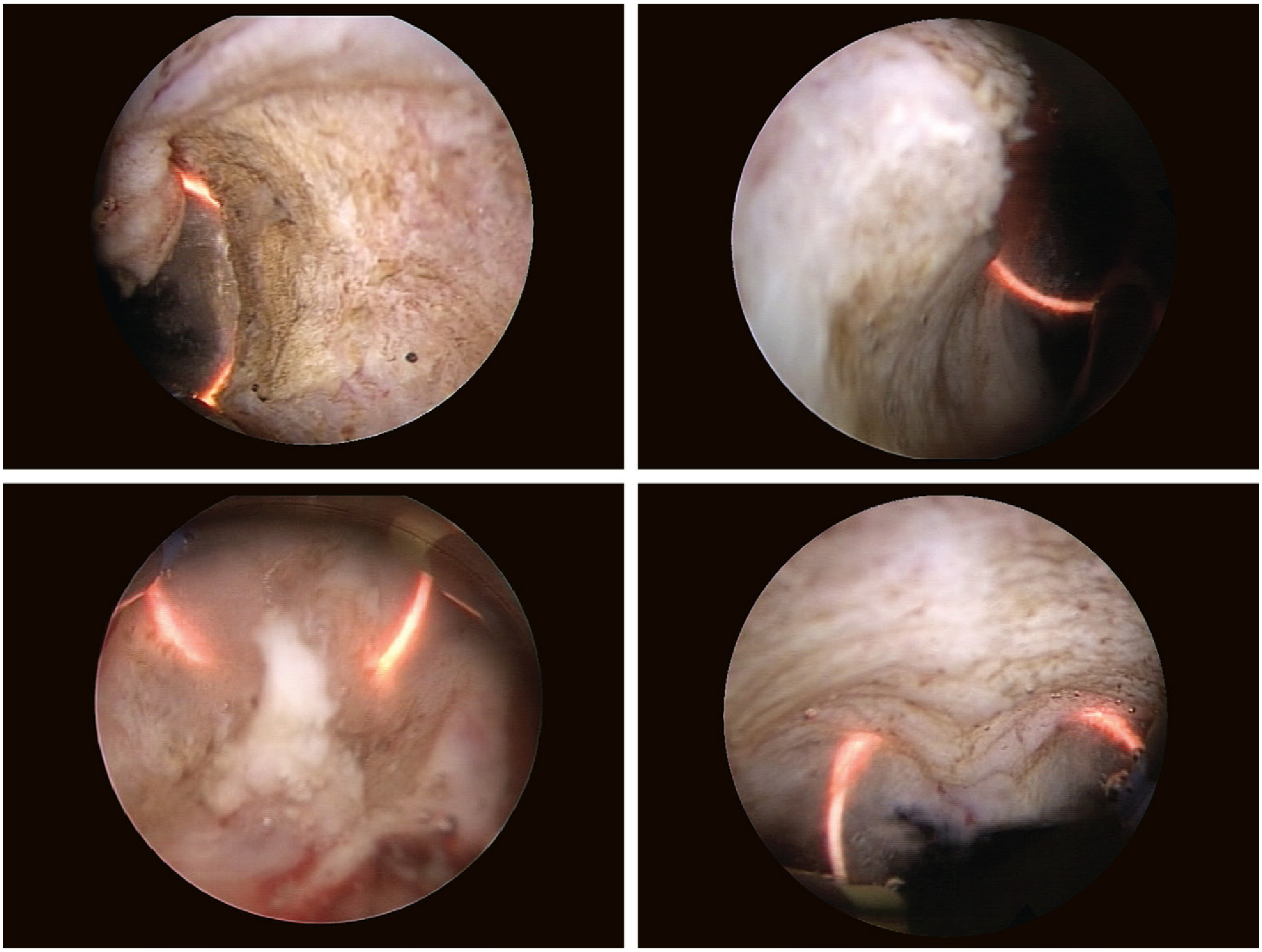

FIGURE 4.10 **Loop bipolar resection for histopathological examination.**

Other studies (Hon et al., 2006) did not record significant differences in terms of intraoperative bleeding, fluid absorption, and pre- and postoperative levels of sodium and hematocrit. Also, postoperative parameters (Qmax, IPSS, QoL, and VR) showed similar values regardless of the method used.

Some authors measured the average time required for vaporizing 1 g of prostatic tissue: 2.8 min (Dincel et al., 2004). The long-term results are relatively comparable, although the values for IPSS and Qmax are superior for TURP (Kaya et al., 2007; Autorino et al., 2009; Botto et al., 2001) (Table 4.2).

Multicenter studies on larger groups of patients (Choi et al., 2006; Tefekli et al., 2005; Che et al., 2009) did not show significant differences between groups in terms of operating time, the amount of vaporized tissue, or serum hemoglobin changes. Serum sodium levels decreased by 1.1 mEq./L in the PKVP group and by 4.7 mEq./L in case of TURP. Urethro-vesical catheterization and hospitalization duration were shorter in patients with PKVP. A month after the intervention there were no significant differences between groups regarding the mean values of Qmax and IPSS. The authors conclude that although some parameters were equal in the two groups, the less pronounced decrease in serum sodium levels lowers the risk of TURP syndrome, while the use of saline solution may allow the approach of large prostates.

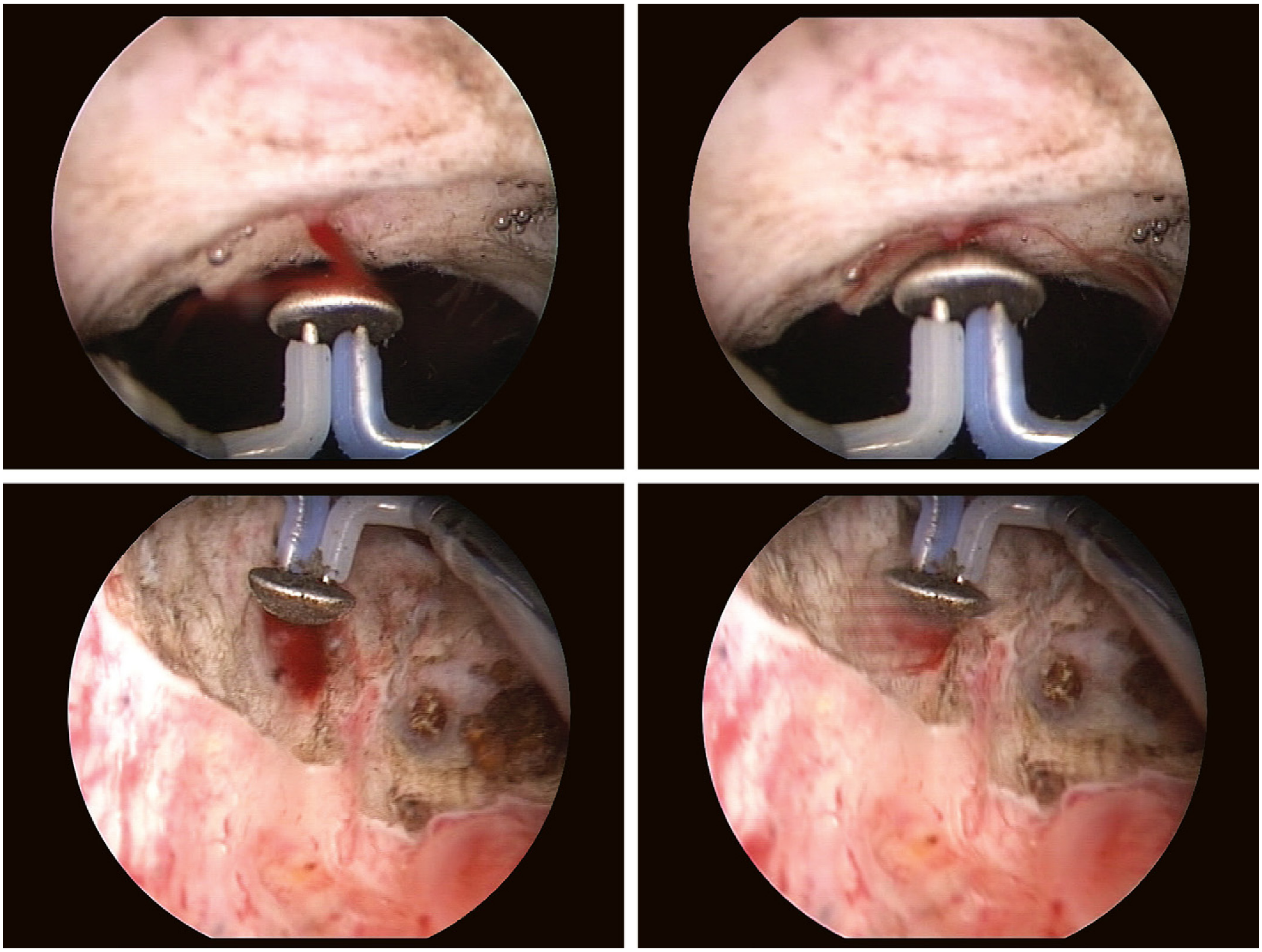

FIGURE 4.11 **Coagulation using the "mushroom."**

TABLE 4.2 Comparative Analysis of Long-Term Results

	PKVP		TURP	
Criterion	**2 years**	**3 years**	**2 years**	**3 years**
IPSS	7.1	7.6	5.2	5.7
Qmax (mL/s)	12.5	14.4	14.4	21.8

The most frequent complications in patients undergoing vaporization were the irritative ones, occurring at a rate of 12.2% of cases (Tefekli et al., 2005). Recatheterization was necessary in a proportion of 6.1%, while 4.1% of patients underwent reintervention.

This therapeutic method for patients with prostate adenoma is safer than the traditional method. However, irritative phenomena and the high rate of urethral strictures reported by some authors (Liu et al., 2009)

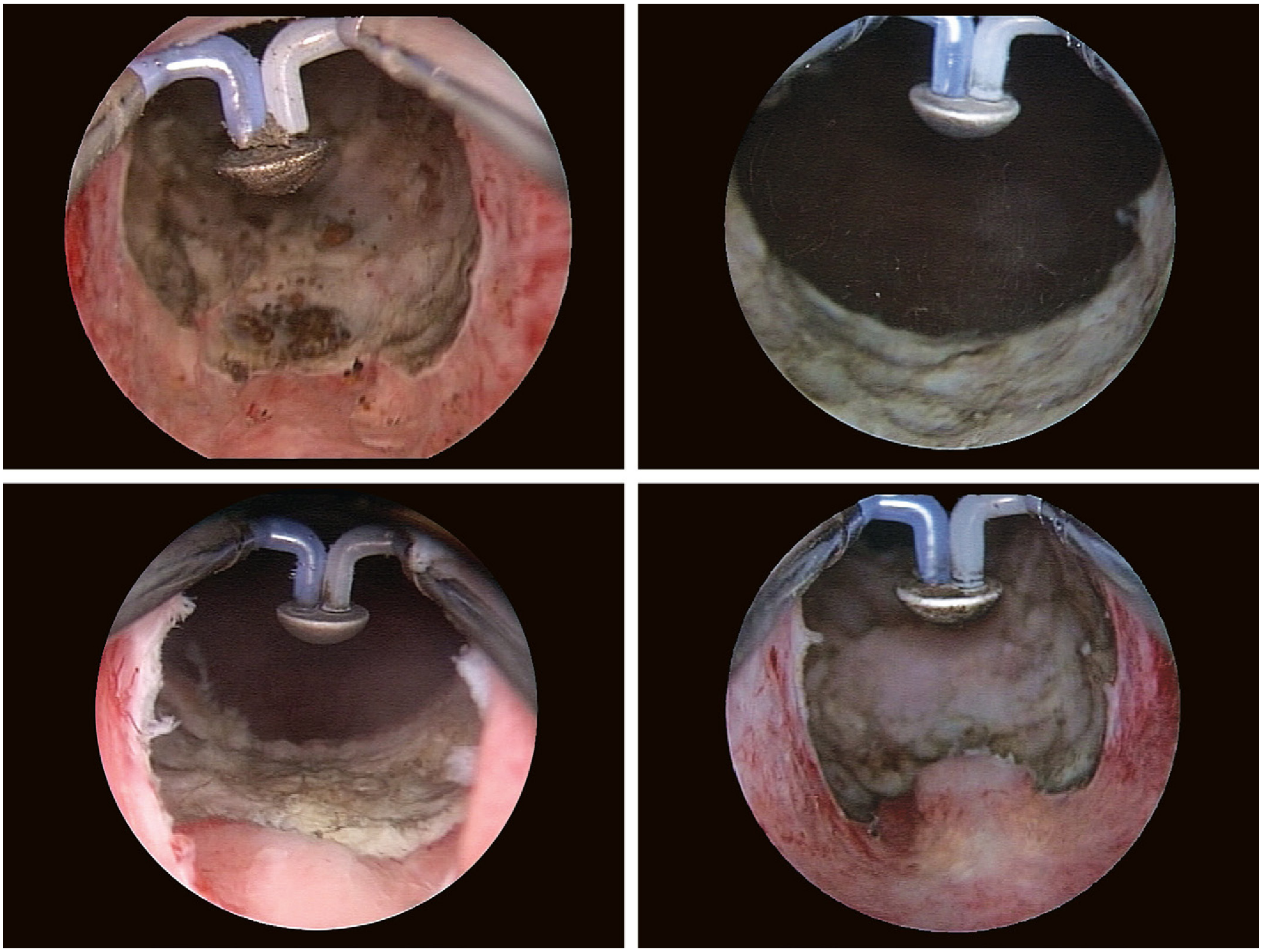

FIGURE 4.12 **Prostatic lodge after vaporization.**

should be the subject of future studies. The high rates of recatheterization reported by Dunsmuir et al. (2003) and Tefekli et al. (2005) in the studies that analyzed plasmakinetic vaporization can be attributed to residual adenomatous tissue edema.

4.4.2 The TURis System

Recent randomized studies (Chen et al., 2010) have shown that in terms of operating time and amount of tissue resected, the parameters were similar in both groups (TURP vs. TURis). The advantages of TURis consist in a less pronounced reduction of serum sodium levels and of hemoglobin. Also, the amount of fluid absorbed is lower for the new method (208 mL) compared to the standard one (512 mL).

While achieving postoperative results similar to monopolar resection, it is considered that TURis ensures maximum safety and low complication rates, the most common of which are represented by postoperative urethral strictures (Puppo et al., 2009) (Table 4.3).

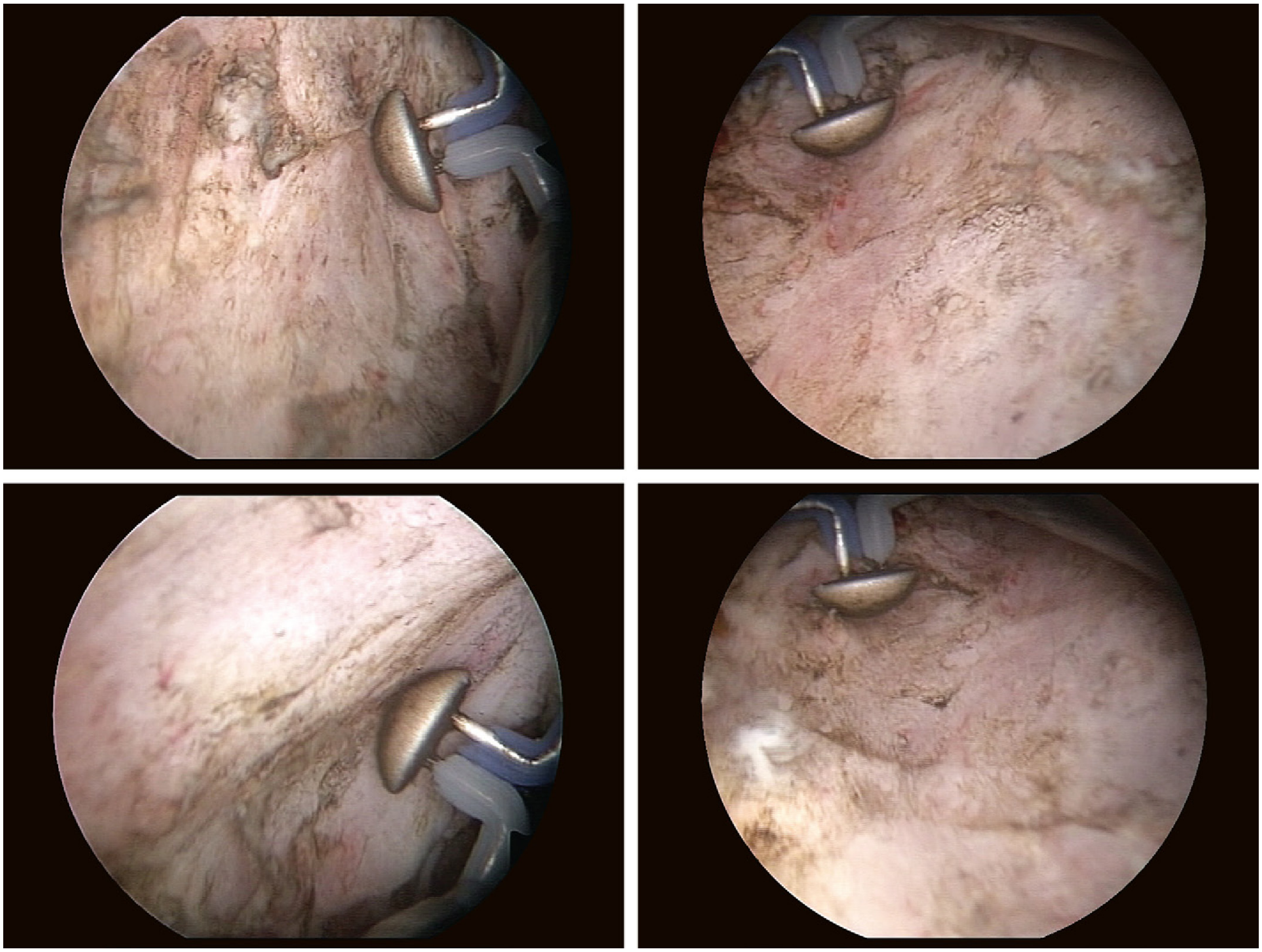

FIGURE 4.13 **Final postoperative aspect (prostatic capsule identification).**

TABLE 4.3 Intra- and Postoperative Complications After TURis

Complication	Percentage (%)
Blood transfusions	1.1–4
TURP syndrome	0
Urethral strictures	2.7–4
Bladder neck sclerosis	1
Urinary retention	2.1

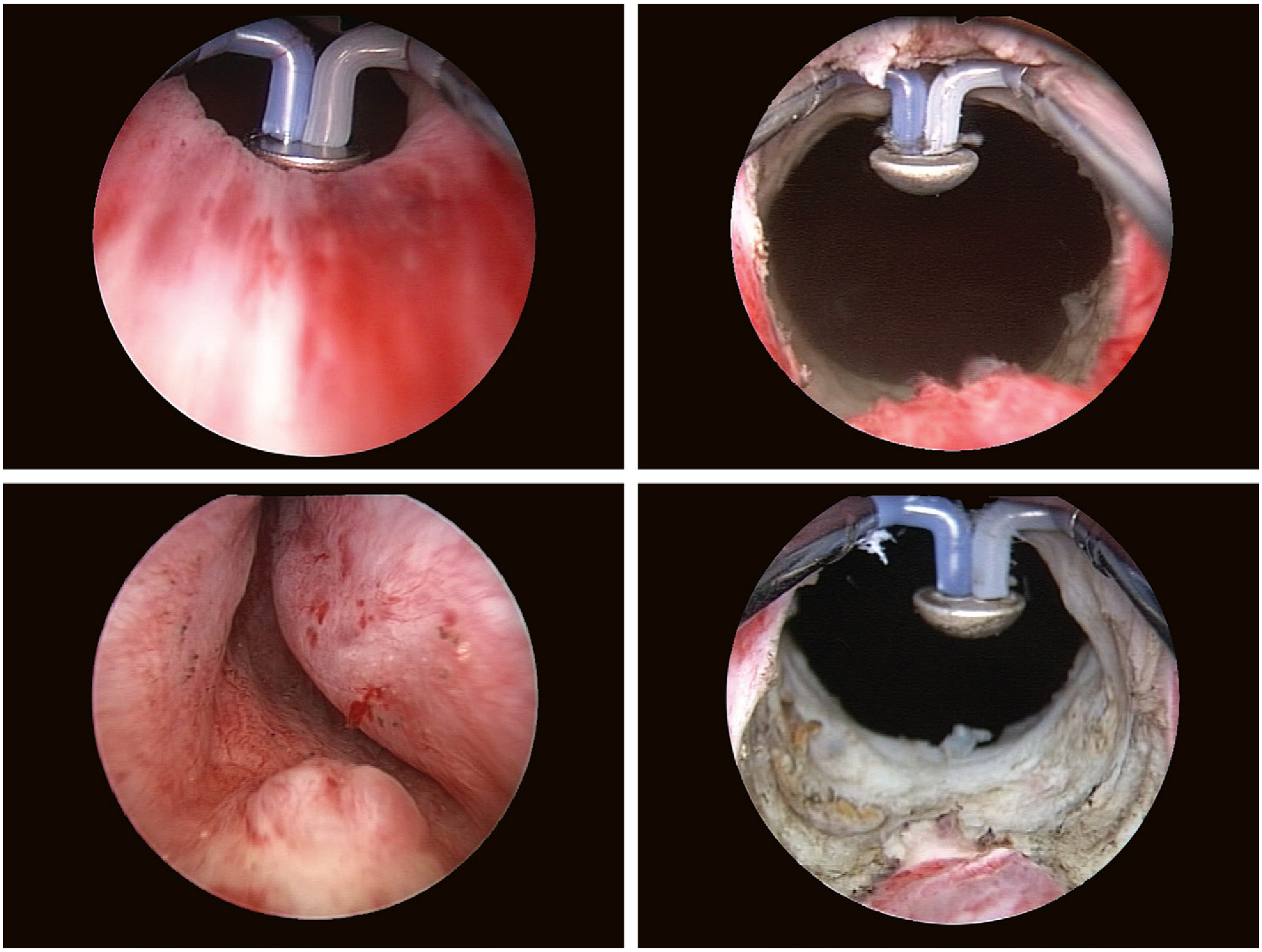

FIGURE 4.14 **Pre- and postoperative comparative aspects.**

TURP syndrome, a formidable complication of transurethral resection, has been the subject of numerous research papers. Thus, in a randomized, prospective study (Singhania et al., 2010) the efficacy and safety of bipolar resection (which used saline irrigation of 0.9% NaCl) were evaluated in comparison with standard TURP (which used 1.5% glycine). The group that underwent monopolar resection presented more important declines of sodium levels and osmolarity (4.12 mEq./L and 5.14 mOsmol/L, respectively) compared to the TURis group (1.25 mEq./L and 0.43 mOsmol/L). The decrease in hemoglobin levels was also studied (0.55 gm% for TURis and 0.97 gm% for TURP, respectively). These results, confirmed by other studies as well (Reich et al., 2010), emphasize once again the high safety level of TURis, while providing an efficacy comparable to TURP.

Intra- or postoperative bleeding is a common complication that occurs after TURP, thus justifying the search for new minimally invasive approaches. The analysis of the incidence of bleeding in the case of TURis demonstrates a 34% lower level of bleeding compared to monopolar resection (Fagerström et al., 2010).

The results of studies published in Romania overlap with those published in the literature, confirming the advantages of this new treatment method (Geavlete et al., 2010) (Table 4.4). All these studies demonstrate that electrovaporization of the prostate is a promising alternative for the treatment of patients with prostate adenoma, showing a good efficiency, low morbidity, and rapid postoperative recovery.

As additional arguments, the short periods of catheterization and hospitalization can be mentioned as well as the low complication rates and the significant improvement of functional parameters during follow-up.

TABLE 4.4 Comparative Analysis of the Results of TURis versus TURP

	TURis		TURP	
Criterion	**3 months**	**6 months**	**3 months**	**6 months**
IPSS	4.8	5	8.6	9.1
Qmax (mL/s)	22.3	21.8	20.0	19.3
Residual volume (mL)	18	16	28.5	26.0

In this regard, bipolar endoscopic techniques have proved to be at least equal, and in many cases superior, to traditional monopolar resection. In conclusion, the latter's status as "gold standard" in the endoscopic treatment of prostate adenoma appears to be seriously questioned.

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CHAPTER

5

Endoscopic Incision of the Prostate (TUIP)

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5.1 GENERALITIES

Transurethral incision of the prostate (TUIP) is a surgical technique developed in the mid-nineteenth century. The first descriptions date back to 1834, when Guthrie suggested mechanical dilaceration of the bladder neck (Hedlund and Ek, 1985). However, there is no clinical data regarding the number of interventions or Guthrie's results. During the same period (1887) Bottini proposed a similar technique, based on diathermy (Edwards et al., 1985). However, at that time, TUIP was not embraced on a wide scale as a viable alternative for the treatment of prostate adenoma.

The technique of TUIP was originally described by Keitzer as an endoscopic alternative for treating subvesical obstruction in younger patients with small prostate adenomas (Keitzer et al., 1961). The principle of the technique is different from transurethral resection of the prostate (TURP): removal of the obstruction by decreasing the constrictive tonus, secondary to prostate incision (and not by tissue resection, as in the case of TURP) (Fig. 5.1).

Since its introduction, TUIP has gradually taken its place in the therapeutic arsenal, especially due to its simplicity, low complication rate, and satisfactory long-term results. In addition, most authors consider that it is easy to learn this technique. The first long-term results were published by Orandi (1973), who recommends TUIP as a viable therapeutic method in young patients with moderate prostate volumes or in those with associated conditions that contraindicate excision. On the other hand, the intervention is not justified in the absence of significant obstructive symptomatology.

5.2 INDICATIONS

According to the European Association of Urology guidelines, TUIP is indicated in patients with a prostate volume that does not exceed 30 cm^3 (measured by transrectal ultrasound) (Fig. 5.2) and that does not have a median lobe. The EAU recommendation is based on the analysis of many randomized clinical trials comparing TUIP with TURP, the therapeutic gold standard of the moment, in terms of effectiveness, intra- and postoperative complication rates, and long-term outcomes (de la Rosette et al., 2010) (Fig. 5.3).

The experience gained over time makes some authors assert that TUIP can also be performed with good results in the case of adenomas with a volume exceeding 30 cm^3 in young patients or in patients who associate other conditions that contraindicate other methods of treatment. Initially, TUIP represented a method of surgical treatment indicated in patients with small, obstructive adenomas who were not candidates for TURP or for open surgery. This target group consisted of young men with considerable obstructive symptoms but who did not have significantly enlarged prostates.

It was found that, given a similar symptomatology, patients with small prostates (Fig. 5.4) mainly have stromal hyperplasia and respond less favorably to TURP as compared to men who have bulky prostate adenomas with glandular hyperplasia (Kelly et al., 1989).

Some authors have indicated TUIP in patients with bulky adenomas (Orandi, 1985). In these cases deep incisions were performed, invariably leading to the opening of the venous sinuses and to perforation of the capsule, causing

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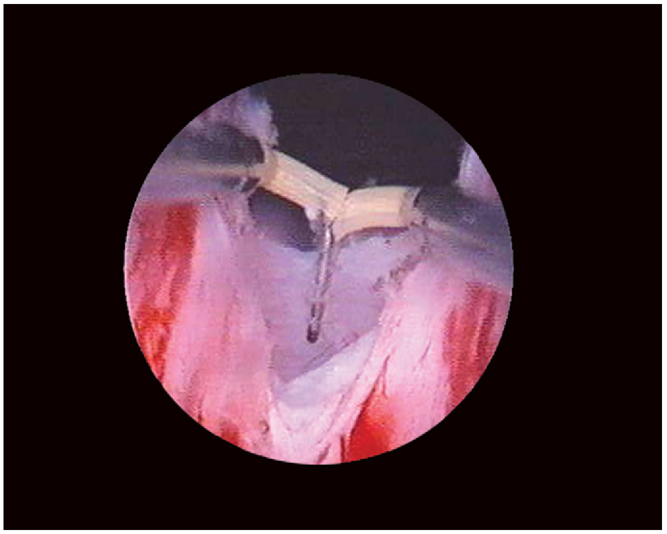

FIGURE 5.1 Transurethral prostate incision.

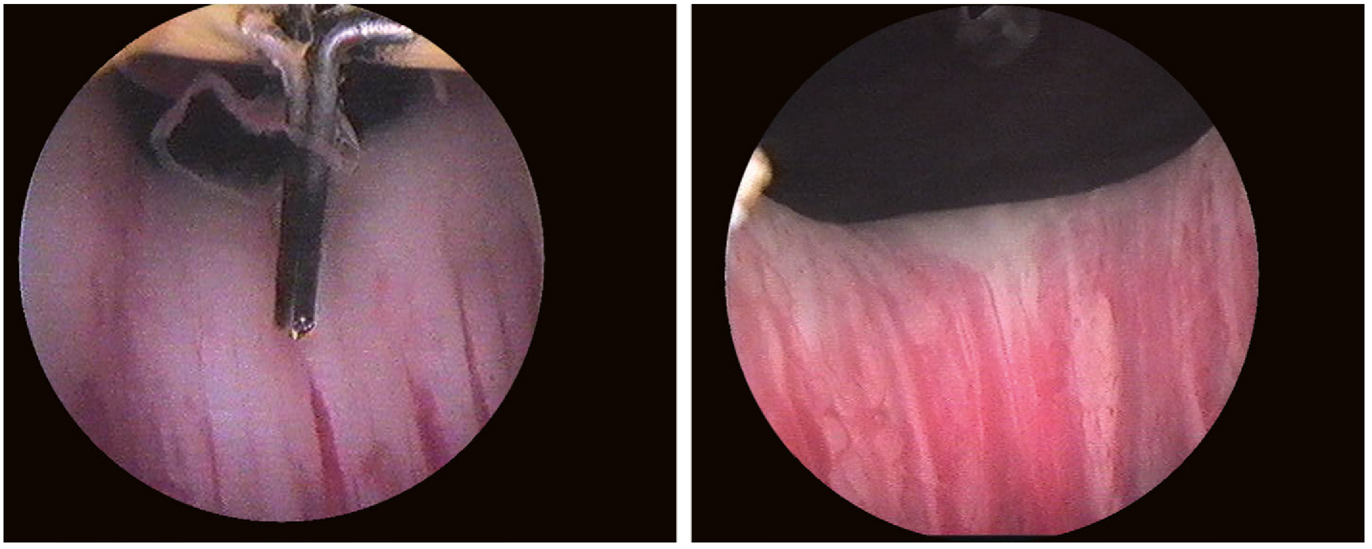

FIGURE 5.2 Prostate adenoma with TUIP indication.

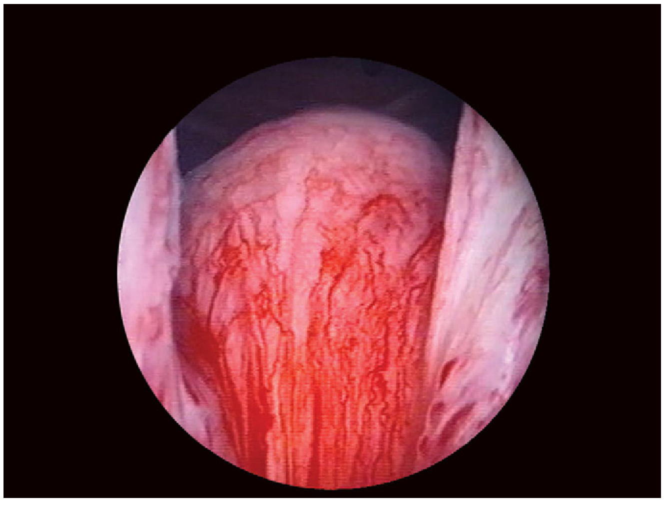

FIGURE 5.3 Prostate adenoma with contraindication for TUIP (presence of a median lobe).

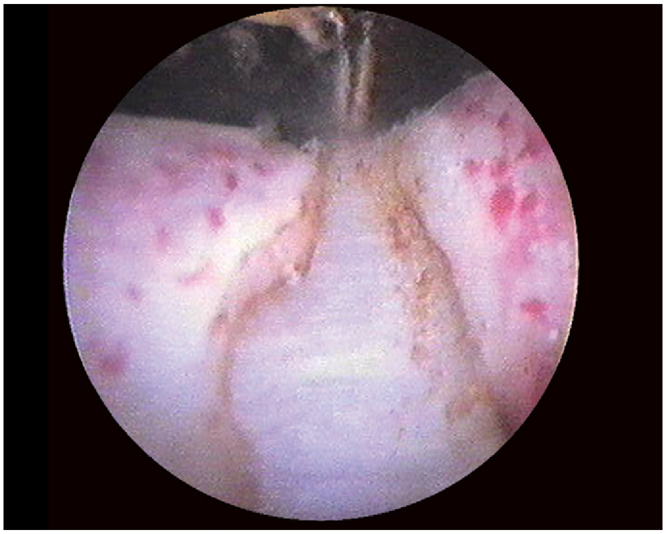

FIGURE 5.4 **TUIP in a young patient with a prostate under 30 cm^3.**

extravasation and uncontrolled venous bleeding. Fulguration was frequently required, which significantly increased the incidence of postoperative complications.

Another indication of TUIP is the obstruction of the bladder neck after TURP (Fig. 5.5) or transvesical adenomectomy (Jocius and Sukys, 2002). A rare indication for TUIP is represented by a median cyst of the prostatic urethra (Fuse et al., 2003) (Fig. 5.6).

5.3 SURGICAL TECHNIQUE

This technique has some undeniable advantages: it is relatively easy to learn, fast, and has a low cost, with good functional results if the indication is correct. Most commonly, the intervention is performed under spinal anesthesia, although some authors prefer general anesthesia. More and more authors are now using only local anesthesia. This can be a major advantage in patients with anesthetic risk and for departments that are trying to reduce costs.

The instruments used are represented by the resectoscope or the rigid urethrocystoscope with a 30° telescope. Practically all of the accessory tools that allow this maneuver can be used for the incision: cold knife (Fig. 5.7), Collings loop, mono- or bipolar resection loops, vaporization electrodes, laser fibers (Fig. 5.8), etc.

The instrument of choice with which the incision is made must favor the least expensive procedure, the literature demonstrating that no tool or technique provides better results than the other. Therefore, the use of expensive equipment for TUIP is unjustified, and these should be directed toward other procedures where they can make a noticeable therapeutic difference.

The first description of the surgical technique belongs to Orandi (1973), who modified the "prostate divulsion" technique imagined by Aboulker and Steg (1964). Thus, he suggested that endoscopic incision of the prostate could have an efficiency similar to the divulsion technique but with fewer complications. Initially, access to the bladder was achieved through a perineal urethrotomy.

A resectoscope is generally used to make incisions (usually with the Collings loop) at 5 and 7 o'clock, starting distally from the ureteral orifices, extending to the prostatic urethra, and ending proximal to both sides of the verumontanum (Fig. 5.9).

In younger patients who wanted to preserve ejaculation, Orandi modified the technique, performing superficial incisions limited to the prostatic urethra without extension to the bladder neck. This amendment was subsequently embraced by other authors (Ruzic et al., 2002), who performed short and shallow incisions at 5 and 7 o'clock, located exclusively at the level of the prostatic urethra and reaching the fibrous capsule. This provided a significant increase of the maximum urinary flow rate and an important reduction of symptoms, while maintaining normal ejaculation in most patients.

The technique was modified by numerous authors, who described the use of a single incision for TUIP (Geavlete, 2001). Single incisions were usually performed at 5, 6, or 7 o'clock, with extension to both sides of the

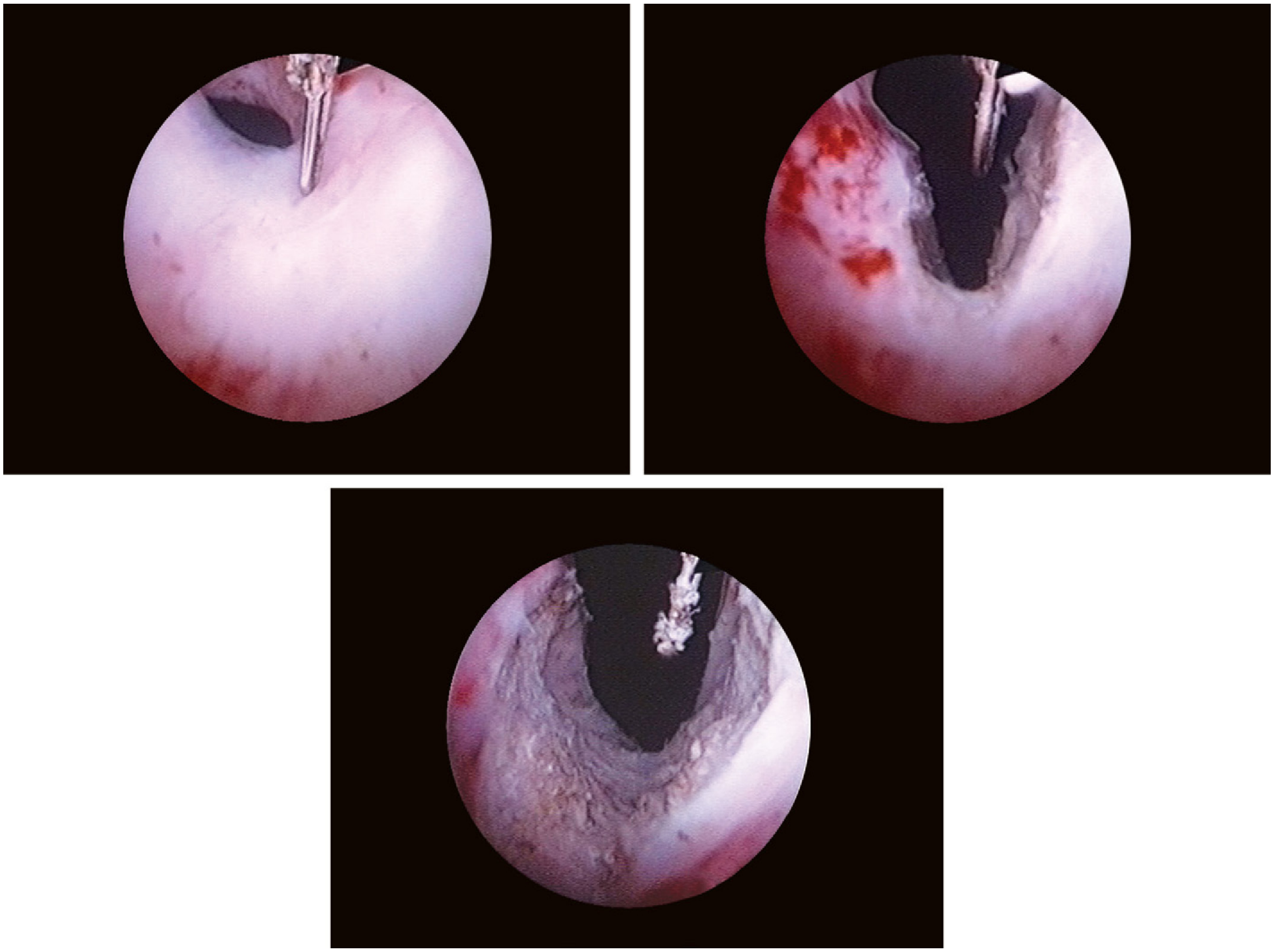

FIGURE 5.5 **TUIP in a patient with bladder neck obstruction after TURP.**

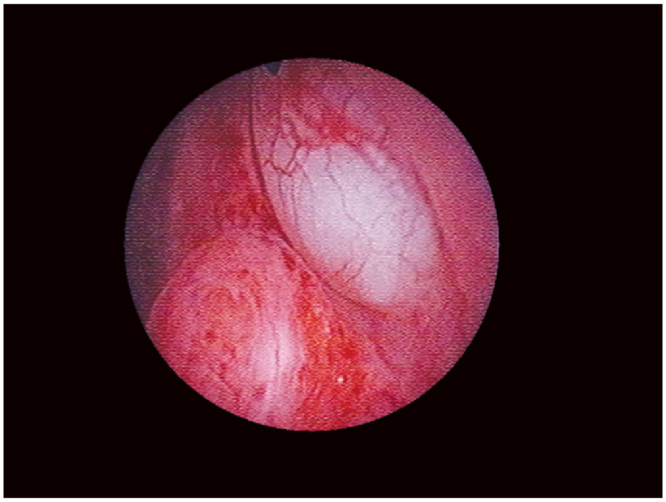

FIGURE 5.6 **Cystic tumor lesion of the prostatic urethra.**

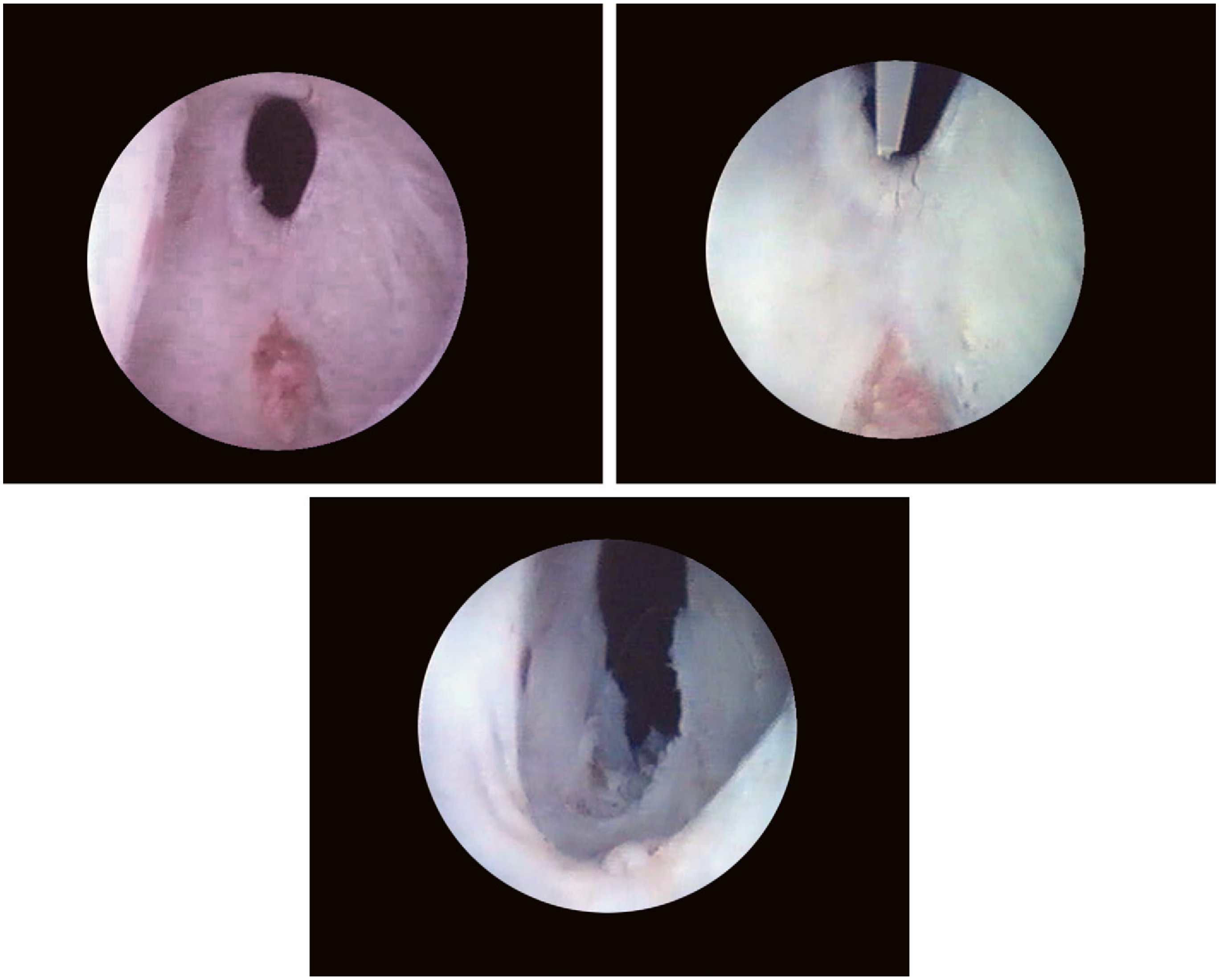

FIGURE 5.7 **Cold knife TUIP in a patient with cervical sclerosis after TURP.**

verumontanum (Fig. 5.10). By using a single incision on the midline, most authors reported a significant reduction in the incidence of retrograde ejaculation (15–5%) as well as clinical outcomes comparable with the classical technique (Turner-Warwick, 1979; Geavlete, 2001). Other authors consider that the results are similar regardless of the type of incision: single or multiple. A recommendation cannot be made in the present (supported by clinical evidence) in favor of single or multiple incisions. Global analysis of the available data shows that single incision is most frequently located at 6 o'clock, while in the case of multiple incisions, they are most often done at 5 and 7 o'clock. The changes described by other authors consist of the use of Nd:Yag or Ho:Yag lasers for making the incision (Johnson et al., 1992) but with no comparative studies to prove their superiority. There are authors who report using a greater number of incisions, with different locations around the circumference of the prostate, but there is no clinical data to justify this approach.

An interesting technical alternative is represented by the association between TUIP and posterior resection of the prostate at 4 and 8 o'clock (Lin, 1992). The authors report that this method avoids adhesions that may occur between the incised parts of the prostate, thereby facilitating the maintenance of deep incisions up to the prostatic capsule.

Other authors made a channel in the prostate tissue using endoscopic resection, thus also obtaining prostate tissue specimens for histopathological diagnosis. Although they reported an efficacy similar to TUIP, they also noticed a higher reintervention rate due to postoperative urine retention (Simşek et al., 1993). Minimal transurethral prostate resection combined with bladder neck incision proved to be superior to standard TURP, due to the lack of difficulty in inserting the urethral catheter at the end of surgery, the reduction of bladder neck contraction, and the reduced

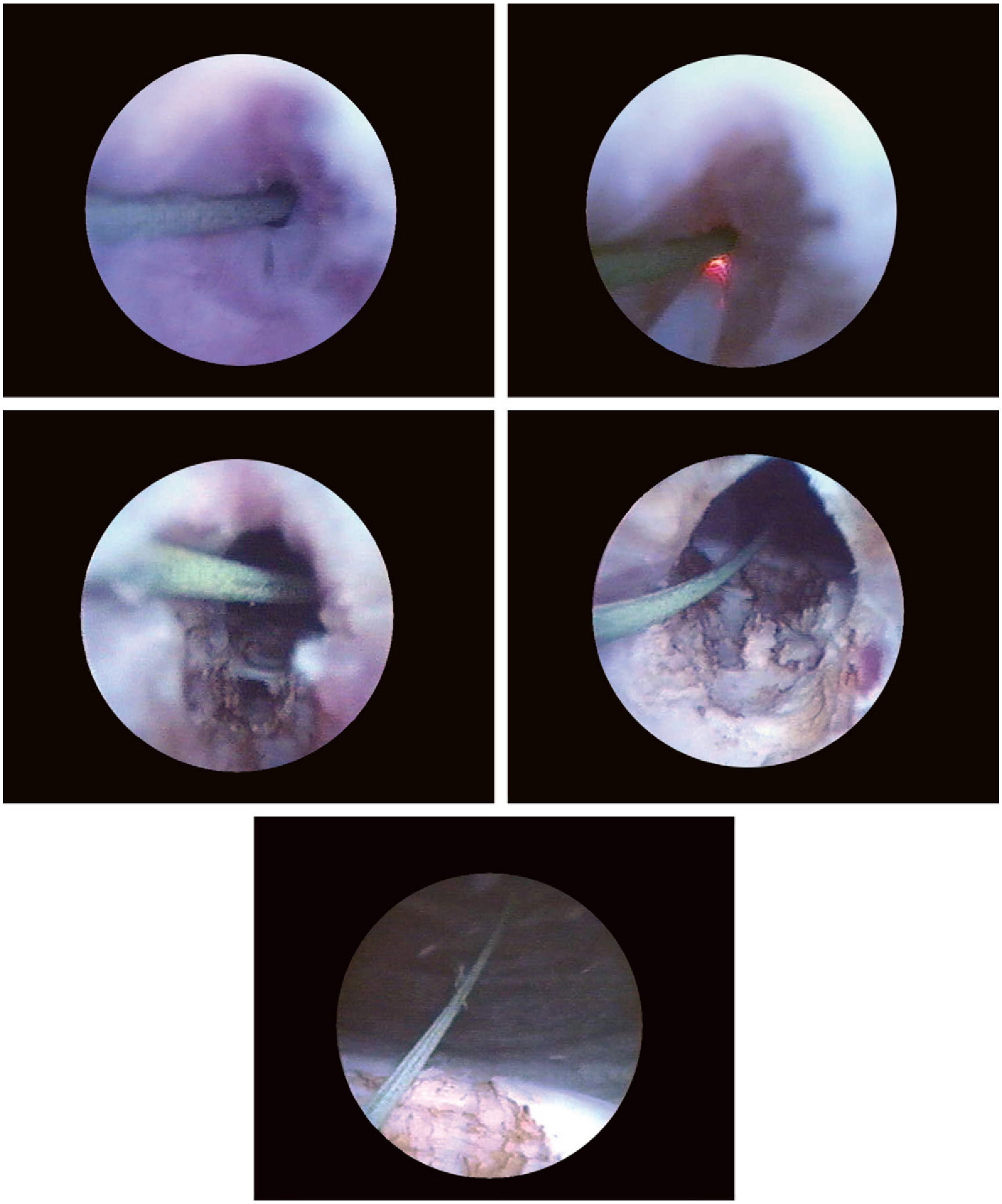

FIGURE 5.8 **Nd:YAG laser TUIP.**

incidence of retrograde ejaculation (Yeni et al., 2002). However, this study is an isolated experience, which was not supported by other data.

A technical alternative proposes to limit incisions to the bladder neck, considering that it is useless to extend these incisions toward the verumontanum or distal to it. The benefits include a shorter operating time and a shorter catheterization period (Miller et al., 1992), with similar long-term results.

No matter which technical option is chosen, with regards to the depth of the incision, this should be performed up to the prostatic capsule. This is a structure that is easy to recognize due to its endoscopic appearance, which is completely different from that of the prostatic tissue (Fig. 5.11).

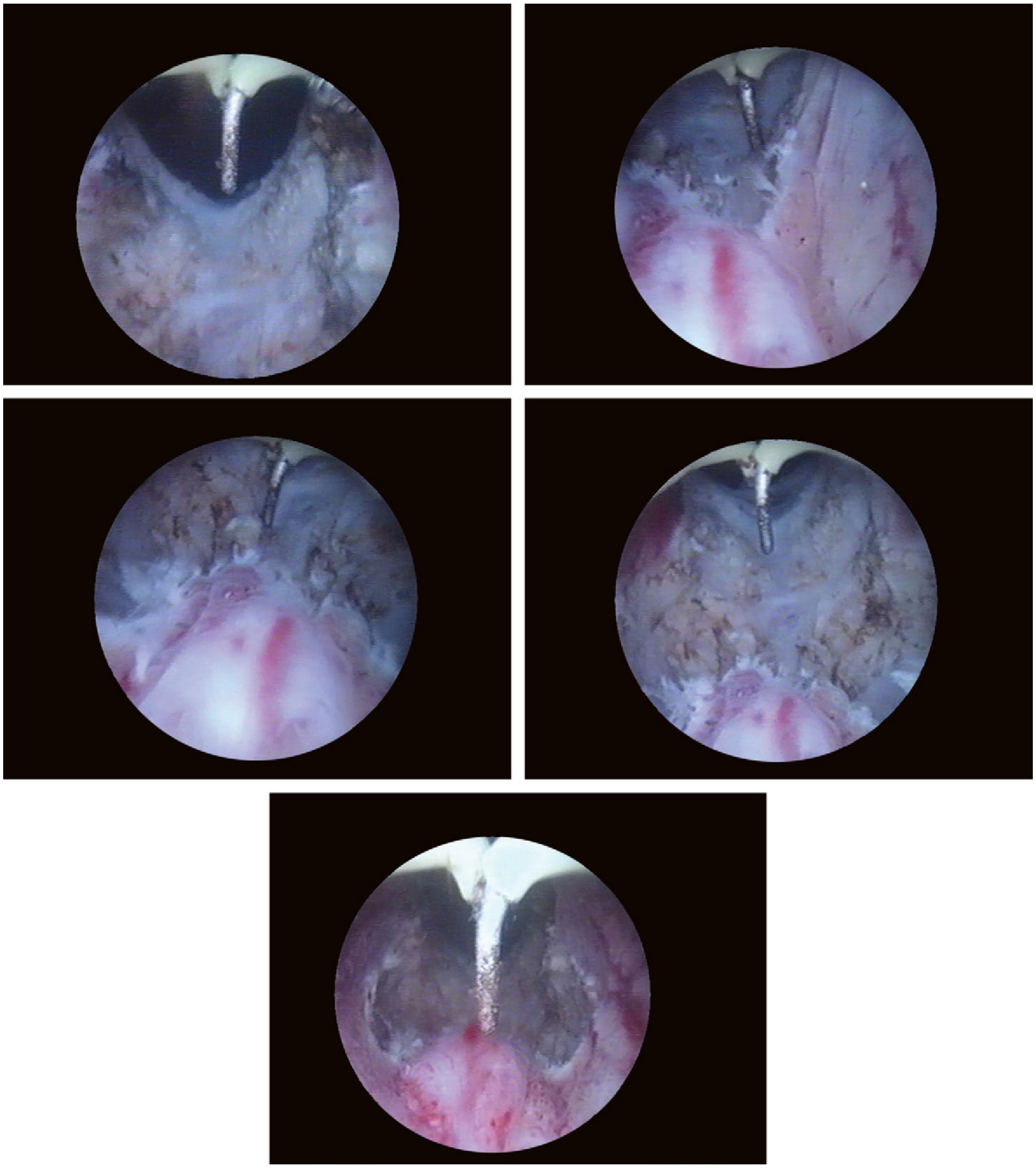

FIGURE 5.9 **Extension of the incisions at 5 and 7 o'clock to the prostatic urethra on both sides of the verumontanum.**

An incision exceeding in depth the prostatic capsule is associated with the risk of damaging the rectum or of extravasation of irrigation fluid (Fig. 5.12).

At the end of the intervention, the aspect of the bladder neck will be assessed, with the endoscope placed distal to the prostatic urethra. If there is no visible obstruction of the bladder neck, the intervention can be concluded with the insertion of an urethro-vesical catheter, which will be maintained for a period of 24–72 h, depending on local anatomical features or on other associated conditions (Fig. 5.13).

Some authors avoid inserting an urethro-vesical catheter, stating that in this way, postoperative bleeding is significantly reduced while obtaining a similar functional result. However, there is no clinical evidence to recommend a minimum catheterization period.

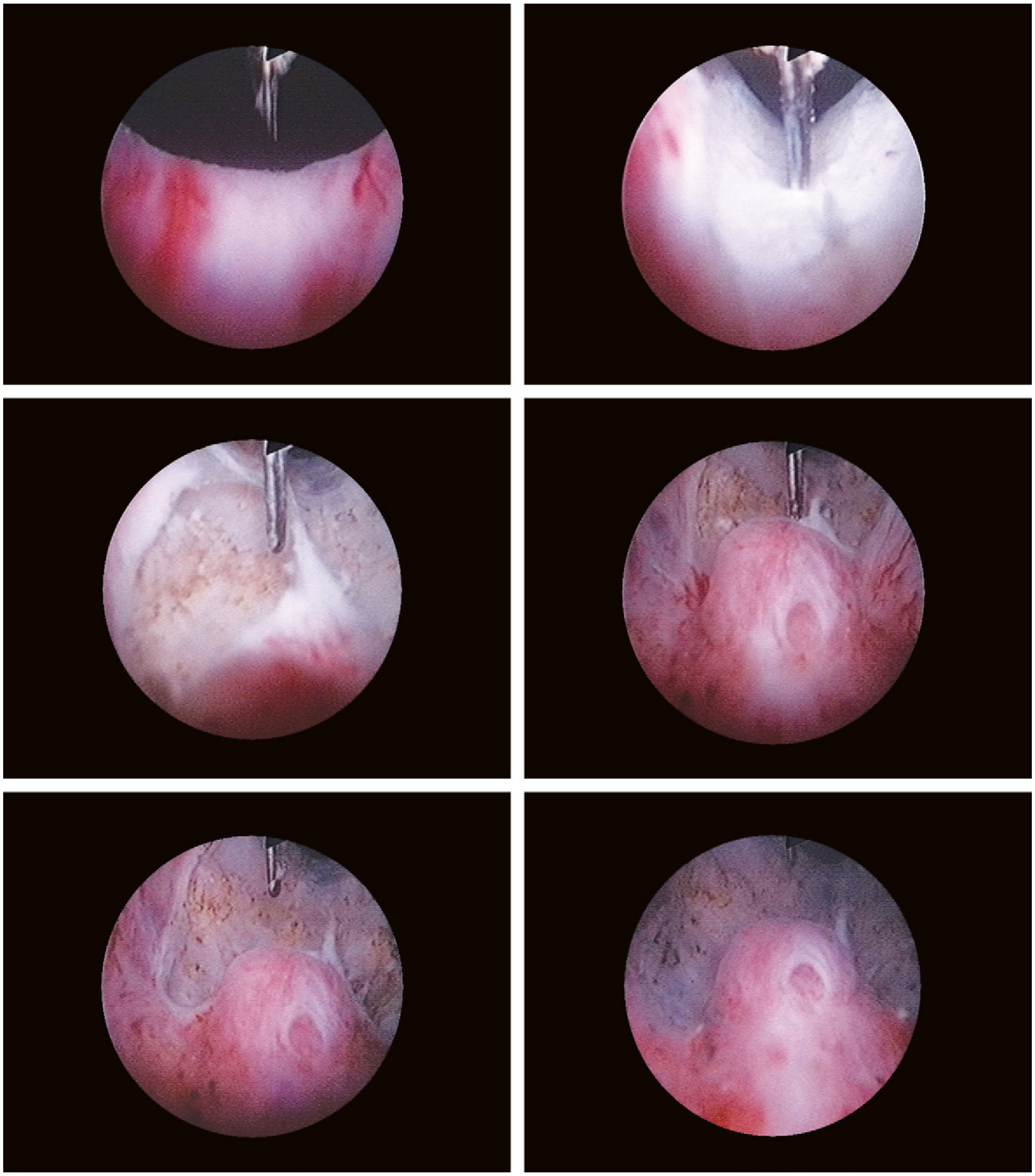

FIGURE 5.10 **Modified TUIP technique: a single incision in the bladder neck with extension to both sides of the verumontanum (the inverted "Y").**

5.4 COMPLICATIONS

In general, for any method to be considered a viable alternative to a given standard treatment, it must have a similar efficacy with lower risks. Hydroelectrolytic disorders and intraoperative bleeding are the main complications of TURP (McConnell et al., 1994). Sexual function alterations that occur after TURP include erectile dysfunction and retrograde ejaculation. A major advantage of TUIP over TURP, important especially in young patients but which should be considered in the elderly as well, is a much lower incidence of retrograde ejaculation. If in the case of TURP, an incidence of retrograde ejaculation of approximately 50–95% is accepted, for TUIP this value decreases dramatically, even dropping below 10%.

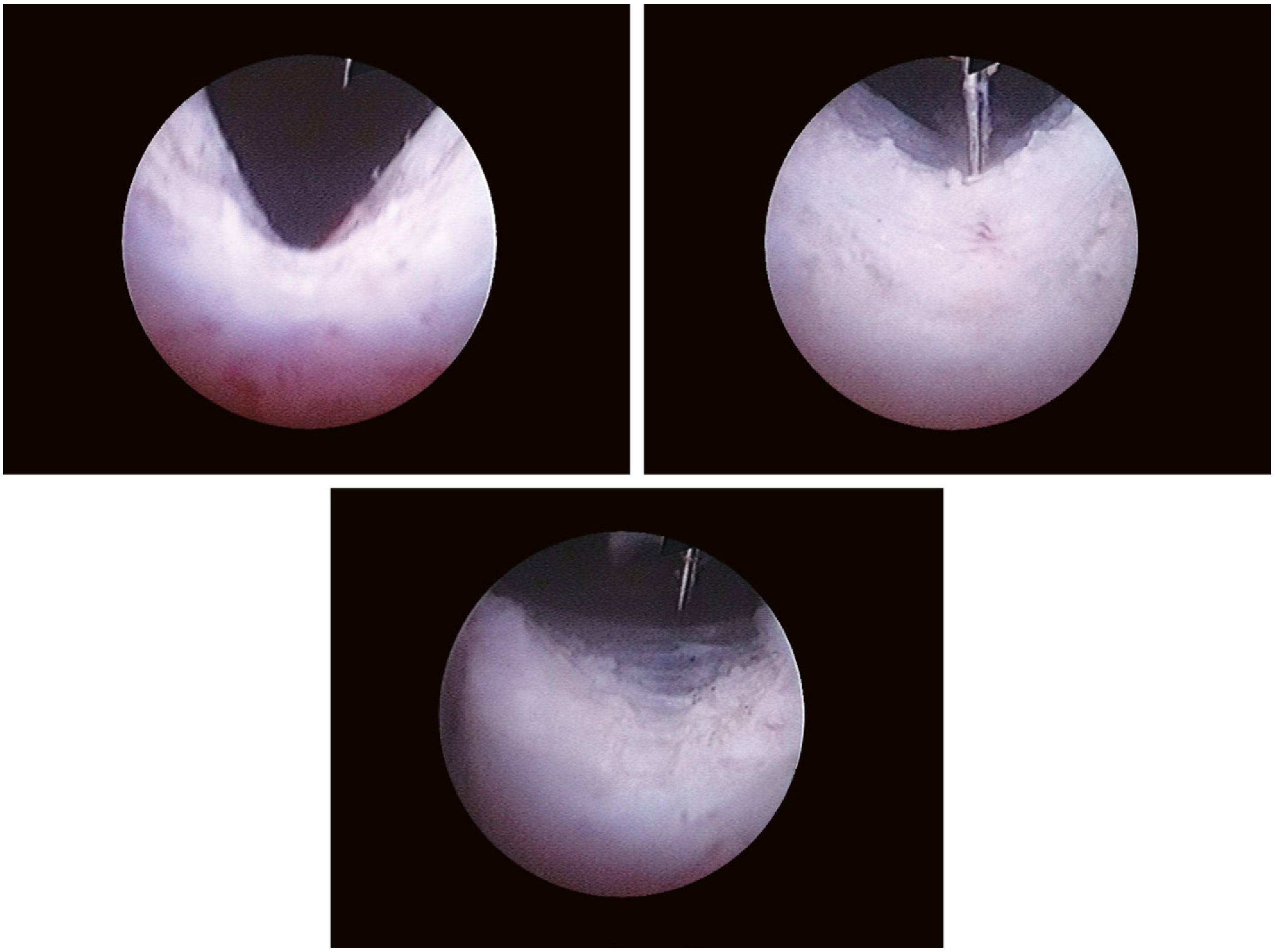

FIGURE 5.11 **The incision at 6 o'clock up to the prostatic capsule.**

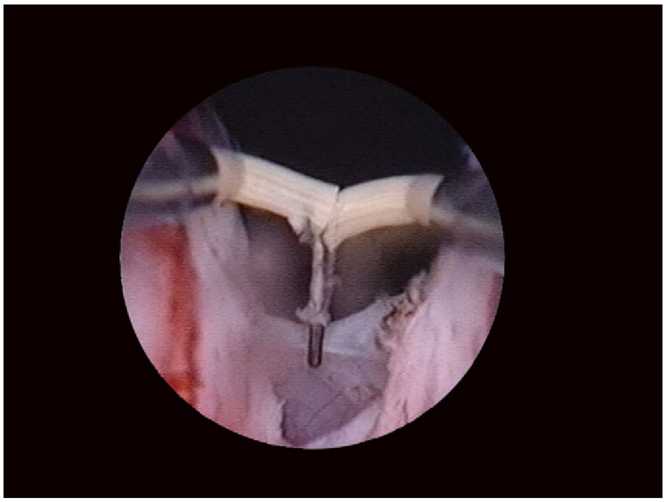

FIGURE 5.12 **Damage to the prostatic capsule during TUIP.**

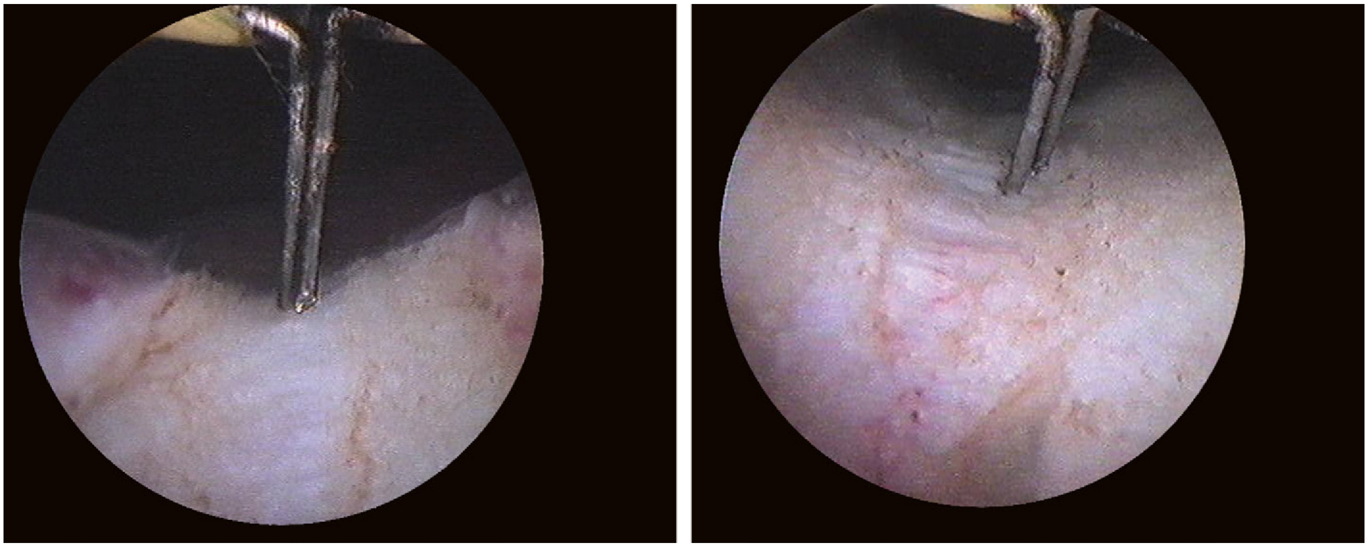

FIGURE 5.13 **Final aspect (unobstructive) of the bladder neck after TUIP.**

5.4.1 Intraoperative Complications

Because the operating time is relatively short in TUIP, hydroelectrolytic disorders are not encountered and are not mentioned in any major study. TUIP is performed much faster than TURP, and the volume of liquid necessary for lavage is significantly lower. Severe bleeding requiring blood transfusions very rarely occurs in patients with TUIP. Dorflinger et al. (1992) showed that blood transfusions were necessary in 13% of patients with TURP and were not required in any patient with TUIP. Edwards reported a transfusion rate of 1.6% in patients with TUIP and 19.6% in patients with TURP (Edwards and Powell, 1982). In Orandi's group (646 patients with TUIP), 6 patients (1%) required blood transfusions.

5.4.2 Postoperative Complications

Edwards observed a rate of retention due to clots of 1.3% in the TUIP group and 2.3% in the TURP group (Edwards et al., 1985). Dorflinger assessed 43 sexually active patients, randomized into two groups: TUIP and TURP. At 1 year after surgery it was observed that only 1 of 19 patients with TUIP presented retrograde ejaculation, as compared to 12 of 24 for TURP (Dorflinger et al., 1992).

Larsen reported that 2 of 7 patients with TUIP presented retrograde ejaculation, while 8 of 8 patients with TURP had this complication (Larsen et al., 1987). Christensen reported a 13% incidence of retrograde ejaculation in the TUIP group, as compared to 37% in the TURP group (Christensen et al., 1990).

5.5 RESULTS

In order to benefit from a complete and accurate assessment of an intervention that aims to restore the functional status of the lower urinary tract, standardized and unanimously accepted instruments are necessary, producing comparable and reproducible data.

As with other alternatives used in the treatment of benign prostatic hyperplasia (BPH), it is necessary to objectively evaluate the extent of the patient's suffering. The use of symptomatic scores and questionnaires that assess the quality of life – IPSS, BOO, QOL, etc. – is the best means by which the physician can understand how upset and concerned the patient is by his urinary problems. Similarly, the results of the intervention can be assessed, or more exactly, the patient's perception of them. A study published by Katz in 1994 reported a satisfaction rate of 94% after TUIP, clearly superior to another group of patients who underwent TURP (Katz et al., 1990). From an objective standpoint, the most accurate and complete evaluation is given by urodynamic exams. If the usefulness of flowmetry is currently limited due to the high variability between individuals, the same cannot be said about the pressure flow study, which allows an accurate correlation between detrusor pressure and the urinary flow obtained.

Establishing standardized examination techniques allowed the results obtained by different authors to be compared and analyzed. In this way, they noticed a significant decrease after TUIP in detrusor pressure at the moment of urination. The use of Abrams–Griffith nomograms demonstrated in a significant number of cases results interpreted as equivocal in patients who before surgery would qualify in the obstruction category. This finding signifies a decrease of detrusor pressure at the moment of urination, concomitantly with an improvement of urinary flow values.

A study published by Sirls et al. (1993) on a relatively small group of patients shows a decrease of maximum detrusor pressure from 84.5 cm water preoperatively to 44.5 cm water, a value that can be assigned as the upper limit of normal in conjunction with the patient's age. This study also shows a reduction by half of postmictional residues. The authors point out that the best results were observed in patients with prostates not exceeding 30 cm^3 (Sirls et al., 1993).

The first major study regarding the efficacy of TUIP was performed by Orandi (1973). He presented excellent initial results after treating 40 patients. Later, after 646 interventions, he published an extensive evaluation covering 15 years (Orandi, 1985). He obtained a considerable improvement of symptoms in 79% of cases, a slight improvement in 11% of cases, and unfavorable results in 10% of cases. Although the overall rate of complications was not different as compared to a group of patients who underwent TURP, the incidence of bladder neck sclerosis was higher in patients treated by resection.

Another study conducted on 100 patients with prostate adenoma with a maximum volume of 30 cm^3, in whom incisions were performed at 5 and 7 o'clock (from the bladder neck up to 1 mm proximal to the verumontanum), showed an increase of mean urinary flow rate from 7.6 mL/s preoperatively to 12.6 mL/s after surgery (Drago, 1991). After 1 year, the symptom score improved in 80% of patients. TURP was necessary in 12 patients, while 3% of patients had retrograde ejaculation. Drago emphasizes that the cost of the TUIP procedure is significantly lower.

Kelly et al. assessed 26 patients treated with TUIP, showing a significant decrease of the symptomatic scores (9.6–2.8) and a significant improvement of urodynamic parameters such as maximum flow rate (5.1–10.8 mL/s), detrusor pressure at maximum flow rate (102.5–58.3 cm H_2O), and incidence of detrusor instability (46–27%). The authors reported only one complication (retention due to clots) (Kelly et al., 1989).

Sirls et al. (1994) evaluated the long-term efficacy of TUIP using objective (urodynamic) and subjective (symptom score and evaluation of sexual function) parameters. The study group consisted of 41 men, and the mean follow-up period was 53 months. Preoperative and postoperative symptomatic scores (Madsen–Iversen) and urodynamic parameters were compared. Mean symptomatic scores decreased from 12.5 to 6.9, while the flow rate increased from 10 mL/s to 15 mL/s. The incidence of retrograde ejaculation was 11%. Only one patient required prolonged hospitalization for hematuria (3 days). This study argues that TUIP is an effective treatment over the long term for selected patients with bladder obstruction.

In a prospective randomized study, Christensen compared the long-term results achieved after TUIP and TURP, respectively, in patients with prostate adenomas of approximately 20 g. In patients treated with TUIP, a single incision was performed at 6 o'clock, from the interureteric ridge to the verumontanum. In the TURP group, 95% of patients experienced a significant improvement at 3 months and 64% at 3 and 4 years. In the TUIP group, 81% of patients showed improvement at 3 months and 78% at 3 and 4 years. Four years after the procedure, the maximum flow rate was significantly higher than the preoperative maximum flow rate in the TUIP group (10.9 mL/s vs. 7.8 mL/s). Similar results were reported in the TURP group (14.6 mL/s vs. 9.7 mL/s). The authors concluded that in patients with small prostatic adenomas, the efficacy of TUIP was similar to that of TURP (Christensen et al., 1990).

These results were confirmed by other prospective studies comparing the two methods (TUIP vs. TURP) for the treatment of small prostate adenomas (Soonawalla, 1992), thereby confirming that, in selected cases, there are no significant differences between the two methods in terms of long-term efficacy. Furthermore, the rate of blood transfusions is significantly higher for TURP (38% vs. 0% for TUIP), while TUR syndrome occurs in 6.4% of patients with TURP and in none after TUIP. The authors conclude that in these cases, a higher incidence of major complications is observed after TURP. After 34 months of follow-up, Riehmann published similar results on two groups of patients treated with TURP or TUIP, noting a twice higher incidence of retrograde ejaculation in the TURP group and a slightly higher rate of reinterventions in the TUIP group (Riehman et al., 1995).

Many other studies have reported promising results regarding the long-term effectiveness of TUIP, with a significant reduction in morbidity, mortality, hospitalization, and costs compared to TURP. In general, it is considered that improvement of symptoms after TURP occurs in 75–96% of cases, while patients that have been subjected to TUIP have a 78–83% chance of symptom relief. Given the low overall morbidity of TUIP, these data confirm that TUIP is an excellent treatment option (Tkocz and Prajsner, 2002).

Hugosson et al. estimated that the cost of TURP in Sweden is six times higher than the cost of TUIP (performed on an outpatient basis under local anesthesia). On the other hand, TUIP is not an effective procedure for patients with

TABLE 5.1 Summary of Results of Comparative Studies Between TUIP and TURP

	TUIP	TURP
Symptom improvement (%)	78–83	75–96
Morbidity (%)	2.2–33	5.2–30.7
Mortality (%)	0.2–1.5	0.53–3.31
Urinary incontinence (%)	0.061–1.1	0.68–1.4
Reintervention due to complications (%)	1.34–2.65	0.68–10
Erectile dysfunction (%)	3.9–24.5	3.3–34.8
Retrograde ejaculation (%)	6–55	25–99

a large median lobe or with a prostate volume exceeding 30 g. Also, when TUIP is performed, tissue is not collected for histopathological examination (Hugosson et al., 1993). The comparative results reported for all of the studies described earlier are summarized in Table 5.1.

Since its introduction on a large scale, TUIP has earned its place among the methods recommended for the treatment of prostate adenomas smaller than 30 cm^3. This is supported by the European Association of Urology recommendations (based on numerous meta-analyses and randomized trials). TUIP is the best alternative for patients who want to maintain sexual function. The technique is also recommended in young patients and in those with small prostates without a median lobe. The procedure is simple, and it is the cheapest of all transurethral procedures that target the prostate. Data show that the favorable results are maintained over the long term, with an overall rate of complications that appears to be lower compared to transurethral resection.

There are no clinical trials comparing TUIP with the very recent methods of surgical treatment recommended for BPH. As new treatment methods are made available, such as laser therapy, TUMT, TUNA or intraprostatic injection of various agents, the surgeon is faced with the dilemma of choosing the best and most effective treatment option for each patient. After many years of clinical use, TUIP has become an established method of minimally invasive treatment, with good long-term efficacy and in line with therapeutic advances.

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CHAPTER

6

Laser Treatment for Benign Prostatic Hyperplasia

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6.1 HISTORY

The word "LASER" is an acronym for "light amplification by stimulated emission of radiation." Laser is one of the most important scientific discoveries of the last half of the twentieth century, often compared in importance with the discovery of electricity. Shortly after it was discovered, its applications in industry and especially in medicine increased continuously, contributing to many modern methods of diagnosis and treatment. The progress recorded over the last few years (the emergence of new types of lasers and optical fibers) has transformed laser into one of the ideal sources of energy used in medicine. The development of endoscopic instruments and the possibility of using laser fibers with very small diameters have significantly and positively influenced its use in urology, more than in any other medical specialty.

The discovery of laser was made possible by the development of quantum physics at the beginning of the twentieth century. In 1900 Max Planck introduced the concept of discontinuous variation of energy and the notion of photon or quantum energy (elementary and indivisible quantity of energy characterizing a wave of a given frequency). The discovery of the photoelectric effect by Albert Einstein in 1905 and the planetary model of the atom by Ernest Rutherford in 1911 created the premises for Albert Einstein to introduce the concept of stimulated emission of radiation in 1917. He could not specify at that moment the practical applications or how to achieve this (Absten, 1991). However, in 1960, the theory issued by Einstein was applied into practice by T.H. Maimen, who obtained the first laser beam using a synthetic ruby crystal on which light from a high-intensity lamp was focused (through an elliptical mirror). The beam was monochromatic, nondivergent, and coherent (Maiman, 1960).

Thereafter, its practical applications developed in all areas of activity, including medicine: retinal tumor ablation (1961), vaporization of atheromatous plaques (1963), and dental enamel evaporation (1964). The first commercial surgical laser was manufactured in 1965. The following period was marked by the emergence of other types of lasers (e.g., the CO_2 laser in 1967 and the argon laser in 1968).

Laser was used in urology for the first time in 1966 by Parson, who experimentally used a ruby laser on a dog during an open surgery. Two years later, in 1968, Mulvany fragmented a urinary stone with a ruby laser, thus marking the beginning of laser lithotripsy in urology (Floratos and de la Rosette, 1999).

Initial enthusiasm was later tempered by the high cost of the equipment and materials. However, due to the technical progress achieved, especially in the field of fibers, the role of laser in the urologic therapeutic arsenal was re-evaluated, becoming increasingly more important among treatment alternatives for different conditions, especially due to its clear advantages in terms of postoperative morbidity.

6.2 GENERALITIES

Any laser has three basic elements (Fig. 6.1) (Stuart, 2000):

1. an active medium, containing specific atoms, which determines the wavelength of the laser beam; this may be
    a. gaseous (argon, CO_2)
    b. solid (Nd:YAG)
    c. liquid (dye)

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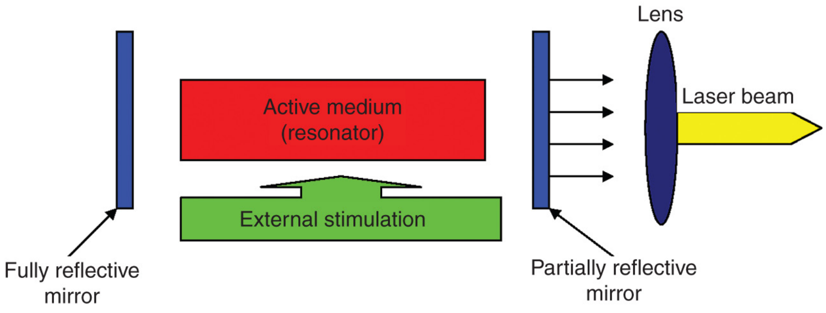

FIGURE 6.1 **The principle of laser operation.**

2. an external energy source such as
   a. light
   b. heat
   c. electrical energy
3. an optical resonator with two reflective mirrors between which the active medium is placed

Most lasers use electrical energy (high-voltage electrical discharges – CO_2 laser) or light (xenon or krypton lamp – Nd:YAG laser) as a source of energy.

The active medium is inside the resonator. For YAG lasers, the active medium is a mixture of yttrium and aluminum; this medium is "doped" with ions (neodymium [Nd], holmium [Ho], erbium [Er]), which, although in minority in the environment, issue light and confer the YAG laser its specific wavelength. The laser beam emerges directly from the resonator or is focused through a converging lens (Stein and Kendall, 1984).

In a normal population of atoms, the majority are in a state of rest or fundamental state E0. By the absorption of photons, a small percentage of atoms can achieve the higher energy level E1 (Fig. 6.2).

A mechanism known as spontaneous emission is involved in the case of natural light: an atom found in the higher energy level E1 returns to fundamental state E0, releasing its excess of energy under the form of a photon of light (Fig. 6.3).

Albert Einstein (1917) suggested the existence of another possibility of energy emission: stimulated emission. This occurs when a photon with a specific wavelength stimulates an excited atom, releasing light energy with the same wavelength (Fig. 6.4). This principle is the basis for the operation of modern lasers.

A form of external energy must cross the active medium in order for "light amplification" to be achieved. A large number of atoms absorb enough energy to pass into a higher energy level, followed by the spontaneous emission of photons as the excited atoms return to the initial state. Depending on the moment when each active medium reaches a specific energy level and spontaneously emits its excess of energy, the wavelength of the emitted photons will be characteristic for each active medium. "Stimulated emission" occurs when a photon collides with an excited atom, which absorbs an amount of energy equal to the energy of the photon and in turn emits another photon. The two photons have the same wavelength, are in phase, and move in the same direction.

Amplification of light occurs inside the active medium, which has two mirrors at both ends and is crossed by photons. The mirror located at the end that emits the laser beam is mainly reflective. It is crossed by part of the photons, which will constitute the laser emission. On the other hand, the rest of the photons are reflected at this level toward the active medium, thus continuing to stimulate the release of other photons by excited atoms. Therefore, a certain percentage of the photons are permanently moving inside the active medium between the two mirrors. This

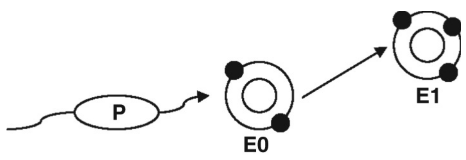

FIGURE 6.2 **Energy absorption.** A photon of light, P, donates its energy to an atom found in the fundamental energy state E0. After absorption, the atom passes into the higher energy level E1.

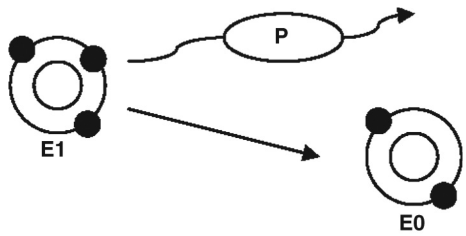

FIGURE 6.3 **Spontaneous emission of energy.**

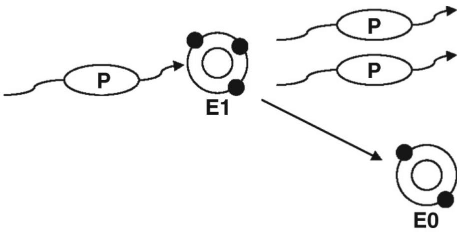

FIGURE 6.4 **Stimulated emission of energy.** An atom in a higher energy level, E1, is stimulated by a photon with the same wavelength and releases two photons with the same wavelength; the atom returns to fundamental energy state E0.

movement occurs with the speed of light and stimulates the emission of other photons by the excited atoms. The laser beam is therefore monochromatic, coherent, and very intense, since it is the result of amplification (stimulated emission of radiation) (Fisher, 1996). Focusing with the help of lenses is made possible by the coherent nature of the beam.

Regarding the physical properties of lasers, four key elements must be known: power, energy, coherence, and radiance. Energy describes the mechanical work (measured in joules), while power refers to the released energy and is measured in joules per second or watts (1 J/s = 1 W). Coherence represents the amount of energy released over the area unit (J/cm^2). Radiance is the intensity of the laser beam and is measured in watts per square centimeter.

Energy can be released in two ways for each laser type: pulsed beam or continuous beam. The release of energy in the case of continuous beams is similar with the flash of light: the luminous intensity over the unit of time is constant. Pulsed lasers generate light like a stroboscope: the energy is released in a series of intense flashes of very short durations (in milliseconds or nanoseconds). A beam with a continuous appearance may result if the impulses follow each other at a fast enough rate, as is the case of light from the stroboscope. The key difference is the fact that the level of energy released during an impulse (the maximum power) is much higher as compared with the level of energy produced by a continuous laser beam over the same unit of time.

The laser–tissue interaction is at a maximum when the laser beam is directed perpendicular to the tissue's surface. These interactions are influenced by the wavelength of the laser as well as by the tissues' optical properties (Jacques, 1992).

Laser energy suffers several phenomena when coming into contact with a tissue:

1. reflexion, depending on the tissue and the laser's wavelength
2. absorption (conversion into heat) and then diffusion into the neighboring tissues
3. transmission to the structures located beneath

The depth of penetration of a laser into the tissue corresponds to the tissue's thickness, where 90% of the laser beam's energy is absorbed. This depth of penetration is influenced by the absorption coefficient of the tissue and by the laser's wavelength (Boulnois, 1986).

The lasers' effects on tissues are generally divided into four categories (which, in fact, overlap most of the time) (Cheong et al., 1990):

- thermal effects
- photochemical effects
- electromechanical effects
- photoablation effects

Thermal effects (which are the most used in urology) may be reversible or irreversible. The reversible ones occur when the temperature increase is not significant or when the exposure time is insufficient to produce tissular necrosis. Irreversible thermal effects are classified into three categories: hyperthermia, coagulation, and vaporization. Hyperthermia corresponds to a moderate increase in temperature of a few degrees (41–45°C) for a short period of time (minutes). Late cellular death occurs due to enzymatic impairment. This process is difficult to control because it is not accompanied by any visible effect, and for this reason it is rarely used in medical practice.

Coagulation is obtained at temperatures between 50°C and 90°C maintained over a matter of seconds. A retraction of tissues occurs due to the distortion of proteins and collagen. The effect is visible because the area exposed to the laser beam is bleached (Fig. 6.5). The coagulated tissue will be eliminated (coagulation necrosis), followed by scarring. Coagulation is used to destroy tumors (which will be eliminated thereafter) or for hemostasis.

Vaporization corresponds to an immediate loss of substance (Fig. 6.6). It occurs at temperatures above 100°C maintained for short periods of time (a matter of seconds). Vaporization is produced by cellular explosion. A microscopic exam of the affected area reveals, around the vaporized area, a zone with coagulation necrosis (transitional area between

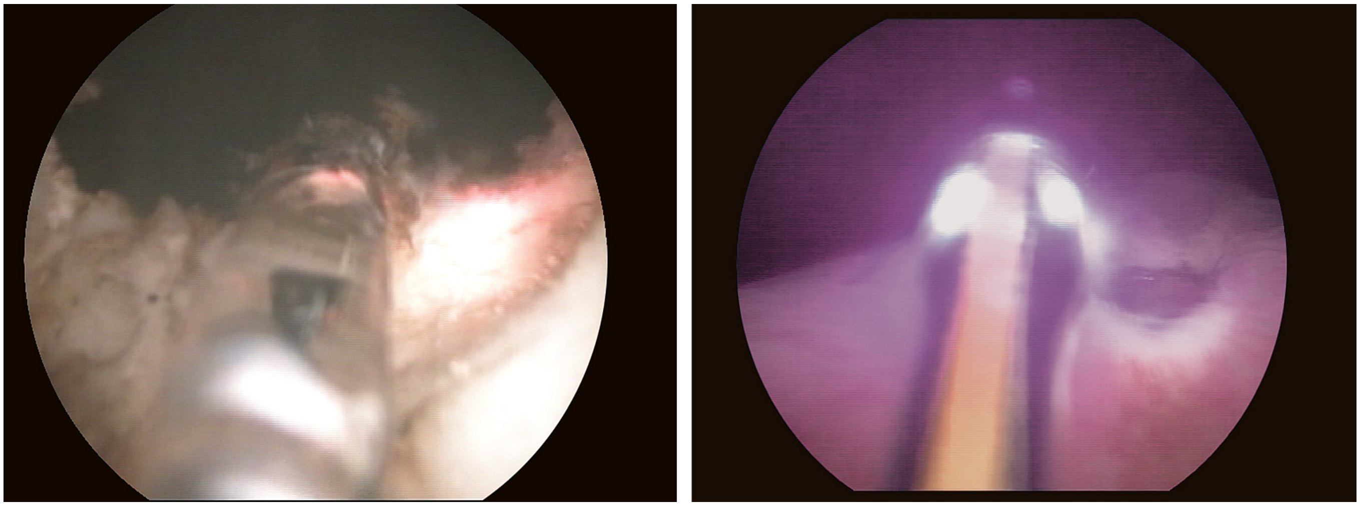

FIGURE 6.5 **Laser coagulation.**

the vaporized tissue and the unaffected tissue), which is responsible for the hemostatic effect of the laser. An incision of the tissue without capillary bleeding is obtained if the vaporized zone is around 100–500 μm. Tissue carbonization occurs at temperatures above 100°C.

The thermal effects of lasers are used in almost all medical specialties. The most important lasers used in clinical practice, especially due to their thermal effect, are: CO_2, Nd:YAG, Ho:YAG, KTP, argon, and diode laser.

The current surgical techniques are multiple and depend mainly on the devices used: the laser source and the type of optical fiber. Thus, in the case of the first types of fibers used (cut at right angles), the laser beam emerges through the end of the fiber (parallel with it). A direct contact between the fiber and tissues is required for an effective treatment; thus, such methods are known as "contact methods." Fibers with a lateral release of energy were developed because of the specific anatomy of the prostate. These have mirrors or prisms, even small lenses, which transmit the beam at variable angles (70–90°) to the laser fiber. They are protected by devices (made from metal or glass) that also play the role of keeping a minimum distance between the source and tissue. In this case, the energy is not transmitted directly to the tissues, so these procedures are called "contactless methods." A special category is represented by interstitial procedures, in which the laser energy is applied directly inside the prostate, with minimal injuries to the prostatic urethra.

The procedures that are most frequently described in the literature are represented by

- Transurethral laser-induced prostatectomy (TULIP)
- Visual laser ablation of the prostate (VLAP)
- Holmium laser ablation of the prostate (HoLAP)
- Holmium laser resection of the prostate (HoLRP)
- Holmium laser enucleation of the prostate (HoLEP)
- Photoselective laser vaporization prostatectomy (PVP)
- Interstitial laser coagulation (ILC)

Some of these are used in a small number of cases or have been replaced by improved procedures.

6.3 TYPES OF LASERS

Depending on the type of active medium in which emission occurs, medical lasers are divided into the following (Grasso et al., 2006):

- Lasers with a gaseous medium (argon, CO_2). The laser emission occurs due to high voltage or high-frequency electrical release.
- Lasers with solid medium (yttrium-aluminum-garnet – YAG). The active medium consists of a mixture of yttrium and aluminum, "doped" by ions: neodymium (Nd), holmium (Ho), and erbium (Er). Excitation is achieved by light emitted by a flash lamp or a diode.

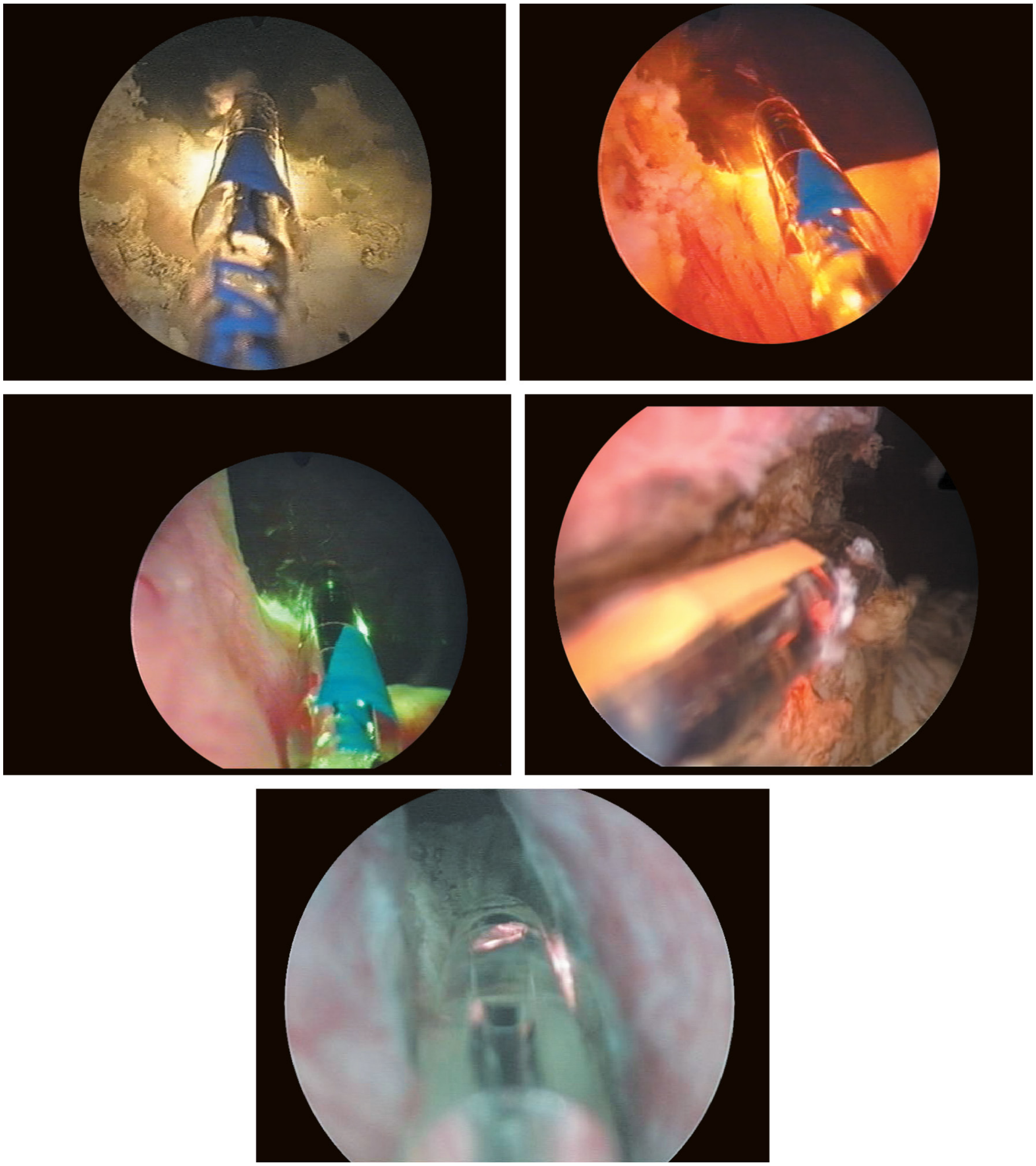

FIGURE 6.6 **Laser vaporization.**

- Lasers with liquid medium (dye) that use the emission of organic dyes excited by light. Excitation is achieved either with the help of a flash lamp or by using another laser.
- Diode lasers are lasers with continuous emission in the infrared or visible spectrum. These are compact lasers with good efficiency.

There are two types of systems, depending on the mode of transmission of the beam: optical fiber lasers and lasers with an optical arm. An optical fiber (Fig. 6.7) has two parts: the central part ("core"), which transmits the beam, and the protective sheath.

Optical fibers may be flexible or rigid and represent an almost ideal way of transmission (with a very good efficiency). However, they have two limitations:

- they can only transmit light with a wavelength close to the ultraviolet or infrared spectrum
- they modify the geometry of the laser beam: when leaving the fiber, the beam is no longer parallel but divergent

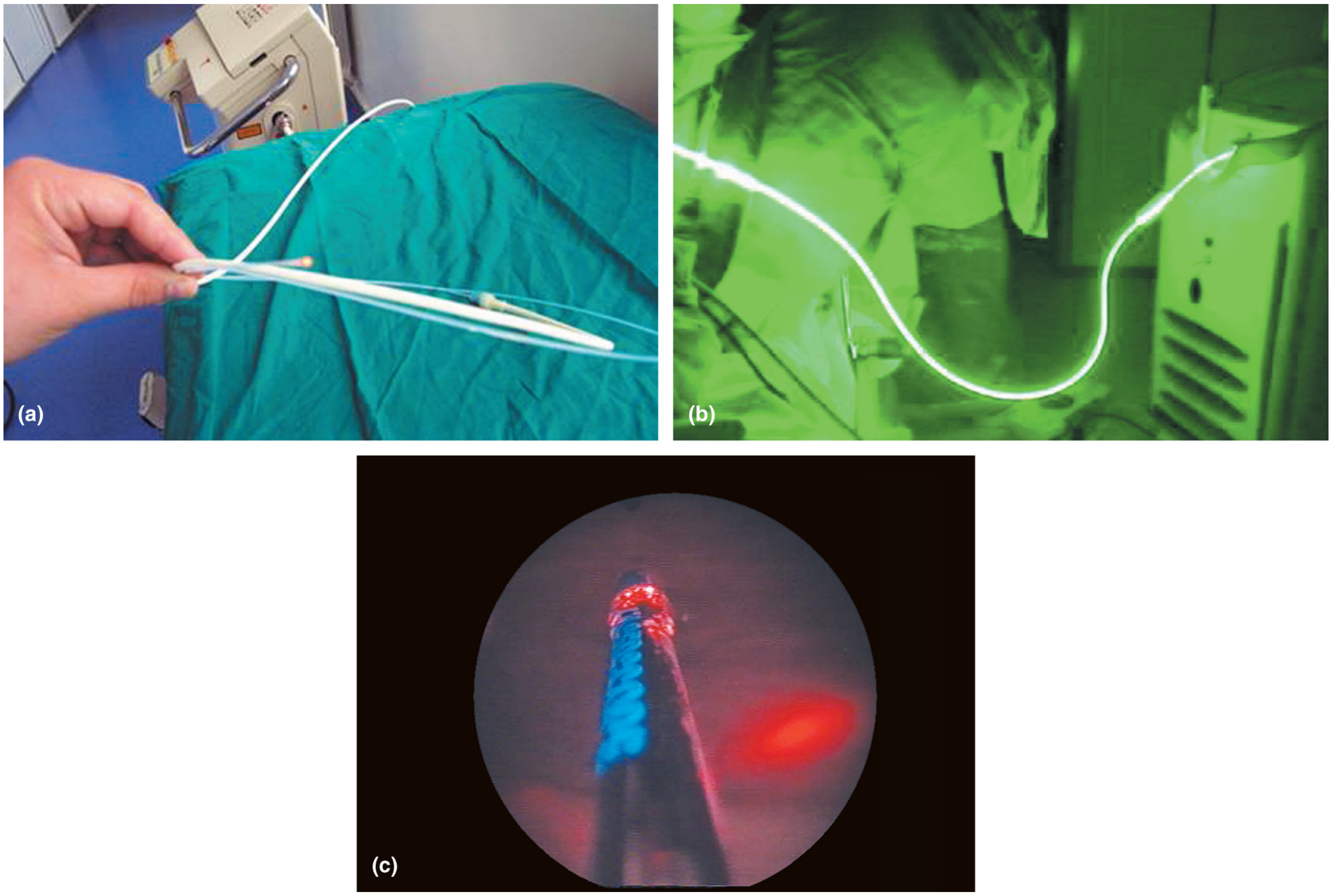

FIGURE 6.7 **Optical fibers.** (a) Nd:YAG laser and (b, c) KTP laser.

The optical arm is used for lasers emitting in the ultraviolet or infrared spectrum (CO_2). The optical arm consists of a multimirror system.

Laser treatment of benign prostatic hyperplasia (BPH) was first described in 1986 but started to be used in clinical practice in 1990, with the development of laser fibers. Different laser techniques were subsequently tested, with different types of lasers and optical fibers. The Nd:YAG laser was the first one used for the treatment of BPH and is the most studied one, but newly developed lasers have gained ground. Currently, the lasers most frequently used for the treatment of BPH are

- Nd:YAG
- Ho:YAG
- KTP (green laser)
- diode
- thulium
- Er:YAG
- combined lasers

6.3.1 Nd:YAG Laser (Neodymium:Yttrium-Aluminum-Garnet)

This is one of the lasers most frequently used in urology (Fig. 6.8). The beam has a wavelength of 1060 nm, is invisible, and is less absorbed by water and hemoglobin. It can be easily transmitted through flexible optical fibers made from silicon, and an ordinary irrigating fluid can be used: water, saline solutions, or glycine.

The energy diffuses into the tissues, inducing coagulation necrosis at a distance of up to 4 mm in depth. Hemostasis is excellent due to this effect. Vaporization of the tissues is achieved by using the laser in contact with them, and so the incisions are done.

FIGURE 6.8 **Nd:YAG laser.**

FIGURE 6.9 **Nd:YAG laser incision of a bladder neck stenosis.**

The Nd:YAG laser is used for contactless coagulation of superficial tumors of the urinary tract, for BPH treatment, and for making urinary incisions (urethra, bladder neck, ureter, and ureteropelvic junction) (Fig. 6.9). Other indications are urethral condylomas and hemangiomas as well as penile superficial carcinomas.

6.3.2 Ho:YAG Laser (Holmium:Yttrium-Aluminum-Garnet)

The holmium laser (Fig. 6.10) is a pulsed laser with a wavelength of 2100 nm; the energy can be transmitted through flexible optical fibers. The active medium is represented by a rare element (holmium) that can be combined either with yttrium-aluminum-garnet (Ho:YAG) or with yttrium-scandium-gallium-garnet (Ho:YSGC). The duration of the laser pulses is 250–350 μs, and the energy released after every pulse is 0.2–4 J/pulse. The frequency is 5–45 Hz and the average power is between 3 W and 100 W.

The Ho:YAG beam is significantly absorbed by water. However, most of the energy is absorbed by the tissue surface, determining sectioning or vaporization, with a reduced penetrability (0.5 mm). Therefore, accurate incisions can be performed, with only a small area being deteriorated due to heat. Also, the Ho:YAG laser is widely used in lithotripsy.

6.3.3 KTP Laser (Potassium-Titanyl-Phosphate)

This laser is derived from Nd:YAG, whose frequency was doubled by introducing an intermediate crystal of potassium titanium phosphate (KTP), which resulted in halving the wavelength to 532 nm. The laser beam is green (Fig. 6.11) and is poorly absorbed by water but with a high absorption by hemoglobin, thus having hemostatic effects similar to those of the Nd:YAG laser. The penetrability is low (1–2 mm), with its vaporization and sectioning being similar to those of the CO_2 laser (avoiding the development of scars due to the devascularization of the surrounding tissues).

FIGURE 6.10 **Ho:YAG laser.**

FIGURE 6.11 **KTP laser.** (a) LaserGreen HPS and (b, c) aspects from the operating room during vaporization with green laser.

6.3.4 Diode Laser

Diode lasers (Fig. 6.12) are small, low cost lasers, recently introduced in urological practice. The wavelength is between 760 nm and 1500 nm. Their power is still low, but they can be used in the contact mode for prostate vaporization (Fig. 6.13) or ILC.

The indigo laser (Indigo® Laser Treatment System) (Fig. 6.14) is the laser (diode type) most frequently used in the United States for ILC of the prostate. The wavelength is between 800–850 nm, with a maximum power of 20 W. Silicon fibers are used, with a length of 2.4 m and a diameter of 1.5 mm.

6.3.5 Thulium Laser

The thulium laser is derived from the Ho:YAG laser, with the first published studies dating back to 2006 (Gordon and Watson, 2006), with a wavelength of 1735 nm, and with silicon fibers of 600 μm. The main advantages over holmium

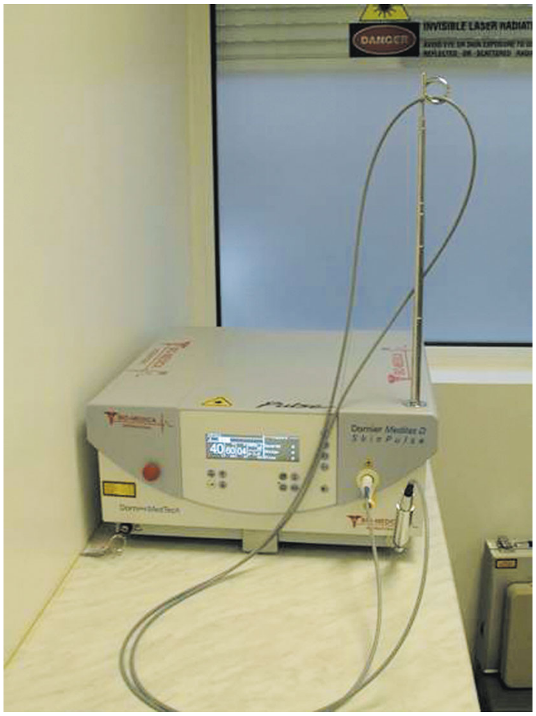

FIGURE 6.12 **Diode laser.**

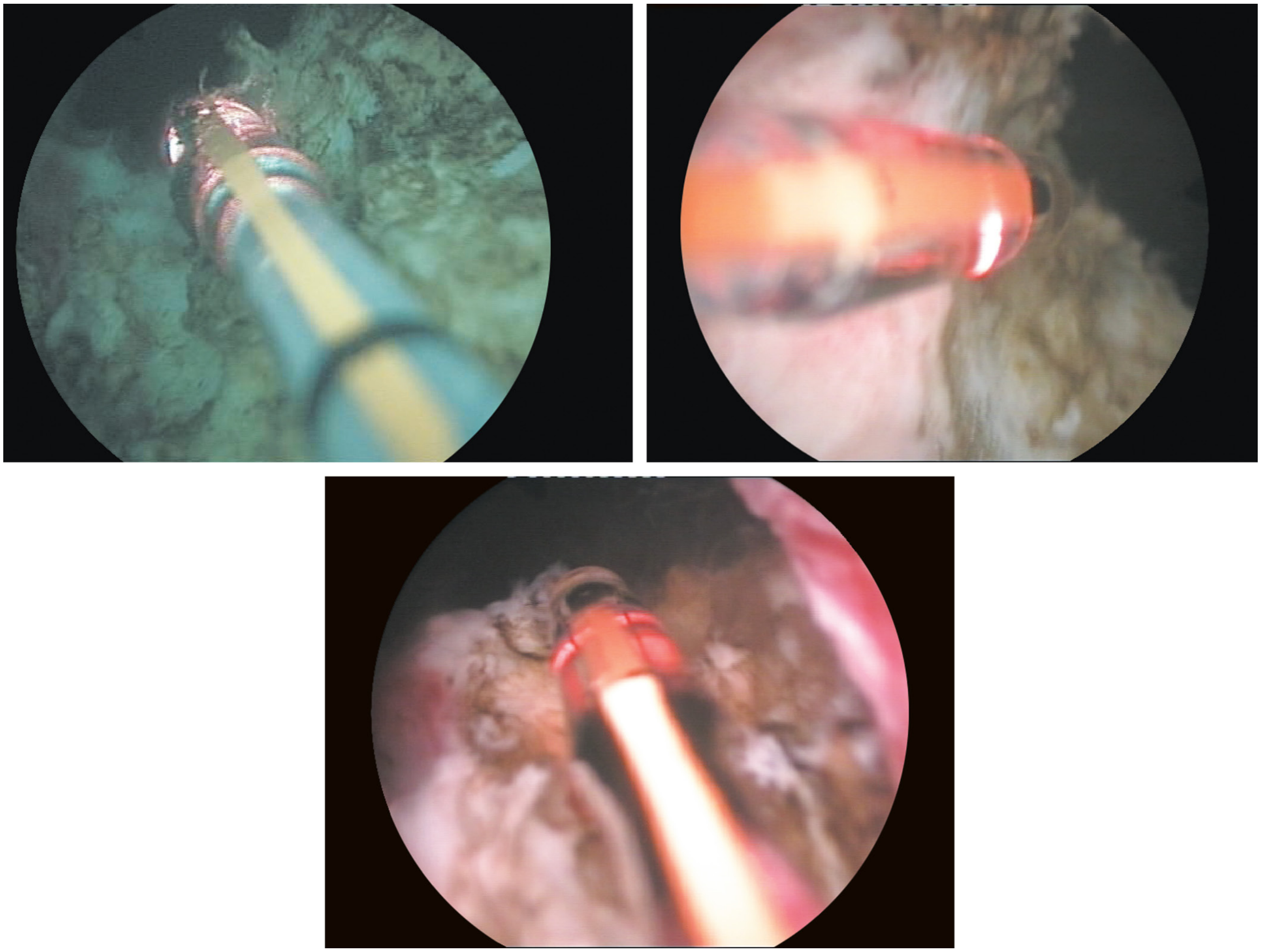

FIGURE 6.13 **Vaporization with a diode laser of prostate adenoma.**

FIGURE 6.14 Indigo laser.

lasers are its smaller dimensions and a higher efficiency. However, larger studies are necessary to prove its superiority over Ho:YAG.

6.3.6 Er:YAG Laser (Erbium:Yttrium-Aluminum-Garnet)

This is one of the most recent lasers used in urology. According to recent studies, it is superior to the Ho:YAG laser, especially for incisions and laser lithotripsies. Er:YAG incisions of the bladder neck or of urethral strictures are more accurate compared with the Ho:YAG laser, with minimal secondary thermal effects. The main disadvantage of the Er:YAG laser is the high price of the optical fibers.

6.3.7 Combined Lasers

The wavelengths of lasers may currently be modified by associating different types of lasers. Therefore, different laser combinations have been developed in the last years: CO_2 + Nd:YAG, KTP + Nd:YAG (RevoLix2) (Fig. 6.15), and Ho:YAG + Nd:YAG.

The characteristics of the main types of lasers used to treat BPH are presented in Table 6.1.

6.4 TRANSURETHRAL LASER-INDUCED PROSTATECTOMY

The first studies regarding transurethral ultrasound-guided laser prostatectomy were published in 1991, using an Nd:YAG laser (Assimos et al., 1991; Roth and Aretz, 1991). The procedure requires special equipment: the laser fiber is included in a device containing a transurethral ultrasound transducer of 7.5 MHz as well as a prism that deflects the laser beam at a 90° angle. The whole system is protected by a balloon that also maintains a minimum distance between the tissue and the distal end of the optical fiber. The proximal end of the device is mounted in a handle, which enables better positioning, both axially and radially, of the therapeutic end

FIGURE 6.15 RevoLix laser.

TABLE 6.1 Characteristics of the Main Types of Lasers Used to Treat BPH

Laser	Wavelength (nm)	Penetrability (mm)
Nd:YAG	1064	3–5
Ho:YAG	2100	<0.5
KTP	532	1–2
Diode	800–1100	Variable, depending on the wavelength
Er:YAG	2940	3–6

(the distal one). It should be emphasized that there is no optical system; the procedure is carried out only under ultrasound guidance.

At the beginning of the procedure, an ultrasound exam is done to evaluate the prostate, establishing the extent of the transitional zone, after which the irradiation is performed. The therapeutic end is moved in successive passages in an axial plane from the bladder neck to the apex, at a speed of approximately 0.1–1 mm/s. Medium powers are used (35–40 W), the depth of the coagulated area is approximately 6–15 mm, and a significant amount of heat is released inside the tissues. It is recommended to alternate with the irradiation of the prostatic lobes to allow cooling of the tissues. The procedure usually starts at 3 o'clock, continues at 9 o'clock, then at 4 o'clock, and finally at 8 o'clock, until the entire circumference is irradiated.

The technique was used for several years with inconclusive results (Puppo et al., 1994). It was abandoned and replaced by visual laser ablation of the prostate (VLAP), with a better ablation of prostatic tissue under direct visual control. However, a multicenter study (McCullough et al., 1993) analyzed the results of this procedure performed in 150 patients, underlining the fact that the AUA score decreased on average from 18.8 to 6.1 (68%), and Qmax increased from 6.7 mL/s to 11.9 mL/s (an increase of 78%).

6.5 VISUAL LASER ABLATION OF THE PROSTATE

This procedure is done under visual control using ordinary endoscopic equipment. It was first described by Costello et al. (1992), who used an Nd:YAG laser with an energy of 60 W, applied for 60 s into four quadrants in the prostate, thus achieving a coagulation necrosis (Costello et al., 1992). Thereafter, the method started to be used on a wide scale in urological clinical practice.

The beam has to fall perpendicularly to the tissue surface in order to obtain a good irradiation. For this reason, different types of devices were developed to deflect the laser beam at a right angle to the axis of the cystoscope, the so-called lateral "view" fibers (side-firing delivery systems). These devices are based on the reflection or on the refraction of the laser beam.

The reflective systems use a gold plated mirror or a mirror made from pure gold to deflect the laser beam (Fig. 6.16). The deflexion angle varies between 45° and 105°, the most frequently used angle being 90°. The laser beam's divergence, which differs depending on the design of the mechanism of reflection (ranging from 7 to 380), is very important because it influences the size of the beam acting upon the prostate tissue, determining the power's density. The main disadvantage of these types of fibers is represented by the fact that they favor the absorption of a very high amount of energy when used in contact with the tissues (with tissue carbonization). The system is also quite fragile because the metal end could melt or fracture during the intervention, especially if the irrigating flow is insufficient. To avoid these drawbacks, it is recommended that intraoperative applications be made 2–3 mm away from the tissue, thus significantly reducing the power's density. These types of lateral view fibers are used especially for contactless coagulation.

Refractive systems use glass or quartz prisms cut at angles of 45°. The angle of deflection of the laser beam varies between 78° and 90°. This refractive system is protected by a device made from glass, located at the distal end of the fiber (Fig. 6.17).

This type of fiber induces a high density of power followed by vaporization when it is used in contact with the tissue. The power density diminishes when the fiber is removed from the tissue, and the main effect is represented by coagulation. Therefore, this device can be used for both coagulation and vaporization of tissues.

VLAP is indicated in all patients with BPH in whom medical treatment is not efficient. Nevertheless, the European Association of Urology recommendations limit its use to certain categories of patients: those receiving anticoagulant medication, patients with increased surgical risk and who are unsuitable for TURP, and patients in whom maintaining ejaculation is intended.

The technique is performed under general, regional, or even local anesthesia, through periprostatic and pudendal blockade (by transperineal approach) (Leach et al., 1994). A standard 21 F or 26 F urethrocystoscope or cystoscopes specially designed (with continuous irrigation) for laser applications are used. If the irrigating flow is unsatisfactory, a suprapubic catheter can be used to increase flow and improve visibility during the procedure. The method does not require special irrigation fluids because their intraoperative absorption is minimal. Saline solution is usually used because of its lower price as compared to osmolar solutions.

Special devices for continuous irrigation (pumps) are not recommended because their use is associated with an increased risk of bladder injuries. The irrigating flow under the influence of gravity is enough and is obtained by placing the container holding the liquid at a height of about 30 cm above the plane of the bladder.

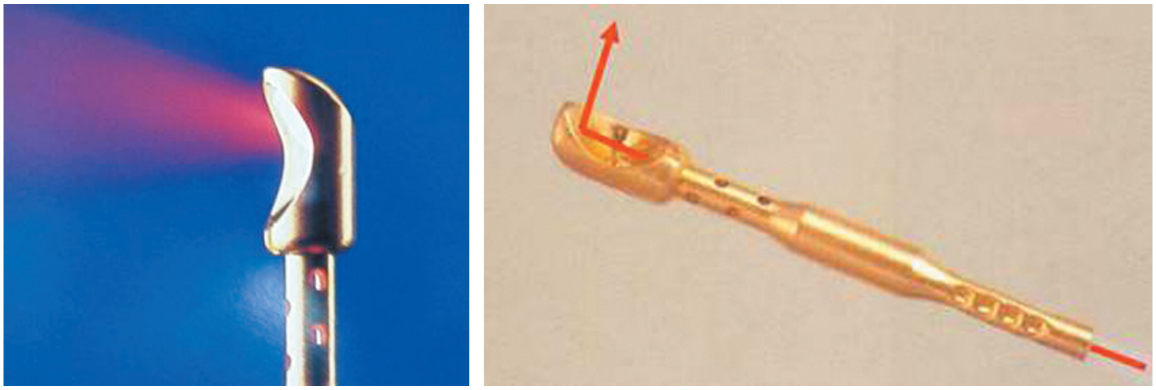

FIGURE 6.16 **Nd:YAG laser fiber with a reflective system for VLAP.**

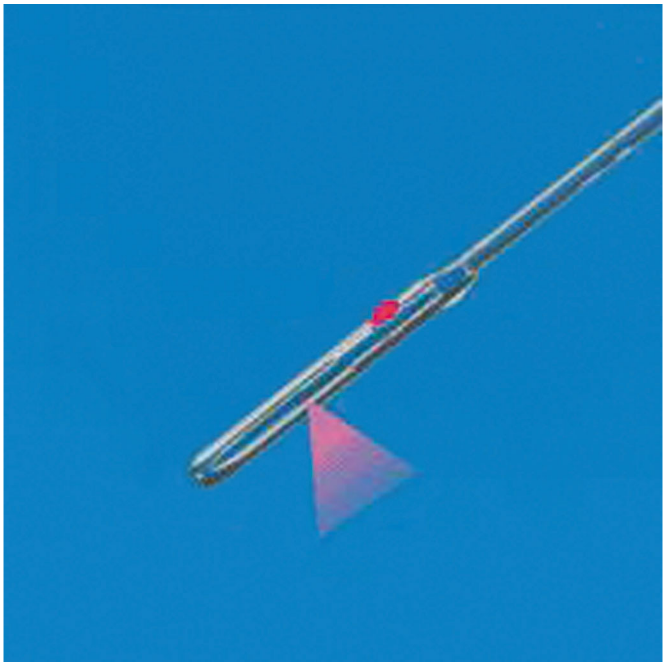

FIGURE 6.17 **Lateral view fiber (refractive system with quartz end).**

Relatively high powers are used (40–80 W). The laser fiber is positioned 2–3 mm away from the tissue. The time needed for irradiation is quite long (60–90 s/application), aiming to achieve a proper coagulation of tissue (noticed when it becomes white).

Several techniques have been described. In one of these methods, the laser energy is applied in four quadrants for the lateral lobes: at 4, 8, 2, and 10 o’clock. Each application is carried out at 1–2 cm from the previous one, until the tissue becomes white.

Irradiation starts from the bladder neck and continues toward the verumontanum (Kabalin, 1993; Norris et al., 1993). For large prostates, additional irradiation is done at 3 and 9 o’clock. The median lobe is irradiated at 6 o’clock or at 5 and 7 o’clock in case of larger lobes (keeping the distance of 1–2 cm between applications). An energy of 1000 J is needed on average for every gram of tissue destroyed by VLAP.

Another technique consists of longitudinal or radial irradiation of the prostate, starting from the bladder neck. In the longitudinal irradiation technique, the fiber is moved with a speed of 1 mm/s from the bladder neck toward the verumontanum. The procedure is repeated after a line is finished, with the fiber being slightly rotated toward the next tissue area that will be coagulated, until the whole prostate is bleached. It is recommended to start the procedure 1 cm below the verumontanum whenever preserving ejaculation is important; this approach also significantly lowers (up to 0%) the rate of complications (bladder injuries).

In the radial irradiation technique, the probe is rotated 360° with a speed of 1 mm/s, starting from the bladder neck. The procedure continues with a new area located 5 mm distal from the previous one, until the entire prostate is irradiated. It is recommended to finish the procedure 5 mm proximal from the verumontanum. The average duration of the intervention is 45 min.

The results of this treatment are based on achieving a coagulation of the prostatic tissue. The energy of the Nd:YAG laser is almost entirely absorbed by the prostatic tissue (and not by water) and is transformed into thermal energy. The intracellular temperature rises above 60°C, with cell death and tissue necrosis. After an initial increase in the prostate volume secondary to edema, the necrotic tissue is gradually eliminated or resorbed. Due to this mechanism, the urethro-vesical catheter should be left in place for a long time (7–14 days), since patients have significant dysuria after surgery.

The results after VLAP have certain advantages as compared with TULIP, making this procedure attractive for many urologists. In long-term studies, the results were stable over time, with the maximum flow rate increasing on average from 7.3 mL/s preoperatively to 15.2 mL/s at 3 months and remaining at the same level at 1, 2, and 3 years thereafter (17, 18.3, and 18.5 mL/s, respectively) (Kabalin, 1996). The AUA score also had a favorable evolution, dropping on average from 20.3 before surgery to 10 (after 3 months) and 5.7 (after 1 year), respectively.

The urodynamic analysis of results obtained after VLAP shows a decrease of detrusor pressure from 74 cm H_2O before surgery to 54.2 cm H_2O at 3 months after surgery, with a favorable evolution of the AUA score (21.4 before surgery and 9.4 at 3 months after VLAP) and of the maximum urinary flow (6.5 before VLAP and 10.6 mL/s after 3 months) (James et al., 1995).

The urodynamics studies usually show a decrease of subvesical obstruction from 80% (before starting treatment) to 5% (at 6 months after treatment) (Tee Slaa et al., 1995). However, meta-analyses comparing TURP versus VLAP show better results for TURP regarding the symptoms score (78% vs. 66%) and the increase of maximum urinary flow (127% vs. 77%) (Hoffman and MacDonald, 2002). The rate of reinterventions is also higher after VLAP (38% vs. 12% for TURP) (Abdel-Khalek and El-Hammady, 2003). Attempts to combine these two techniques (resection of the residual tissue after VLAP to reduce intraoperative bleeding) did not show statistically significant differences as compared with TURP as the single therapy (Planz et al., 2003).

The rate of complications varies from one center to another. However, regarding intraoperative bleeding and the need for blood transfusions, results are consistent: no study reported patients treated by VLAP needing post-operative transfusions (Anson et al., 1995). Moreover, most authors agree on recommending VLAP for patients on anticoagulant therapy or for those with altered coagulation tests secondary to hematological conditions (Costello and Crowe, 1994; Kingston et al., 1995). It is also certain that VLAP is not complicated by "TURP syndrome" or by changes in serum sodium levels (Cummings et al., 1995).

Other complications are described in different proportions:

- retrograde ejaculation (27–33%)
- urethral strictures (0–1.8%)
- bladder neck sclerosis (0–4%)

Dysuria persists in 15% of patients up to 3 months after VLAP. Episodes of acute urinary retention may occur in approximately 30% of cases.

There are authors who argue that the long-term results of this technique are not encouraging, suggesting precautions regarding the indications of VLAP, especially in patients who are candidates for TURP. Thus, some studies show that, although over 90% of patients no longer have subvesical obstruction at 3 months after VLAP, the reintervention rate (TURP) is 43.8% after 4 years.

The major disadvantage of this technique, compared with TURP, is a lack of immediate effects and the need for prolonged bladder catheterization (from several days to 3–4 weeks). Even after the catheter is removed, the improvement sets in gradually after 3–4 weeks.

The best results are obtained in prostates of 50–60 g. VLAP is not indicated in patients with chronic urinary infection or chronic bacterial prostatitis because of the risk of infection of the necrotic tissue that remains in place for several weeks after the intervention (until its complete evacuation). TURP is often needed in these cases to solve the complication.

6.6 INTERSTITIAL LASER COAGULATION

This procedure, based on hyperthermia inside the prostate, was developed by Bown and was described in 1983. Thereafter, other authors performed *in vivo* and *in vitro* studies to evaluate the applicability of this concept on different tissues. The first clinical applications of thermotherapy were described in 1990 in patients with malignant cerebral tumors.

ILC for BPH, using special fibers, was first described by Hofstetter in 1991. The principle of using ILC for BPH therapy is represented by the possibility of generating a coagulation necrosis inside the prostate, thus reducing its volume through atrophy and regression. In contrast to the contactless laser techniques, in which the volume of necrotic tissue is limited by the penetration capacity of the laser beam, in ILC the applicator can be inserted as much as necessary to achieve coagulation of the desired volume. In theory, this technique allows for necrosis of the adenomatous tissue while maintaining the integrity of the urothelium.

ILC is indicated in patients with subvesical obstruction due to BPH who are candidates for open or endoscopic surgery. It is also possible to treat the median lobe of the prostate. Associated conditions, such as urethral strictures or bladder stones, can also be treated during the same intervention. Patients with chronic urinary retention or with preoperative reduced detrusor function require prolonged urethro-vesical catheterization after ILC because of the time needed for the prostatic tissue to retract after the absorption of necrosis. This phenomenon is common to all procedures that do not achieve the immediate removal of resected tissue.

An additional incision of the bladder neck is sometimes necessary in the case of small prostate adenomas with an important median lobe. The incision is done at 5 and 7 o'clock or at 7 o'clock using a Collings loop or a laser fiber. It is possible to use combined techniques (ILC of the lateral lobes and transurethral resection of the median lobe) to reduce the duration of postoperative bladder catheterization.

Clinical studies show a decrease of the symptoms score from 24 to 9 after 3 months, reduction of the postvoid residual volume from 230 mL to 70 mL, and an increase of Qmax from 6 mL/s to 14 mL/s. The prostate volume decreased on average by 18% after 3 months (Krautschick et al., 1999; Daehlin and Fruga, 2007).

Prospective studies comparing ILC with TURP show higher success rates for transurethral resection, with a higher reintervention rate for ILC (between 16% and 50%). Intraoperative complications are less frequent in patients treated by ILC (Kursh et al., 2003; Muschter et al., 1997). Performing bladder neck incision together with ILC results in a rapid improvement of symptoms comparable to TURP.

Normal ejaculation is maintained in around 80–90% of patients treated with lasers. In order to preserve physiological ejaculation, it is recommended to avoid intervention upon the bladder neck, although in this case there is a risk of inferior results regarding the urinary flow rate. Although the results are inferior as compared with TURP or other types of laser procedures, ILC is indicated for high-risk patients who require a minimal surgical intervention with a low rate of complications.

6.7 LASER VAPORIZATION OF THE PROSTATE (LVP)

Although VLAP was a laser procedure frequently used in the 1990s with good short-term results, dysuria after VLAP and the need for prolonged postoperative bladder catheterization limited its indications, and it was obvious that VLAP could not replace TURP as standard treatment for BPH. Less interest for VLAP was determined by the development of laser equipment, with high-energy systems able to achieve tissue vaporization.

Laser vaporization of the prostate is derived from VLAP but uses high energies and a small laser spot, thus inducing vaporization and not coagulation (as is the case of VLAP) of prostatic tissue.

The first laser used for LVP was an Nd:YAG laser in which the distal end of the fiber was modified by adding a sapphire crystal that absorbs the energy of the laser beam and reaches very high temperatures, allowing vaporization of the prostatic tissue or bladder neck incision. The first results were reported in 1994 (Watson et al., 1994), showing significant improvements of the maximum urinary flow rate (9 mL/s before surgery and 18 mL/s after surgery) and of the IPSS score (18 before surgery and 5 after surgery). However, vaporization of the prostatic tissue and the creation of a prostate lodge similar to TURP proved to be difficult in the case of prostates larger than 40 cm^3.

The development of laser fibers with a diameter up to 10 mm led to a shorter duration of the intervention. However, this technique remained relatively ineffective in the case of large prostates. Randomized studies comparing laser vaporization with Nd:YAG and TURP did not show significant differences between these two procedures regarding the postoperative evolution of the maximum urinary flow rate and AUA score. The duration of intervention is similar for both procedures, but the average period of hospitalization and of urethro-vesical catheterization are lower in patients treated with laser (30 h vs. 48 h and 24 h vs. 48 h, respectively) (Wheelahan et al., 2000). However, the need for urethro-vesical recatheterization and the reintervention rate are significantly higher in patients treated with the Nd:YAG laser (28% vs. 12% and 18% vs. 9%, respectively) (Keoghane et al., 2000). Also, the cost of the supplies is about 20% higher for the Nd:YAG laser as compared to TURP.

These disadvantages of using the Nd:YAG laser for prostate vaporization (the need for urethro-vesical recatheterization and the relatively high rate of reinterventions) are mostly explained by the technical characteristics (nonselective absorption by tissues and high penetrability), which determine mainly coagulation of tissues at the expense of their vaporization. Thus, although a cavity similar to that obtained after TURP is created, the limited efficiency of vaporization and the use of high energies to obtain this vaporization are accompanied by an increase in the depth of coagulation necrosis, leading to the persistence of dysuria and irritative symptoms after surgery (with an incidence of about 30%). For these reasons, the Nd:YAG laser has been replaced by much more efficient lasers in terms of prostate vaporization: holmium, KTP, or diode laser.

6.7.1 Holmium Laser Ablation of the Prostate

The Ho:YAG laser was the next step in the systems designed for prostate vaporization. This was mainly due to its ability to vaporize tissues with low coagulation necrosis and reduced penetrability (below 500 μm – 10 times less than the Nd:YAG laser). As the Ho:YAG laser beam is highly absorbed by water, vaporization bubbles are produced at the distal end of the fiber, inducing a shock wave and, through a photomechanical effect, determining tissue destruction (vaporization) and superficial coagulation. This mechanism of action requires positioning and maintaining the fiber in the immediate vicinity of the tissues (maximum 2 mm) in order to achieve efficient vaporization.

Gilling et al. (1995) was the first to describe the use of the Ho:YAG laser for this kind of therapy. He combined this laser with an Nd:YAG laser to improve the efficiency of VLAP (Gilling et al., 1995). The technique was called combined endoscopic laser ablation of the prostate (CELAP) and was developed to reduce the duration of postoperative urethro-vesical catheterization after VLAP. The holmium laser was used to create a "channel" inside the prostate, after which contactless coagulation was done with an Nd:YAG laser. Comparative studies showed a significantly shorter catheterization period in the case of CELAP (4.1 days) versus VLAP (11.6 days). However, this procedure was soon replaced, discarding the Nd:YAG laser when the holmium laser was proved to have an excellent capacity for hemostasis and to be superior in terms of vaporization of prostatic tissue (Gilling et al., 1996). The procedure, called HoLAP, developed rapidly and is now widely used by an increasing number of urologists. Ho:YAG lasers with powers of 60–100 W are used.

Fibers of 550 μm are used with a refractive system, which emit the laser energy at an angle of 70° to the fiber axis (not 90°). Thus, the striated sphincter is protected (when the urologist works at the apex of the prostate), and better intraoperative visibility is ensured (Fig. 6.18).

The target of the laser fiber, located on the inferior side, guides the surgeon to know in which direction he or she will apply the laser energy.

From a technical point of view, HoLAP is similar to laser ablation using Nd:YAG, KTP, or diode lasers. The procedure can be performed under general or spinal anesthesia, using an ordinary 22–28 F cystoscope with continuous irrigation or one specially designed for laser applications, with an internal sheath that stabilizes the laser fiber (Fig. 6.19). The working channel must have a diameter of at least 7.2 F.

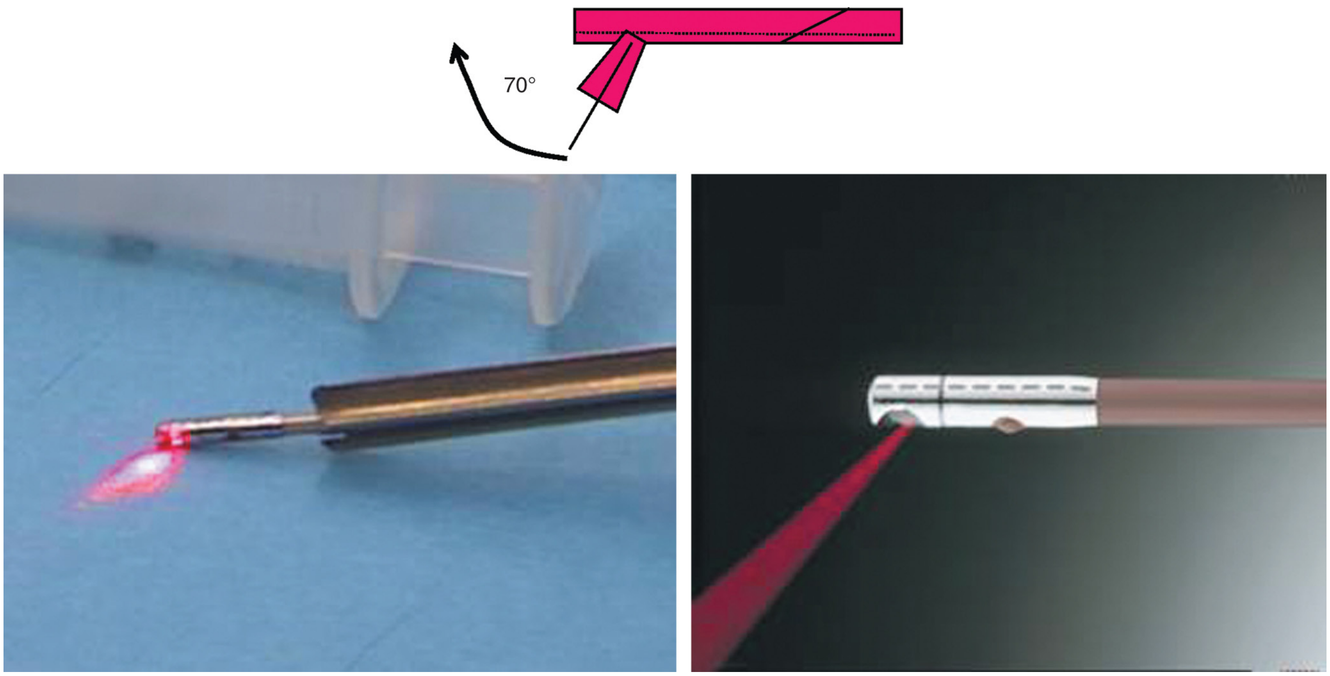

FIGURE 6.18 **Laser fibers used for HoLAP.**

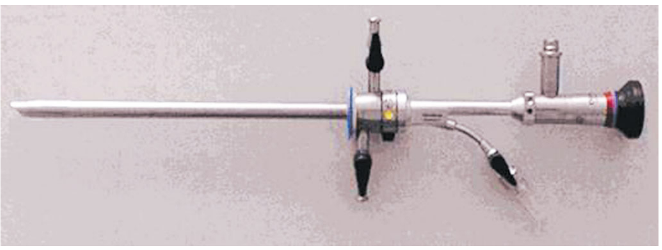

FIGURE 6.19 **Olympus cystoscope for laser applications.**

The procedure is relatively simple: vaporization is done by rotating the laser fiber in the immediate vicinity of the prostatic tissue, with the immediate creation of a cavity. The procedure starts at the level of the median lobe at 5 and 7 o'clock, creating a cavity similar to that obtained after TURP. The initial vaporization of the median lobe will facilitate operative movements and increase efficiency of the irrigation, allowing for good intraoperative visibility. As with TURP, the verumontanum should not be overpassed in order to protect the external sphincter. Vaporization is done in depth until the transverse fibers of the prostate capsule are noticed. Coagulation of larger blood vessels can be carried out by removing the fiber from the tissue. The vaporization of the right lateral lobe followed by the left one is done after the vaporization of the median lobe, through successive rotating movements, starting from the bladder neck up to the verumontanum. Thus, a cavity similar to that obtained after TURP is created.

In the opinion of some authors, postoperative urethro-vesical catheterization is optional, depending on the degree of obstruction and the type of anesthesia used (Tan et al., 2003). Analgetics are not necessary, but antibiotics are recommended for about 7 days.

HoLAP indications are similar to those of TURP (patients in whom medical treatments are not effective or who have developed complications secondary to subvesical obstruction). It is recommended that the choice regarding the surgical technique (open or endoscopic) as well as the source of energy used (electrical or laser) be made depending on the size of the prostate, the operator's experience, and associated comorbidities of the patient. However, because in the case of HoLAP the laser spot has small dimensions, this technique is time consuming and is usually used for adenomas smaller than 40 cm^3. Nevertheless, there are authors who have used this method to treat prostates of 120 cm^3 (Tan et al., 2003).

Results are similar for HoLAP and TURP, but the incidence of blood transfusions is zero in the case of HoLAP, since intraoperative bleeding is minimal. The duration of postoperative bladder catheterization is significantly shorter (less than 24 h), while the operating time is similar for both techniques. Another advantage of HoLAP is the possibility of performing it in patients under anticoagulant therapy.

There are many studies addressing the long-term results. The most cited one belongs to the inventor of this technique, who evaluated a group of patients with a follow-up of 7 years (Tan et al., 2003). The results of this study are similar to those from other studies and are presented in Table 6.2. The reintervention rate for BPH after HoLAP is around 15%.

The efficiency and simplicity of this technique, the possibility to be done on a day care basis, and its applicability to all categories of patients with BPH have led to the widespread use of HoLAP. This method is in competition with another similar technique using a different type of laser: PVP.

6.7.2 Photoselective Laser Vaporization Prostatectomy

The KTP laser (potassium-titanyl-phosphate) is one of the most recent developments for the treatment of BPH. The doubling of the frequency of the Nd:YAG laser with the help of a crystal of KTP results in a laser with a wavelength of 532 nm, with completely different interactions with tissues as compared to the Nd:YAG laser (Kuntzman et al., 1996). The KTP laser is selectively absorbed by hemoglobin, determining a rapid vaporization of prostatic tissue with reduced penetrability and coagulation.

The KTP laser was first used in the treatment of prostate conditions in 1991 but with inconclusive results at that time because of the use of low-power lasers (less than 40 W). Since 1996, due to the increase of the laser's power to 60 W and subsequently to 80 W, the efficiency significantly improved (Kuntzman et al., 1997). The main system used in clinical practice is a KTP laser of 120 W (GreenLight HPS system, American Medical Systems, Minnetonka, Minnesota, USA) with a wavelength of 532 nm, the energy being transmitted through a specially conceived fiber.

A 22 F cystoscope with continuous irrigation is used. The laser spot is emitted at a 70° angle to the axis of the fiber and is easily directed because of a mark located on the opposite side of the site of the beam emission (Fig. 6.20).

TABLE 6.2 Long-Term Results for HoLAP

	Initial	Evaluation after 1 month	Evaluation after 7 years
Number of patients	79	79	34
Qmax (mL/s)	9.2 (4–16)	15.2 (11–25)	16.8 (5–35)
IPSS score	18.8 (8–34)	9.4 (5–25)	10.0 (0–26)
Prostatic volume (cm^3)	40.5 (14–133)	–	–
Operating time (min)	30.8 (5–90)	–	–

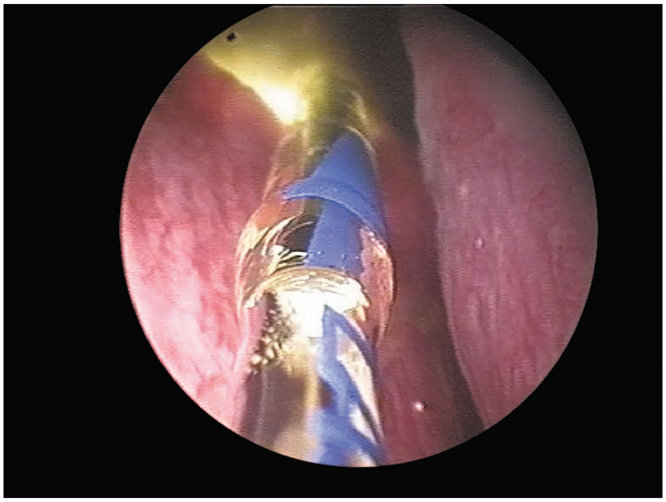

FIGURE 6.20 **Easy targeting of the laser spot (due to fiber marking located on the opposite side).**

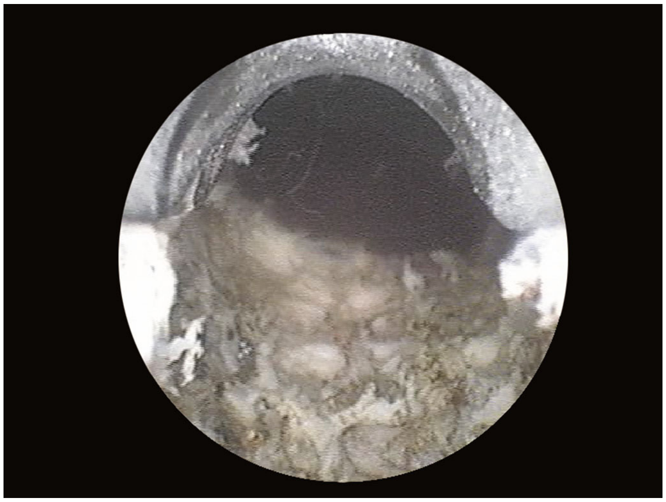

FIGURE 6.21 **Obtaining a regular surface by slow and steady intraoperative movements.**

Handling of the fiber must be done with slow but steady movements to avoid the formation of craters within the prostate. The uniform dissipation of energy leads to a smooth surface (Fig. 6.21).

The speed of fiber rotation must also be adapted to the efficiency of vaporization: if the efficiency is high (Fig. 6.22), the speed may increase, but if the efficiency is low due to a poorer blood supply, then the speed will have to be decreased.

The fiber must be maintained so that the laser spot is directed as perpendicularly as possible to the tissue (Fig. 6.23).

The working distance between the fiber and the tissue is a key element and must be kept as low as possible (maximum 4 mm) (Fig. 6.24). Increasing the distance to the tissue may cause interference with tissue debris and with bubbles originated from vaporization, altering efficiency. It is recommended to avoid working in direct contact with the tissue, since the heat that is released can damage the fiber. It is also recommended to use lower powers (80 W) at the beginning of the procedure. The power can be increased to 120 W after the working channel is created.

6.7.2.1 Techniques

Most authors describe six steps for PVP:

- preliminary cystoscopy
- creating the working channel
- vaporization of the lateral lobes
- vaporization of the apex
- vaporization of the bladder neck or of the median lobe
- the final control

It is essential to gently insert the cystoscope using an optical shutter, thus avoiding injuries of the prostatic urethra. Preliminary cystoscopy (Fig. 6.25) provides information regarding the prostate size, length of the prostatic urethra, presence of potential urethral strictures, etc. The cystoscope is moved slowly to avoid secondary bleeding. Cystoscopy allows for the examination of ureteral orifices and the exclusion of any potential associated bladder tumors or of other congenital anomalies.

It is crucial to create the working channel at the beginning of the intervention because it allows for easy handling of the fiber, thus avoiding tissular contact that can lead to its degradation. This working space will also ensure optimal irrigation, which is very important for intraoperative visibility.

It is possible to create the working channel (Fig. 6.26) by different types of approaches:

- anterior
- median (central)
- posterolateral

The anterior approach has the advantage of reducing the risk of bleeding by avoiding injuries of the prostatic urethral mucosa in the case of large prostates. The median (central) approach is easier and is recommended for novice surgeons as well as in the case of smaller prostates. The posterolateral approach is less used. At the end of this phase,

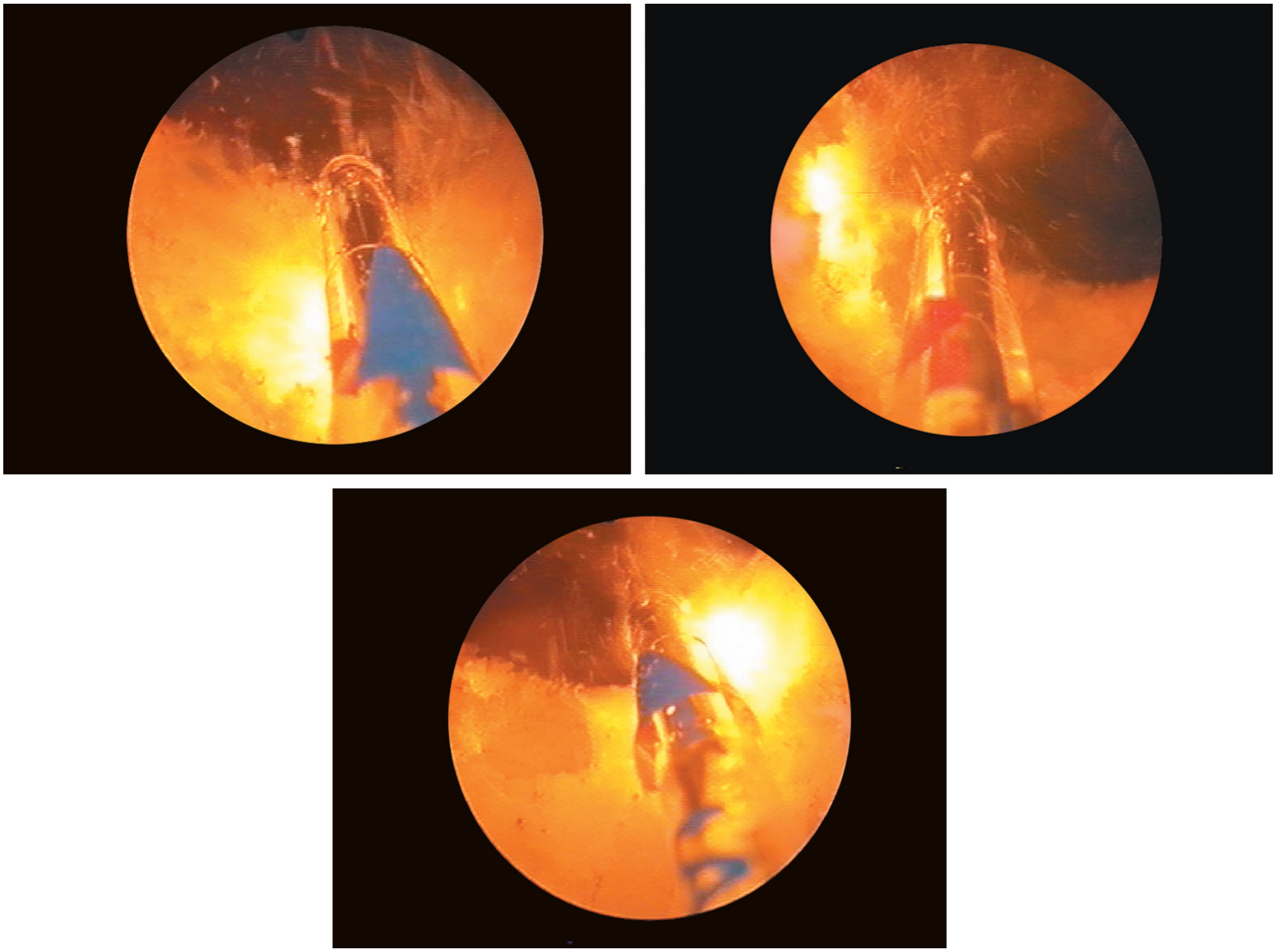

FIGURE 6.22 **Effective vaporization allows for increased speed of fiber rotation.**

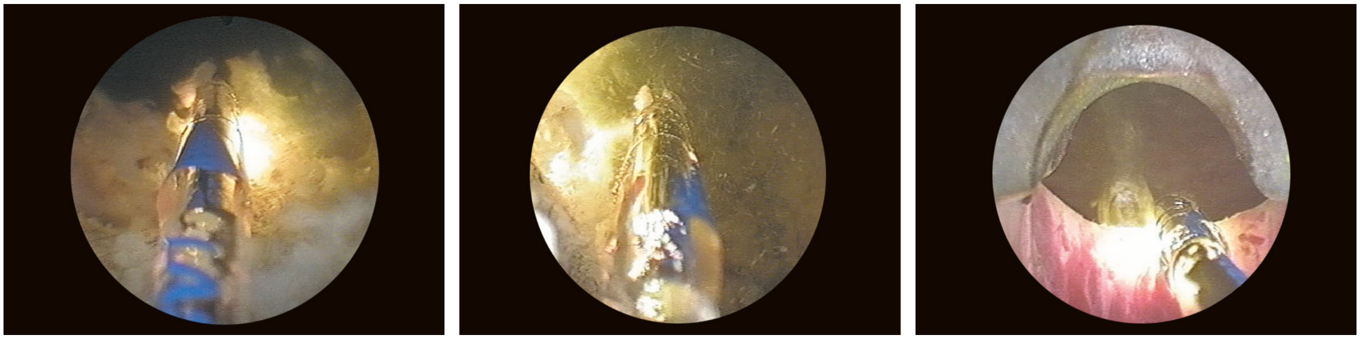

FIGURE 6.23 **Maintaining an angle of incidence of the laser beam perpendicular to the tissue allows for efficient vaporization.**

two fundamental reference points should be set: the bladder neck and the external urethral sphincter (the inferior limit of vaporization).

After these two reference points are set (the bladder neck and the urethral sphincter), vaporization of the lateral lobes can be done (Figs 6.27 and 6.28). This should be performed symmetrically, layer by layer, with the goal being to obtain a smooth surface. This is achieved by guiding the fiber toward the tissue projections without vaporization in the areas already treated. One of the advantages of a smooth surface is better bleeding control (which is harder to

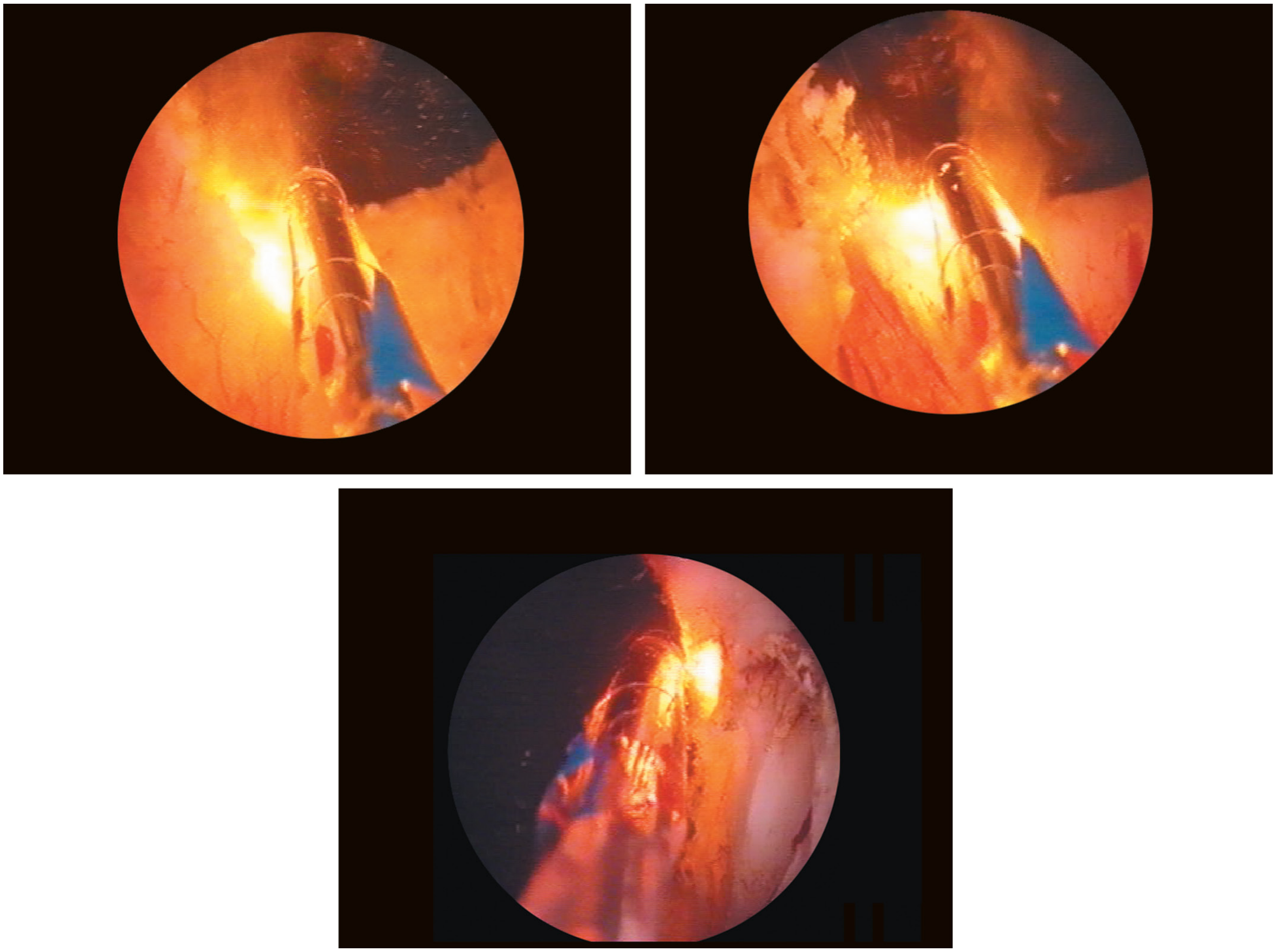

FIGURE 6.24 **Maintaining an optimum distance between the fiber and the tissue.**

achieve in the case of a surface with irregularities). The goal of this phase is to obtain a concave area in each lateral lobe with ablation of as much prostatic tissue as possible.

Vaporization of the apex (Fig. 6.29) must be very precise in order to remove the apical tissue without producing injuries of the sphincter. Increased attention is required during anterior vaporization when it is necessary to work with the fiber far from the cystoscope.

The bladder neck and the median lobe are approached at the end of the intervention because vaporization at these levels is more easily done after the ablation of the lateral lobes in the previous phase (Fig. 6.30). The median lobe may be approached from left to right or from right to left, but what counts more is the gradual "polishing" of its contour while avoiding the ureteral orifices.

Some authors recommend performing an incision of the bladder neck at 5 and 7 o'clock, up to the circular fibers, to delineate the depth of vaporization (followed by vaporization of the tissue between these incisions). At the end of the procedure the bladder is emptied to check for potential migrated tissue fragments. The prostate lodge should have the form of a concave, wide and open cavity with a smooth and regular surface (Fig. 6.31).

Similar to HoLAP, postoperative urethro-vesical catheterization is not compulsory, since only 60% of patients require it, the average duration of catheterization being 24 h. Indications are the same as for HoLAP but also include patients with large prostate adenomas (up to 120 g) or in whom previous minimally invasive procedures (TUNA, TUMT) have failed. Contraindications are represented by acute prostatitis, urinary tract infections (appropriate treatment before intervention is required), and suspicion of prostate cancer (Malek et al., 2001).

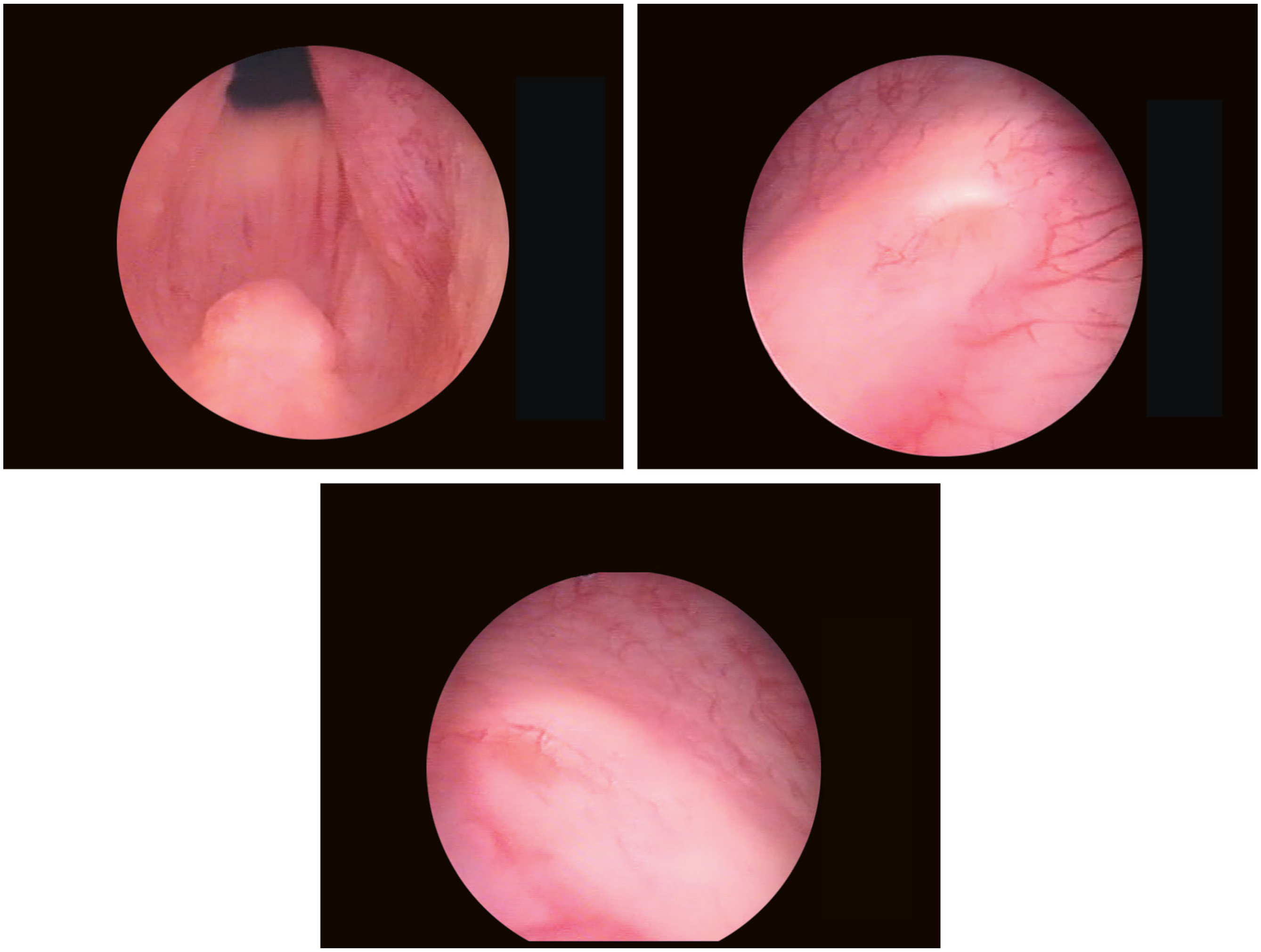

FIGURE 6.25 **Preliminary cystoscopy – the first operating step during PVP.**

The results obtained after the use of low-power KTP lasers (30–40 W) are similar to those obtained after TURP, but irritative symptoms persist for an extended period of time. The reintervention rate is around 6% at 3 years (Shingleton et al., 2002).

The introduction of the HPS 120 W system has significantly improved results, with studies showing that these results are maintained over the long term (Te et al., 2003; Gomez et al., 2007; Ruszat et al., 2006, 2007; Rajbabu et al., 2007) (Table 6.3). The rate of complications after PVP is low, with the most frequent being retrograde ejaculation and transient dysuria (Table 6.4).

TABLE 6.3 Long-Term Results of PVP

	Initial	Evaluation after 1 year	Evaluation after 2 years	Evaluation after 3 years
Median IPSS score	22.0	4.0	3.8	3.8
Median Qmax	7.8	27.0	26.3	23.8
Median postvoid residual volume	154.0	51.0	21.0	26.5

TABLE 6.4 The Rate of the Main Complications After PVP

Complication	Percentage
Urethral stricture	0
Reintervention	1
Erectile dysfunction	0
Urinary infection	1
Transient urinary incontinence	3
Urinary retention	3
Retrograde ejaculation	9–37
Hematuria	7–10
Transient dysuria	16

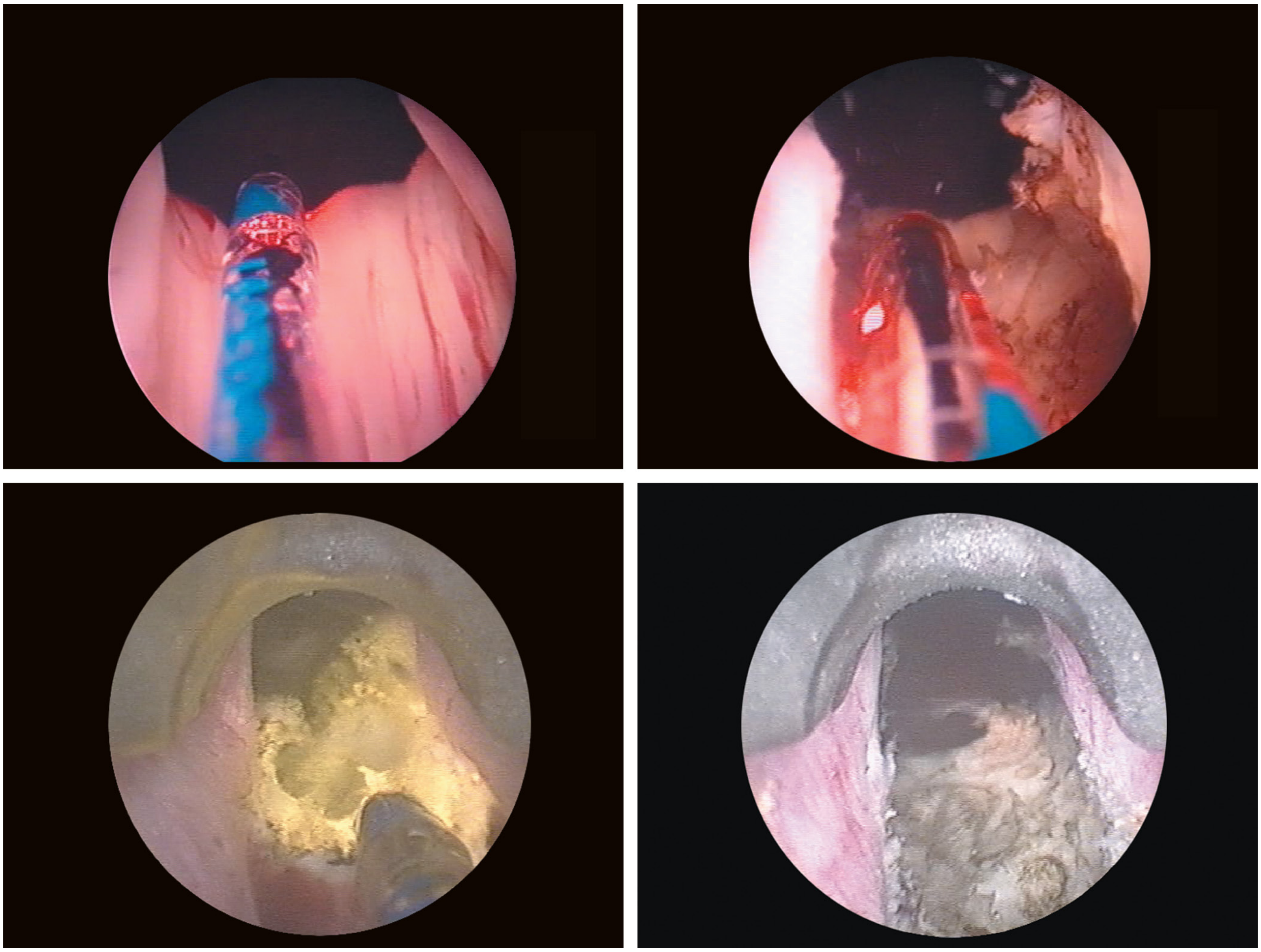

FIGURE 6.26 **Creating the working channel.**

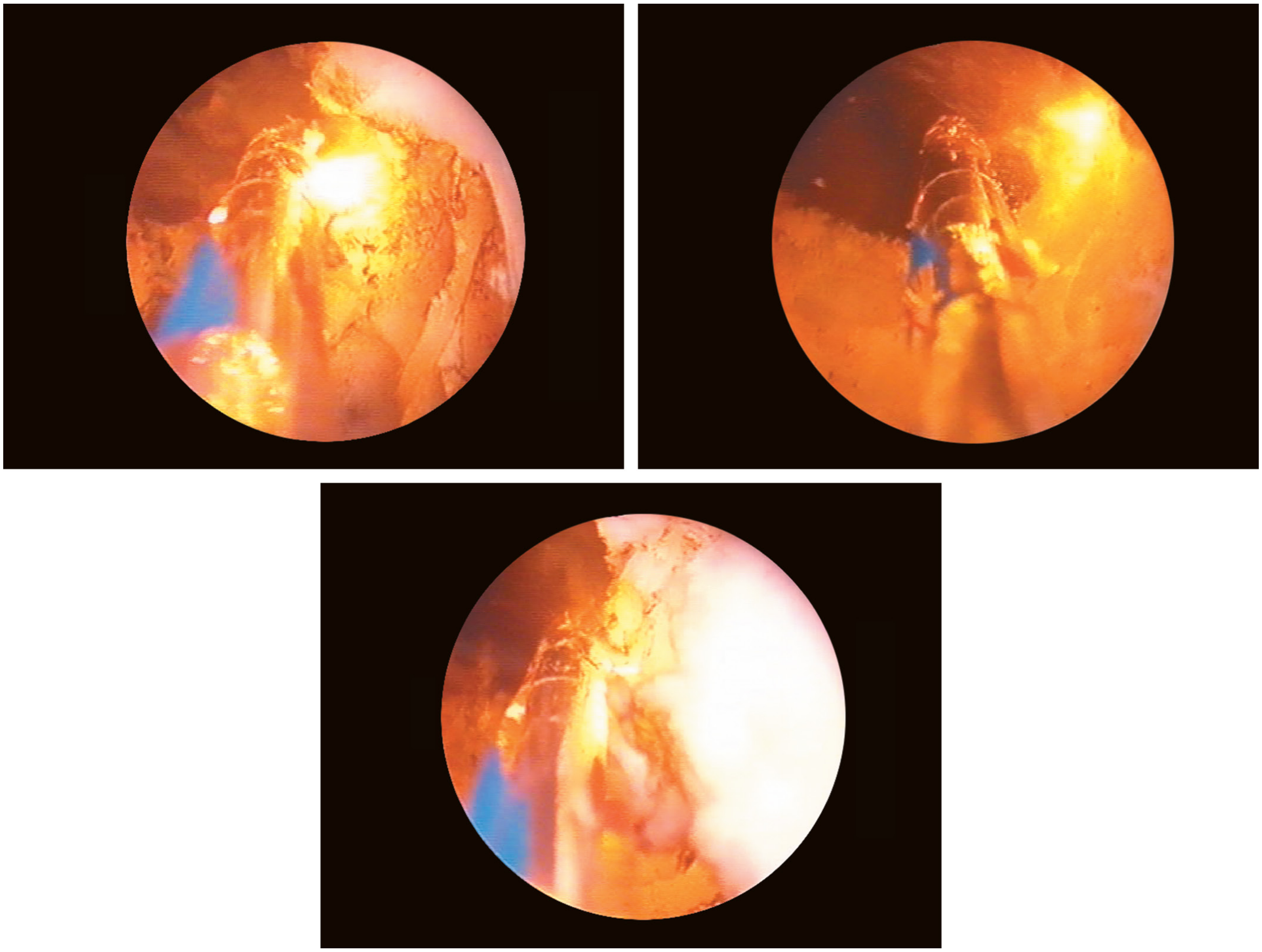

FIGURE 6.27 **Vaporization of the left prostatic lobe.**

FIGURE 6.28 **Vaporization of the right prostatic lobe.**

Although the decrease in prostate volume after PVP is less than after TURP (40% and 50%, respectively), urethrocystoscopies performed after surgery show large prostate lodges. The high efficiency of this procedure, the rapid improvement of symptoms, the low rate of adverse effects (with the preservation of sexual function), and the favorable long-term results are the reasons behind the swift development of this technique, which may become a new standard of care in the treatment of BPH.

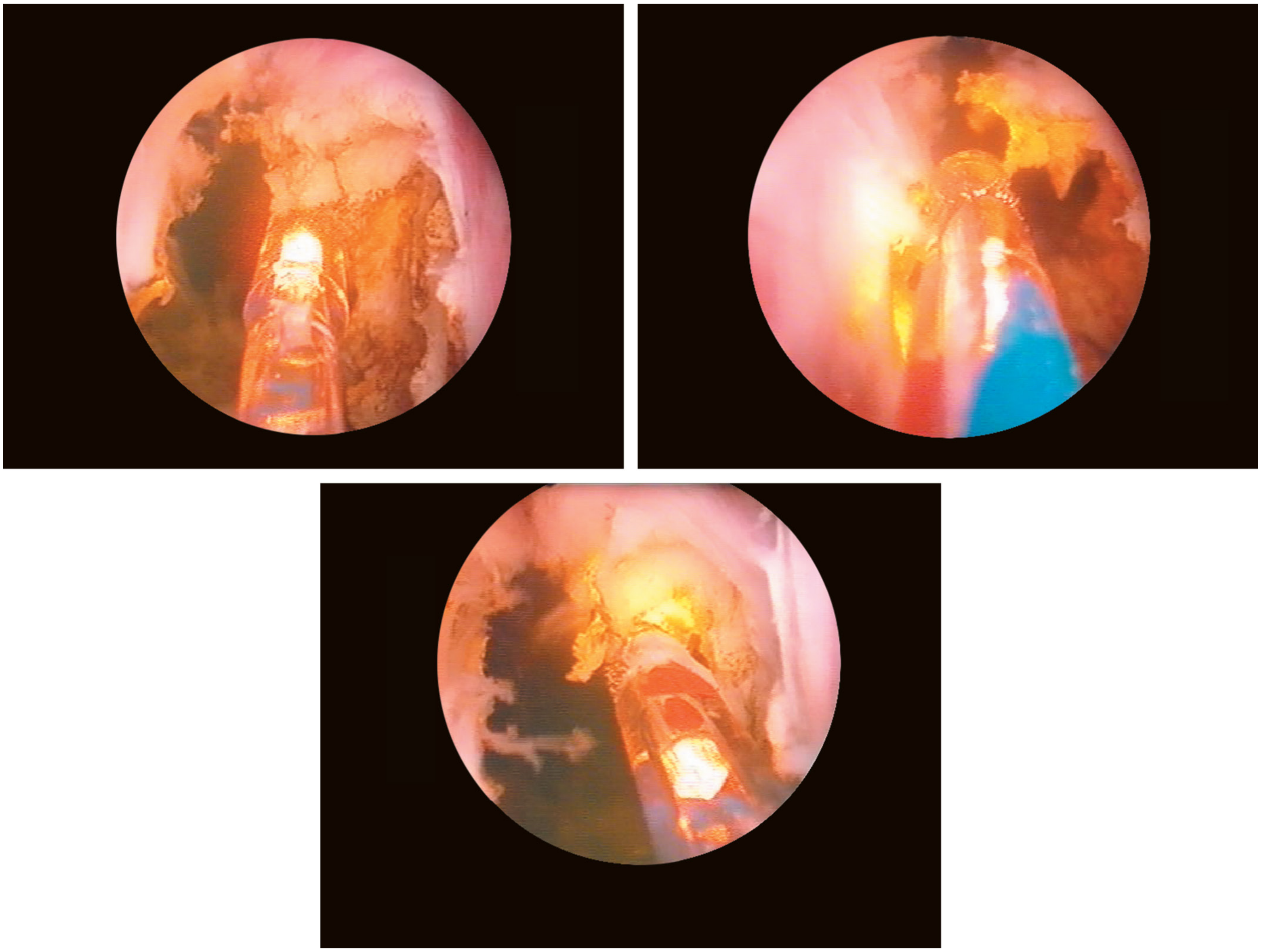

FIGURE 6.29 **Vaporization of the apex.**

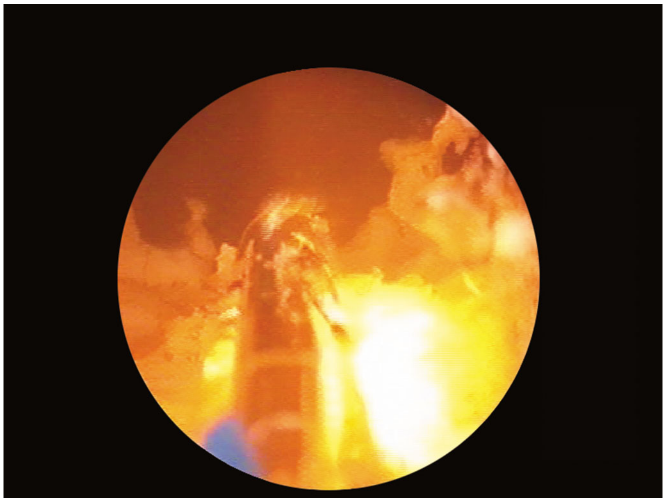

FIGURE 6.30 **Vaporization of the bladder neck.**

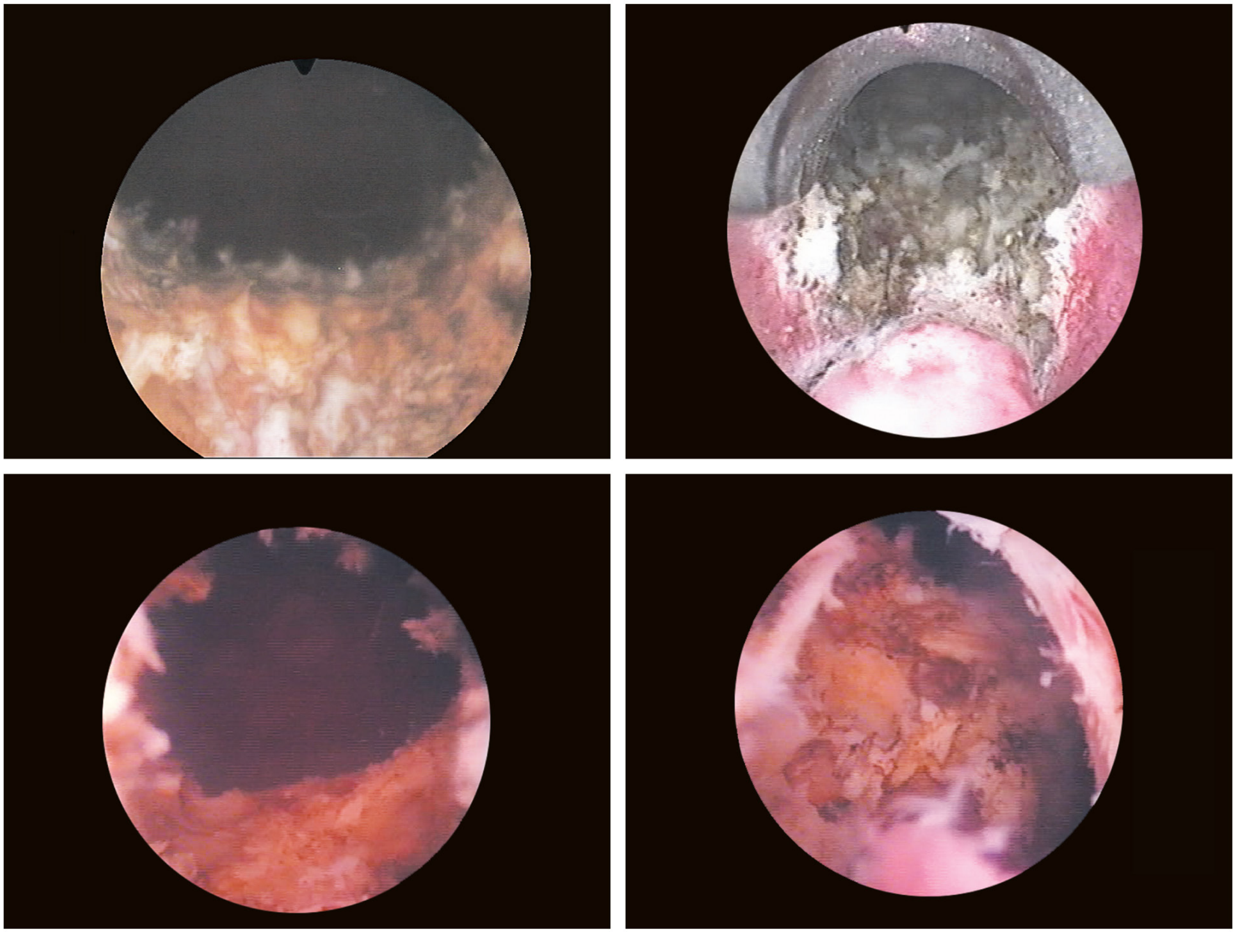

FIGURE 6.31 **Final postoperative appearance after PVP.**

6.7.3 Diode Laser Vaporization Prostatectomy (DVP)

The diode laser (potassium-titanyl-phosphate) is one of the newest treatment modalities for BPH, with properties similar to the green laser but with a significantly lower price. Also, the device has small dimensions, with a higher maneuverability and mobility (Fig. 6.32).

Similar to PVP, the procedure is performed using a cystoscope or, more recently, a laser resectoscope (Fig. 6.33). This has a working channel similar to the classical resectoscope (the intraoperative movements thus being similar to TURP).

The technique follows the same steps described for PVP (Fig. 6.34) and the initial results are identical.

FIGURE 6.32 **A 150-W diode laser.**

FIGURE 6.33 **Laser resectoscope.**

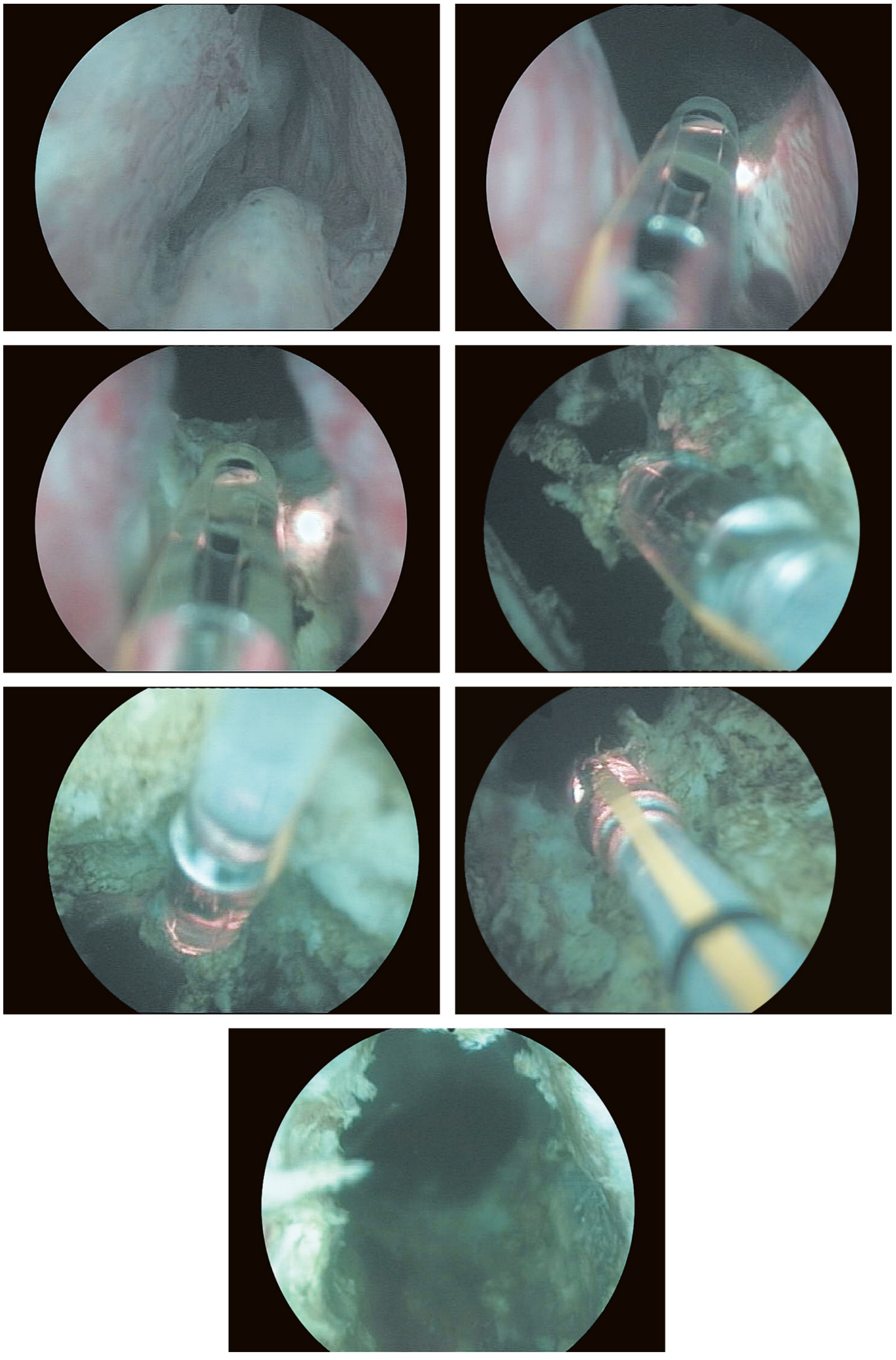

FIGURE 6.34 **DVP – intraoperative appearance.**

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CHAPTER

7

Enucleation of Benign Prostatic Hyperplasia

Petrişor Geavlete, Gheorghe Niţă, Bogdan Geavlete

7.1 HOLMIUM LASER ENUCLEATION OF THE PROSTATE (HOLEP)

Laser resection of the prostate, which was described for the first time by Gilling (1996a), is similar in principle to transurethral electroresection. The lasers used are the Ho:YAG, Nd:YAG, or diode. The most frequently used in medical practice is the Ho:YAG laser, the method being known in the literature as Holmium laser resection of the prostate (HoLRP). This procedure was developed because of the necessity to completely and efficiently remove the prostatic tissue while obtaining samples for histopathological exam. The method allows for complete enucleation of the adenomatous tissue with minimal intraoperative bleeding (Cresswell et al., 1997).

Fibers of 550 μm are used, and the device is set to 2–2.8 J and 25–40 Hz (70–80 W). A resectoscope with continuous irrigation and a special working element are used. The irrigating fluid is represented by normal saline solution.

Retrograde enucleation of the prostate is performed, after which the tissue is fragmented into pieces small enough to be extracted through the resectoscope's sheath (Gilling, 1996a,b). The procedure begins with a bladder neck incision performed at 5 and 7 o'clock, extended proximal from the verumontanum, followed by retrograde enucleation of the median lobe. It is recommended that the median lobe be divided into small fragments before its complete enucleation. Resection of the lateral lobes follows, first defining the apical limit of resection. A series of incisions are done starting from the bladder neck toward the apex of the prostate, ensuring that they are slightly convergent toward the prostatic capsule so as to obtain prismatic prostate tissue fragments with the base toward the prostatic urethra and the tip toward the capsule. These are pushed into the bladder and removed later. A clamp may be used to remove larger fragments. The postoperative urethro-vesical catheter is left in place for 24 h.

The results were compared to transurethral resection of the prostate (TURP) as well as to other laser procedures for benign prostatic hyperplasia (BPH) treatment (Table 7.1) (Gilling et al., 1997). The advantage in comparison with TURP is a much better control of hemostasis (Gilling 1996a), obtained by the use of relatively high laser powers. On the other hand, the method is quite laborious, the duration of the procedure is longer than for TURP, and the technique has a slow learning curve, even for experienced endoscopists (it is necessary to perform at least 20 procedures during the learning curve).

The technique evolved rapidly. Another procedure, holmium laser enucleation of the prostate (HoLEP), was developed based on it. HoLEP has practically replaced HoLRP. The procedure was described for the first time by Gilling and Fraundorfer (1997) and was made possible by the development of advanced devices that allow for the morcellation and removal of enucleated prostatic tissue from the bladder. Lasers of 100 W are used, which are set to 2 J and 50 Hz. The 550-μm fibers are inserted through a 24–27 F resectoscope, specially designed for this procedure. Thus, the internal sheath is modified, incorporating a channel for the laser fiber. The solution used for irrigation is represented by saline solution. The only transurethral morcellator marketed is manufactured by Lumenis.

The procedure is performed under general or spinal anesthesia, and the main surgical steps are derived from HoLRP. First, incision of the bladder neck is done at 5 and 7 o'clock, up to the prostate capsule (which is identified during surgery because of its transverse fibers). This incision is sufficient for small prostates (less than 40 g) without the need for completing the procedure (Cornford et al., 1998). Accurate identification of the prostatic capsule is essential for knowing the depth of the enucleation. The incision is extended distally on both sides of the verumontanum.

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TABLE 7.1 Comparative Results Between TURP and HoLRP

	TURP	HoLRP
Duration of procedure (min)	25.8	42.1
Duration of urethral catheterization (h)	37.2	20.0
IPSS	23 before surgery 7.7 at 1 month 5.1 at 6 months	21.9 before surgery 7.7 at 1 month 3.5 at 6 months
Qmax (mL/s)	9.1 before surgery 22.4 at 1 month 22.3 at 6 months	8.9 before surgery 21 at 1 month 24 at 6 months

It is possible to use the distal end of the resectoscope, together with the laser fiber, for the dissection of the tissue that has been incised. Bleeding vessels can be coagulated by removing the fiber from them.

The next step is represented by the enucleation of the median lobe after its retrograde dissection (up to the prostatic capsule) using transverse incisions and starting from the verumontanum. The resectoscope's sheath is used to help in the dissection and the enucleation of the median lobe, which will be fully detached and pushed up into the bladder.

The next surgical step is represented by enucleation of the lateral lobes, using a circumferential incision starting from 11 o'clock to 1 o'clock, respectively, on each side. The morcellator is inserted at the end of the procedure to remove the fragments from the bladder (Fig. 7.1).

It is possible to use HoLEP for enucleation of very large prostates, of up to 300 cm^3, with results similar to those obtained by TURP. The most frequent postoperative complication after HoLEP is dysuria, with an incidence of approximately 10%. Retrograde ejaculation is present in 74–80% of patients. The most important complications are presented in Table 7.2 (Kuo et al., 2003; Kuntz et al., 2004a; Seki et al., 2003).

This technique requires a lot of skill, and the learning curve is longer than for other laser techniques.

7.2 ENUCLEATION BY PLASMA VAPORIZATION

Obtaining scientific confirmation as a viable treatment modality for BPH represents a real challenge for emerging procedures, most of which fail to pass the test of time. As noted earlier, enucleation of prostate adenoma by holmium laser seems to offer some advantages in terms of operative safety compared to open surgery. On the other hand, this type of procedure has significant disadvantages related to expensive surgical equipment and to a long learning curve.

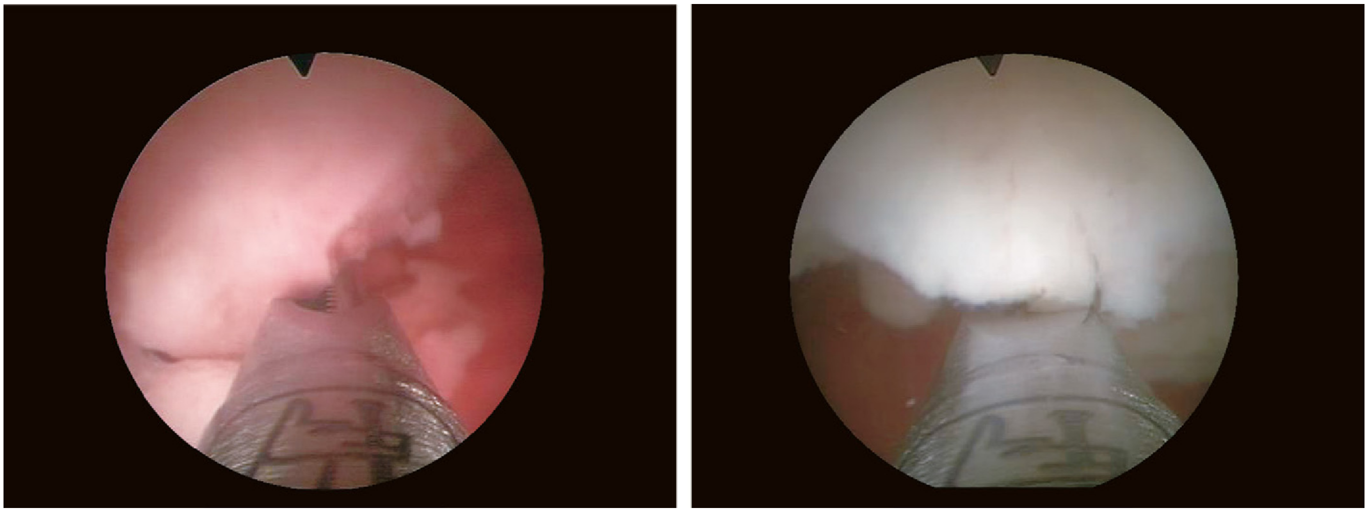

FIGURE 7.1 **Morcellation of a prostate adenoma after enucleation.**

TABLE 7.2 Complications After HoLEP

	Seki et al. (2003)	Kuo et al. (2003)	Kuntz et al. (2004a, b, c)
Blood transfusion	0	2 (1%)	0
Recatheterization	NR	16 (7.7%)	0
Urinary tract infection	4 (6%)	NR	NR
Incontinence	1 (1.5%)	NR	1 (1%)
Urethral stricture	5 (7%)	5 (2.4%)	3 (3%)
Bladder neck contracture	0	8 (3.8%)	3 (3%)
Reintervention	3 (4.2%)	7 (3.4%)	2 (2%)

Bipolar plasma vaporization has been introduced recently as a viable endoscopic alternative for the treatment of prostate adenoma. The initial results are promising. According to studies, the perioperative parameters of plasma vaporization are satisfactory compared to standard monopolar resection in cases of average size prostate adenomas (30–80 mL) (Geavlete et al., 2010).

On the other hand, bipolar plasma vaporization as a single therapy was less successful in the case of large prostate adenomas, and for this reason other methods were developed. Therefore, considering the potential benefits of enucleation of a considerable amount of adenomatous tissue, a new endoscopic technique was introduced: enucleation by bipolar plasma vaporization of large prostate adenomas (Fig. 7.2).

Similar to HoLEP, the intervention is performed under spinal anesthesia. The procedure uses the Olympus SurgMaster UES-40 bipolar generator, OES-Pro bipolar resectoscope, Visera video system, the "button"-type special electrode (described in Chapter 6), and the Wolf morcellator. Compared to laser therapy, the costs of bipolar electrosurgery are significantly lower, even in the case of large prostate adenomas.

The technique generally follows the classical steps of laser enucleation. The first step consists of enucleation of the median lobe, using incisions of the bladder neck at 7 and 5 o'clock, which are continued toward the verumontanum (Fig. 7.3).

The next step is represented by an incision at 12 o'clock, with subsequent separation of the two lateral lobes followed by downward enucleation by plasma vaporization as well as mechanical enucleation of the two lobes (Fig. 7.4).

Subsequently, enucleation of the lateral lobes by plasma vaporization is performed upward starting from 5 o'clock to 7 o'clock, respectively, thus obtaining complete excision of the lateral lobes (Fig. 7.5).

Throughout the entire procedure, close contact must be rigorously respected between the crown of plasma produced on the surface of the "button"-type special electrode and the prostate capsule. This way, the correct enucleation plane is permanently maintained, with a clear view of the prostate capsule fibers (Fig. 7.6) and reduction of both the duration of the procedure and intraoperative bleeding.

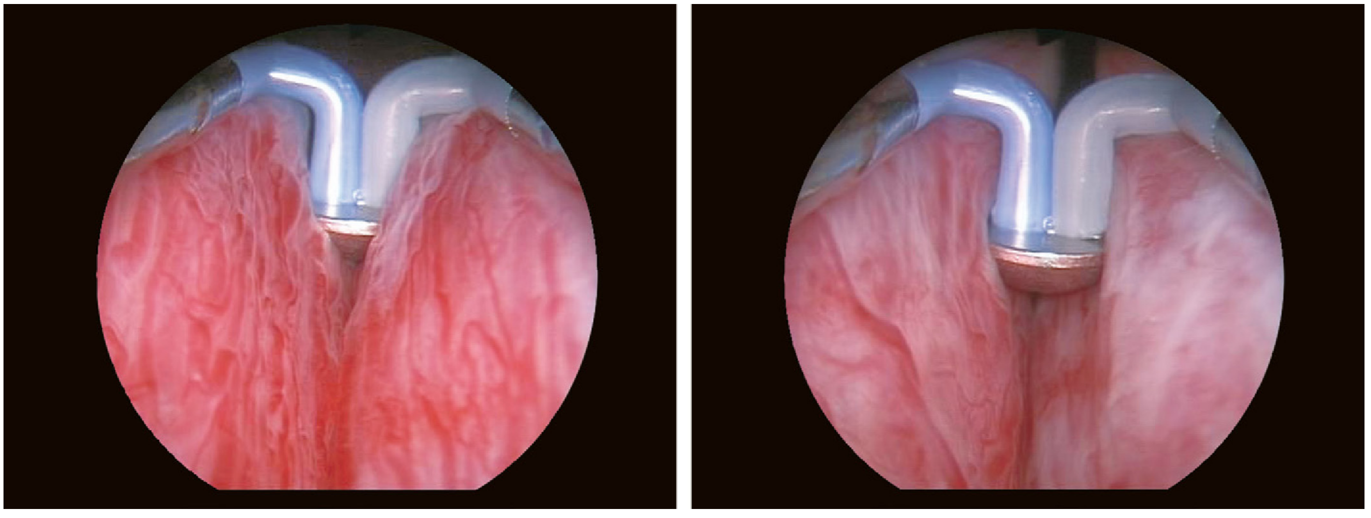

FIGURE 7.2 **Enucleation by bipolar vaporization for large prostate adenomas – initial endoscopic aspect.**

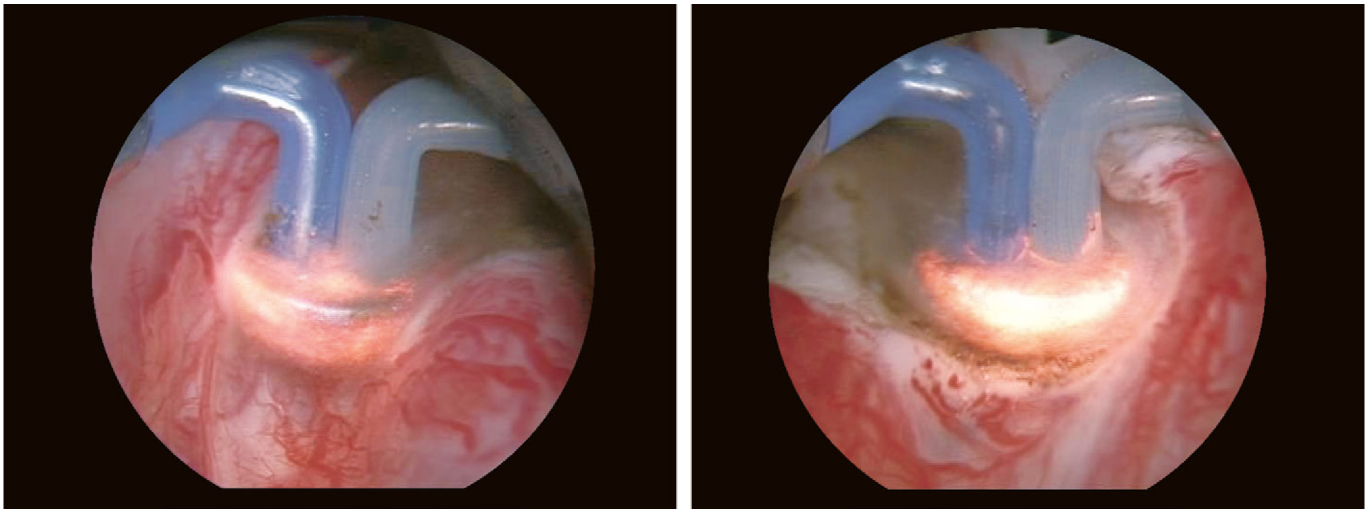

FIGURE 7.3 **Plasma enucleation of the median lobe by incisions at 7 and 5 o'clock.**

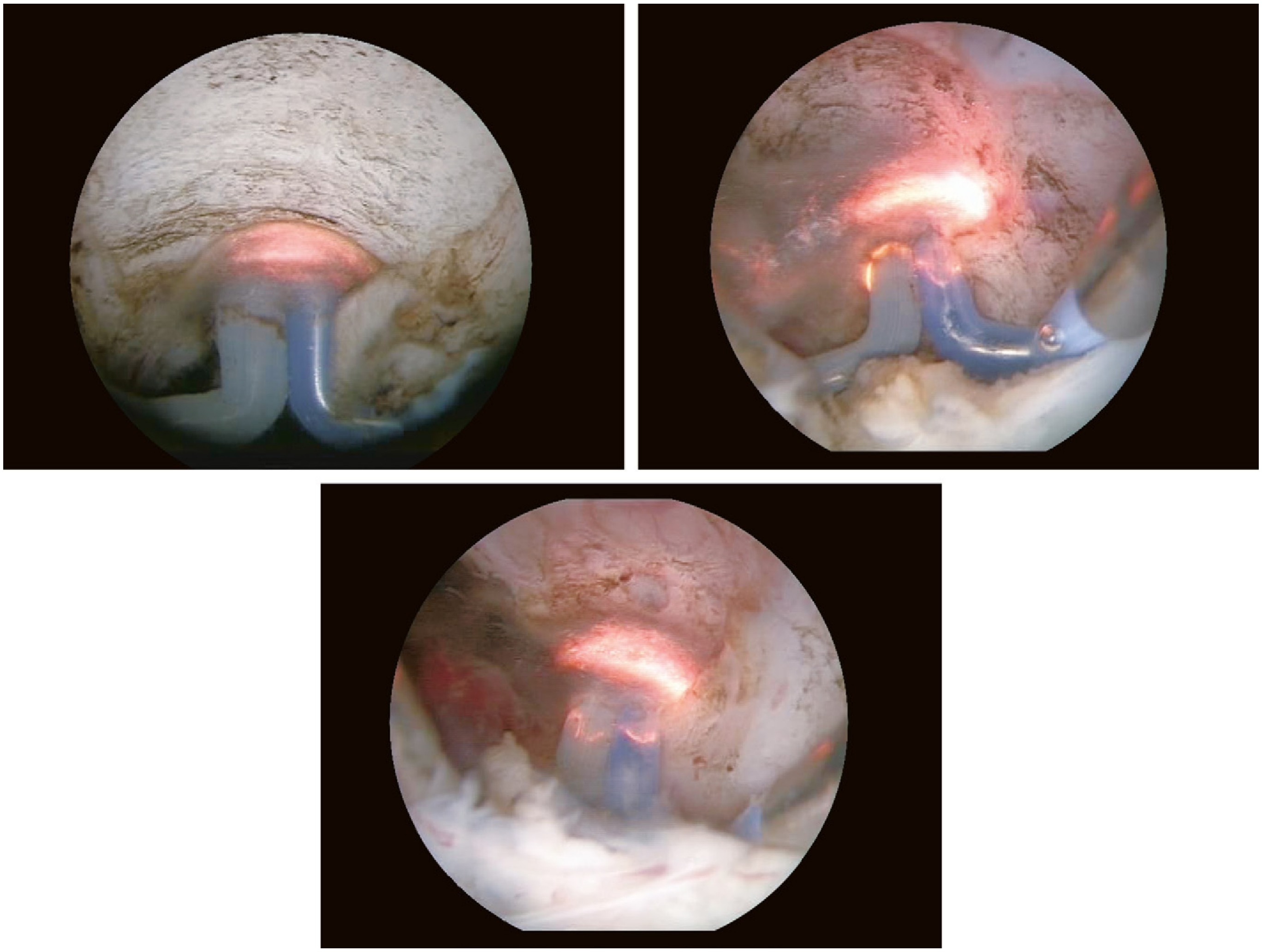

FIGURE 7.4 **Incision at 12 o'clock and downward enucleation.**

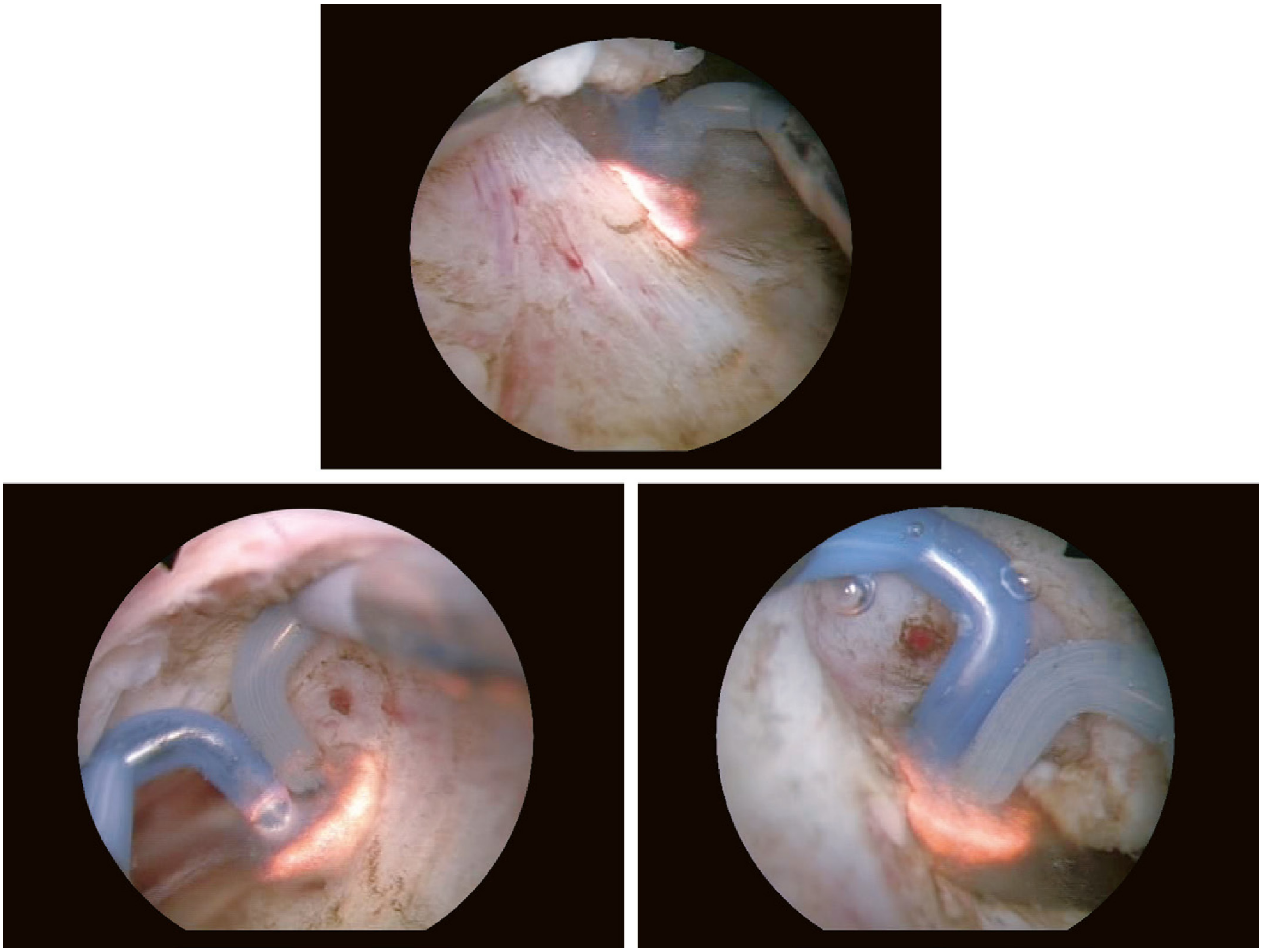

FIGURE 7.5 Upward enucleation of the lateral lobes.

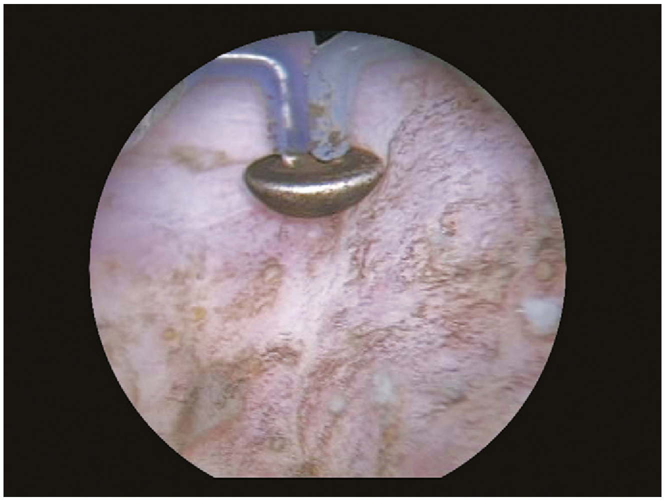

FIGURE 7.6 Prostate capsule – intraoperative aspect.

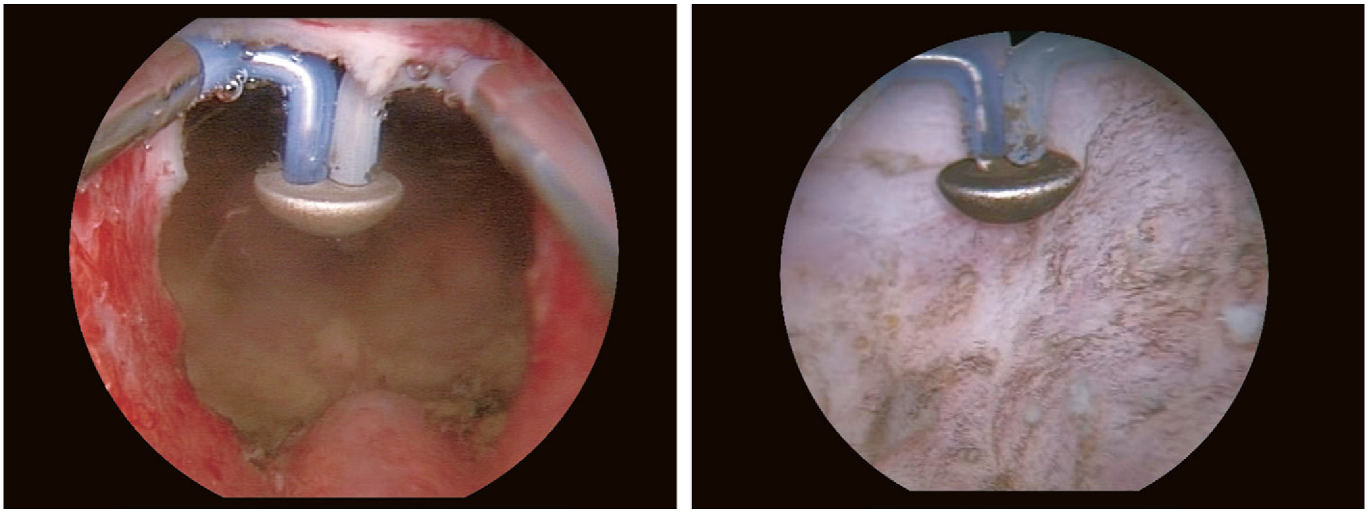

FIGURE 7.7 **Large prostatic lodge with a smooth capsule after plasma enucleation.**

The final result is a large prostatic lodge with a smooth surface and without irregularities (Fig. 7.7).

All the bleeding sources are coagulated at the end, followed by complete morcellation of the previously enucleated prostatic tissue (Fig. 7.8).

Enucleation by bipolar plasma vaporization is relatively easy to perform, due to an increased surface of vaporization and to the efficient coagulation specific for the "button"-type electrode features that significantly improve the speed and accuracy of this method. Moreover, ablation of the adenomatous tissue is optimized because vaporization is done simultaneously (Fig. 7.9).

Until now, the concept of prostate enucleation by endoscopic electrosurgery included different types of procedures, initially marked by a certain degree of success but still insufficient to ensure their integration into current urological practice. For example, after partial monopolar resection of the prostate, some authors performed a detachment of residual adenoma from the surgical capsule by direct visualization, using a special blade (Hiraoka and Akimoto, 1989). This technique was later modified to perform only enucleation with the detachment blade or even with the tip of the resectoscope, followed by morcellation of the adenomatous tissue (Hiraoka et al., 2007; Iwamoto et al., 2008). Moreover, standard resection was transformed into an enucleation-resection type procedure (e-TURP), a combination of the basic steps of classical TURP and HoLEP. Only the bipolar resectoscope was used for this type of intervention (Galanakis et al., 2010).

According to the literature, prostate enucleation with a plasmakinetic system using the Gyrus bipolar device is a safe and feasible procedure from a technical point of view but with poorer perioperative results compared to HoLEP (Neill et al., 2006).

On the other hand, this procedure is remarkably efficient in improving lower urinary tract obstruction due to prostatic adenoma, similar to standard resection (Zhao et al., 2010). However, the studies previously mentioned included only patients with medium prostates (51.0–68.4 mL) (Neill et al., 2006; Zhao et al., 2010), leaving the problem of surgical treatment for large adenomas unresolved.

Postoperative recovery after enucleation by plasma vaporization seems comparable with that after holmium vaporization in terms of median durations of catheterization and hospitalization (26.5 h vs. 25–36 h and 2.3 days vs. 1.2–2.7 days, respectively) (Elzayat, 2006; Naspro et al., 2006).

Of course, a direct comparison with the "gold standard" for the treatment of large adenomas, that is, transvesical prostatic adenomectomy, is absolutely necessary when a new surgical technique is evaluated. The advantages of plasma enucleation over open surgery are quite obvious when taking into account the available studies, with a shorter catheterization time (26.5 h vs. 153.6–194.4 h) and hospitalization (2.3 days vs. 7.7–10.5 days) (Mccullough et al., 2009) as well as a lower drop of hemoglobin levels (0.8 g/dL vs. 2.8–3 g/dL) (Kuntz et al., 2004b; Porpiglia et al., 2006).

In terms of perioperative complications, results regarding the safety characteristics for laser enucleation are consistent with the literature (Kuntz et al., 2004c), while at the same time underlining the significant advantages of endoscopic enucleation over open surgery. The studies show relatively important complication rates for transvesical

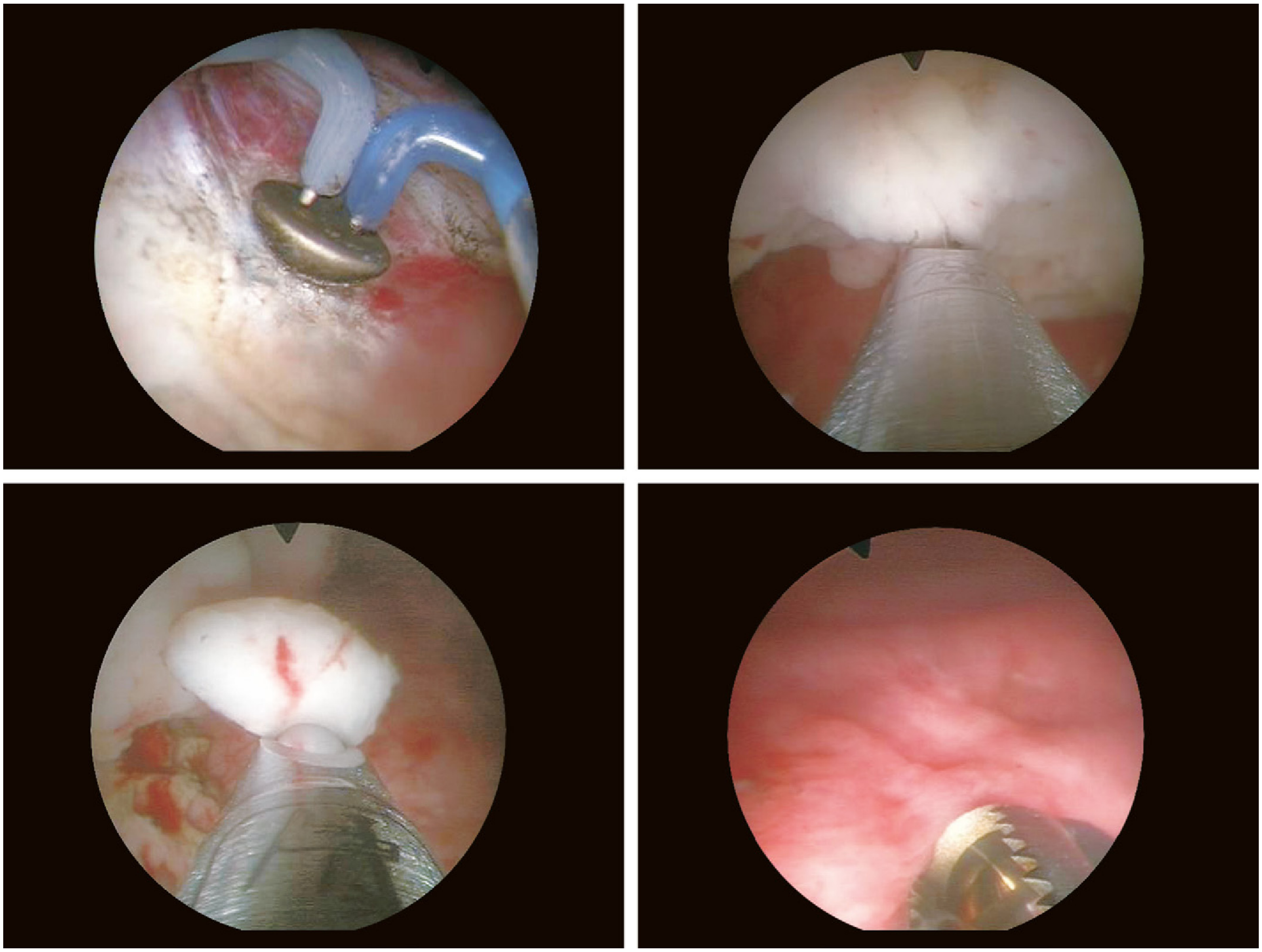

FIGURE 7.8 **Coagulation of the bleeding sources and morcellation of the adenomatous tissue.**

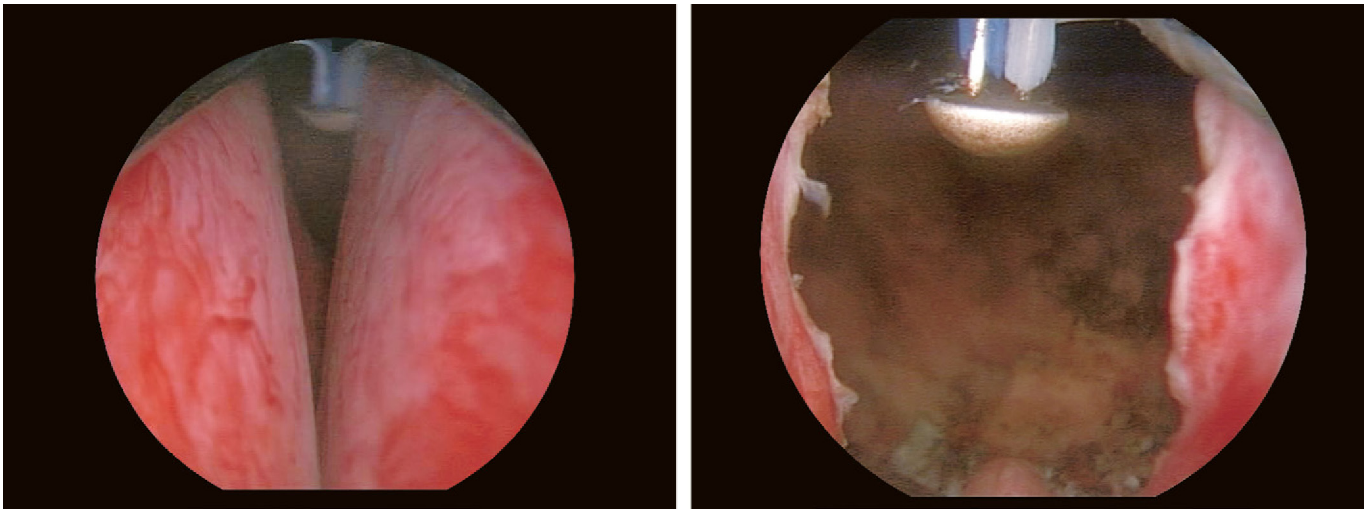

FIGURE 7.9 **Pre- and postoperative aspects in a patient with bipolar enucleation.**

surgery (29.3% for bleeding, 10.2% for blood transfusions, 7.6% for urinary retention, and 1.2–5% for reintervention) (Porpiglia et al., 2006). The rate of early irritative symptoms is around 10%, comparable with that recorded for HoLEP (9.3%) (Elzayat, 2006).

Regarding the learning curve, this procedure is quite easily performed by urologists with an average endoscopic experience. Due to the easy maneuverability of the equipment and to the superior safety profile, this technique can become a routine procedure after the first 15–20 interventions.

Of course, the long-term benefits and overall viability of this technique will depend on the results of extended follow-up as well as on future studies that will evaluate the defining characteristics of the method.

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CHAPTER

8

Microwave Thermotherapy in the Treatment of Prostatic Adenomas (TUMT)

Gheorghe Niţă, Cristian Persu

8.1 GENERALITIES

The treatment of benign prostatic hyperplasia (BPH) by thermotherapy is based on the effects of microwaves, which are applied using a transurethral device. The heat generated inside the prostate induces necrosis through coagulation of blood vessels. Only the first cellular layers (which come into contact with the device) suffer necrosis, because this type of energy has a reduced penetrability and the procedure is performed under continuous washing and cooling irrigation. After a period of exposure, necrosis generates a reduction in the size of the prostate, while also reducing the degree of subvesical obstruction.

Transurethral microwave thermotherapy (TUMT) is a procedure found at the border between medical and surgical therapy. According to the European Association of Urology (EAU) Guidelines, TUMT is recommended for patients who do not want surgery or who do not respond to medical treatment (Oelke et al., 2009). Developed in the early 1980s, TUMT has been extensively studied, initially in basic research projects and then in multicenter clinical trials worldwide. A brief analysis of the available results divides those who have used prostate thermotherapy into two distinct groups: physicians who are enthusiastic about TUMT and those who are disappointed by its results and do not consider thermotherapy to be a real option for the treatment of prostatic adenoma (Harada et al., 1985).

Currently, the technology underlying TUMT is marked by the emergence of many devices that provide an increasing amount of energy and from which better results are expected. While the first devices raised the local temperature to values of 42–44°C, modern devices generate temperatures that can reach 70°C. The effect of microwaves is due to the fact that the temperature is increased over a very small area, without affecting the surrounding tissues (Magin et al., 1980).

A major advantage of this technique derives from its simplicity and reduced invasiveness. The learning curve is short, only local anesthesia is necessary, the patient does not require hospitalization, and the procedure has a low impact on sexual function. All these elements make TUMT an important alternative in the treatment of prostate adenoma, a technique that can be performed under a day care basis or in medical centers with only minimal equipment.

The existing data suggest a lower impact of the procedure on sexual function as compared to TURP. On the other hand, the reduction of the degree of subvesical obstruction is lower than that after TURP, while the average duration of maintaining a urinary catheter is longer (Spatafora et al., 2007).

8.2 BASIC PRINCIPLES OF TUMT

Although microwave thermotherapy has been widely used for over two decades, there are still many theories trying to explain the phenomena that occur locally and the mechanisms through which the symptoms of patients improve. Even though the mechanism of action of TUMT on the prostate is not completely understood, it is clear that the therapeutic results are the expression of a variety of factors. The few currently existing theories merely present

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the components of a highly complex mechanism found in close relation with local factors, both physiological and pathological.

8.2.1 The Sympathetic Nerve-Ending Degeneration Theory

According to this theory, microwaves destroy a part of the adrenergic neurons of the prostate because of the thermal effect. The symptomatic relief in patients could be explained by the interruption of the adrenergic mediated nervous pathway (Ramsey et al., 1998). A study performed in patients with TUMT (Perachino et al., 1993) describes the interruption of the nerve fibers with almost total destruction of the axons. The authors therefore suggest a mechanism of action similar to α blockers but based on the destruction of adrenergic receptors and not on blocking them by drugs.

This theory is supported by another study, which shows a complete disappearance of nerve fibers in the muscular layer of the prostate (on biopsies), without any changes to the fibers in the epithelial layer and lamina propria (Brehmer et al., 2000). The highest rate of disappearance of α1 adrenergic receptors is noticed in areas where the maximum levels of the temperatures are reached (Bdesha et al., 1996). According to the advocates of this theory, the inconsistent efficiency of the method is explained by the variable number of nerve endings.

8.2.2 Thermal Effect and Blood Vessel Destruction

The first, and perhaps most widespread, theory that tries to explain the mechanism of action of thermotherapy is based on the thermal effect, which causes coagulation of blood vessels, inducing tissue necrosis. Experimental studies have shown that, after exposure to microwaves, the temperature increases only within the prostate, while insignificant increases are recorded in the urethra and rectum (Devonec et al., 1993). Thus, during TUMT, constant temperatures were noticed inside the rectum, variations of ±2°C were observed in the lumen of the urethra, and temperatures up to 70°C were recorded in the prostatic lobes. The maximum penetrability of microwaves is around 15 mm (Osman et al., 2000). The areas affected by ischemia represent approximately 30% of the total prostate volume and 63.6 ± 34% of the volume of the prostate transitional zone. Therefore, the authors argue that TUMT could equal, in terms of results, transurethral electroresection (Osman et al., 2000).

The pathological examination of prostate tissue exposed to temperatures of 45°C for 1 h highlights hemorrhagic necrosis (followed by uniform removal of affected tissue), with a clear limit of demarcation between the affected and the healthy area (Larson et al., 1996). The use of Doppler ultrasound for assessing the vascular impact of thermotherapy at the prostatic level reveals a marked increase in blood flow concomitant with the increase of temperatures, an effect which is more obvious in the posterior half of the gland. Another effect of high temperatures is a reduced peripheral vascular resistance within the prostate (Larson and Collins, 1995).

8.2.3 Induction of Apoptosis

The latest theory that tries to explain the results of thermotherapy supports the induction of apoptosis in adenomatous cells as a result of a sudden temperature increase. Thus, on the biopsy cups obtained after transvesical adenomectomy in patients with recent TUMT, areas of necrosis were observed up to a depth of 4–5 cm; outside of these areas, groups of cells found in the process of apoptosis were seen, alternating with normal cellular areas (Brehmer, 1997).

Cellular apoptosis was also demonstrated by microscopic and electron microscopic studies in patients who underwent TURP after TUMT. At 24 h after thermotherapy, 76% of the affected cells developed apoptosis and 14% necrotic lesions. Apoptotic activity was six times greater (than in basal conditions) at 24 h after treatment. Thermal energy induces apoptosis if it is applied slower (Brehmer et al., 2000).

8.3 SURGICAL SYSTEMS

Five systems are currently available for TUMT. The principle on which they are built is similar: a work item being inserted transurethral into the prostate, where transmitters contained in this device are activated, generating microwaves that will be sent to the prostatic tissue. The Prolieve device, manufactured by Boston Scientific, used cooling with water, while dilation at the prostatic level was done with a balloon. This device is no longer used. The TherMatrx TMX-2000 system has the lowest energy of all the available devices and does not use a cooling circuit. It is the simplest TUMT device available. The Targis device (Fig. 8.1), manufactured by Urologix, is a bipolar system with a cooling circuit and is the most frequently used device for TUMT (with the most available clinical data).

FIGURE 8.1 **Targis system.** (a) Microwave generator and (b) urethral catheter.

Urologix also produces the Prostatron system (Fig. 8.2), a monopolar system with a cooling circuit, conceptually simpler than Targis but with similar efficiency and safety.

A study comparing the heating capacity of the two widely used TUMT devices, Targis and Prostatron, showed a higher efficiency for Targis, which also features manual control of frequency (Larson et al., 1998). The most advanced equipment available is CoreTherm, manufactured by Prostalund, a device that stands out thanks to its feedback system with continuous monitoring of temperature.

FIGURE 8.2 **Prostatron system.**

8.4 RESULTS

There are many studies that support prostate thermotherapy due to the encouraging results obtained. Most of these are open studies, without a control group. Most studies found an improvement of the IPSS symptom score by an average of 10 points. The most obvious improvement is observed within 3–6 months after treatment, and the IPSS score remains constant over the long term (Lao and Bushar, 2008).

Low-energy systems (Prostatron) significantly improve the symptom score and the maximum urinary flow rate (Devonec et al., 1991). However, the increase of maximum urinary flow (from 8.4 mL/s to 10.8 mL/s) is closer to that obtained by medical therapy rather than by surgical treatment. Blute obtained an improvement of maximum urinary flow (from 8.5 mL/s to 11.3 mL/s) accompanied by a significant improvement of the symptom score using an enhanced version of the Prostatron system. However, 36% of patients developed postoperative complete urinary retention; in 4% of cases, the urethro-vesical catheter was left in place for more than 1 month (Blute et al., 1993). In a recent meta-analysis, results were better when higher energies were used (Kaye et al., 2008).

In a study that included 187 patients with a follow-up period of 4 years, the satisfaction rate was 62% after 1 year, 34% after 2 years, and 23% after 4 years. Over 60% of patients required another therapy (Hallin and Berlin, 1998). On the other hand, there are studies suggesting the existence of a very high rate of respondents to placebo, demonstrating similar results in 2 groups of patients: the first treated with TUMT and the second group in which the procedure was simulated with the device switched off (Hoffman et al., 2007; de Wildt et al., 1996; De La Rosette et al., 1994).

A Swedish meta-analysis demonstrated a rapid increase of the number of patients treated by TUMT immediately after the procedure became available, followed by an equally rapid decrease. Medical treatment was recommended instead of TUMT in most cases (Blomqvist et al., 1997).

Pressure-flow studies conducted in patients who were treated with TUMT conclude that the detrusor pressure corresponding to the maximum urinary flow does not change significantly at 6 months after treatment, as compared to the initial measurement. However, a slight improvement of maximum flow is noticed (Tubaro et al., 1995).

The results of treatment improved after the development of systems generating high amounts of energy. The symptom score was reduced by more than half and the maximum urinary flow increased with more than 5 mL/s in several studies (Francisca et al., 2000; Djavan et al., 1999). Due to these results, the indication for using TUMT was also extended to patients with complete urinary retention, although the available data are not sufficient to support this conclusion (Floratos et al., 2000; Kellner et al., 2004). Regarding long-term efficiency of the procedure, the maximum symptomatic relief is obtained 2 years after treatment, being more important in patients treated with higher energies (Trock et al., 2004).

8.4.1 TUMT Versus TURP

The comparative analysis of results of the two therapies demonstrates the decrease of the symptom score to almost zero in the TURP group and an improvement of over 50% in the TUMT group. Regarding the maximum flow, the differences are at least as important: from 8 mL/s to 12.3 mL/s in the TUMT group, while flow increases from 8 mL/s to 18 mL/s after TURP. On the other hand, 25% of patients who underwent electroresection developed retrograde ejaculation, a complication that is not seen in the TUMT group. Urethral strictures have an incidence of 7.5% after TURP, while no patient experienced this complication in the group treated with thermotherapy (Dahlstrand et al., 1993). Pressure-flow study at 6 months after surgery shows superior results in patients with TURP, although urethral resistance is significantly decreased in both groups (Höfner et al., 1993).

Use of a high-energy device reduces the differences between TUMT and TURP regarding the symptom score, with better results for TURP in terms of maximum urinary flow. The higher rate of complications in the TURP group is offset by the significantly longer urethro-vesical catheterization in the TUMT group (Ahmed et al., 1997).

Regarding the urodynamic results at 6 months after the procedure, subvesical obstruction persisted in 40% of patients with TUMT as compared to only 15% after TURP. After 2 years, 25% of patients initially treated with thermotherapy required an alternative treatment for prostate adenoma (D'Ancona et al., 1998). The quality of life improved after both methods, with a more significant improvement in the symptom score for TURP (Francisca et al., 2000).

A comparison done by D'Ancona between TUMT and TURP in a group of 52 patients showed a significant improvement of symptoms in 56% of cases in the TUMT group and in 74% of cases in the TURP group. By studying only the degree of obstruction, improvement was seen in 90% of cases in the TURP group and in 70% of cases in the TUMT group. Erectile dysfunction and retrograde ejaculation were less frequent in the TUMT group. The mean duration of urethro-vesical catheterization was 4 days in the group treated by transurethral resection and 12 days in patients who underwent thermotherapy. On the other hand, a higher incidence of urinary irritative symptoms and of urinary infections was observed in the group treated with TUMT (D'Ancona et al., 1998).

A meta-analysis performed in 2000 found that, while morbidity is lower after TUMT, the method is not as efficient as TURP. Catheterization after TUMT is longer in all groups of patients, while long-term results are favorable in approximately 25% of cases (which is a counterargument for using this technique) (Wheelahan et al., 2000). Another meta-analysis conducted in the United States shows an increase in mean urinary flow rates from 7.9 mL/s to 13.5 mL/s (after TUMT) and from 8.6 mL/s to 18.7 mL/s (after TURP), concluding that TURP is superior regarding improvement of the symptom score, urinary flow, and long-term efficiency (Hoffman et al., 2004).

A significant percentage of patients who do not respond to thermotherapy are noticed in most studies conducted so far. Although it is difficult to formulate a clear explanation, one can speculate that a faulty technique or malfunctioning technical devices are to blame. On the other hand, the presence of similar or greater percentages of patients with good and long-lasting results is noticed in studies with long-term follow-up.

Patients may lose a degree of confidence in this procedure due to the reintervention rates, which reach 50% in some studies.

TUMT is not as efficient as TURP regarding the reduction of the degree of subvesical obstruction. However, its effects on the prostate have been proven, and the IPSS score significantly improves in a large number of cases. It is obvious that high-energy devices offer better immediate results than the first generation systems. Future developments will probably lead to the widespread use of high-energy TUMT, which seems to provide superior long-term results, which will be validated by clinical trials. The use of high energies, however, also has its inconveniencies, including the need for stronger sedation. Future studies will have to determine the exact place of TUMT in the treatment of prostate adenoma.

The devices currently available are different in terms of energy parameters and cooling systems but have in common a very good safety profile and similar efficiency. Manufacturers recommend different treatment modalities, but this has no effect on the results of the procedure.

The criteria for selecting patients who could benefit from TUMT are hard to define. However, when the characteristics of the ideal patient are defined, this technique may get a second wind.

The low invasiveness as well as the small number of adverse events indicates this method for patients who do not respond or are not satisfied with medical therapy and whose symptoms do not require a more aggressive therapeutic approach. The unsatisfactory results of thermotherapy do not exclude the possibility that, in a later stage, the patient would benefit from another interventional treatment.

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CHAPTER

9

Radiofrequency Ablation in the Treatment of Benign Prostatic Hyperplasia (TUNA)

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9.1 GENERALITIES

Although transurethral needle ablation (TUNA) of the prostate is a relatively newly developed technique, still evolving and improving, it has earned a place in the panoply of minimally invasive treatments for prostate adenoma due to its efficiency, simplicity, and relatively low cost.

The technique is simple and consists of the introduction of needles, which generate radiofrequency inside the prostatic lobes. A local increase in temperature occurs, at levels higher than 100°C, followed by tissue necrosis through coagulation of blood vessels. The procedure does not require a long learning curve. The treatment is performed under local anesthesia, and intravenous sedation or locoregional anesthesia is rarely necessary. All these elements make TUNA a procedure that can be performed on an outpatient or daypatient basis, even in the absence of equipment specific for operating rooms.

The procedure was developed in the early 1990s, and the first preliminary studies started in 1993. Before being used in clinical urology, TUNA proved its efficiency in interventional cardiology, where it was used for ablation of nerve bundles in patients with Wolff–Parkinson–White syndrome (Calkins et al., 1992). In the United States, the procedure has been approved for the treatment of benign prostatic hyperplasia (BPH) since 1996.

9.2 INSTRUMENTS

The TUNA device (manufactured by Medtronic Inc.) consists of an energy generator (external) and an internal applicator (Fig. 9.1). The generator produces a monopolar signal with a radiofrequency of 490 kHz, which allows a good penetrability and a uniform distribution inside the tissues. The internal applicator, usually with a 22 Ch caliber, has two needles at its distal end, which are protected by sheaths made of Teflon. These needles are placed inside the prostatic tissue during the procedure.

A neutral plate is placed on the sacrum. The thermal effect is the result of prostatic tissue resistance when the electric power travels between the active electrodes and the neutral plate. This design feature, with an active electrode of small dimensions and a neutral one with a large surface, favors the concentration of energy in the area located in the immediate vicinity of the needle. The energy diffuses through the neutral plate without any effects on the tissues. The volume of tissue affected by the thermal effect is influenced by the position and depth where the electrodes are placed and by the power and duration of the procedure. Radiofrequency increases molecular agitation by stimulating ions, thus inducing particle collisions; this phenomenon determines a local increase of temperature. Heat dissipation is very low; therefore, the procedure is safe (Schulman and Zlotta, 1995). If too much power is used, a phenomenon of "drying" occurs in the prostatic tissue, which increases tissue impedance and prevents the desired thermal effect. Therefore, the key to a successful procedure is identification of the correct level of energy, which will induce necrosis in the targeted areas without changing the properties of the surrounding prostatic tissue (which would result in scarring around the needles and failure of the procedure) (Schulman et al., 1993).

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FIGURE 9.1 **Prostiva device for TUNA (manufactured by Medtronic).**

Although radiofrequency has no effect on blood vessels, regardless of their caliber, vascularization seems to play an important role in delineating the thermal effect induced by the delivered energy – energy that is converted into heat and is lost by convection (Organ, 1976). A comparison between TUNA and transurethral microwave therapy (TUMT) highlights some interesting aspects. First, the basic principle is identical: increasing temperature in the treated tissue, which induces subsequent changes. The devices used are very similar, although the principle of power generation is different. On the other hand, microwaves have an effect on a wider area and penetrate deeper into the tissue. These features require maintaining a lower temperature for TUMT (to keep the safety profile), resulting in a longer duration of the procedure. Radiofrequency allows the temperature to increase to higher levels, even if the area in which the therapeutic effect is noticed has a smaller surface (Perlmutter et al., 1993). In current devices, the temperature reaches approximately 100°C in the targeted area (with a very rapid decrease in the surrounding areas).

The probe (Fig. 9.2), which in itself is an endoscopic instrument, is similar to a cystoscope through which the 0° telescope can be inserted. This part of the system is reusable, thus significantly lowering the cost per procedure. With modern systems, insertion of the therapeutic needles is done under direct visual control (and not blindly or guided by transrectal ultrasound, as was the case with the first systems). It is also possible to adjust the angle between the probe and the therapeutic needles, a maneuver that was not possible with the first generation of instruments. These technical improvements allow for the treatment of more particular cases, such as a large median lobe or bladder neck hypertrophy.

The needles located at the tip of the endoscopic instrument are protected by Teflon sheaths, thus preventing accidental sticking of other structures. They also protect the prostatic urethra (against the thermal effect).

9.3 INDICATIONS

Radiofrequency is currently indicated in patients with bilobed prostate adenoma that does not exceed 60 g and without other complications requiring surgical treatment. Data suggest that the indication could be extended beyond the limit of 60 g, but the procedure will last longer. The method may also be attempted in patients with obstructions due to the median lobe by rotating the endoscope so that the two needles are placed inside this lobe. However, the

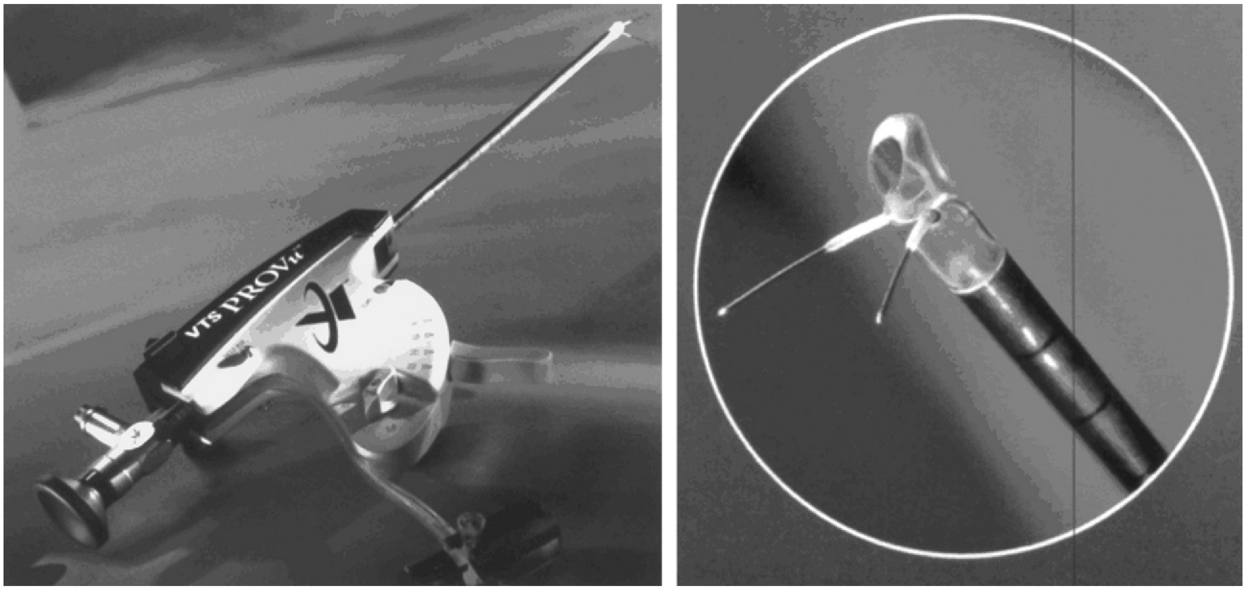

FIGURE 9.2 The applicator of the TUNA system.

two needles should be inserted cautiously to avoid injuring the rectum or other adjacent structures. Another possible indication is an obstruction due to bladder neck hypertrophy with the same precautions mentioned earlier (Naslund, 1997).

It is important to note that TUNA does not intend (and is not able) to completely remove the obstruction secondary to BPH, and the result of this technique is more symptomatic than curative. But even so, TUNA is a viable alternative for a large number of patients (Beduschi and Oesterling, 1998). Although TUNA has many indications, no clear criteria have been established to determine the place of this therapy among the therapeutic alternatives for BPH. Perhaps the future will bring improved selection criteria of patients for TUNA.

While the indications of this technique are still not clear, there is a consensus regarding contraindications: there are no absolute contraindications, although many authors avoid performing TUNA in patients with a large median lobe or with bladder neck hypertrophy.

9.4 TECHNIQUES

9.4.1 Preoperative Evaluation

Preoperative evaluation includes a clinical exam and an ultrasound of the prostate, measurement of the maximum urinary flow, and assessment of the patient's symptoms using a symptoms score. Urinary infections should be treated before the intervention. The measurement of prostate-specific antigen (PSA) levels is considered to be a routine element in the evaluation of patients with prostatic adenoma. Any suspicion of prostate cancer should be clarified before the intervention (Lepor, 1998).

Complex imaging investigations are necessary only when complications are suspected, situations in which a different therapeutic alternative is usually required. A preoperative urethrocystoscopy may be useful but is not mandatory. Although urodynamic assessment is not a routine examination before treatment, the measurement of certain parameters offers valuable information on the therapeutic effect and on the expected outcome of the patient. Preoperative evaluation includes the measurement of maximum urinary flow (Qmax) and of postvoid residual volume.

Urethral pressure profiling or pressure-flow studies are rather experimental and are not part of the usual assessment protocol. However, these measurements may offer additional information for establishing a more accurate indication of the procedure.

A study published in 2001, including 24 patients, showed that there are no variations in terms of the volume of the prostate or PSA levels immediately after the intervention (Minardi et al., 2001). Instead, the authors noticed a reduction of the opening pressure and of the detrusor pressure when reaching Qmax. A meta-analysis (including six studies that performed pressure-flow studies before and after TUNA) showed a decrease of the detrusor pressure when reaching Qmax from 85.4 cm water to 64.8 cm water, 3 months after the intervention. The postoperative urodynamic profile showed a complete disappearance of obstructions in many cases (Campo et al., 1997).

9.4.2 TUNA Technique

One of the major advantages of TUNA is its low degree of invasiveness, which allows the procedure to be performed on an outpatient basis. Local anesthesia is usually sufficient due to the small number of nerve endings in the prostatic tissue. Some authors prefer intravenous sedation and in rare cases spinal or even general anesthesia. The thermal effect does not involve the nerve endings located beyond the urethra, so irritative symptoms will be mild at the end of the procedure.

The patient is placed in the gynecological position, as in the case of endoscopic resection. The internal applicator (the probe) is inserted under visual control until it reaches the prostate, where the two needles are placed inside the tissue. Their position and depth can be checked by transrectal ultrasound. Prior knowledge of the prostate's size is useful in order to properly place the therapeutic needles, thus increasing the efficiency of the procedure.

The thermal effect extends 5–6 mm beyond the needle, so it should not be placed too close to the limit of the prostate to avoid injuries of the neighboring structures. On the other hand, for the same reasons, a safe distance must be kept between the needle and the prostatic urethra. The surface of the area of necrosis is approximately 2 cm^2, so the surgeon can plan a treatment strategy to evenly cover the entire volume of the prostate. Such a surface corresponds to approximately 10 g of prostate tissue.

The number of these areas of necrosis depends on the volume of the prostate, with the mention that each time the radiofrequency generator is turned on, two such surfaces are produced, corresponding to the two treatment needles.

It is recommended to use a single treatment plan if the prostatic urethra is 3 cm long, and another therapeutic plan should be added for each additional 1 cm. After completing the therapy for one lobe, an identical procedure will be used for the other one (Roehrborn et al., 1998).

Approximately 5 min are necessary to achieve one area of necrosis, which corresponds to an energy level of 2–15 W and a constant temperature in the range of 80–100°C. The temperature inside the urethra does not exceed 46°C. The average duration of the procedure is about 30 min, depending on the volume of the prostate, on the amount of energy used, and on the speed of assessment made between applications. At the end of the procedure, a urethro-vesical catheter is inserted for 24 h. There are authors who consider this maneuver to be unnecessary.

9.5 RESULTS

The first studies conducted on animals focused more on conceptual verification of the device and less on its efficiency. They proved, in animal prostates or *ex vivo* in human prostates, that the device can create areas of necrosis of 1 cm diameter, without damaging the rectum, bladder, or urethra (Ramon et al., 1993). Other studies showed that the lesions are well delineated from the surrounding tissues, initially having a hemorrhagic aspect, which becomes necrotic after 7 days and then fibrous after 15 days (Schulman et al., 1993).

One of the first studies performed in patients with BPH analyzed the effects of TUNA over a period of 1–46 days after the procedure, based on neurohistochemical analysis. The resulting lesions were approximately 10 mm^2, with the destruction of all tissular elements. The areas of necrosis were identified at a distance of 0.3–1 cm from the urethra without any urethral lesions. By specific staining of the neural cells, the destruction of these cells was proven within the first 24 h after the procedure (Zlotta et al., 1997). It was also found that nitric oxide receptors are the most vulnerable to thermal degradation, and lesions of the α-adrenergic receptors are most pronounced after 1–2 weeks. Thus, the lesions induced by thermal energy develop sequentially, and the effects on the prostate probably appear in the same manner (Issa et al., 1996).

Available data indicate that the temperature in the treatment zone is maintained in the range of 90–100°C, whereas it does not exceed 50°C at the periphery of this area.

There are many clinical data supporting TUNA as a safe and efficient treatment in BPH, although the number of randomized clinical trials is still limited. The evaluation of therapy is generally based on symptoms scores and on the maximum urinary flow, and the results are sometimes compared with medical treatment. The existing data demonstrate an increase of the maximum urinary flow by approximately 6 mL/s, which represents an improvement of 77%. The IPSS score records an improvement of over 50%, corresponding to an improvement of 13.1 points (Issa and Oesterling, 2000). Giannakopoulos reported the highest increase in maximum urinary flow, with an average of

9.2 mL/s (Steele and Sleep, 1997). The worst results are reported by Rosario et al. (1997), who recorded an average increase of urinary flow of 2.7 mL/s and an improvement of the symptom score by 10.8 points.

In a study comparing TUNA and TURP, the symptom score improved by 13.6 points in the TUNA group and by 15 points in the TURP group. The maximum urinary flow rate increased by 6.3 mL/s after TUNA and by 12.4 mL/s after transurethral resection. Treatment was considered to be ineffective in two patients from the TUNA group. On the other hand, in the TUNA group, adverse events were limited in both number and severity, and no negative impact on sexual function was noticed (Bruskewitz et al., 1998). In another study on 188 patients who underwent TUNA, with a follow-up period of 5 years, the retreatment rate was 23.3% without any major complications during follow-up. The symptom score decreased from 20.9 to 8.7, comparable to the improvement obtained by conventional surgical treatment. The improvement of the maximum urinary flow was far less spectacular with an average increase of only 3.5 mL/s, an improvement commonly seen after medical therapy (Zlotta et al., 2003).

A randomized study published in the United States in 2004 reported that 14% of patients who underwent TUNA subsequently required another treatment (compared to only 2% after TURP) (Hill et al., 2004).

A financial analysis aiming to compare the costs of different treatments for BPH highlights some interesting aspects: after 5 years, treatment with α-blockers costs less than TUNA, which has the same price as finasteride. Thus, a combined medical treatment is significantly more expensive than TUNA over the long term (while TUNA remains cheaper than TURP). However, TUNA is superior in improving the IPSS, while TURP is more efficient in improving the maximum urinary flow (Naslund et al., 2005).

In a meta-analysis published in 2004, Boyle reports that all available studies, regardless of design or other parameters, found an improvement in IPSS of at least 50% after 1 year as well as a similar trend for maximum urinary flow, although this parameter appears to decline after the first year of treatment (Boyle et al., 2004).

9.6 COMPLICATIONS

There are no published data reporting deaths during TUNA or as a direct consequence of this procedure. Most commonly, patients develop complete urinary retention after TUNA with an incidence ranging from 13.3% to 41.6%. It is therefore considered normal for the patient to have at least one episode of urinary retention within the first 24 h after the procedure, and for this reason bladder catheterization is recommended immediately after the procedure (Kahn et al., 1998).

Mild and transient hematuria is common without requiring any treatment. Precautions are necessary only in the case of patients under anticoagulant treatment or in patients with coagulation disorders due to other conditions.

Irritative symptoms (including imperious urination, the feeling of incomplete voiding, etc.) are moderate and usually disappear after 1–7 days. The mechanism of occurrence of these symptoms is unknown (Millard et al., 1996). The incidence of urinary infections is low: approximately 3% of patients. Antibiotic prophylaxis is recommended in all cases, similar to all interventional procedures involving the urinary tract. Although urinary infection is usually asymptomatic, sometimes it can lead to more severe complications, such as epididymitis (Rodrígo Aliaga et al., 1997). Some authors report urethral strictures, which may occur in up to 1.5% of patients. None of the studies reported urinary incontinence after TUNA.

It is generally accepted that the procedure has no negative impact on sexual function. However, there are sporadic reports of retrograde ejaculation after the procedure, without a clear explanation. Cases of erectile dysfunction have also been reported, although it is considered that a psychological mechanism, rather than a morphological lesion, is involved.

The reintervention rate reported in the literature is approximately 14%, which is considered to be reasonable in comparison with other surgical alternatives. There are authors who consider that the need for reintervention in less than 2 years, as happens in most cases, is an element that should be discussed in detail with the patient, as it may change his decision in favor of other treatment options (Steele and Sleep, 1997).

Patients must be followed for at least 6 months after the procedure, given the evolutive potential of lesions induced by TUNA (up to 3 months). This is also the reason for which, regardless of the results, the procedure should not be considered to be a failure at earlier than 3 months. Symptomatic relief is evident within the first few weeks, continues in the next months, and stabilizes within 2–6 months after the procedure (Chapple et al., 1999).

TUNA is considered to be an alternative that has overcome the minor inherent shortcomings common to the onset of any new technique and has found its place in modern urology, which is in a continuous search for novel treatments for BPH. The technology behind TUNA is constantly improving and, as clinical evidence continues to emerge, the technique seems increasingly promising, following the trend of providing treatment with the lowest possible degree of invasiveness, with a low rate of long-term complications, and with the best results.

Following a rigorous technique that will constantly monitor the depth of the maneuver and the correct positioning of the needles guarantees the success of the intervention, with a low rate of complications. Currently, TUNA is widely used in the United States, while in Europe the number of centers using this technique is limited. Although there are insufficient solid data with long-term follow-up, the available information suggests that TUNA is highly efficient and safe and will keep its place in the minimally invasive treatment of BPH, along with other therapeutic options.

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CHAPTER

10

Transurethral Balloon Dilation of the Prostate

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10.1 BASIC PRINCIPLES OF TRANSURETHRAL DILATION

Although in the early 1980s transurethral resection of the prostate was the "gold standard" for the treatment of benign prostatic hyperplasia (BPH), its relatively high costs and increased rate of complications led to the development of new therapeutic alternatives:

- α blockers (Kirby et al., 1987; Fabricius et al., 1990)
- 5-α reductase inhibitors (Kirby et al., 1992)
- prostate stenting (Harrison and DeSouza, 1990; Chapple et al., 1990)
- microwave therapy (TUMT) (Lindner et al., 1987; Yerushalmi et al., 1985)
- prostate dilation techniques

Prostate dilation is not a new concept, being first described in 1830 (Hinman, 1983), but the efficiency was modest at that time, especially because of the difficulties related to urethral catheterization. In 1956, Deisting imagined a metal dilator that opened inside the prostate, thus eliminating the difficulties raised by urethral catheterization. He reported good results in 324 patients with a success rate of 95%. However, prospective randomized studies (conducted during that period) reported significantly better long-term results for transurethral resection of the prostate (TURP) or open surgery as compared to transurethral dilation (Aalkjaer, 1965).

The modern technique of transurethral balloon dilation of the prostate (TUDP) was described by Burhenne et al. (1984). They (by using angioplasty balloons) demonstrated on a cadaver that it is possible to increase the caliber of the prostatic urethra by inflating a 24 F balloon for 30 s. To further demonstrate the efficiency of his method, he performed a balloon dilation on himself, obtaining an increase of urinary flow that persisted for 4 weeks. Several studies were published thereafter, analyzing the efficiency of balloon dilation in patients with BPH, and several theories trying to explain the mechanism of action of this technique were enounced.

10.1.1 The Theory of Ischemic Atrophy

According to this theory, the dilation produced by the balloon determines a reduction of the prostatic blood flow, which is sufficient to induce tissue necrosis, followed by prostate atrophy. This theory is supported by the following changes observed during nuclear magnetic resonance (Johnson et al., 1987):

- increase of periurethral T2 signal immediately after TUDP
- in some cases, reduction of the prostate volume
- no changes of the prostate capsule and in the surrounding tissues

However, these conclusions were not confirmed by other studies, and histological examinations performed on animals immediately after TUDP found minimal changes of the prostatic urethra (Castaneda et al., 1987).

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10.1.2 The Theory of Capsular Distension

According to this theory, distension of the prostatic capsule, with the consecutive reduction of the elastic fibers, represents the main mechanism of action in TUDP. There are many controversies regarding capsular distension induced by balloons, this mechanism being supported by the following (Wasserman et al., 1990):

- the pain felt by patients when local anesthesia is used
- an increase in capsular circumference after TUDP (usually mild)
- a gradual drop of pressure inside the balloon during dilation

10.1.3 The Theory of Commissurotomy

According to this theory, a rupture of the anterior and/or posterior prostate commissure occurs during TUDP; this rupture can be observed during cystoscopy (Isorna et al., 1989). This is the mechanism of action of the Deisting dilator. Other studies subsequently proved that there is no relationship between commissurotomy and clinical results after TUDP (Gill et al., 1989; McLoughlin et al., 1991).

Of the three theories mentioned earlier, the only reasonable mechanism that could significantly improve subvesical obstruction is the theory of ischemic atrophy because it implies a reduction of prostate volume. Nevertheless, even for this theory there is no convincing evidence. It is unlikely that the other two theories (capsular distension and commissurotomy) can generate long-term clinical improvements, since there is a tendency for the recurrence of the initial obstruction (in the absence of another factor to maintain the urethral lumen, such as a stent) during the healing process of the lesions produced during the maneuver.

10.2 INSTRUMENTS

The ideal balloon for prostate dilation should have certain characteristics:

- It should uniformly dilate the prostatic urethra.
- It should not be longer than 4 cm.
- It should not be larger than 90 F.
- It should support pressures of up to 4 atm.
- It should not migrate during the procedure.
- It should be possible to remove it without injury after surgery.
- It should be easy to handle.

Three systems are approved in the United States for transurethral dilation (Table 10.1):

- Optilume catheter (American Medical Systems, Minnetonka, MN)
- Uroplasty system (Advanced Surgical Interventions, Inc., San Clemente, CA)
- Dowd dilation balloon (Microvasive, Watertown, MA)

10.3 INDICATIONS

The selection criteria of patients are not precisely established and are variable from one author to another, since TUDP is not a widely used procedure. However, the most important inclusion criteria are represented by the following:

- Age of the patient between 30 years and 89 years (Klein, 1990; Dowd and Smith, 1990). TUDP results are influenced by the patients' age, the best results being obtained in patients under 65 years of age (Hernandez-Craulau, 1990).

TABLE 10.1 Main Characteristics of Balloon Dilation Systems

	Optilume	Uroplasty	Dowd
Dimensions (after the balloon is inflated) (F)	90	75	90
Maximum pressure (atm)	4	3	4

- Qmax value between 2 mL/s and 21 mL/s (Goldenberg et al., 1990; Marks, 1992).
- Preoperative postvoid residual volume between 20 cm^3 and 300 cm^3 (Hernandez-Craulau, 1990; Lepor, 1992).
- Prostate volume.
- Length of the prostatic urethra between 1.5 cm and 4.5 cm (Kelly et al., 1989; Goldenberg et al., 1990; Klein, 1990).

An important criterion in the selection of patients is represented by prostate volume. The best results have been obtained in patients with a prostatic volume of less than 50 cm^3. Prostate anatomy is another defining element in the selection of patients; median lobe hypertrophy is an exclusion criterion.

The best results are obtained in patients with (Reddy, 1991)

- moderate symptoms
- bilobed prostate adenoma <40 cm^3
- residual volume <150 mL

Exclusion criteria are much better established, being represented by

- urethral strictures
- prostate adenocarcinoma
- neurogenic bladder
- acute prostatitis

Acute urinary retention represents a relative contraindication for TUDP.

10.4 TECHNIQUE

Although prostatic tissue does not contain many sensory nerve fibers, the prostatic capsule is abundantly innervated by fibers from the pelvic plexus, which descends posterolateral from the prostate (Walsh and Donker, 1982). This is why the distension of the prostatic capsule during TUDP is painful and accompanied by imperious urination. The intervention can be carried out comfortably by perineal injection of a local anesthetic (Reddy, 1990) by using a gel with 2% lidocaine inside the urethra, intravenous sedation, spinal, or even general anesthesia.

The patient is placed in the lithotomy position, and a urethrocystoscopy is initially performed to exclude any associated bladder conditions. A calibration catheter with a balloon is inserted through the working channel of the cystoscope; the balloon is inflated with 10 mL of saline solution and gently pulled back up to the bladder neck. The distance between the bladder neck and the external urethral sphincter is measured (using the 1 cm marks of the calibration catheter). Thus, the length of the prostatic urethra is measured, according to which the adequate dilator is chosen.

The special 26 F dilator is inserted. The mandrin of the dilator is removed, leaving its sheath in place. The balloon catheter is lubricated and inserted through the sheath of the dilator until its first mark is seen under fluoroscopic guidance (indicating that the tip of the catheter is inside the bladder).

The distal balloon of the catheter is inflated and pulled back into the bladder neck. Through the sheath of the dilator (besides the catheter), a 0° or 30° telescope is inserted, after which the sheath is withdrawn until the second mark of the catheter is visualized. This indicates the distal limit of the dilation balloon that should be found immediately above the external urethral sphincter, assuming that the length of the prostatic urethra was correctly assessed. Cystoscopy has the role of confirming the proper positioning of the balloon at this level. It is also possible to position the balloon under fluoroscopic control by marking the bladder neck and the external sphincter using needles placed in the skin.

After the cystoscope is withdrawn, the balloon is inflated to a maximum diameter of 30 mm (90 F) with a pressure of 4 atm using a pump. During this step, the balloon tends to migrate into the bladder, a phenomenon that can be prevented by a firm tractioning of the catheter. The position of the balloon can be checked by a rectal examination during the procedure. The balloon is kept inflated for 10 min, after which it is deflated and withdrawn inside the sheath to reduce the risk of urethral injuries during extraction. At the end of the intervention, a 20 or 22 F urethro-vesical catheter is inserted and maintained for 48–72 h. Postoperative antibiotic prophylaxis is indicated only in selected cases. After the procedure, a retrograde urethrography or a flexible cystoscopy is routinely recommended to confirm the divulsion of the prostatic lobes (or anterior commissurotomy). The procedure can be repeated if divulsion is not confirmed or if immediate postoperative results are unsatisfactory.

10.5 RESULTS

Transurethral balloon dilation represents a minimally invasive therapeutic alternative for symptomatic prostate adenoma but only in selected cases. It has several advantages: the procedure is simple, safe, low cost, and may be performed under local anesthesia. It is also possible to perform this procedure in patients with moderate surgical risk, requiring a minimal period of hospitalization and convalescence. In addition, TUDP does not exclude the possibility of another subsequent treatment and is not complicated by retrograde ejaculation, incontinence, or erectile dysfunction (Hernandez-Craulau, 1990). However, there are no large-scale studies evaluating the efficiency of this method. There are authors who even consider that the results of this technique are only based on the placebo effect, and that the results and their duration are not predictable.

Only half of the patients treated by this method have a significant improvement of symptoms. Thus, a study conducted in 48 patients who underwent TUDP showed improvement of symptoms in 47% of cases, but 89% of the patients presented subvesical obstruction 11 months after surgery, demonstrated by urodynamic study (Gill et al., 1989). However, other studies report superior results: symptomatic relief in 70% of patients, with no obstruction in 48% of cases (3 months after surgery) (McLoughlin et al., 1991).

The rate of complications after TUDP is very low. After dilation, some patients may experience the following (Hernandez-Graulau et al., 1989):

- temporary urinary incontinence with spontaneous resolution within the first month after treatment
- mild hematuria
- urinary retention, especially in patients in whom the urethro-vesical catheter is removed in less than 24–48 h after the procedure. Reinsertion of the urethro-vesical catheter for another 2–3 days usually solves this complication.
- prostatitis requiring antibiotics.

Although these complications are very rarely encountered, the method appears to have limited value in the treatment of BPH and is recommended especially in young patients who wish to maintain ejaculation.

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CHAPTER

11

Prostatic Stents

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11.1 GENERALITIES

Subvesical obstruction is one of the most frequent urological conditions in day-to-day practice. Although medical treatment can be efficient in many cases, there are numerous patients with severe symptoms requiring surgical desobstruction. Transurethral resection of the prostate (TURP) is still the "gold standard" for the treatment of benign prostatic hyperplasia (BPH), and the efficiency of any other method is assessed in comparison with TURP. All urologists deal with elderly patients who have indications for TURP but in whom associated diseases contraindicate a surgical intervention, and therefore permanent catheterization remains the only alternative (Brierley et al., 2001).

Prostatic stents were developed as an alternative to conventional surgical therapies. The principle of the method consists of restoring the urinary flow by inserting a tubular structure (stent) that maintains the lumen of the prostatic urethra. The word "stent" comes from the name of a dentist, Charles Stent, who lived in London in the nineteenth century and who used a splint to stabilize skin grafts (Sigwart, 1996). Stents were initially introduced as a therapeutic alternative for some cardiovascular diseases; subsequently, they were also used for different other conditions, such as stenoses of coronary, femoral or renal arteries, obstructions of the vena cava, tracheal stenosis, etc. The first data regarding stents for the treatment of BPH date back to the 1980s (Fabian, 1980). Prostatic stents were first introduced for the treatment of symptomatic BPH, but their role was unclear at the beginning, and it was considered that they might be used in virtually any patient (Harrison and De, 1990). Later it became obvious that their main indication is represented by patients with contraindications for surgery and for whom there is no alternative other than permanent bladder catheterization.

11.2 CLASSIFICATION OF STENTS

The performance criteria for prostatic stents were established during The Third International Consultation on Benign Prostatic Hyperplasia, which was organized in 1995. The ideal stent should be

- easy to insert (without visual or radiological control)
- easy to extract whenever necessary
- stabilized at both ends to prevent migration
- with thin walls, for a minimal urodynamic resistance
- soft and flexible for patient comfort
- resistant to encrustation
- efficient in relieving symptoms of the lower urinary tract
- able to allow maintenance of continence
- less aggressive against tissues
- associated with lower rates of urinary tract infection than intermittent or permanent urethro-vesical catheterization
- cheap

Stents are classified into permanent or temporary stents (Ogiste et al., 2003).

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TABLE 11.1 Main Features of Temporary Prostatic Stents

Stent	Expansion	Dimensions		Material	Duration of use (months)
		Caliber (F)	Length (mm)		
UroSpiral (Fabian stent)	Nonexpandable	21	40–80	Stainless steel	≤12
Prostakath	Nonexpandable	21	40–80	Stainless steel plated with gold	≤12
Intraurethral catheter (IUC)	Nonexpandable	16–18	25–80	Polyurethane	≤6
ProstaCoil	Self-expandable	24/30	40–80	Nitinol	≤36
Memokath 028	Thermo-expandable	22/34	30–70	Nitinol	≤36
Biofix	Self-expandable	21	45–85	Polymeric polylactate	≤6
Barnes	Nonexpandable	16	50	Polyurethane	≤3
Trestle	Nonexpandable	22	75	Polyurethane	≤6

11.2.1 Temporary Prostatic Stents

Temporary stents are placed inside the prostatic urethra to keep its lumen open and are not incorporated into the urethral wall. They are tubular devices made of nonabsorbable or biodegradable materials. They are placed inside the prostatic urethra for a limited period of time, and they are not covered by urethral epithelium in time. Nonabsorbable stents must be removed every 6–36 months, depending on the material from which they are made. They can be easily removed or changed under local anesthesia or sedation. They are designed for short-term use as an alternative to permanent urinary catheterization or cystostomy in patients with high surgical risk. Temporary stents allow for normal urination in this category of patients. The success rate is between 50% and 80%. They are easily repositioned or replaced, but catheterization or cystoscopy cannot be performed as long as the stent is in place. The most commonly reported complications are encrustation, migration, disintegration, stress incontinence, and bacteriuria.

The main features of temporary stents are summarized in Table 11.1. Depending on the materials they are made of, they can be classified as follows:

- metal stents
- polyurethane stents
- polyglycolic or polylactic acid stents

These classes of stents have features related to their design and biodegradability.

First generation spiral metal stents were made of stainless steel. Urospiral (Porges) and ProstaKath are the most prominent examples. Urospiral is a stainless steel stent of 21 F and a length between 40 mm and 80 mm. ProstaKath is also a stainless steel stent of 21 F, but it is gold plated to prevent encrustation (Booth et al., 1992). These types of stents have been used with satisfactory results in patients with high surgical and anesthetic risk as well as chronic urinary retention. However, the rate of complications was significant, with the most common complications being recurrent urinary infection, stent migration, hematuria with urinary retention due to clots, and encrustation (Nordling et al., 1992).

The development of modern alloys such as nitinol (nickel–titanium) allowed the introduction of second generation metal stents, such as ProstaCoil® (InStent Inc., Minneapolis, MN, USA) and Memokath® (Engineers and Doctors A/S, Hornbaek, Denmark), which are self-expandable or thermo-expandable stents (Fig. 11.1) (Madersbacher, 2006).

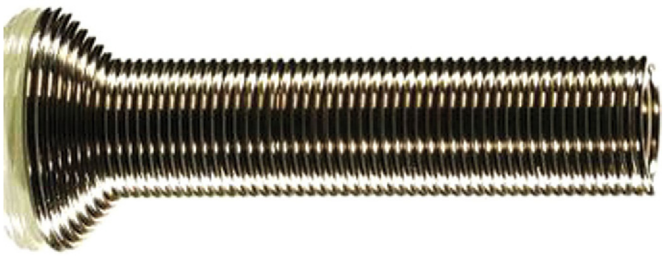

FIGURE 11.1 **Memokath thermo-expandable metal stent (Engineers and Doctors A/S, Hornbaek, Denmark).**

The Memokath stent (Engineers and Doctors A/S, Copenhagen, Denmark) is made of nitinol, an alloy of nickel and titanium, which has the property of "shape memory." A shape memory alloy can "remember" its form and returns to that form after being deformed when heated to a certain temperature. Nitinol alloy exists in two crystalline forms: martensite and austenite. When heated, nitinol under the form of martensite will return to its original shape after plastic deformation. This is the result of a phase transformation known as martensitic transformation. Nitinol was discovered 40 years ago and was originally used in submarines; it was later used in orthopedic implants, metal guides, and prostatic stents.

The Memokath stent is flexible and thermo-expandable at a temperature of 45–50°C. Like other temporary stents, it is easily inserted and maintains its shape and position in the prostatic urethra. It was first used by Poulsen et al. (1993). Polyurethane stents such as Trestle (Boston Scientific, Natick, MA, USA), Barnes (Bard, Covington, GA, USA) or Spanner® (AbbeyMoor Medical, Miltona, MN, USA) were developed as alternatives to the metal ones. The Spanner stent has a particular design, similar to the distal end of a Foley urethro-vesical catheter, with an intra-vesical balloon that prevents its anterograde migration, a cranial urinary port, and a caudal prostatic part (Fig. 11.2) (Corica et al., 2004).

Polylactic and polyglycolic acid stents are biodegradable (Fig. 11.3) (Pétas et al., 1998). These stents can expand by 70% as compared to their original diameter (50% in the first 30 min) due to the properties of the polymers (Talja et al., 1997).

FIGURE 11.2 **Spanner prostatic stent (AbbeyMoor Medical, Miltona, MN, USA).**

FIGURE 11.3 **Biofix® polyglycolic acid biodegradable stent (BionxImplants, Tampere, Finland).**

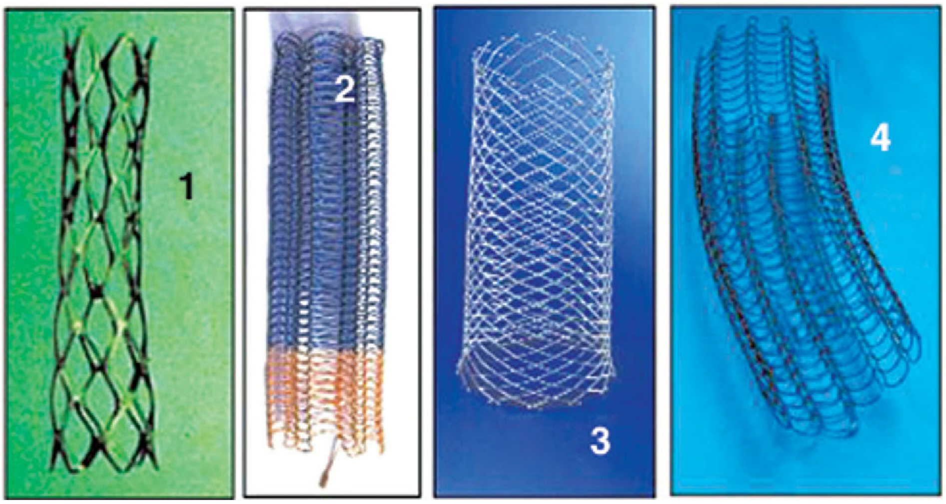

FIGURE 11.4 **Permanent prostatic stents.** (1) ASI or Titan, (2) Memotherm, (3) Urolume, and (4) Ultraflex.

11.2.2 Permanent Prostatic Stents

All permanent stents (Urolume, Memotherm, Ultraflex, Titan), which were initially developed as vascular stents and were later adapted for urology, allow the growth of tissue toward the lumen, with gradual epithelialization and embedding of the stent into the urethral wall (Fig. 11.4) (Madersbacher, 2006). This property leads to a theoretical reduction of the risk of urinary infections, migration, and encrustation but has the disadvantages of difficult removal (if necessary) and of reduction of the diameter of the lumen in time.

The ideal permanent stent should be inserted under local anesthesia, should not migrate, is not excessively epithelialized, and does not suffer encrustation. None of the permanent prostatic stents available at this time fulfill all of these criteria. Most of them present the phenomenon of encrustation, excessive intraluminal tissue growth, or cause irritative symptoms. The main features of permanent stents are summarized in Table 11.2.

11.3 INDICATIONS

Although this minimally invasive method was regarded with much enthusiasm in the 1990s (Oesterling, 1991), its indications are currently significantly limited. The reasons for this evolution are complex, including the good results and reduced morbidity of conventional techniques used in the treatment of prostate pathology, the development of new minimally invasive techniques that can also be performed in patients with contraindication for TURP, the relatively modest results of urethro-prostatic stenting, and the specific morbidity associated with stents (including the difficulties of removal in case of failure of the procedure, etc.).

Stents may be used in patients with prostate adenoma for (Madersbacher, 2006) the following:

- permanent treatment of obstruction
- short-term treatment of obstruction
- diagnosis

Prostatic stents are recommended by the European Association of Urology Guidelines for the permanent treatment of obstruction secondary to benign prostatic hypertrophy only in patients with a high surgical risk, with recurrent

TABLE 11.2 Main Features of Permanent Prostatic Stents

		Dimensions			
Stent	**Expansion**	**Caliber (F)**	**Length (mm)**	**Material**	**Duration of use (months)**
Urolume/Wallstent	Self-expandable	42	20–40	Steel "Superalloy"	Permanent
Titan	Balloon-expandable	33	19–58	Titanium	Permanent
Memotherm	Thermo-expandable	42	20–80	Nitinol	Permanent
Ultraflex	Self-expandable	42	20–50	Nitinol	Permanent

episodes of urinary retention, as an alternative to urethro-vesical catheterization, and in patients in whom other surgical methods are contraindicated (BPH Guidelines Panel et al., 2007).

Because of the potential complications of prostate stenting, Reichle et al. recommend this method only in patients with severe comorbidities, especially cardiovascular disease, which are common in the elderly. Moreover, prostate stenting is never the first choice of treatment in these patients, since most of them can benefit from other minimally invasive methods (Reichle et al., 2006). Additionally, the method is contraindicated in patients with strictures of the lower urethra, kidney or bladder stones, active urinary infections or bladder neck sclerosis, median lobe prostatic adenoma, or in patients with a prostatic urethra shorter than 2 cm (Reichle et al., 2006).

Temporary prostatic stents can be used in patients with prostate adenoma treated by minimally invasive procedures that do not immediately solve the subvesical obstruction. Thus, when methods such as interstitial laser coagulation (ILC), visual laser ablation of the prostate (VLAP), or transurethral microwave thermotherapy (TUMT) are applied, a subvesical obstacle due to prostate edema may occur, which may require intermittent or permanent catheterization for a period of up to 6–8 weeks. These patients may benefit from biodegradable prostatic stents. However, their short resorption time, sometimes of only 3–4 weeks, may be insufficient in some cases (Madersbacher, 2006).

Diagnostic stenting implies inserting the stent prior to TURP, especially in patients who associate subvesical obstruction with severe detrusor overactivity (Parkinson's disease, multiple sclerosis, etc.). After stenting, only patients who will not develop urinary incontinence or aggravation of imperious urination after surgery will be selected for TURP. Biodegradable stents are usually used in these patients (Knutson, 2004; Madersbacher, 2006; Saussine et al., 2006).

11.4 TECHNIQUE

Depending on the type of prostatic stent used, the insertion technique has some particular aspects. We present in detail the technique of inserting thermo-expandable spiral metal stents, due to their wide applicability in the present. A series of technical features of other types of stents will also be described.

The insertion of temporary thermo-expandable metal stents can be performed under local anesthesia, an important element taking into account the selection criteria for patients who are candidates for such a procedure (elderly, with significant comorbidities).

The equipment necessary for the intervention consists of the following:

- the Memokath 028TW (for rigid endoscope) or 028SW (for flexible endoscope) insertion kit
- a rigid or flexible cystoscope
- local anesthetic gel
- 100 mL Guyon syringe
- 50 mL sterile water heated to 55°C
- a thermometer to check the water temperature

The stents may have a length of 30, 40, 50, 60, or 70 mm, while their diameter ranges from 24 F (before expansion) to 44 F (at the caudal end, after expansion). It is recommended to have available stents of all sizes at the moment of the intervention, so the adequate stent can be chosen during the procedure.

The first operative step consists of urethrocystoscopy, both to exclude any associated conditions (tumors, stones, etc.) and to evaluate the morphology of the prostatic urethra. The distance between the bladder neck and the verumontanum is measured as accurately as possible using the cystoscope. The distal end of the cystoscope is placed at the bladder neck and this landmark is marked by applying a special metal clip on the endoscope, immediately next to the urethral meatus. While keeping the penis in a fixed position, the end of the cystoscope is withdrawn up to the verumontanum, after which another metal clip is applied on its sheath (Fig. 11.5). The distance between these two metal clips (from the internal edge of the first to the external edge of the second) is measured, and the procedure is repeated to obtain more accurate data.

The adequate length of the stent is chosen after these two measurements, taking into account the fact that after positioning and expansion of its end, the length is shortened by approximately 4 mm. A 0° telescope is attached to the insertion system, which is supplied with the stent. This device is inserted transurethral under direct visual control, its distal end positioning itself at the bladder neck. Fifty milliliters of saline solution heated to 55°C are injected for the expansion of the caudal end of the stent. After removal of the insertion system (Fig. 11.6), the proper position of the stent will be radiologically and visually checked (Fig. 11.7).

Incorrect positioning of the stent can be corrected by using the urethrocystoscope or a semirigid ureteroscope inserted through the stent lumen (Fig. 11.8).

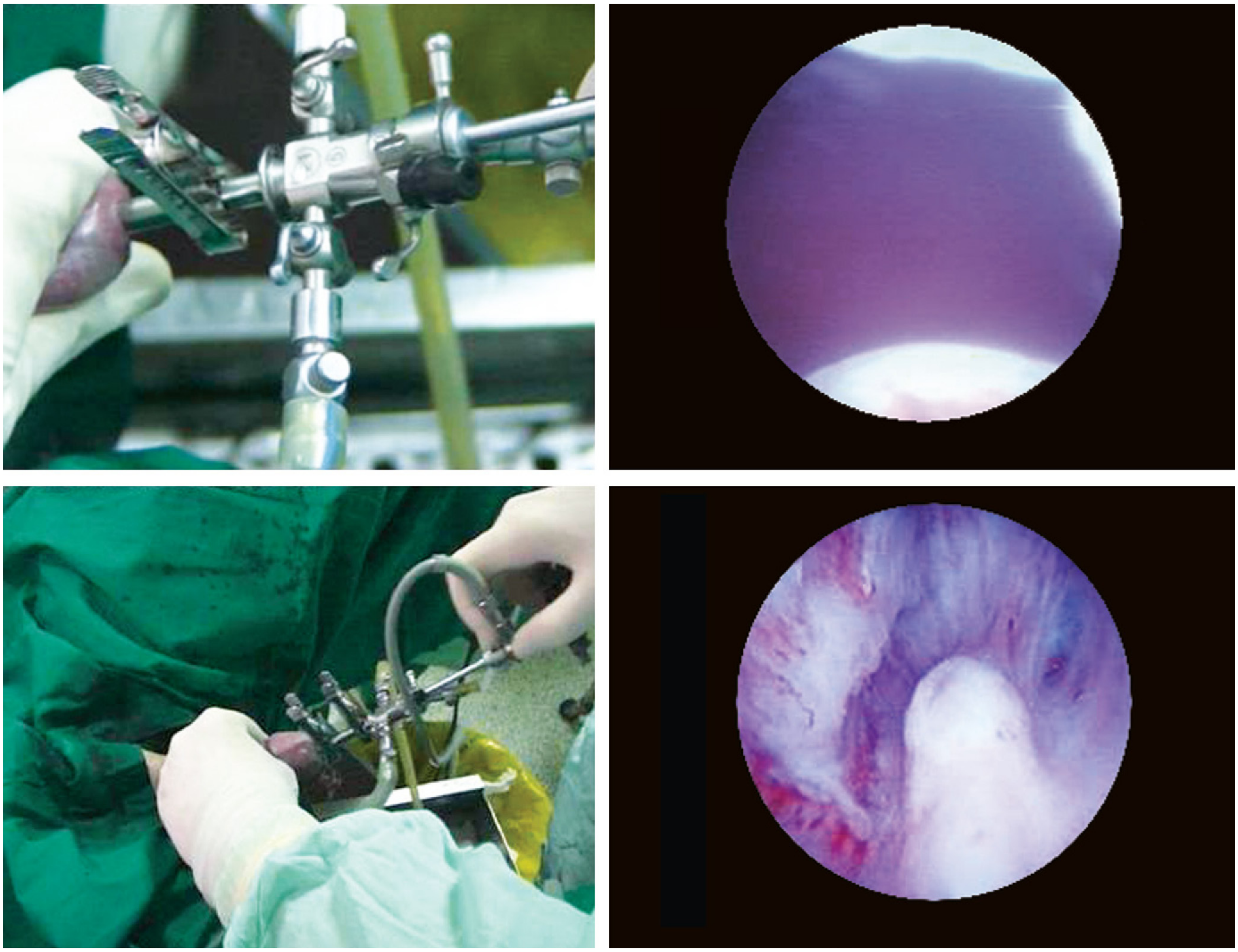

FIGURE 11.5 **Positioning the two clips to measure the distance between the bladder neck and the verumontanum.**

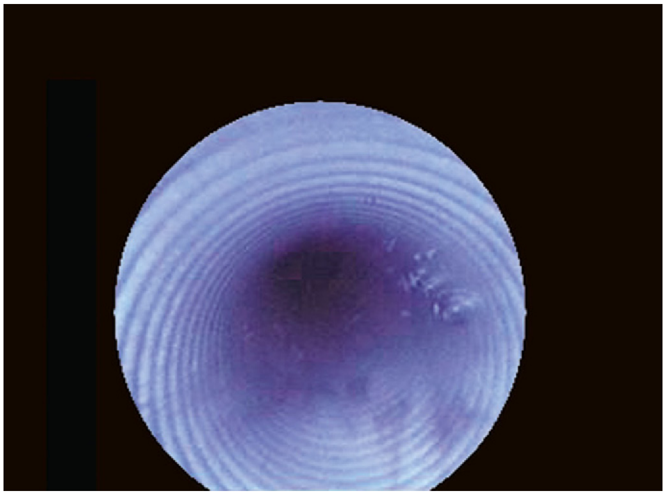

FIGURE 11.6 **Removal of the optical system after stent positioning.**

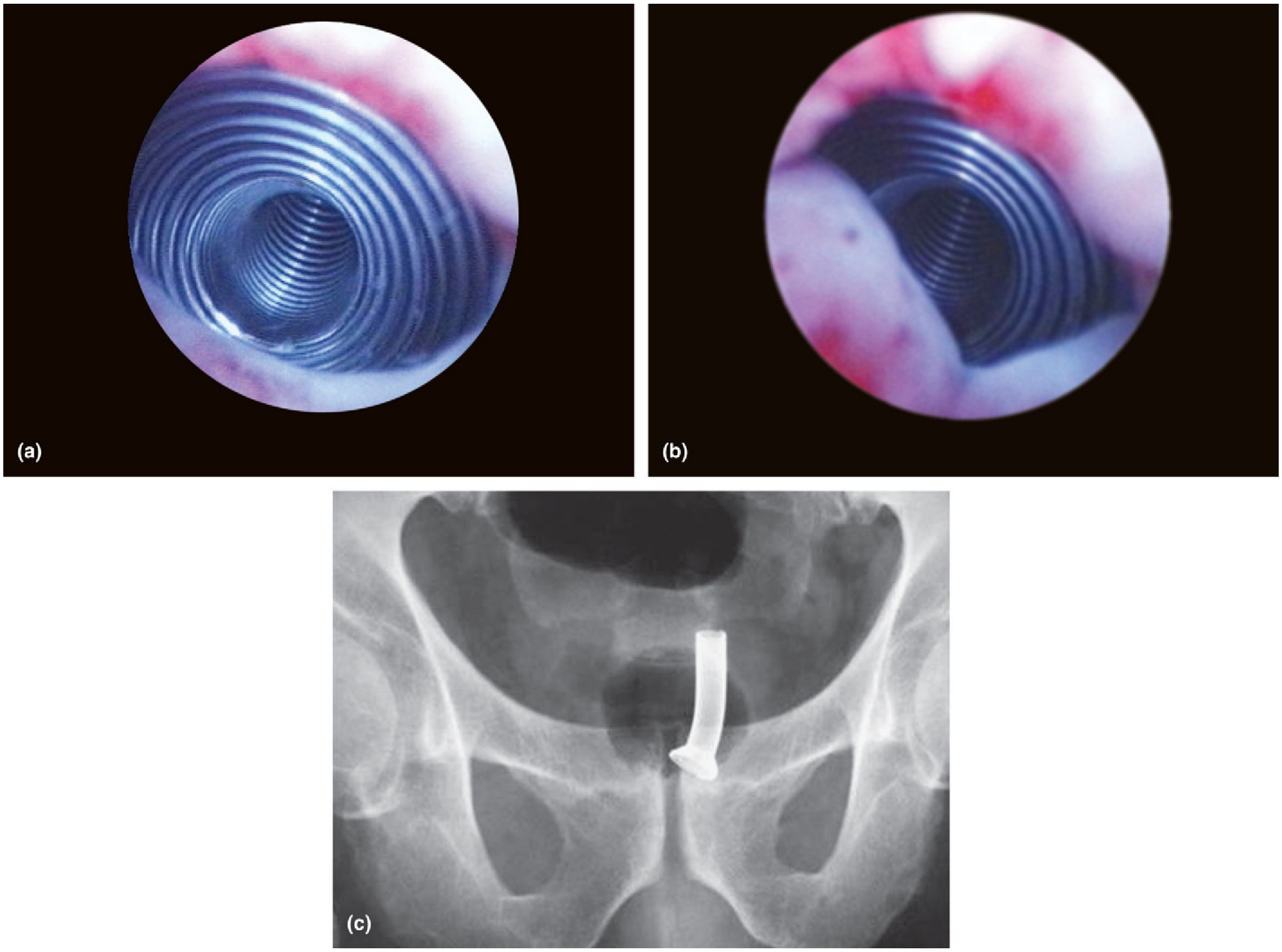

FIGURE 11.7 **The position of the stent is checked by endoscopy (a, b) and radiography (c).**

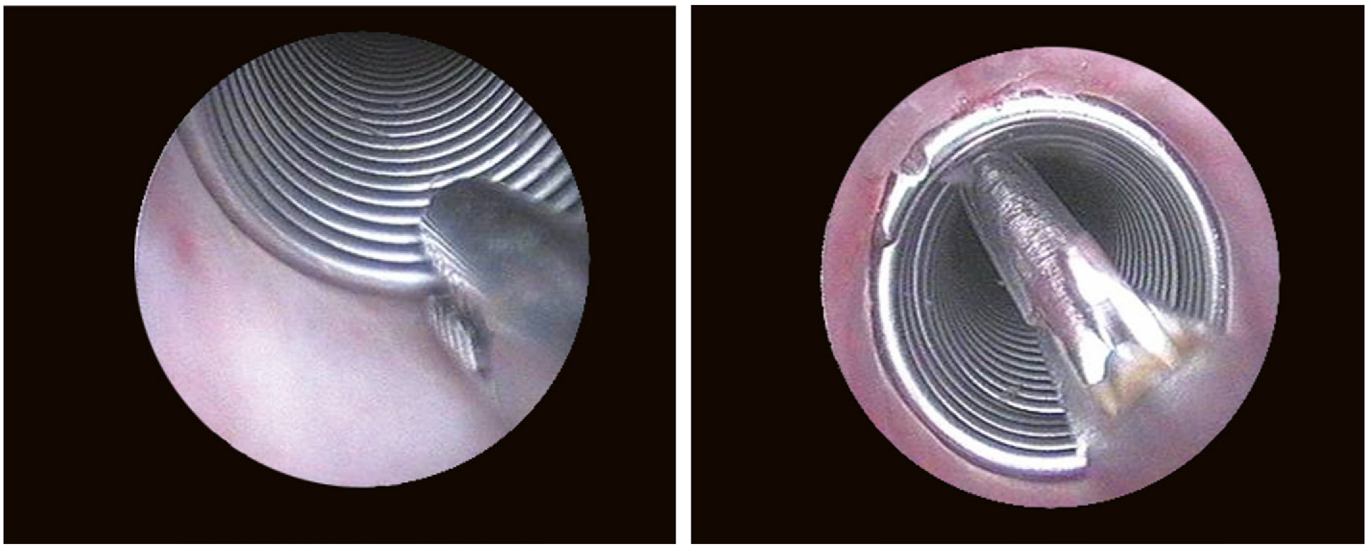

FIGURE 11.8 **Repositioning in case of stent malposition using a forceps.**

Whenever it is necessary to extract the stent for different reasons, this can be easily achieved by injecting 50 mL of sterile water at 5°C, after which its distal end is caught with a forceps. This maneuver disrupts the spirals of the stent, which results in the end in a metallic "wire."

Regarding other models of stents, choosing the appropriate dimensions can be achieved by methods other than the direct visual (endoscopic) control described earlier:

- fluoroscopy
- transabdominal ultrasound
- transrectal ultrasound

Fluoroscopy involves the identification of two anatomical landmarks, the external urethral sphincter and the bladder neck, after which the distance between them is measured. This can be achieved with a ruler during urethrography (difficult to perform) or by retrograde insertion of a radiopaque catheter.

Measurement by transabdominal ultrasound has the disadvantage of a difficult visualization of the prostatic apex located behind the symphysis pubis. A more accurate identification of anatomical landmarks can be achieved by inserting a Foley catheter, after which the balloon is inflated and gently pulled back up to the bladder neck. However, the presence of a median lobe prostate adenoma can be a source of errors. Transrectal ultrasound allows for a more accurate measurement of the length of the prostatic urethra.

All permanent stents are inserted under endoscopic control. Of the temporary stents, some can be inserted under direct visual control: Memokath (using the technique described earlier), Urospiral®, Barnes®, Biofix, etc. Stent insertion can also be performed under fluoroscopic control (Prostacoil, Prostakath®, Urospiral, etc.), ultrasound control (Prostakath), or manually without guidance (Trestle®).

11.5 COMPLICATIONS

Prostatic stents are associated with a specific morbidity; this is one of the reasons for which their indications have been limited. Potential complications are influenced by factors such as the type of stent, the condition for which stenting was performed, the criteria for selecting the patients, etc. UroLume® permanent stents theoretically present a lower risk of urinary infection, migration, or encrustation.

The epithelialization phenomenon, which is characteristic for this type of endoprosthesis, can lead to restenosis of the lumen, a late complication with an occurrence rate between 2% and 3.3%. Other complications associated with this type of stent are hematuria (6–14%), perineal pain (2–13%), urinary infections (14–16%), and retrograde ejaculation (0–17%). Irritative urinary symptoms such as pollakiuria or imperious urination can occur in a significant percentage of cases within the first 12 months but usually improve spontaneously or after anticholinergic treatment (Oesterling et al., 1994; Milroy and Chapple, 1993; Guazzoni et al., 1993; Anjum et al., 1997). Regarding temporary stents, the rate of complications varies between 13.5% and 18% (Knutson et al., 2002; Perry et al., 2002).

Among the complications frequently reported, we would mention recurrent urinary infections, encrustation and fracture of the stents, irritative symptoms, and urinary retention (Konety et al., 2000; Henderson et al., 2002). These complications may require removal of the stent, with a direct impact on the success rate of the procedure. The rate of failures due to complications can reach 20–30% of cases (Ogiste et al., 2003).

One of the complications with a direct and significant impact on the efficiency of the method as a sustainable treatment of prostatic obstruction is represented by stent migration. Perry, in a study on 211 patients followed for 8 years, reports a stent migration rate of 13% (Perry et al., 2002). Although there are studies that record a lower stent migration rate of 6.3%, this is still the main cause of the method's failure in patients with BPH. Other complications can be represented by hematuria, urinary retention, and urinary incontinence. A summary of these complications is presented in Table 11.3.

11.6 RESULTS

Regarding the results of prostatic stenting for the treatment of obstruction due to benign pathology, there is a significant variability between the studies published in the literature, due to factors related to the type of stents used, selection of patients, etc. The intervention can be considered a success if the result is a sustainable removal of obstruction, without episodes of urinary retention and in the absence of irritative symptoms requiring removal of the stent. Perry et al. studied, over a period of 8 years, 211 patients with Memokath thermo-expandable stents inserted

TABLE 11.3 The Main Complications of Prostatic Stents

Complication	Percentage
Migration	13
Urinary retention (after the procedure)	10
Urinary incontinence	6
Infection	6
Pain	3
Bleeding	3
Encrustation	2
Occlusion	1

for the treatment of obstruction secondary to BPH. During follow-up, 38% of patients died with the stent *in situ*, 34% survived with a functional stent, 4% did not require keeping the stent in place after a variable period of time, and 23% required its removal due to failure of the method (Perry et al., 2002).

Grimsley et al. (2007) evaluating 43 consecutive patients in whom Spanner stents were inserted for benign and malignant prostatic pathology, reported satisfactory results in only 37% of cases. Armitage et al. conducted a meta-analysis that evaluated the results of 20 series with a total of 990 patients treated with UroLume permanent prostatic stents for BPH. Eighty-four percent of patients had spontaneous urination after insertion, but 16.7% required stent removal during the first year due to complications (Armitage et al., 2007). Knutsen studied diagnostic prostatic stenting before TURP on a group of 37 patients with obstructive BPH and overactive bladder. As a result of this procedure, 34.3% of patients were identified as having an increased risk of postoperative incontinence (Knutson et al., 2002).

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C H A P T E R

12

Minimally Invasive Treatment Algorithm for Benign Prostatic Hyperplasia

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As is true for other urological conditions, the treatment of prostate adenoma has improved significantly, with a major impact on the incidences of intra- and postoperative complications. This is due to the development of new minimally invasive procedures and to the improvement of existing techniques.

The therapeutic options for the management of benign prostatic hyperplasia (BPH) are closely linked to technological progress. However, clear selection criteria are needed (based on clinical outcomes, incidences of complications, and morbidity) in order to choose the most appropriate treatment for each patient. Clinical Practice Guidelines (CPG) were developed to help physicians and patients decide on the best treatment option for a certain condition. Table 12.1 presents the most important CPGs regarding the therapeutic options for BPH (De la Rosette et al., 2009; Baba et al., 2006).

However, despite these multiple options, transurethral resection of the prostate (TURP) still remains the "gold standard" for the treatment of BPH, with a long-term efficiency that has not been exceeded by any of the new therapeutic methods, as can be observed in a summary of the results of some of the most important studies published in the literature (Table 12.2) (Kuntz et al., 2004; Bouza et al., 2007; Hoffman et al., 2007; Bouchier-Hayes et al., 2006; Erturhan et al., 2007; Madersbacher and Marberger, 1999).

Most authors recommend an ablative treatment option (TURP or laser vaporization) in patients with absolute surgical indications. Other minimally invasive procedures are preferred in patients in whom a reduction of morbidity is desired. The removal of prostatic tissue generally determines a more significant improvement of symptoms but at the cost of a higher morbidity.

Several factors are taken into account when a treatment algorithm for BPH is elaborated.

12.1 URINARY RETENTION

Patients with urinary retention before surgery usually have a higher rate of intra- and postoperative complications, and the results are sometimes unsatisfactory, especially regarding bladder emptying. Urinary retention was initially an exclusion criterion for most of the minimally invasive procedures (especially for the nonablative ones). As experience grew, most authors also included this category of patients in the studies. The success rates (defined as the percentage of patients with recovery of spontaneous urination after surgery) for the most important minimally invasive procedures are summarized in Table 12.3 (De la Rosette et al., 2008).

However, most of these studies analyzed the short- and medium-term results, while the long-term efficiency was less studied. In a study regarding patients treated with transurethral microwave therapy (TUMT) with a follow-up of 5 years, 28.6% of patients without urinary retention required another procedure, while treatment failure occurred in 37.8% of patients with urinary retention (Gravas et al., 2007). Moreover, the cumulative risk at 5 years was 42.3% and 58.8%, respectively. Therefore, long-term studies are needed to evaluate the durability of the results of nonablative minimally invasive treatments in patients with urinary retention.

Endoscopic Diagnosis and Treatment in Prostate Pathology. http://dx.doi.org/10.1016/B978-0-12-802405-8.00012-3

TABLE 12.1 CPG Recommendations on the Minimally Invasive Treatment Alternatives for BPH

Treatment option	6th International Consultation on New Developments in Prostate Cancer and Prostate Diseases (2006)	European Association of Urology (2009)	American Association of Urology (2008)
HoLEP	R	R	R
TUMT	R	R	R
TUNA	R	R	R
Bipolar TURP	IS	R	A
PVP	IS	R	R
Ethanol injection	I	ND	I

A, under implementation; I, under investigation; IS, insufficiently studied; ND, not discussed; R, recommended; PVP, photoselective vaporization of the prostate.

TABLE 12.2 Efficiency After 1 Year of the Main Endoscopic Alternatives for the Treatment of BPH

Treatment	Number of patients	Symptoms score			Maximum flow (mL/s)			Level of evidence
		Before surgery	After surgery	Results	Before surgery	After surgery	Results	
TURP	1480	ND	ND	70.6%	ND	ND	125%	1a
HoLEP	100	22.1	1.7	20.4* (92%)	4.9	27.9	23.0 (469%)	1b
TUMT	322	19.4	6.7	12.7 (65%)	7.9	13.5	5.6 (70%)	1a
TUNA	182	ND	ND	12.1 (55%)	ND	ND	6.5 (76%)	1a
Bipolar resection	120	23.0	4.0	19.0 (83%)	7.2	19.5	12.3 (171%)	1b
PVP	60	27.2	12.2	15.0 (54%)	8.5	20.6	12.1 (167%)	1b

ND, no data.
* *IPSS.*

TABLE 12.3 Success Rates of Minimally Invasive Treatments in Patients With Urinary Retention

Minimally invasive treatment	Success rate	Follow-up
HoLEP	164/164 (100%)	24 months
TUMT	48/61 (79%)	6 months
TUNA	78/112 (70%)	ND
PVP	68/70 (97%)	12 months

ND, no data

12.2 ANTICOAGULANT THERAPY AND ASSOCIATED CONDITIONS

With increasing life expectancy, a growing number of patients requiring intervention for BPH also have different serious conditions. For these high-risk cases, most authors prefer procedures that require minimal anesthesia/analgesia, with low morbidity and mortality and with a reduced incidence of adverse events.

Studies demonstrate the safety and effectiveness of KTP laser vaporization in patients with coagulopathies or platelet disorders and in patients with high surgical, cardiovascular, or pulmonary risk who cannot discontinue anticoagulants. Holmium laser enucleation of the prostate (HoLEP) was also effective in patients considered unfit for TURP: associated coagulopathies, anticoagulant therapy, and important anemia.

12.3 COSTS

The development of new techniques in medicine represents one of the causes of increased costs, especially when purchasing the necessary equipment. Therefore, the cost is one of the most important disadvantages of laser procedures.

Several economic models have been developed to assess the cost-efficiency of different treatment options for BPH. The costs are significantly reduced for ambulatory treatments, thus making these procedures profitable (compared to surgery, which requires hospitalization). Nevertheless, this advantage may be offset by the high rate of reinterventions for most of the outpatient procedures.

Data suggest that there is a tendency to replace TURP with cheaper pharmacological treatments or with minimally invasive ambulatory procedures. Moreover, the reimbursement policy encourages outpatient treatments. Thus, TUMT and transurethral needle ablation (TUNA) have very good reimbursement rates in the United States ($4272 and $4098, respectively), compared to the costs of these procedures ($552 and $585, respectively) (Manyak et al., 2002; Wei et al., 2005; Lotan et al., 2004).

Some authors argue that the best treatment for BPH is closely linked to the fact that patients and society depend on costs and consequences (disease progression, clinical outcome, duration of in-hospital stay, and catheterization) (Disantostefano et al., 2006). Additionally, long-term results, costs of complications, and reimbursement systems (different from one country to another) are also taken into account when the cost-efficiency of each procedure is calculated.

The algorithm for the surgical treatment of BPH, summarized in Fig. 12.1, is based on the classification of patients according to their surgical risk, as TURP morbidity was the main reason behind the development of new alternatives

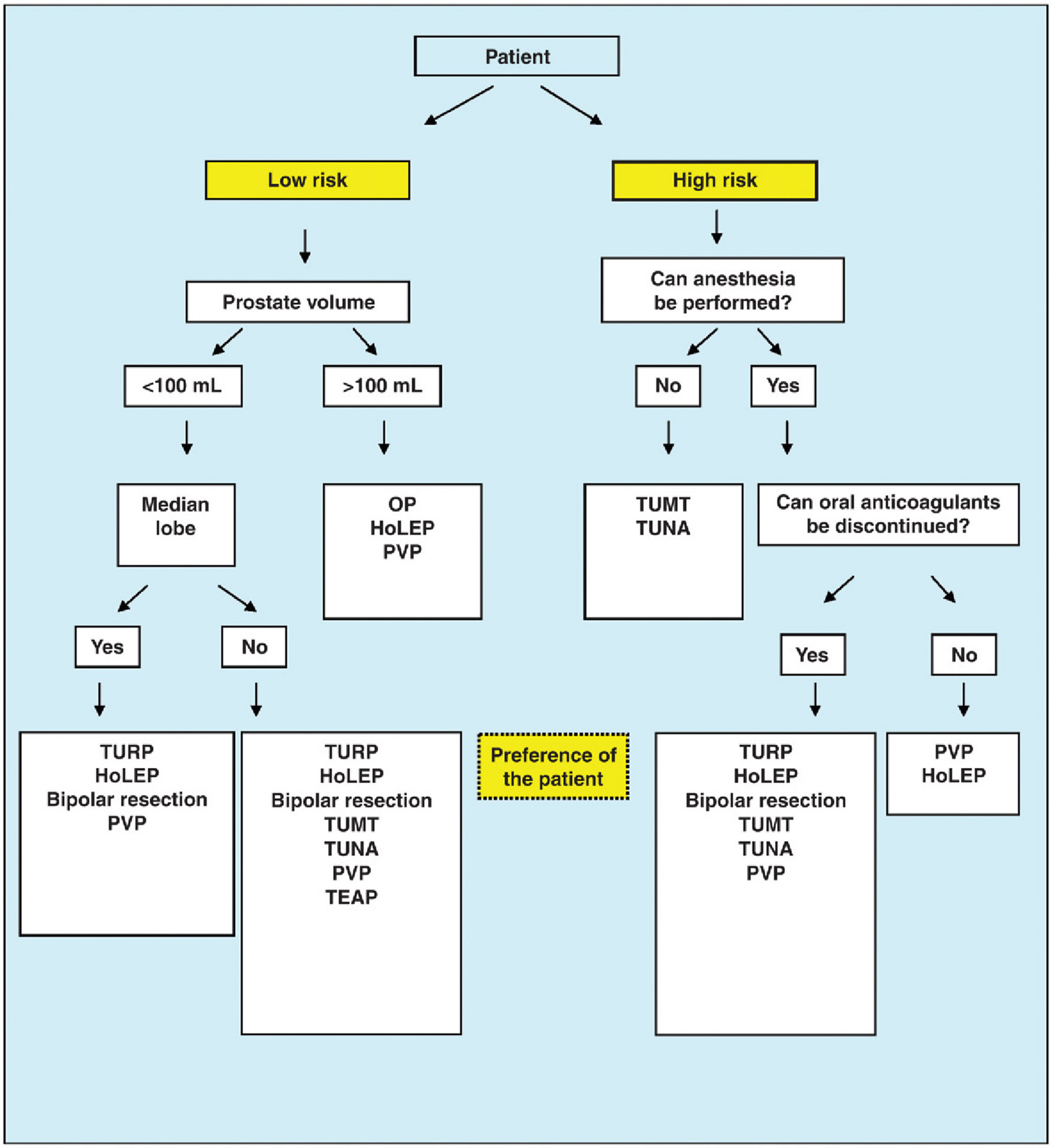

FIGURE 12.1 **Treatment algorithm for BPH.**

of treatment. It should be emphasized that a patient's preference (informed) may also significantly influence the treatment option. Moreover, medical management is also influenced by other factors, including the availability of technical equipment and the experience of the urologist.

TUNA and TUMT are currently considered to be valuable outpatient procedures, and their clinical outcomes are placed between medical and surgical treatment. Nevertheless, HoLEP and KTP laser (the green laser) are serious competitors for TURP, and there are authors who consider that the balance between clinical outcome and morbidity is in favor of these two methods. Paradoxically, the development of minimally invasive procedures was the reason behind the improvement of TURP. For 80 years, TURP was the cornerstone of the management of BPH. TURP reinforced its position after bipolar technology was again introduced.

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C H A P T E R

13

The Place of Endoscopy in the Modern Treatment of Prostate Cancer

Petrişor Geavlete, Gheorghe Niţă, Emanuel Alexandrescu, Bogdan Geavlete

Choosing the optimal treatment method in localized or locally advanced prostate cancer generated, and continues to generate, controversy. Such controversies have been fueled by the development of minimally invasive ablative technologies that allow tumor tissue destruction by applying different energy sources.

Radical prostatectomy, with its different variants (laparoscopic, robotic-assisted, or retropubic or perineal open surgery) has been, for a long time, considered the "gold standard" treatment of localized prostate carcinoma. However, it is an invasive technique with significant morbidity.

The prostate was, and still is, an attractive organ for the implementation of minimally invasive methods due to its anatomical position, which allows for multiple ways of approach:

- transurethral
- transrectal
- transperineal
- retropubic

13.1 TRANSURETHRAL RESECTION FOR URETHRAL OBSTRUCTION

Patients with locally advanced prostate cancer may present with obstructive phenomena and lower or upper urinary tract stasis. These sometimes require an emergency therapeutic approach, having an immediate vital risk that is more important than the neoplastic disease itself. The most common complication is represented by bladder neck obstruction (Fig. 13.1), secondary to the local invasion of the prostate adenocarcinoma (PAC).

Subvesical obstruction occurs relatively late in the local course of a prostate cancer and can be complicated by secondary bladder stones, recurrent urinary tract infections, bladder diverticula, or unilateral or bilateral ureterohydronephrosis, which can lead to renal failure. When dealing with a prostate cancer patient with subvesical obstruction, the urologist can perform a transurethral resection to unblock the bladder neck (Fig. 13.2). In this situation, transurethral resection of the prostrate (TURP) does not have a curative intent for the cancer but is only a palliative measure to reduce obstructive symptoms and improve the quality of life (Sehgal et al., 2005).

In such cases, transurethral resection has the same basic principles as the classic TURP performed for benign prostate hyperplasia. However, there are certain particularities of resection in patients with PAC (Tanagho and Mc Anninch, 2000):

- Arterial vasoconstriction is much lower (as opposed to benign prostatic hyperplasia), which implies intraoperative bleeding (Fig. 13.3). Furthermore, the release of fibrolysines from the neoplastic tissue can contribute to the bleeding. ε-Aminocaproic acid may be useful for these patients, especially in cases with diffuse bleeding and when the source cannot be identified. To reduce bleeding, some authors indicate preoperative hormone therapy. The opening of venous sinuses can cause significant bleeding that is difficult to control. However, some studies have not shown statistically significant differences in the rate of complications and length of hospital stay after TURP in prostate cancer patients as compared to patients with benign diseases (Crow et al., 2002).

Endoscopic Diagnosis and Treatment in Prostate Pathology. http://dx.doi.org/10.1016/B978-0-12-802405-8.00013-5

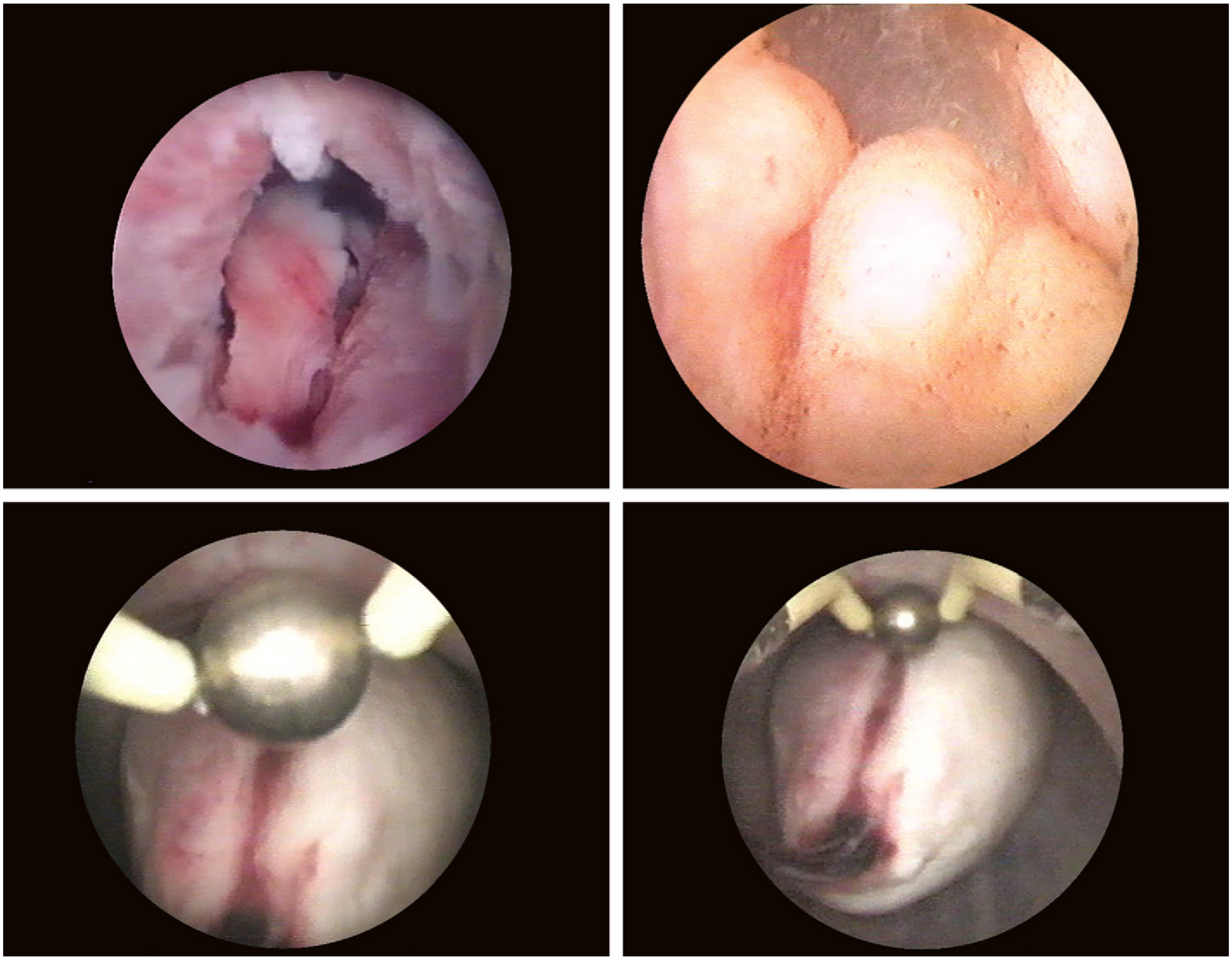

FIGURE 13.1 **Endoscopic aspects of locally advanced PAC.**

- Neoplastic tissue has a yellow or whitish color and increased consistency as compared to adenomatous tissue (Fig. 13.4). Sometimes it can be soft, with a cribriform appearance (Fig. 13.5) (Vanasupa et al., 2000).
- The classic landmarks for transurethral resection can be blurred, which is why overcoming them, especially in the verumontanum region, may cause postoperative urinary incontinence. Most authors recommend caution when performing TURP in patients with locally advanced PAC. The intervention is usually limited, without advancing as usual up to the prostatic capsule (Fig. 13.6) (Blandy et al., 2005).
- Invasion of the bladder neck (Fig. 13.7) and of the external urethral sphincter may favor the appearance of urinary incontinence after TURP.
- Invasion of the ureteral orifices may require resection of the tumoral tissue surrounding them, followed by internal endoprosthesis (Fig. 13.8).

In patients with preoperative radiotherapy, the risk of bleeding or postoperative urinary incontinence is significantly higher (Sehgal et al., 2005). Therefore, TURP should be avoided in cases where radiotherapy has been performed recently. There should be an interval of at least 3 months between radiotherapy and TURP, although most authors prefer at least 6 months (especially after brachytherapy) (Flam et al., 2004). This period of time allows the prostate to shrink in size (secondary to radiotherapy), thus reducing the need for endoscopic resection (Liu et al., 2005). Also, TURP should be avoided before radiation therapy or cryotherapy. Hormone therapy may cause enough reduction in the size of the prostate to improve the subvesical obstruction and the patient's quality of life.

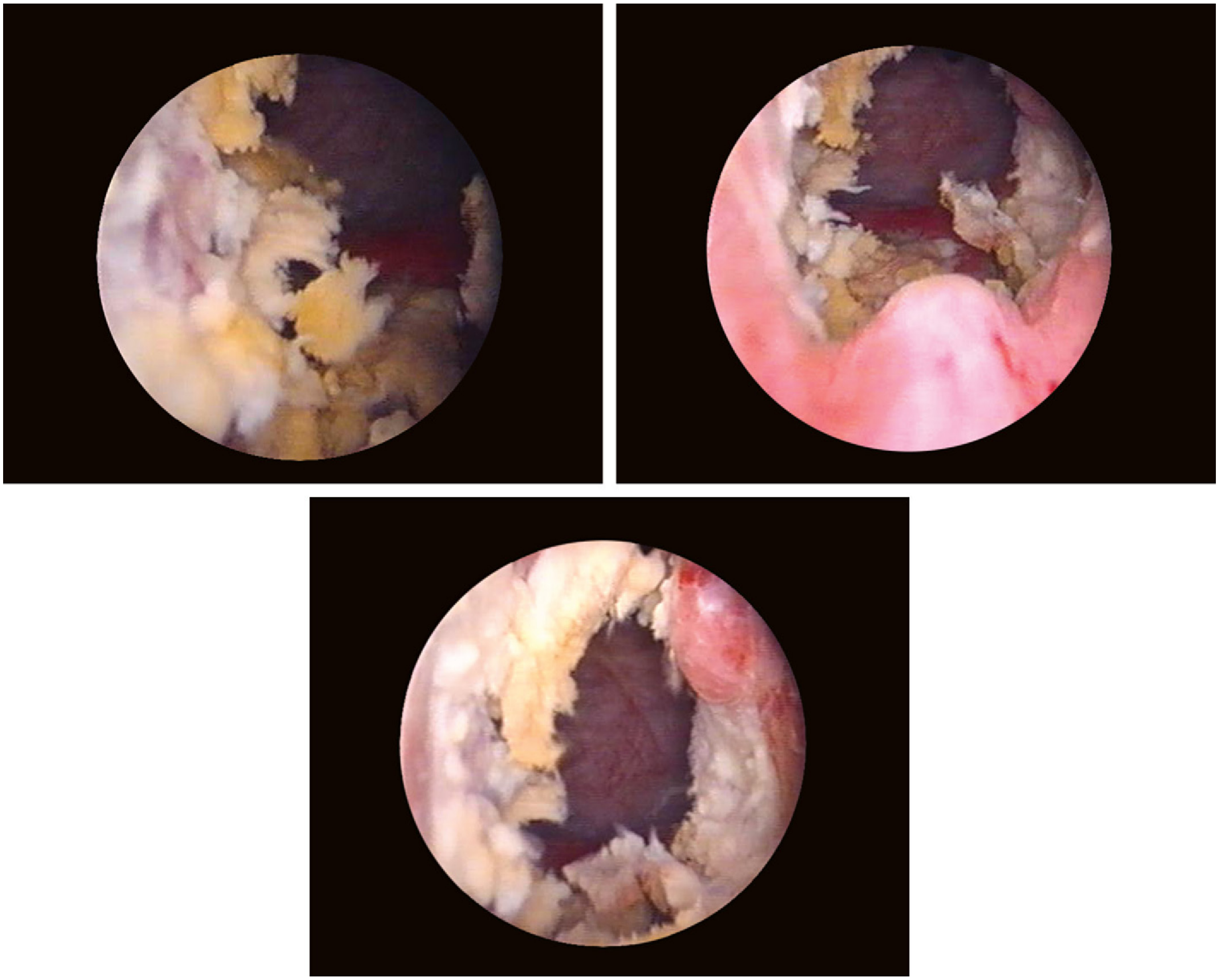

FIGURE 13.2 **Unblocking TURP performed in PAC patients.**

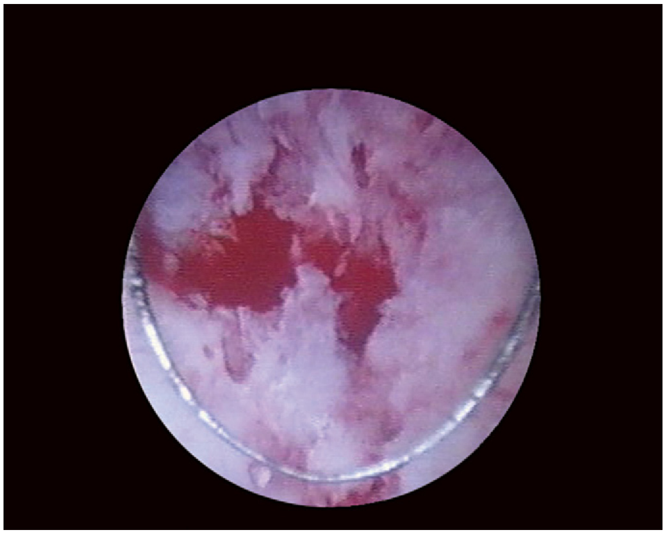

FIGURE 13.3 **Intraoperative bleeding in a PAC patient.**

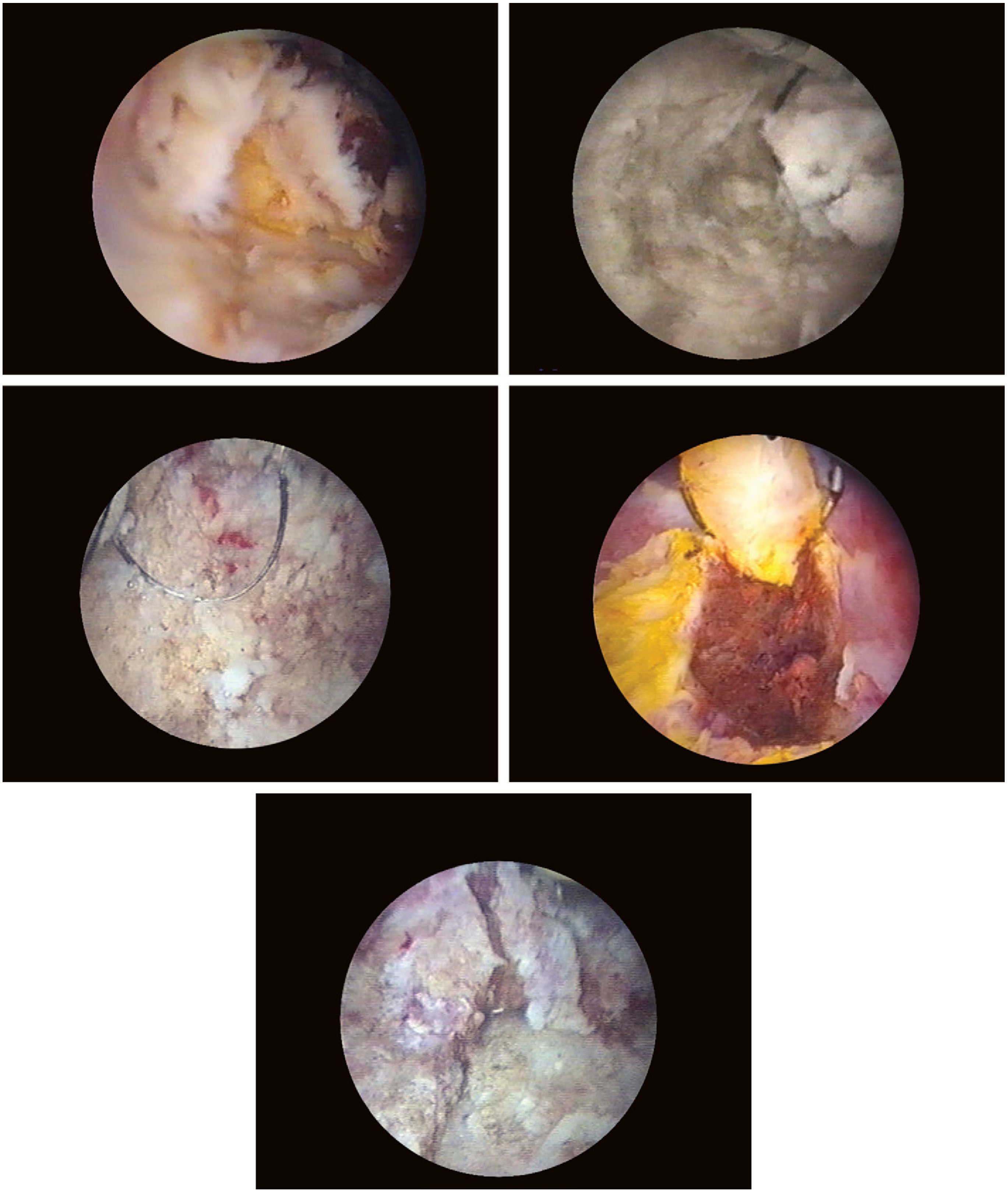

FIGURE 13.4 **Endoscopic aspects of neoplastic prostatic tissue.**

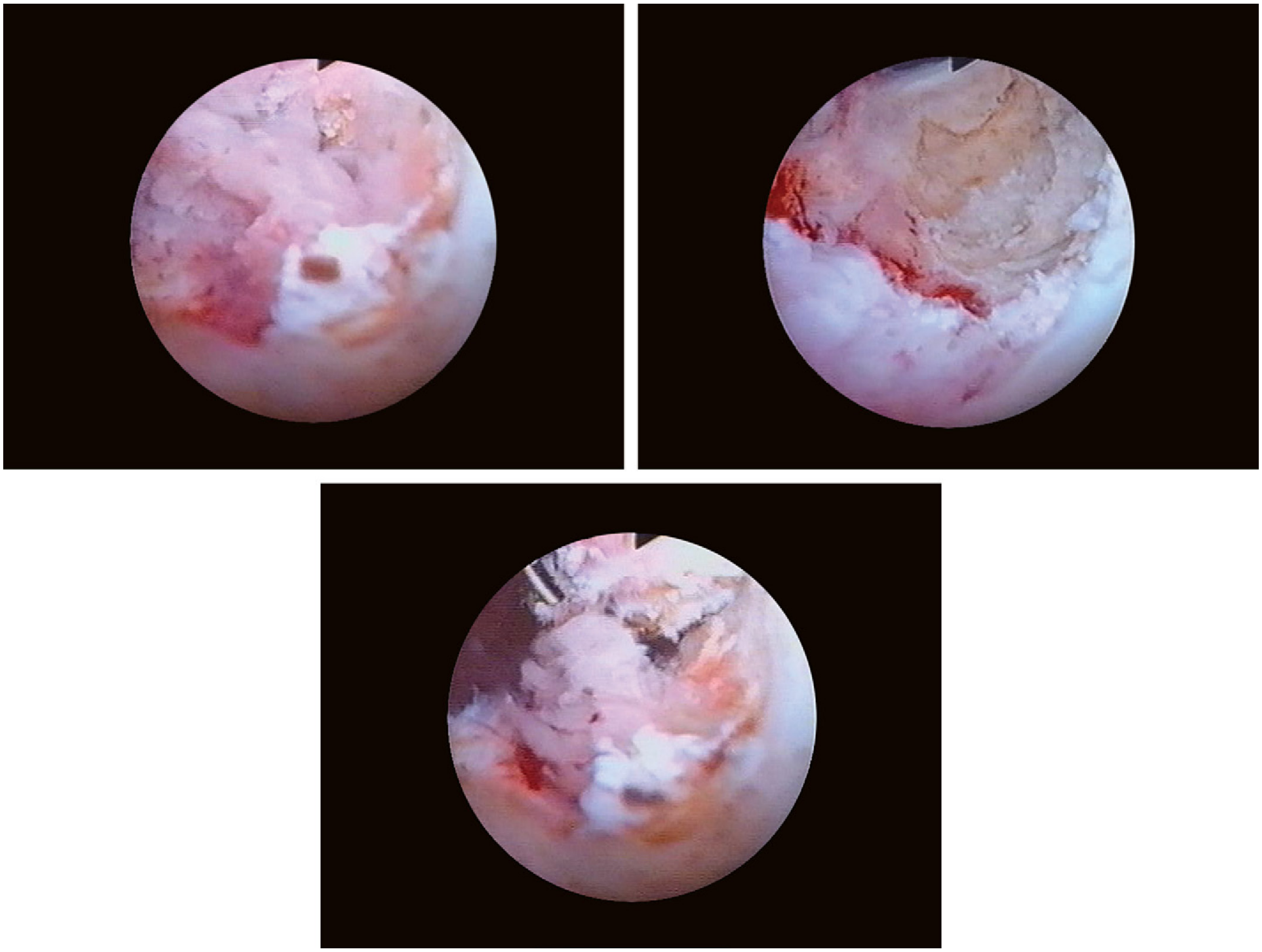

FIGURE 13.5 **Cribriform prostatic cancer.**

The evolution of PAC is not influenced by TURP (Leslie, 2006). Disease progression and mortality rates are similar (in patients undergoing TURP as compared with those who did not receive this intervention). Reapplying TURP for staging does not seem necessary.

13.2 MINIMALLY INVASIVE ABLATIVE TECHNIQUES

Minimally invasive ablative tissue techniques use different forms of energy:

- ultrasound (high-intensity focused ultrasound (HIFU))
- radio waves (radiofrequency ablation (RITA))
- microwaves (transurethral microwave therapy (TUMT))
- cryoablation (cryosurgery)

The purpose of these alternative treatments is to eradicate tumor tissue together with a limited area of healthy adjacent tissue. The procedures are characterized by a low morbidity and preservation of the affected organ. These techniques have not been implemented on a large scale because of two major limitations: the difficulty in obtaining the precise location of the tumor and the exact determination of the tumor's volume.

Although there is no consensus regarding the indications for these methods, they are generally used for

- treatment of localized prostate cancer
- treatment of recurrence (biochemical or local)

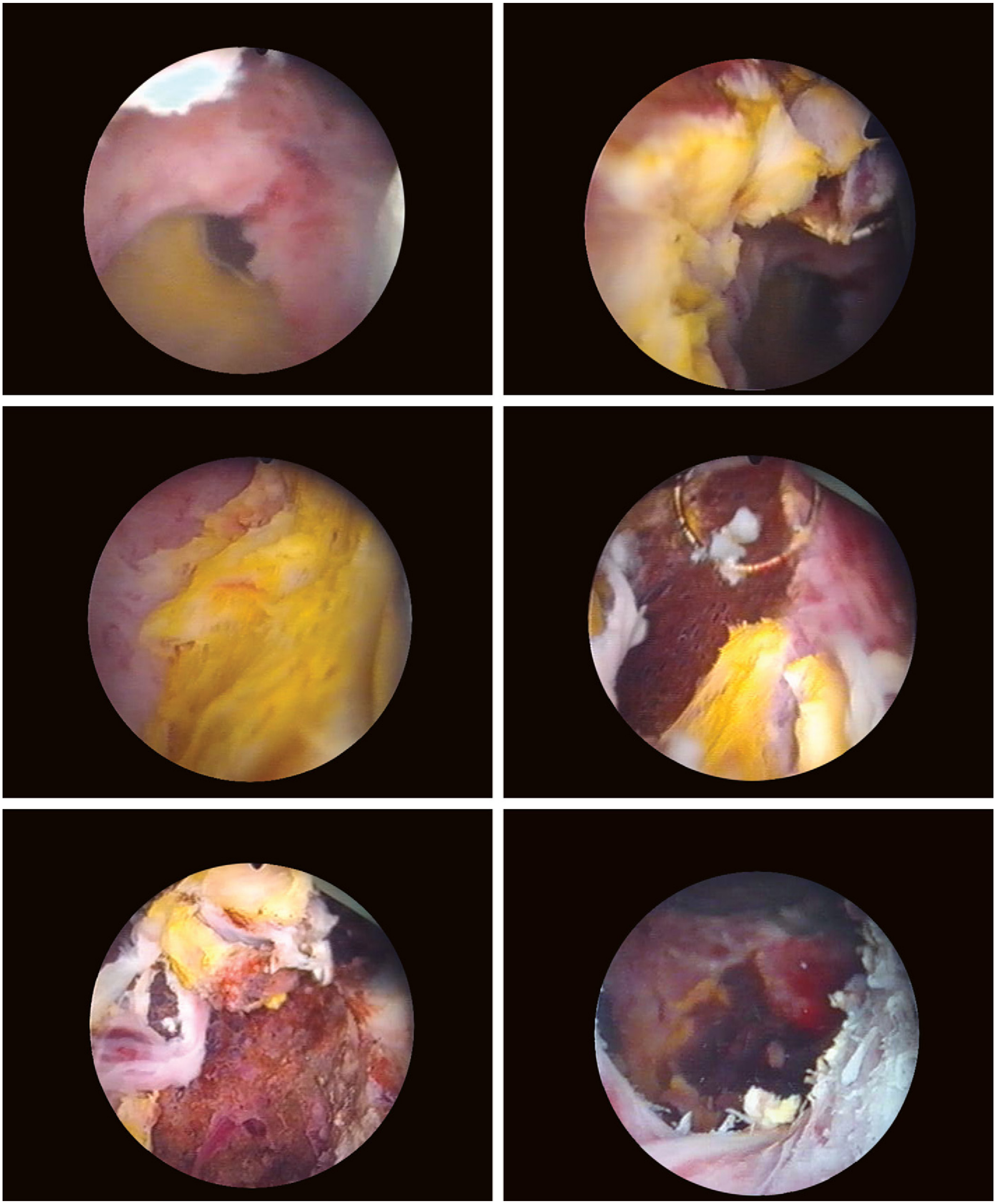

FIGURE 13.6 **TURP performed for PAC with areas of necrosis.**

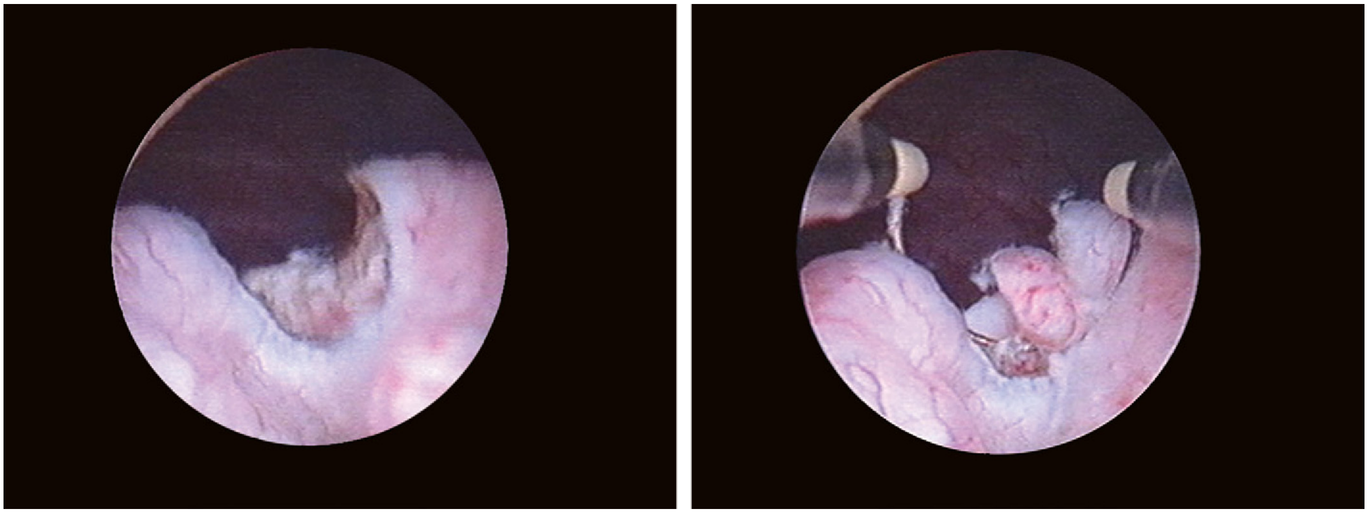

FIGURE 13.7 **PAC invading the bladder neck.**

- palliative treatment – the control of local complications (hematuria, urinary retention, etc.) in patients with disseminated disease

The results are conditioned by the adequate selection of patients, depending on a number of prognostic factors:

- tumor stage
- Gleason score
- prostate-specific antigen (PSA) levels
- tumor volume

Obviously, the best results are obtained in patients with low risk (stage T1c–T2a, Gleason score ≤ 6, PSA ≤ 10 ng/mL). These alternatives also have indications in patients with localized prostate adenocarcinoma with intermediate or high risk (T2b/T2c, Gleason score ≥ 8, PSA > 10 ng/mL) when patients opt for a minimally invasive method (Bahn et al., 2002; Cohen et al., 2008).

13.2.1 Brachytherapy

Brachytherapy is a minimally invasive method with curative intent. It consists of implanting a radioactive source in the prostate, thus generating radiation doses in the prostate while sparing the surrounding tissues. The method was first used in 1983 by Holm, but the transperineal technique under transrectal ultrasound guidance was described in 1985 (Radge et al., 1997).

Brachytherapy can be carried out using high or low doses. High-dose brachytherapy uses Iridium 192. Some authors recommend combining external radiotherapy with high-dose brachytherapy (Borghede et al., 1997), thus obtaining superior results as compared to using only a single technique. Low-dose brachytherapy uses Iodine 125 or Palladium 103, which are introduced into the prostate under transrectal ultrasound guidance. The technique is performed under general or spinal anesthesia and is controlled by a computer program. Doses are usually between 110 Gy and 145 Gy. Postoperative evolution is assessed by monitoring the PSA level every 3 months.

In terms of results, the success rates at 5 years range between 71% and 93% (Cesaretti et al., 2006). There can be urinary complications (30%), gastrointestinal issues (20%), or sexual dynamic disorders (17%) (Speight and Roach, 2005).

In our country, brachytherapy was introduced in 2006 and is performed in the "Fundeni" Center of Urological Surgery, Dialysis and Renal Transplantation, using implants with I 125.

13.2.2 Cryotherapy

Cryotherapy is an ablative method that consists of inducing extremely low temperatures in the targeted tissue for its destruction or its excision. Prostate cryotherapy implies *in situ* controlled freezing of the prostatic tissue, with the objective of partial or total removal of the gland, thus eradicating the disease while maintaining the integrity of the adjacent anatomical structures.

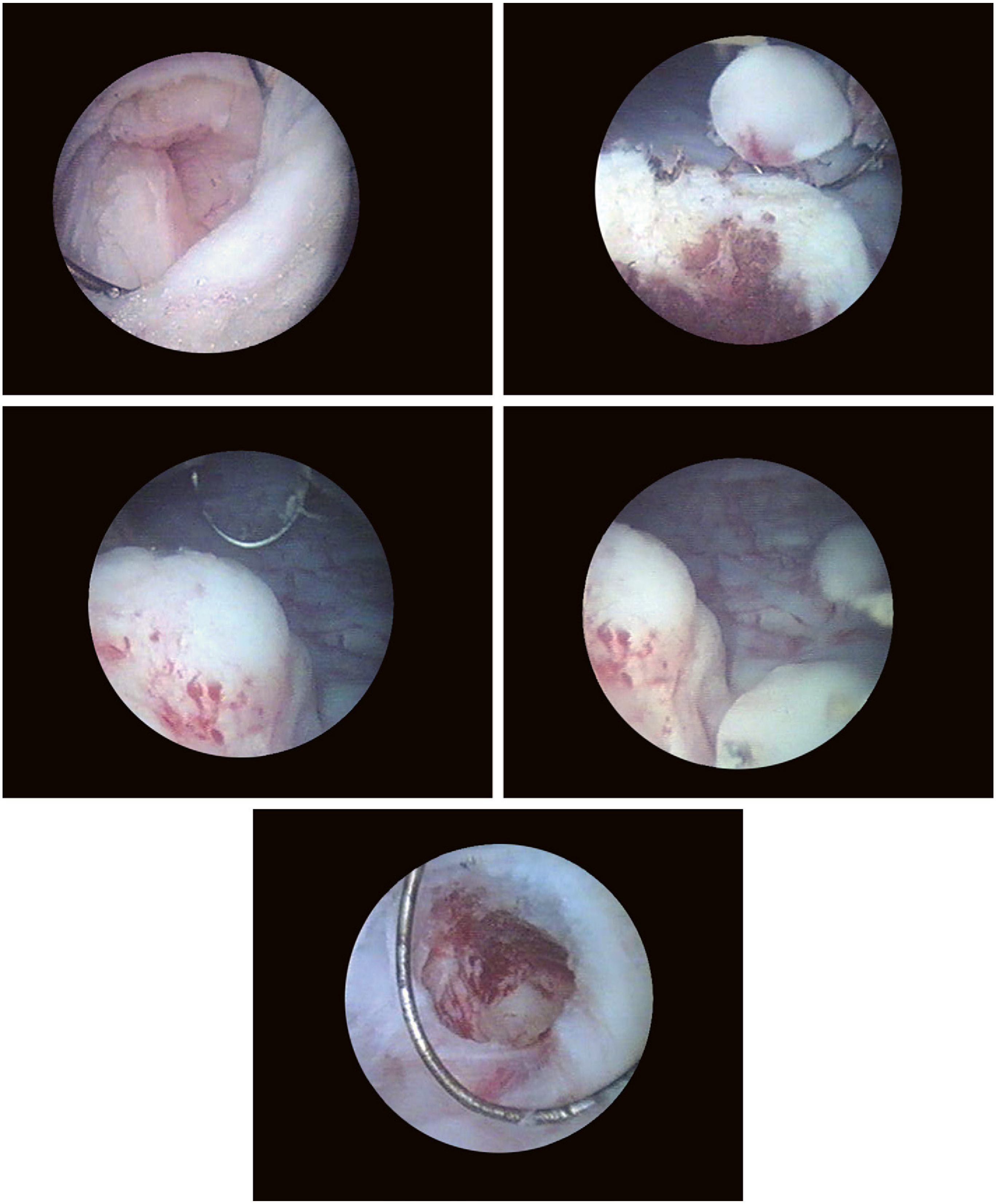

FIGURE 13.8 **Releasing the ureteral orifices in a patient with locally advanced PAC.**

Cryosurgery was first used for prostatic conditions in the 1960s, when the first cryotherapy system was created by Cooper and Lee (Gage, 1998). The transperineal approach was introduced in 1974, initially using a single cryoprobe that was digitally guided and repositioned as needed during the procedure (Megalli et al., 1974). A significant breakthrough was achieved in the early 1990s when transrectal ultrasonography was implemented (Onik et al., 1993), which allowed for optimal cryoprobe placement. Frozen tissue appears on an ultrasound as an image with a hyperechoic contour and a shadow cone (Onik et al., 1993). The introduction of thermocouples (in the mid-1990s) allowed us to determine the extent of tissue damage and thus to arrest the freezing cycle when temperatures below −40°C were reached (Zisman et al., 2001).

Subsequently, another important progress was made when liquid nitrogen was replaced by argon. By simply expanding due to the Joule–Thompson effect, pressurized argon gas allowed for rapid achievement of low temperatures. A computer program was added to these innovations, which offered the possibility to generate preoperative isothermal maps of the prostate based on various cryoprobe placements. This allowed the surgeon to choose the best strategy for placing the cryoprobes in order to obtain a maximal tumor tissue ablation with minimal damage to the adjacent structures.

Current techniques perform tissue ablation by inducing consecutive cycles of freezing and thawing, which cause irreversible cell damage. These lesions mostly result from coagulation necrosis that occurs in the area near the cryoprobes while the cells in the peripheral region remain viable (Larson et al., 2000).

Tissue destruction induced by the extreme cold is the result of a multifactorial process (Saliken et al., 2002):

- protein damage secondary to cellular dehydration
- rupture of the cell membrane due to intracellular crystallization
- vascular swelling
- altered vascular endothelium secondary to platelet aggregation and ischemia
- induction of apoptosis

The first irreversible cellular lesions in the prostatic tissue occur in about an hour: signs of acute inflammation, vascular congestion, areas of interstitial hemorrhage, and coagulation necrosis. Other changes that occur are the appearance of granulation tissue and basal hyperplasia, cellular edema, and focal hemosiderin deposits as well as nerve damage.

Depending on the speed with which they are achieved, temperatures between −20°C and 0°C are sufficient for the complete destruction of the prostate cancer cell. Also, two consecutive cryoablation cycles have a much higher destructive effect than a single cycle (Tatsutani et al., 1996).

The damage of the prostatic tissue that results from cryoablation has the shape of a sphere with two concentric zones that are thermally well differentiated (Tatsutani et al., 1996; Larson et al., 2000). The central area is the part in the immediate vicinity of the cryoprobe, where the lowest temperatures are reached (−20°C to −40°C), which causes coagulation necrosis and irreversible and uniform tissue destruction. The peripheral zone, where temperatures are not as low, is characterized by potentially reversible cellular damage and, therefore, presents the risk of tumor recurrence (Tasutani et al., 1996).

It should be noted that there is no consensus on the indications of cryotherapy, especially as primary therapy, in localized prostate cancer. This is due to the lack of randomized clinical trials comparing the results of cryotherapy to the other methods of treatment. The European Association of Urology Guidelines recommend cryotherapy as a viable treatment option for patients with localized prostate cancer (Aus et al., 2005).

Cryoablation is performed under general or spinal anesthesia. Cryoprobes should be placed in various regions of the prostate so as to ensure the overlapping of the cryonecrosis areas in order for the destructive lesions to involve the entire gland while having minimal side effects. The way cryoprobes are placed depends on the characteristics of the type of cryoprobe used. Both the thermal profile (temperature range around the sample) and the geometry of the induced lesion are essential parameters that are taken into account when placing the cryoprobes.

Technological progress has led to the development of computerized cryoablation systems capable of generating, based on algorithms, the optimal way of placing the cryoprobes (Ellis, 2002). The cryoablation process is initiated from the anterior toward the posterior plane in order to allow for ultrasound visualization during the procedure. Patients are followed up at weeks 2, 4, and 6 after the procedure, and serum PSA is determined every 3 months postoperatively.

Morbidity associated with cryoablation has decreased considerably due to technological developments, reviews of clinical protocols, and a more thorough knowledge of cryobiology (Hoffman et al., 2002). Most recent studies report a lower rate of complications as compared with other treatment options for prostate cancer. Some of the complications of cryotherapy are common to other methods of treatment – erectile dysfunction, urinary incontinence

(3–20%), and intestinal disorders – while others are somewhat specific to this procedure: urethral injuries, urethral stricture, urethro-rectal fistula, pelvic or rectal pain, etc.

Erectile dysfunction is a very common complication after cryotherapy; its incidence ranged between 40–47% a decade ago and 80–100% in the most recent reports (Bahn et al., 2002). Because of its high frequency and clinical consequences, it is the most important complication of cryotherapy. For this reason, cryotherapy is not a therapeutic option in patients who want to preserve erectile function.

The most recent data indicate an incidence of urethral lesions of 3.8–23% after primary cryotherapy (Han et al., 2003) and of 5–44% after salvage cryotherapy (De La Taille et al., 2000). Optimal evaluation of the results of cryotherapy is difficult to achieve due to the great heterogeneity of data published in the literature.

The latest studies report a survival rate without biochemical recurrence at 5 years ranging between 48% and 92% (Donnelly et al., 2002). The local recurrence rate is higher in cancers located at the apex (9.5%) and seminal vesicles (43.8%) in contrast to those located in the central area (4.1%) and the base of the gland (0%).

The largest comparative study between the different methods of local treatment in prostate cancer was published by Katz and Rewcastle (2003) and is based on all studies conducted between 1992 and 2002 that reported a 5-year survival rate without biochemical recurrence. Cryotherapy results were compared with other treatment methods (radical prostatectomy, external radiotherapy, brachytherapy, and 3D radiation) on the three groups of prostate cancer risk. For the low-risk group, all available methods of treatment showed very good results regarding local and distant control of the disease (Stokes, 2000; Bahn et al., 2002). Because of their similar efficacy, choosing the optimal method of treatment for low-risk patients is based more on elements regarding morbidity and quality of life after surgery.

In patients with intermediate and high risk, the choice of optimal therapy becomes even more difficult, with cryotherapy being at least as efficient as other methods of local therapy (Bahn et al., 2002; Long et al., 2001). However, the very good long-term results (>15 years) reported for radical prostatectomy reconfirm this method as the "gold standard" for the treatment of localized prostate cancer.

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CHAPTER

14

Endoscopic Treatment of Prostatic Abscesses

Petrişor Geavlete, Gheorghe Niţă, Cristian Persu, Bogdan Geavlete

The prostatic abscess represents a rare pathological condition (Fig. 14.1) that is usually difficult to diagnose because its symptoms mimic other diseases of the lower urinary tract.

The existing data suggests that the prostatic abscess is a secondary condition that occurs as a complication of an acute or chronic prostatitis, usually untreated or treated inadequately.

Some authors consider that the most frequent physiopathological mechanism is represented by reflux of infected urine into the prostatic ducts, with septic insemination at this level. There are reports of cases in which the etiological agent reached the prostate by hematogenous dissemination from a distant infection: perirenal abscess, appendicitis, otitis, or bronchitis (Fig. 14.2). In these cases, the germs involved are those of the primary focus: *Staphylococcus aureus*, *Candida*, etc. (Trapnell and Roberts, 1970).

There is not a lot of data in the literature that can offer solid recommendations in the era of evidence-based medicine. Most available data comes from case reports or a small series of patients; therefore, there is no consensus regarding a guideline for diagnosis and treatment.

Epidemiologic data from the beginning of the twentieth century reports a mortality rate ranging between 6% and 30% for prostatic abscesses, while the most frequent etiological agent was represented by *Neisseria gonorrhoeae*. More recent data reports a decrease in mortality rates, which are currently between 3% and 16%, and an increase in the incidence of infections with *Escherichia coli*, which currently account for 70% of cases.

E. coli and *Staphylococcus* are the most frequent etiologic agents involved in the development of prostatic abscesses (Fig. 14.3). Other less frequently involved etiologic agents are *Bacteroides fragilis*, *Mycobacterium tuberculosis*, *Actinomyces*, *Citrobacter*, *Aeromonas aerophyla*, *Klebsiella pneumoniae*, and *Burkholderia pseudomallei* (Granados et al., 1992b).

Association of anaerobe germs is responsible for emphysematous prostatic abscesses, which have a suggestive appearance at rectal examination (Mariani et al., 1983). Several factors have changed the epidemiological profile of prostatic abscesses, of which the most important appear to be the widespread use of broad-spectrum antibiotics as well as the increase of life expectancy for diseases that until recently, were considered to be incurable. Another factor involved in this epidemiological change is immunosuppressive therapy, routinely used in organ transplantation, hemodialysis, etc. (Weinberger et al., 1988).

Prostatic abscess has a higher incidence in diabetic and immunocompromised patients (Fig. 14.4). Abscesses may drain spontaneously through fistulas into the urethra or into the peritoneum with secondary peritonitis. However, these situations are rarely encountered, and very few such cases are reported.

The factors that may favor the appearance of prostatic abscesses are represented by associated diseases (diabetes, poor immune status, chronic kidney disease, etc.), interventions on the lower urinary tract, urethrovesical catheterization, and urogenital surgical interventions (Fig. 14.5). Reflux of infected urine into the prostate during urination is considered to be the most frequent cause of prostatic abscesses, although some authors consider that, in most cases, the primary disease is represented by an acute or chronic prostatitis.

The highest incidence of prostatic abscesses is recorded in the fifth and sixth decades of life, but cases have been reported in all age groups, including in newborns. The initial symptoms are nonspecific and include dysuria, pollakiuria, and urinary urgency. One third of patients develop acute urine retention (Fig. 14.6) and up to 72% present

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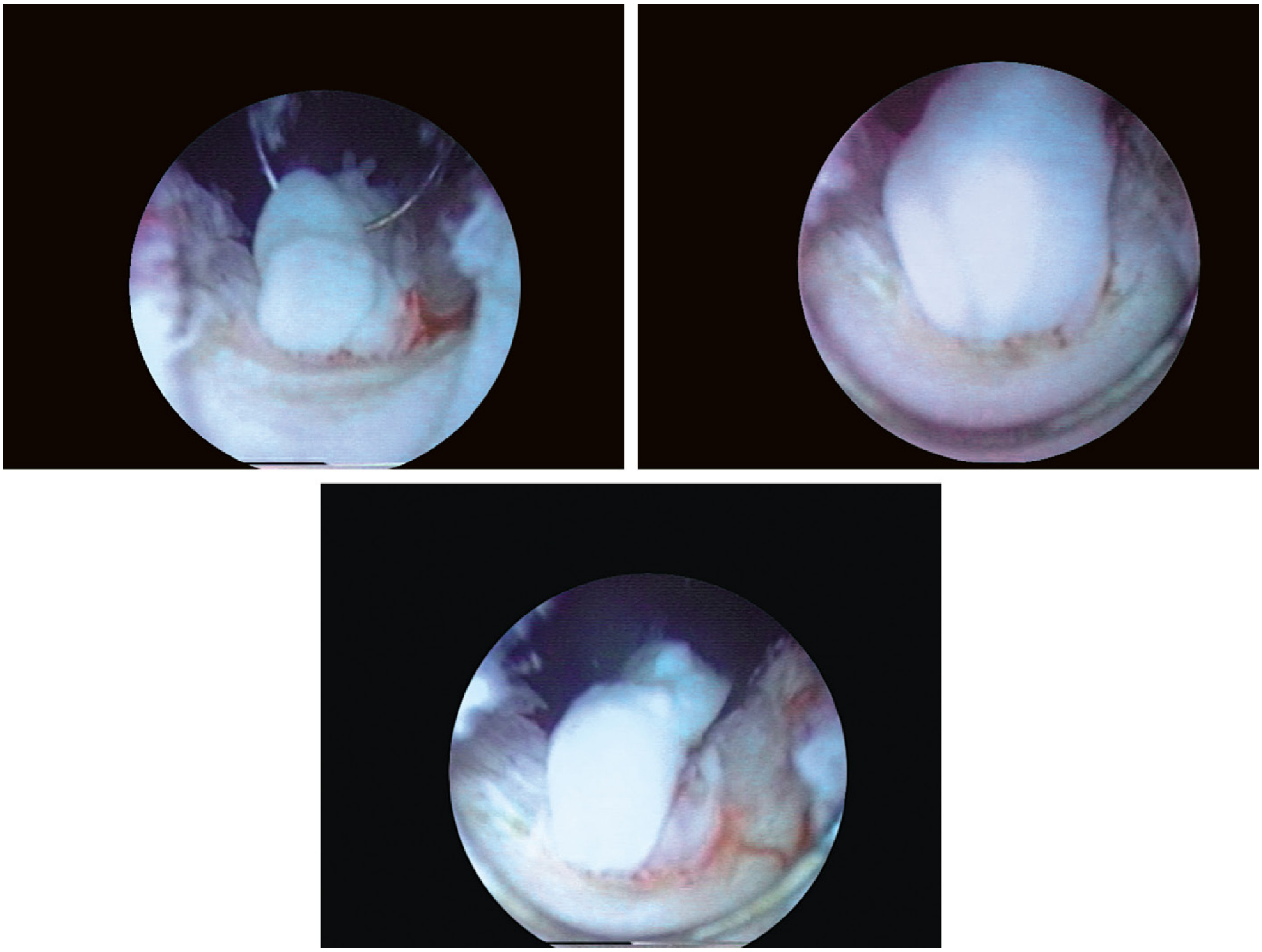

FIGURE 14.1 **Transurethral drainage of a prostatic abscess.**

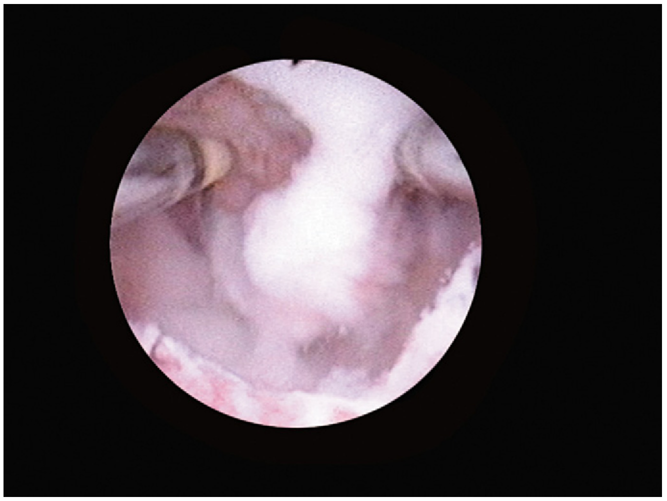

FIGURE 14.2 **Drainage of a prostatic abscess caused by hematogenous dissemination (patient with acute otitis).**

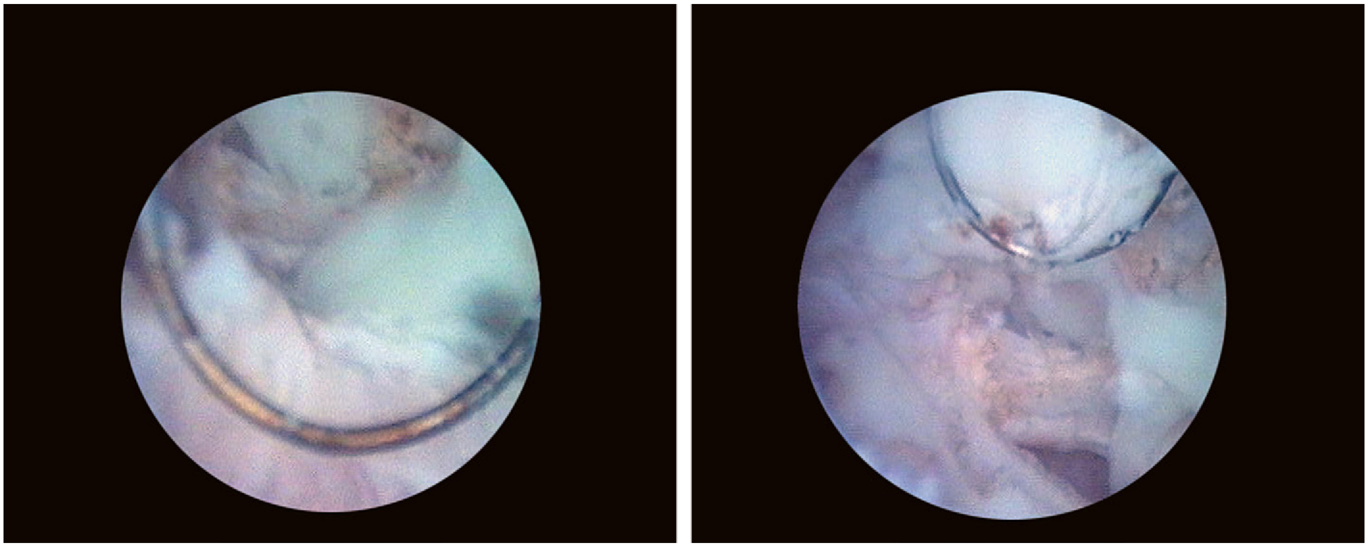

FIGURE 14.3 **Prostatic abscess resulting from microbial association (*E. coli* and *Staphylococcus*).**

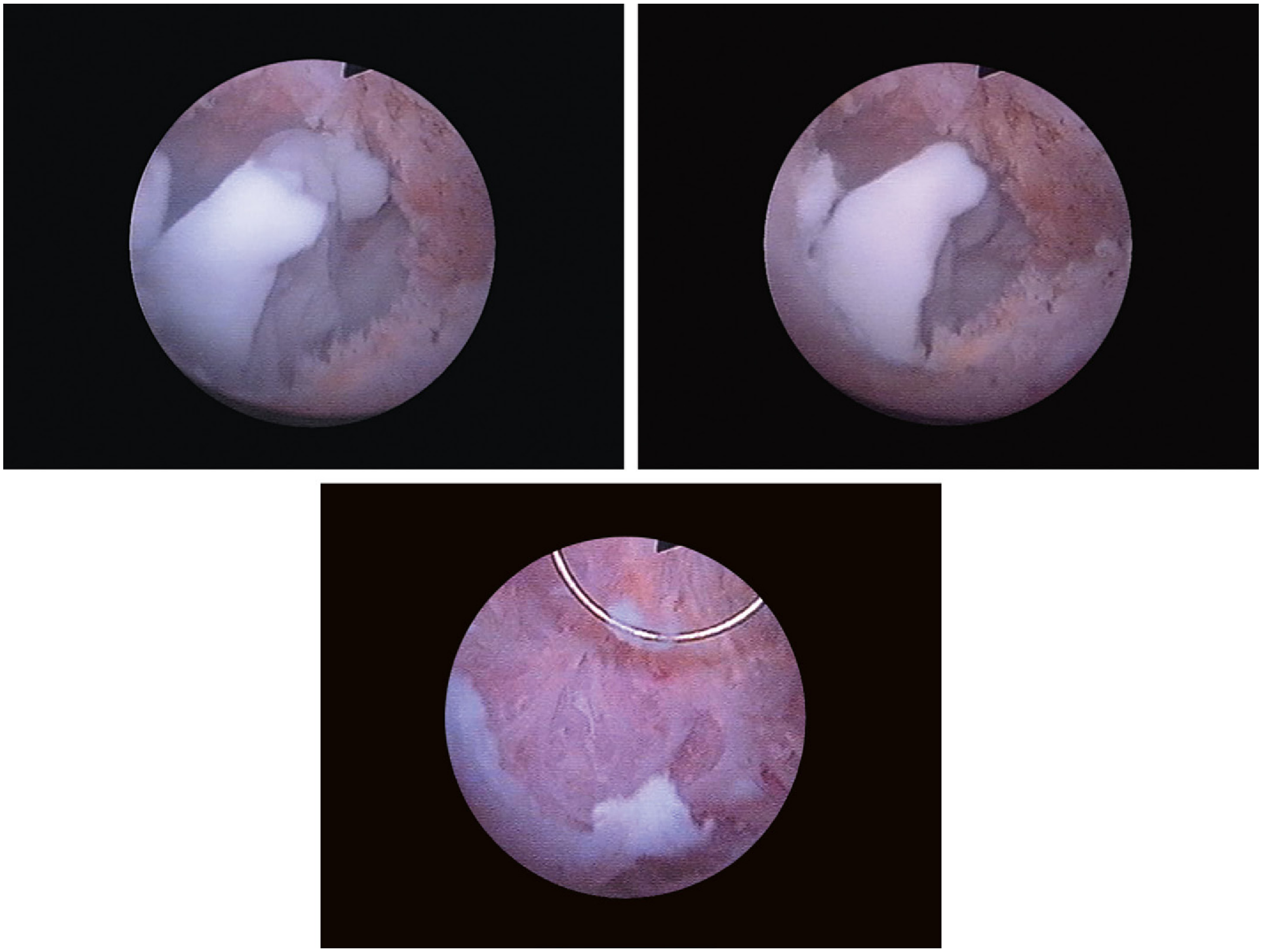

FIGURE 14.4 **Prostatic abscess in a diabetic patient.**

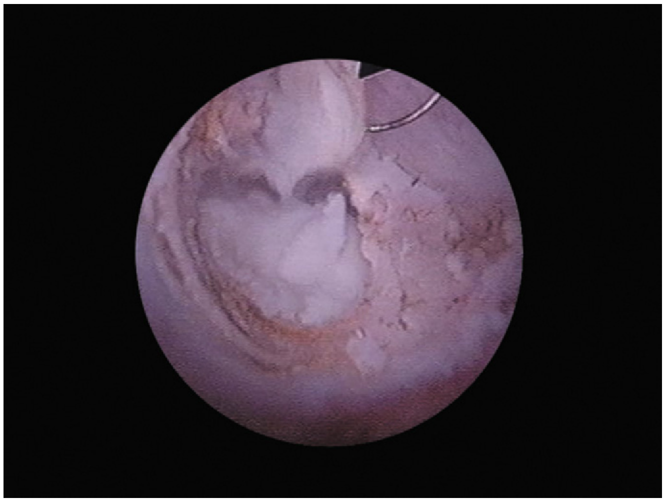

FIGURE 14.5 **Drainage of a secondary prostatic abscess (after a urological intervention).**

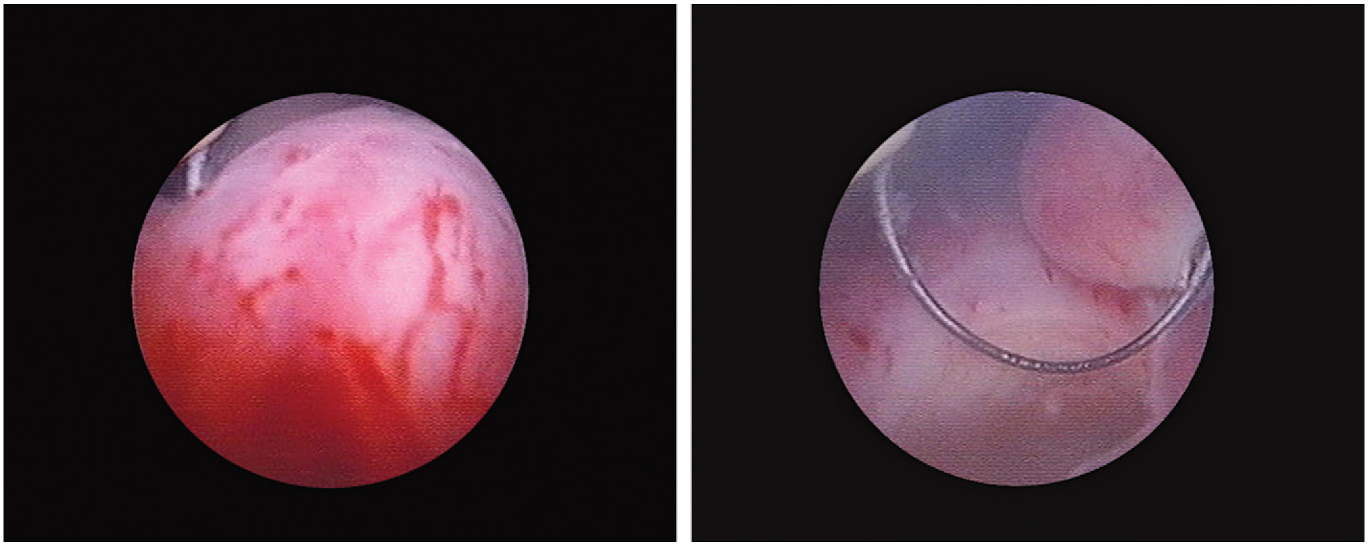

FIGURE 14.6 **Prostatic abscess in a patient with acute urine retention.**

a fever. A quarter of patients with prostatic abscesses present to the doctor with chills after short episodes of fever (Gill et al., 1991). Pain is not a constant symptom, is usually located at the perineal level, and is less frequently felt as a rectal irritation. Two patients with prostatic abscesses without any symptomatology were described in a series of 269 cases. Sometimes, patients may present hematuria or urethral secretions, but these symptoms are frequently sporadic and therefore may not be observed during the physical examination (Oliveira et al., 2003).

There is insufficient clinical data to generate an algorithm for diagnosis and treatment due to the low number of cases reported and to their sporadic nature, thus making it difficult for a center or a team of specialists to gain relevant experience. However, anamnesis and physical examination may lead to a suspicion of prostatic abscess, which can be confirmed by transrectal ultrasound, computed tomography, or MRI. The difficulties in diagnosing this disease are determined both by its low incidence as well as its quiet symptomatology, which is much diminished by therapies very frequently started before any diagnostic procedure (Lin et al., 2001) (Fig. 14.7).

According to data in the literature, a rectal exam can raise the suspicion of prostatic abscess in 16% to almost 90% of cases. The most frequent elements of the rectal exam are areas with a consistency different from that of the rest of the prostate, which change their form during palpation. Prostate pain is always present at the rectal exam (Granados et al., 1992a,b).

Laboratory exams show leukocytosis and leukocyturia, but these are nonspecific and cannot orient the diagnosis. Prostate-specific antigen levels are increased. Cultures obtained from the samples that were collected (urine, blood,

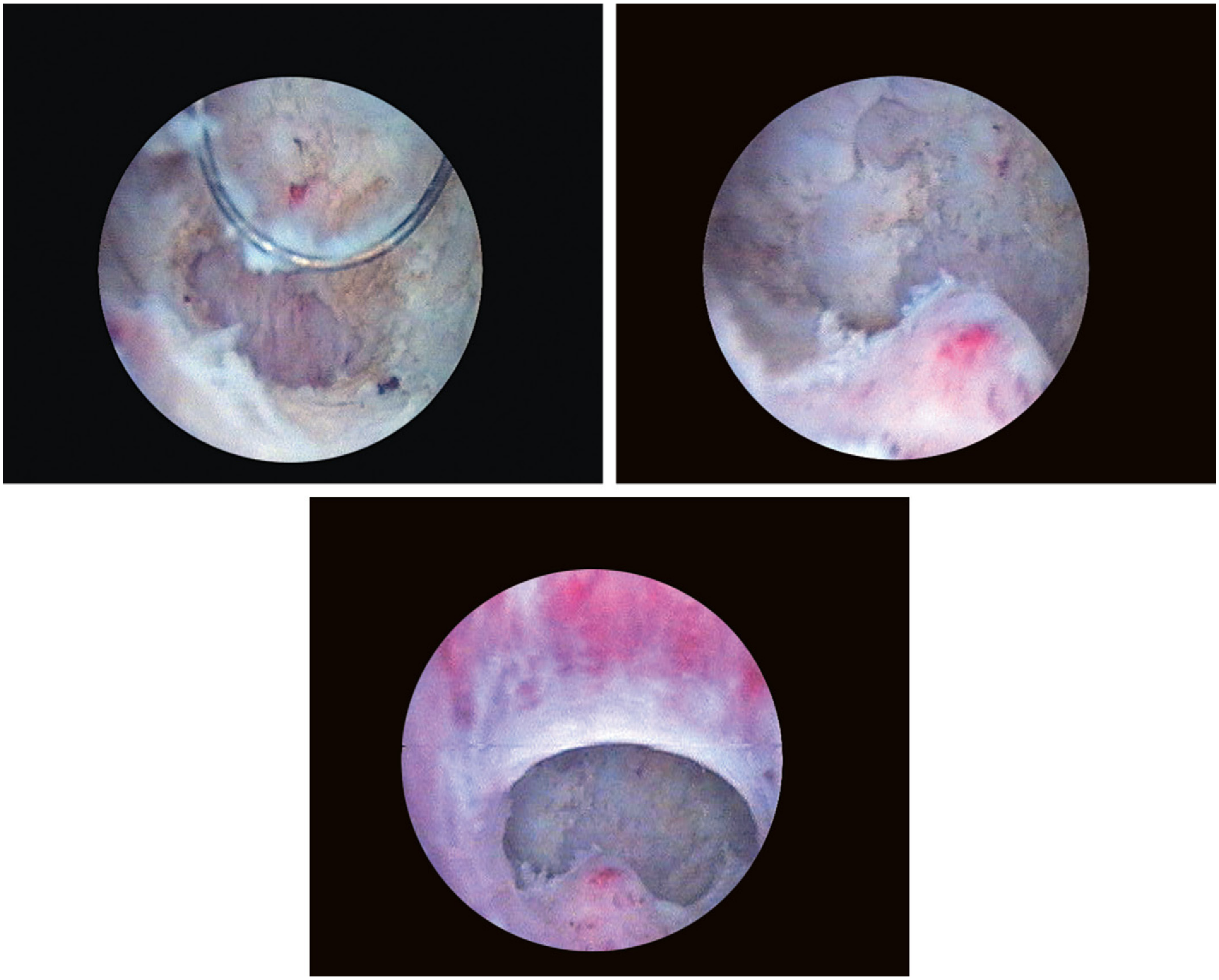

FIGURE 14.7 **Prostatic abscess discovered intraoperatively in a patient with prostate adenoma.**

pus) are considered to be of great importance, especially in patients with a poor immune status, in which atypical germs are frequently encountered.

Transrectal ultrasound has a very good sensibility, is not expensive, and also presents the advantage of being able to guide the puncture for drainage (a maneuver that is performed during the same procedure). The ultrasound exam shows hypoechogenous areas of different sizes with dense content. These areas are located especially in the transitional area of the prostate and also in its central area. Globally, the prostate has a modified morphology and frequently presents hyperechogenous areas, specific for chronic inflammations of the prostate (Aravantinos et al., 2008).

The most important differential diagnosis is with prostate cancer, which may have a similar aspect at the ultrasound exam. Prostatic cysts, another relatively rare condition, must be taken into consideration in the differential diagnosis of prostatic abscesses.

Computed tomography is not a routine examination for this pathology but may offer additional information regarding the abscess' location, its extraglandular extension, etc. However, some studies have demonstrated the superiority of an ultrasound exam over CT for the diagnosis of this disease (Arger, 1985).

The treatment of prostatic abscesses requires hospitalization of patients and postoperative follow-up. Treatment requires not only drainage of the abscess but also adequate antibiotic therapy, preferably by parenteral route.

Drainage can be performed by

- transrectal puncture or aspiration
- perineal drainage

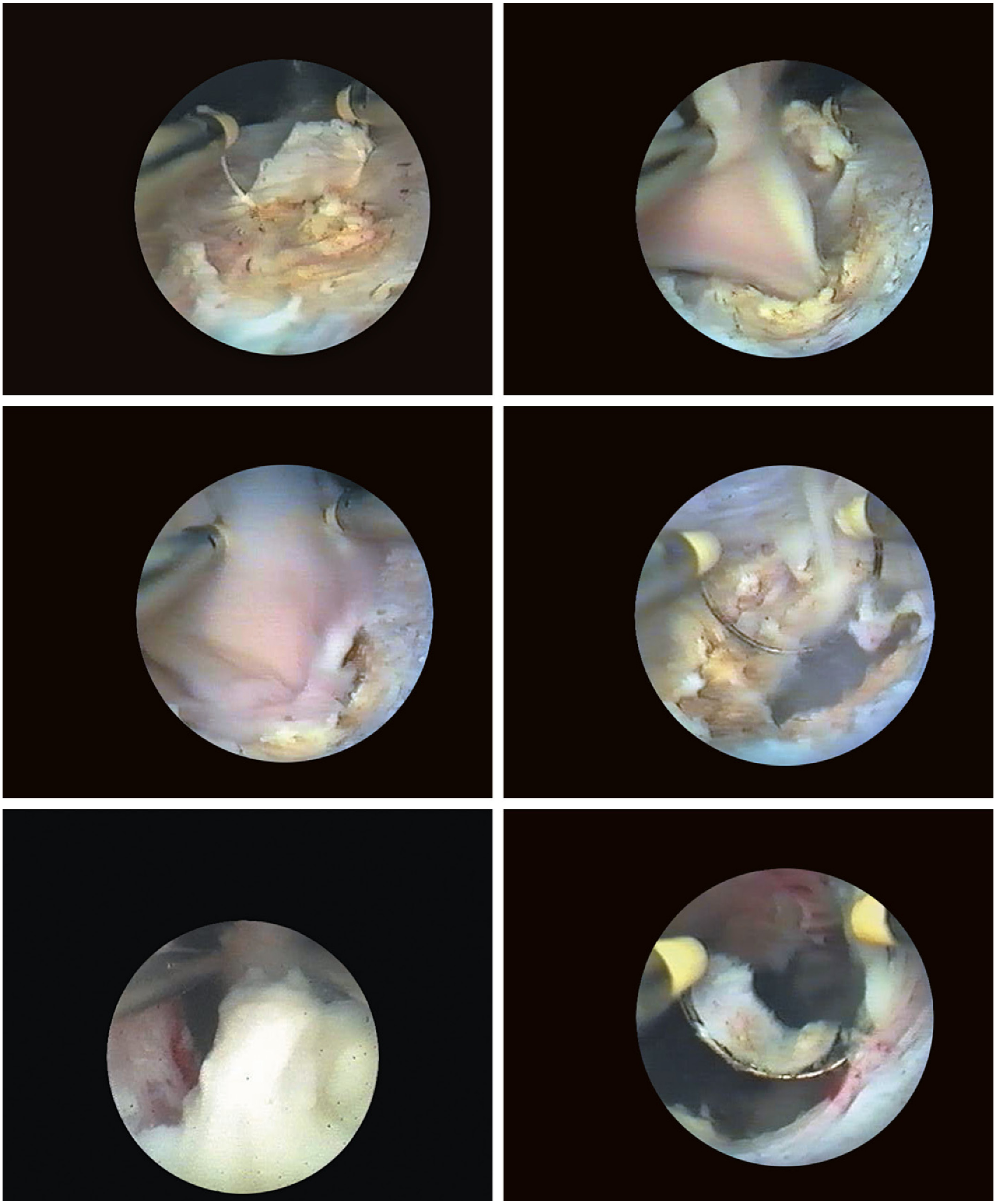

FIGURE 14.8 **Transurethral drainage of a prostatic abscess.**

- transurethral resection
- endoscopic incision of the prostate

Although similar results have been reported regarding the efficacy and safety of these procedures, many authors recommend minimally invasive procedures, which may be performed under local anesthesia and which may be repeated once or several times when necessary (Bachor et al., 1995).

From a historical point of view, the first option for draining prostatic abscesses was represented by an incision and drainage by perineal approach, a procedure that is presently considered to be too invasive and with a high risk of septic dissemination or persistent perineal fistula. This was followed by a period during which the only accepted treatment was endoscopic resection of the prostate, a procedure that solves the acute episode but also prevents recurrences (Fig. 14.8).

Although transurethral drainage is accepted as an efficient method of treatment (Geavlete et al., 1999), some authors consider this method to be too invasive and to incur high risks for the patient, taking into consideration the anesthetic aspects and the significant possibility of septic dissemination or the high incidence of retrograde ejaculation. Cases in which transurethral resection did not completely evacuate abscesses located in the peripheral region of the prostate have also been reported (Kinahan et al., 1991).

A modern technique not yet validated by clinical evidence is transrectal or perineal puncture of the prostate, guided by computed tomography. The major limitation of this method is the use of ionizing radiation, which is known to have harmful effects on tissues (Menhendiratta et al., 2007).

Drainage of prostatic abscesses by ultrasound-guided transrectal puncture is considered by most authors to be the surgical alternative with the lowest degree of invasiveness. Among the advantages of this technique are a proper visualization of the purulent collection, the possibility of permanently monitoring the therapeutic maneuver, and visualization of the adjacent structures. Other advantages of this technique are the use of an ultrasound instead of ionizing radiation as a minimally necessary technical endowment and the fact that the procedure is performed under local anesthesia, making this technique a viable alternative. On the other hand, this technique is debated due to the impossibility of completely evacuating the abscess (Fig. 14.9) and to the risk of septic dissemination in the rectum (Gan, 2000).

However, transrectal ultrasound has a well-established role in the follow-up of patients with prostatic abscess, regardless of the therapeutic alternative that was chosen, due to its superior possibility of visualizing the prostate and the adjacent tissues.

There are no specific recommendations regarding the types of antibiotics that should be used; the use of quinolones or cephalosporins offers good results in most cases. When the prostatic abscess is suspected to be a septic metastasis from another primary focus, antibiotics specific for this focus should be used.

Regardless of the therapeutic alternative that was chosen, samples should be collected (purulent secretion, urine, blood, prostatic tissue) and specifically analyzed. Identification of the germs involved and the antibiogram are considered to be essential steps in the treatment of prostatic abscesses. Some authors recommend suprapubic cystostomy

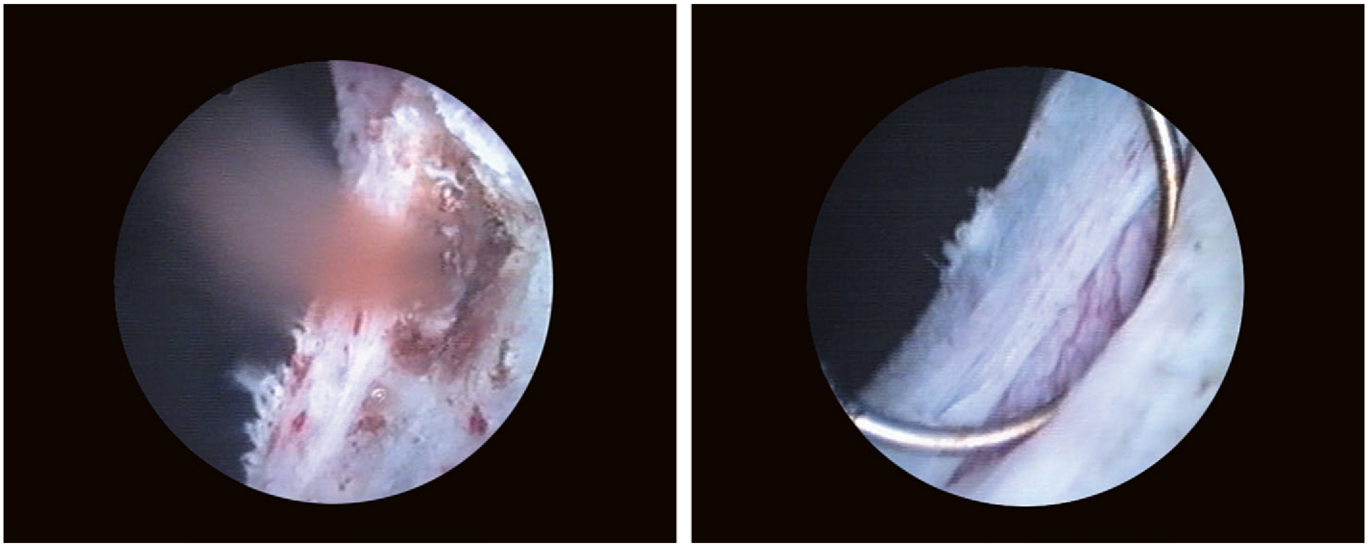

FIGURE 14.9 **Prostatic abscess remaining after ultrasound-guided transrectal drainage.**

as a temporary urinary derivation in the treatment of prostatic abscesses, but there is no data available to demonstrate that this approach can modify the results of therapy.

Prostatic abscesses may evolve toward sepsis and death in the absence of an adequate treatment, and for this reason efficient methods of diagnosis as well as an early initiation of therapy are mandatory. Small abscesses developed in patients with a good immune status may resolve spontaneously, although authors do not recommend a passive, conservative attitude in these cases. Cases have been described where medium-sized abscesses ruptured spontaneously into the urethra, rectum, peritoneum, or at the perineal level. These patients associate a less favorable prognosis, regardless of the direction of abscess evacuation.

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CHAPTER

15

Endoscopic Treatment of Prostatic Lithiasis

Petrişor Geavlete, Gheorghe Niţă, Cristian Persu, Bogdan Geavlete

Prostatic lithiasis represents a common pathological entity but with reduced clinical implications. Prostatic stones are usually identified during other diagnostic or therapeutic procedures and are rarely symptomatic. This is why the literature usually treats this subject superficially.

Prostatic lithiasis occurs only exceptionally in children, is rare before the age of 40, and becomes frequent in male patients over the age of 50. It usually appears as a conglomerate of small stones (Fig. 15.1), but there are cases in which a single large prostatic stone develops (Fig. 15.2). Chronic prostate infections may contribute to their development.

The first description of prostatic stones belongs to Donatus, who made these observations in 1586 during a series of autopsies. Donatus was followed by other anatomists who tried to describe this condition as best as they could. In 1861, Sir Henry Thompson described, for the first time, the corpora amylacea at the level of the prostatic acini, suggesting that these represent the nuclei for the formation of bladder stones. One of the largest series of patients with symptomatic bladder stones was also published at the beginning of the twentieth century – 305 cases, analyzed by Thomas and Robert (Thomas and Robert, 1927; Klimas et al., 1985).

The modern classification of prostatic stones divides them into two large categories, depending on their origin:

- endogenous, developed inside the prostatic acini (Fig. 15.3)
- exogenous, located in the prostatic urethra (Fig. 15.4)

Electronomicroscopic studies have shown the existence of two distinct types of endogenous prostatic stones. The first type is composed mainly of sodium, sulfur, calcium, zinc, and phosphorus, suggesting its origin in the corpora amylacea, which have gone through a mineralization process. The second type of endogenous prostatic stone has a polyhedral structure composed of calcium phosphate under the form of hydroxyapatite crystals. Spectroscopic analysis supports the theory that this type of stone is formed by precipitation of the components found in the prostatic fluid (Vilches et al., 1982). Proteins, cholesterol, and citrate can also appear in the composition of the stones, in a proportion of 20% (Huggins, 1944).

The corpora amylacea have a laminated structure composed of lecithin and epithelial cells. The cells of the prostatic acini, found at the end of their life cycle, pass successively through the phases of atrophy, degeneration, and death. In this moment, the cells will be in suspension in the acinar fluid, which is rich in albumin. DNA and other proteins coming from the cells' nucleus will become nuclei on which the other compounds of the acinar fluid will attach, generating amyloid bodies or corpora amylacea. Thompson's theory supports the existence of an antigen–antibody type reaction, which will lead to the release of calcium and phosphates from the epithelial cells. These ions will subsequently be included into the structure of the growing corpora amylacea (Thomas and Robert, 1927).

Although old, this theory is still accepted today, even though molecular medicine could probably offer a different vision on prostatic lithogenesis. The mechanism through which the calcification processes start has still not been completely elucidated, although there are many hypotheses, from the simple precipitation of salts in the prostatic fluid to mechanisms similar to those involved in osteoid calcification. During urination, a small amount of urine

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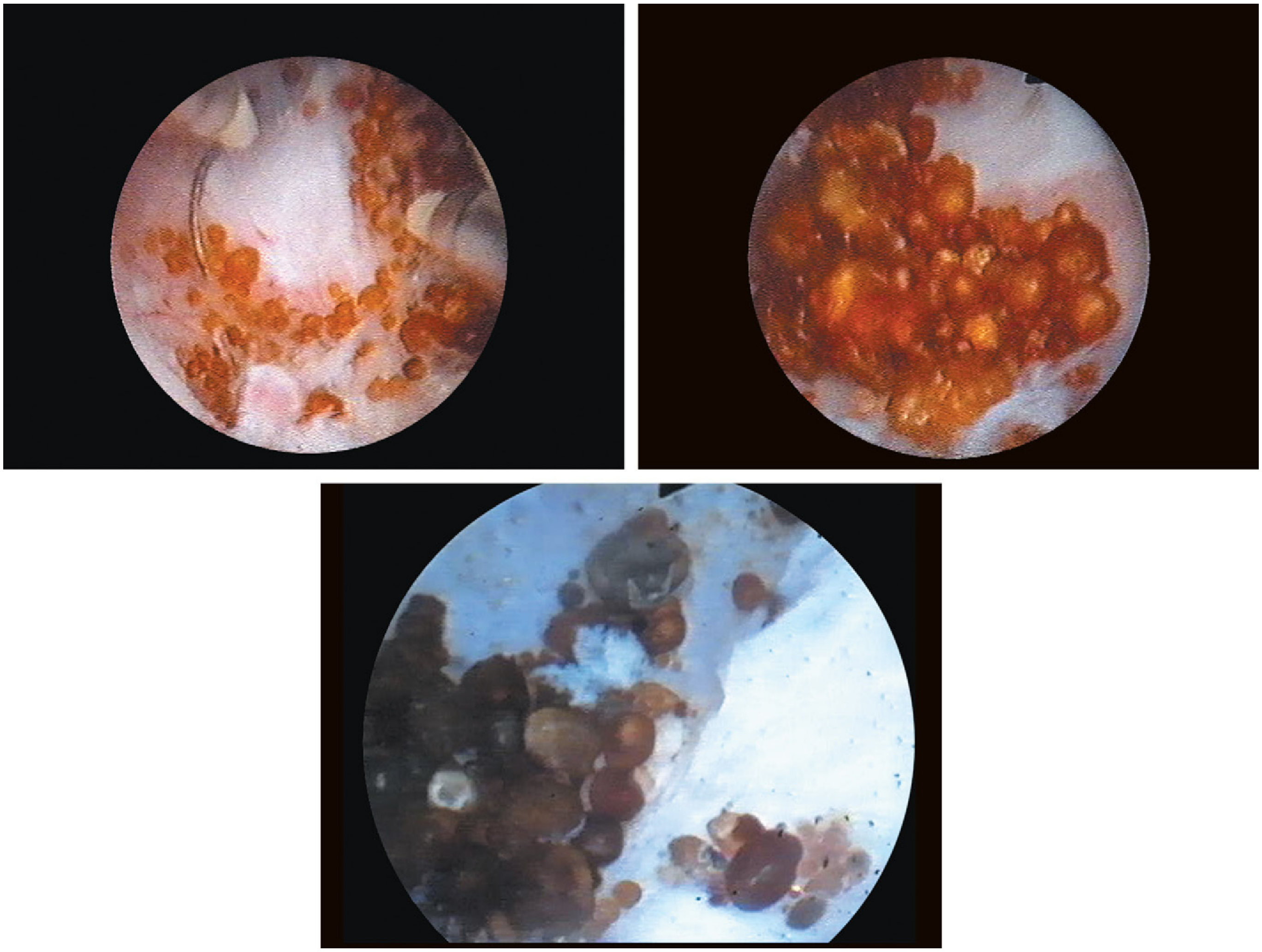

FIGURE 15.1 **Multiple prostatic stones (conglomerates of small stones).**

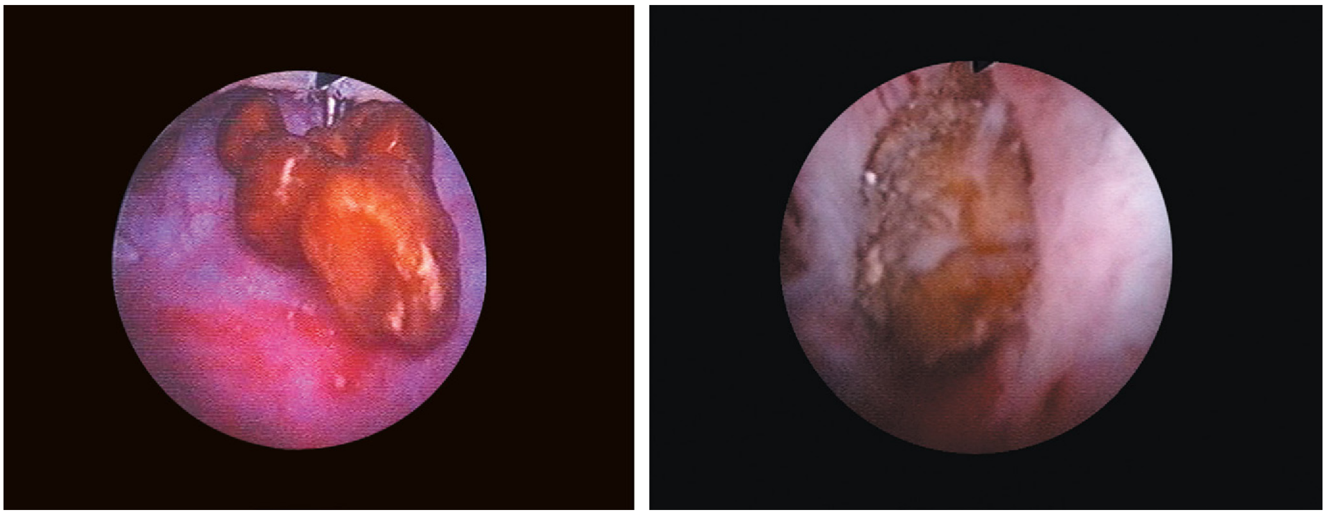

FIGURE 15.2 **Single prostatic lithiasis (large stone).**

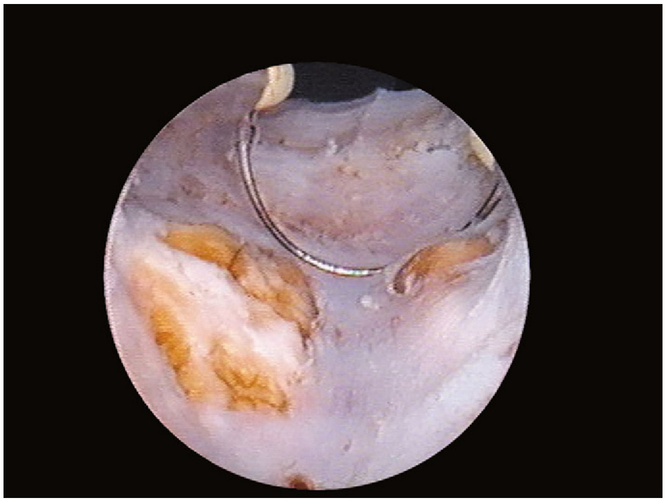

FIGURE 15.3 Endogenous prostatic stones.

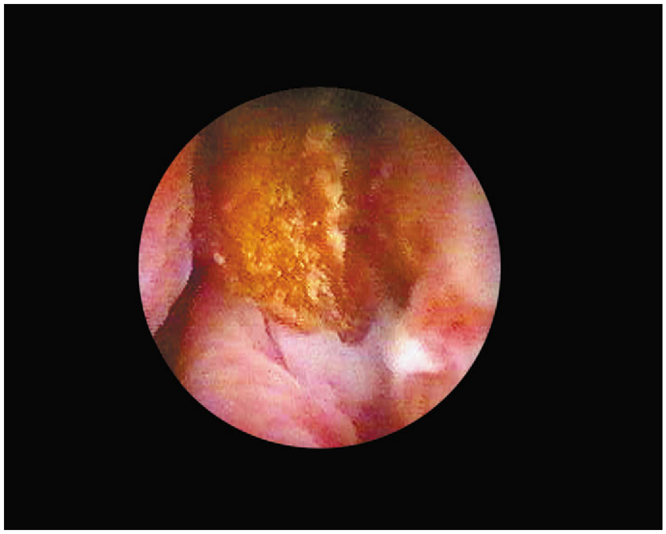

FIGURE 15.4 Exogenous prostatic stones.

reflows into the prostate; some authors consider that precipitation of salts in the urine represents the nucleus on which prostatic stones will form (Gentile, 1947).

Regarding their location, prostatic stones are most frequently found toward the cephalic extremity of the median lobe (Fig. 15.5), followed by stones in the ducts and acini of the prostatic lobes (Fig. 15.6). Intra-acinar stones are visible only by microscopic exam.

The diameter of these stones is variable (they may reach 4–5 cm) while their shape is usually spherical or ovoid (Fig. 15.7). Prostatic stones are not hard and are easily shattered. Their color is most frequently gray-brown.

Prostatic lithiasis is usually discovered during investigations for prostate adenoma, adenocarcinoma, or urethral strictures. Some authors state that any subvesical obstructive syndrome may be considered responsible for the development of prostatic stones, but this theory is not supported by evidence (Leader and Queen, 1958).

The incidences of prostatic lithiasis are not fully known, although there are many case reports in the literature. Prostatic stones are usually discovered by chance following an ultrasound or radiological exam of the prostate

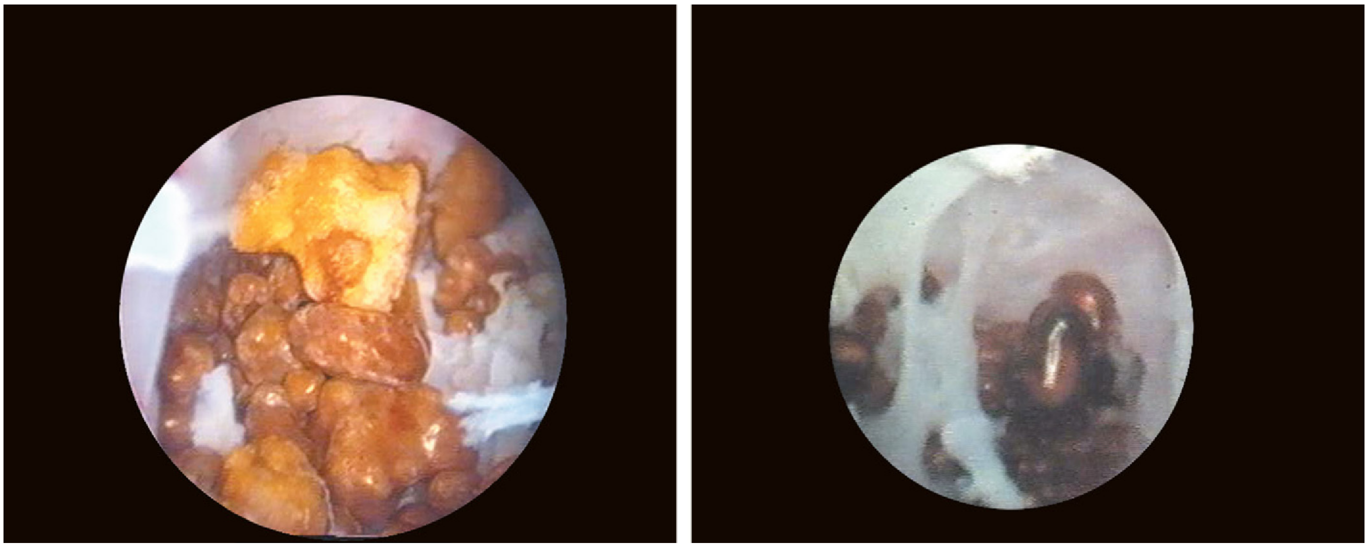

FIGURE 15.5 Prostatic stones located in the median lobe.

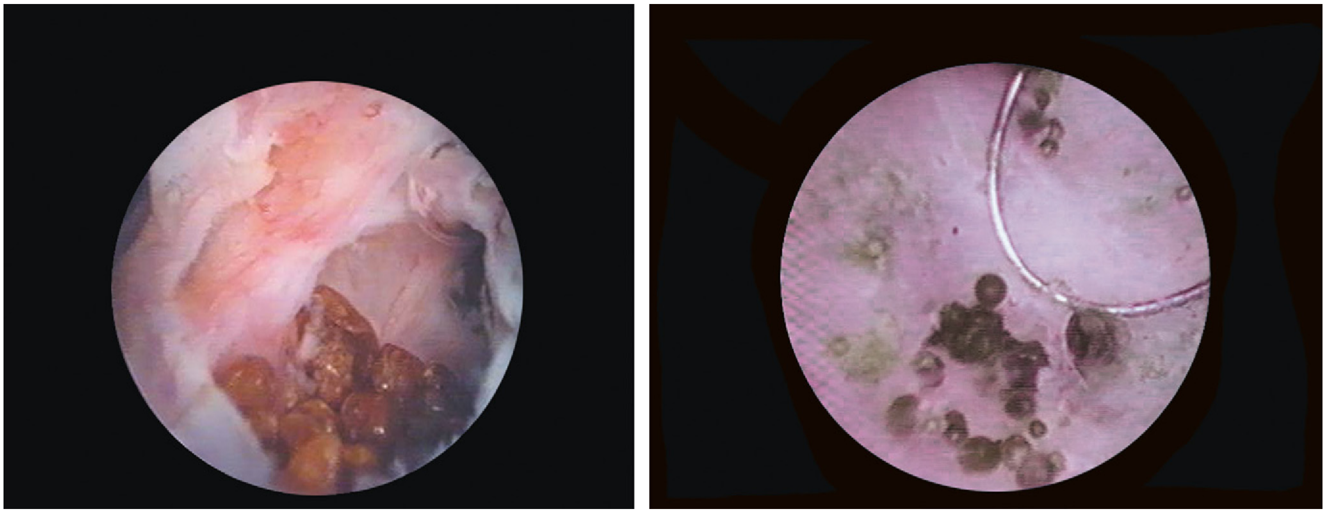

FIGURE 15.6 **Prostatic stones in the lateral prostatic lobes.**

FIGURE 15.7 **Ovoid prostatic stones of variable sizes.**

and are estimated to occur in approximately 5% of men (Fig. 15.8). At the ultrasound exam, they appear as hyperechogenic images with a posterior shadow cone (Resnick et al., 1977). The exact incidence of prostatic stones is not known because the vast majority are asymptomatic, and usually they are not detected even during a rectal exam. However, studies have been published reporting an incidence of prostatic stones of 13.8% in men over the age of 50 (Fox, 1963). Furthermore, in a series of autopsies performed in men over the age of 50, the same author describes prostatic lithiasis in 100% of cases, with differences related more to the number and size of the identified stones.

It is accepted that any pathological status involved in the etiopathogenesis of urinary lithiasis could also be responsible for the development of prostatic stones. The most typical situation is hypercalcemia, which induces hypercalciuria, and which determines the development of both urinary and prostatic lithiasis. This is the only mechanism that can explain the existence of prostatic stones in children (Izzidien, 1980). Alkaptonuria and precipitation of homogentisic acid can be involved in the development of prostatic stones. They can also develop after

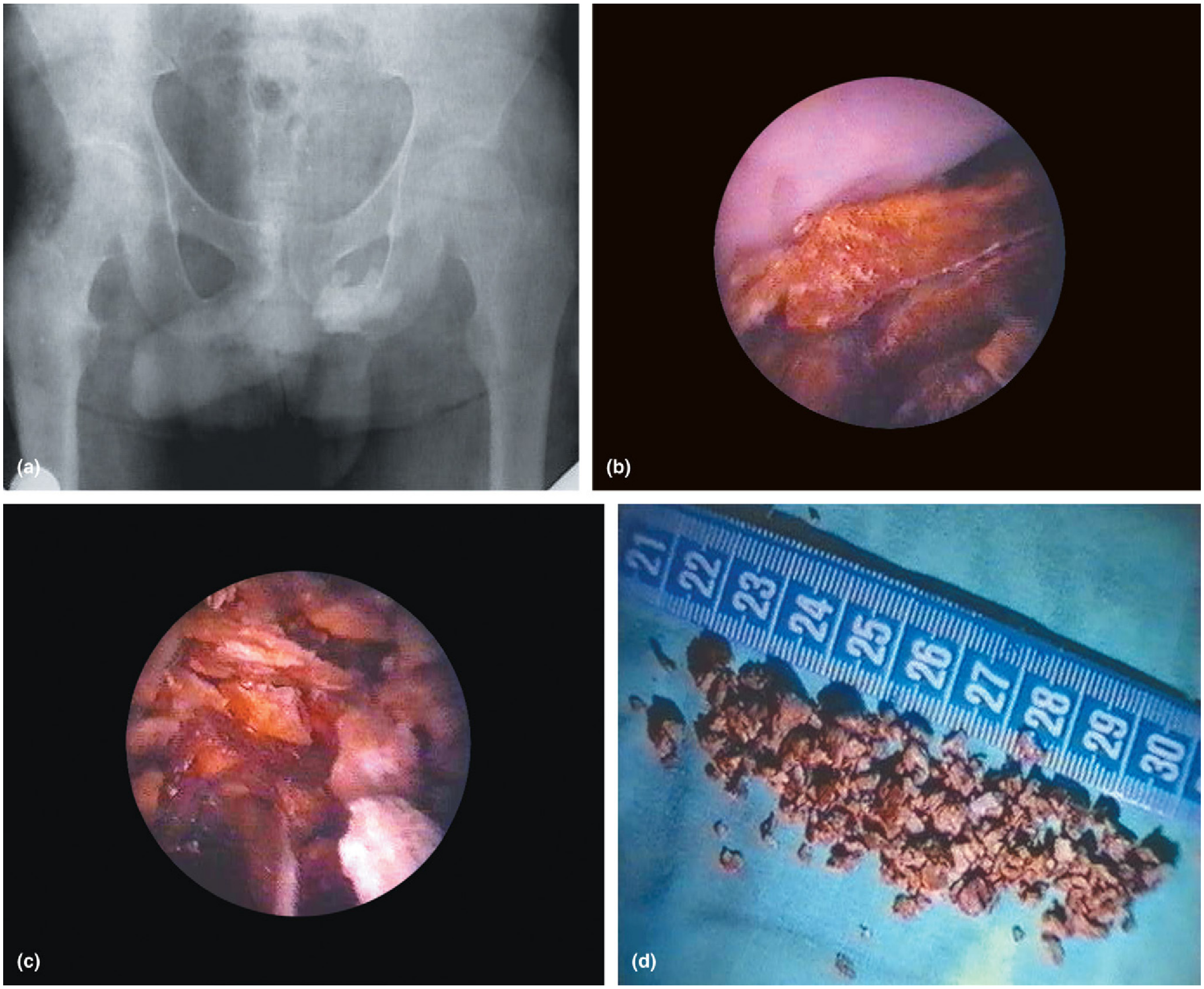

FIGURE 15.8 **Large prostatic lithiasis discovered by chance.** (a) Pelvis radiography; (b, c) intraoperative aspects; and (d) stones extracted at the end of the intervention.

radiotherapy (Jones et al., 1979), prostatic endoscopic surgery (Koh et al., 2002), or positioning of prostatic stents (Chiou et al., 1994).

The diagnosis of prostatic lithiasis can be taken into consideration in any male patient over the age of 40 with lower urinary symptoms. In patients with recurrent infections of the urinary tract, extraction of the stone and its microbiological exam may diagnose the germ responsible for the urinary infection; this suggests the favoring role of prostatic stones in maintaining urinary infections (Eykyn et al., 1974).

Statistical analyses show that over 70% of men with prostatic lithiasis also present an increase of the gland's size, and in 20% of cases the lithiasis can be palpated. However, a link between an occurrence of lithiasis and the increase in the prostate's size has not been proven. It is important to note that a large stone can determine an aspect suggestive for prostate cancer during a rectal exam. When prostatic lithiasis is voluminous, forming a cavity inside the prostate (Fig. 15.9), the clinical exam may show crepitation, more evident toward the base of the gland (Cristol and Emmett, 1944).

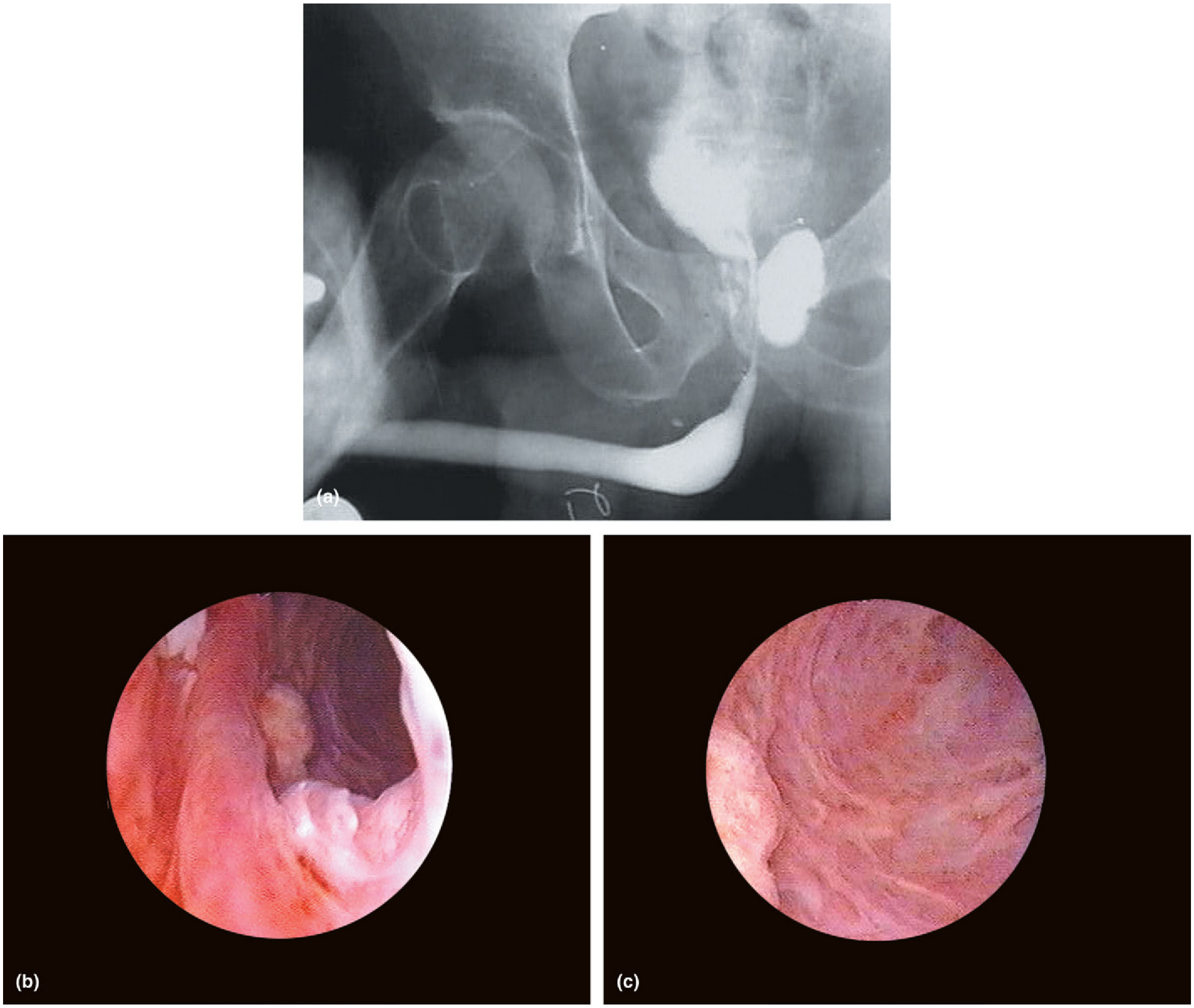

FIGURE 15.9 **Residual prostatic cavity after extracting a voluminous prostatic stone.** (a) Urethrocystographic aspect and (b, c) endoscopic aspect.

A histopathological exam of the prostatic tissue, which comes into contact with calculi, shows an aspect of chronic inflammation with a predominance of lymphocytes and histiocytes. Larger stones are responsible for the dilation of the prostatic ducts and for the disappearance of the epithelial tissue shell of the acini. Sometimes, stones may be included in the nodules of prostate adenoma, although most frequently they are located in the islands of healthy prostatic tissue from between the nodules. In acute inflammatory diseases, the development of polymorphonuclear infiltrate may lead to the appearance of abscesses and periprostatic inflammation.

Prostatic stones are usually asymptomatic and are frequently discovered during endoscopic interventions for prostate adenoma (Fig. 15.10). They are usually located at the limit of the surgical "capsule." Frequently, prostatic calcifications have no clinical significance, but they may be associated with chronic inflammatory conditions of the prostate.

When symptoms occur in patients with prostatic stones, these are frequently secondary to other concomitant diseases, such as prostate adenoma or prostatitis. Symptomatology may include terminal hematuria, hematospermia, perineal discomfort, and ejaculation disorders (Drach, 1975).

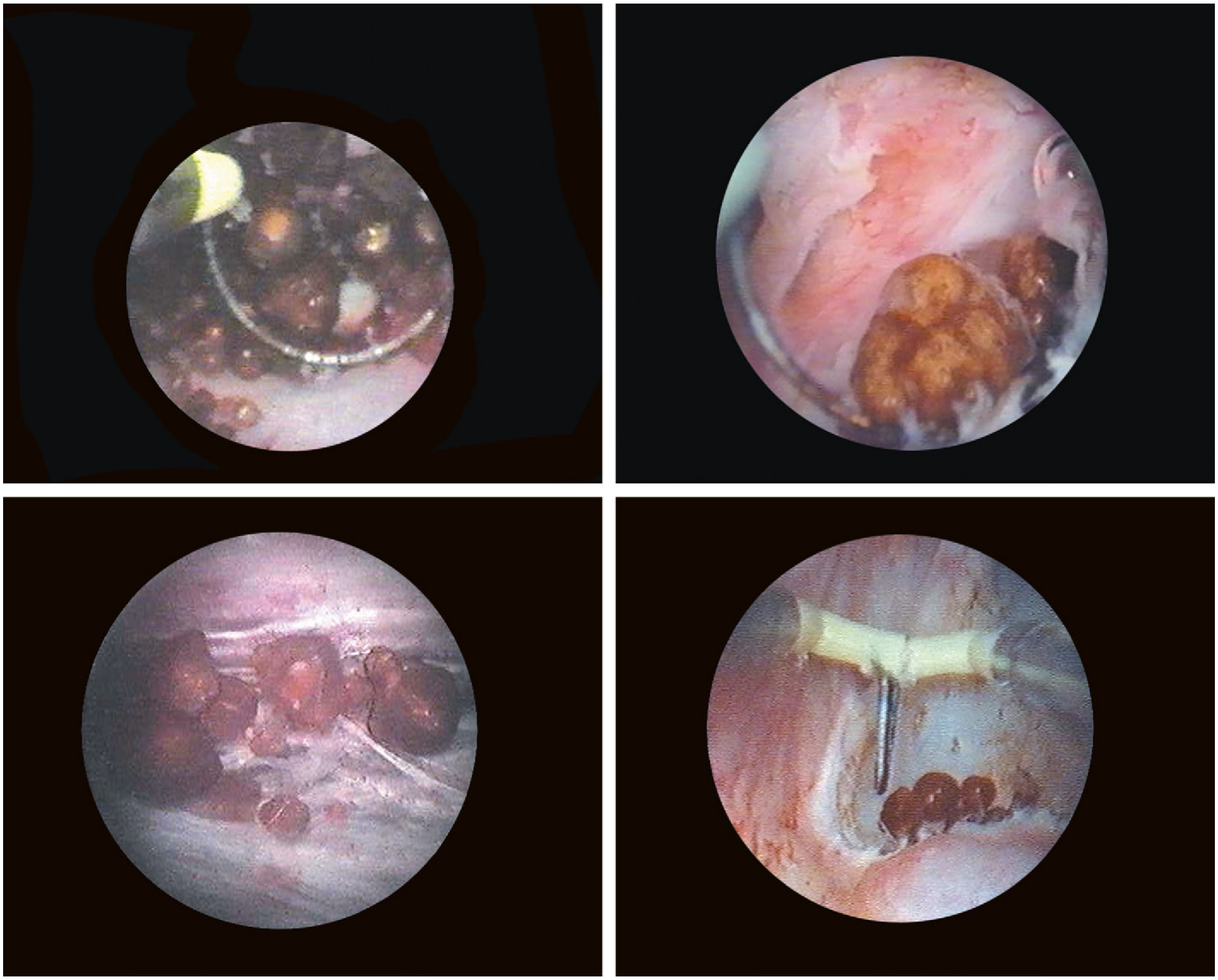

FIGURE 15.10 **Prostatic stones discovered during interventions for prostate adenoma.**

Treatment is not recommended in the case of asymptomatic prostatic lithiasis. If the disease is symptomatic, transurethral endoscopic resection may evacuate the stones (Fig. 15.11). In this case, surgical intervention may lead to the relief of symptoms but does not offer the guarantee that all the stones have been evacuated or that others will not appear. In extremely rare cases in patients with untreatable prostate infections, surgical prostatectomy can be recommended (Drach, 1978). Large stones, or large groups of stones, may require an open, transvesical, or suprapubic surgical approach.

Lithiasis of the seminal vesicles is extremely rare. Stones are usually smooth and tough and may be associated with hematospermia. When multiple stones are present, palpation during the physical exam describes the classical aspect of "bag of nuts." Sometimes, in the case of lithiasis of the seminal vesicles, differential diagnosis with tuberculosis should be performed.

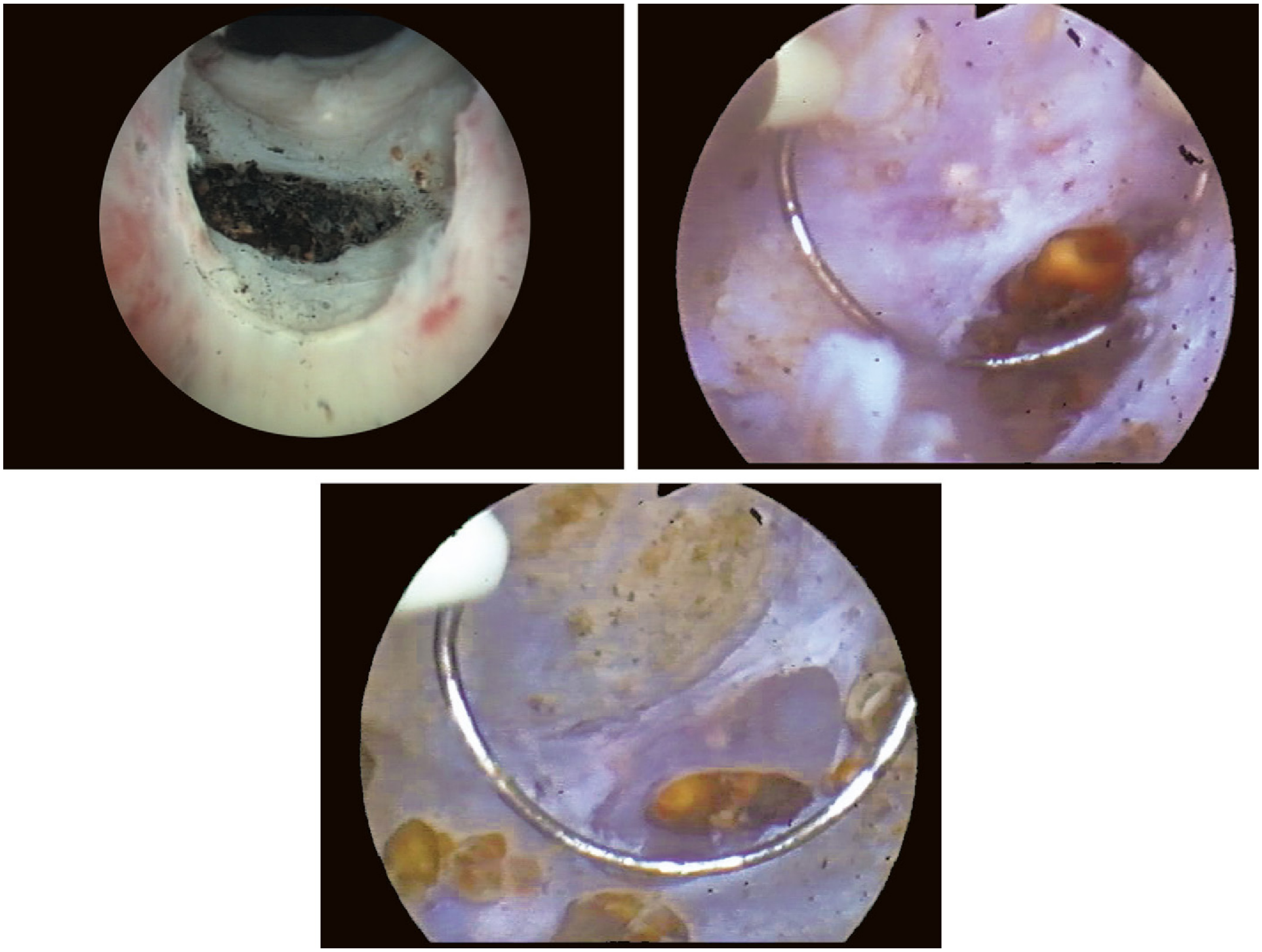

FIGURE 15.11 **Transurethral resection with evacuation of prostatic stones.**

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