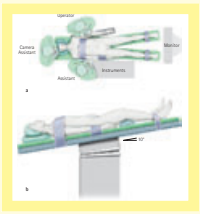
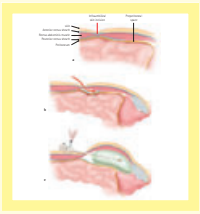
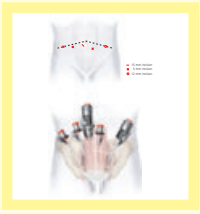
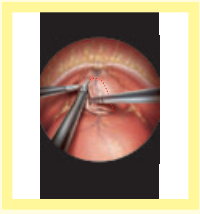
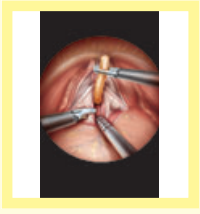
Surgery Illustrated











Surgical Atlas

Nerve-sparing endoscopic extraperitoneal radical prostatectomy

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ILLUSTRATIONS by STEPHAN SPITZER, www.spitzer-illustration.com

INTRODUCTION

Laparoscopic radical prostatectomy (LRPE) was first performed by Schuessler *et al.* in 1992 [1], but it was in 1998 that Guillonneau *et al.* [2] reported an initial series of 28 cases using Gaston's standardized technique based on the primary access to the seminal vesicles. This approach gradually became more widespread and, by 2001, >1200 LRPEs had been reported. The principal advantages of LRPE are that it is minimally invasive, has better visualization of the operative field, an exact and watertight anastomosis, the possibility of early catheter removal, potential reduced blood loss and a shorter hospital stay. However, the transperitoneal approach to an extraperitoneal organ might cause intraperitoneal complications, e.g. bowel injuries, peritonitis, postoperative ileus, peritoneal adhesions, intraperitoneal bleeding or intraperitoneal urine leakage [3].

Raboy *et al.* [4] described the first case report of extraperitoneal RPE (ERPE), and Bollens *et al.* [5] described the first series of cases using this technique. In 2002 we reported our technique and initial experience with the totally endoscopic ERPE (EERPE) [6]. The most important argument in favour of the extraperitoneal technique is mainly the exclusion of intraperitoneal complications. Proven advantages of avoiding peritoneal entry are limiting the risk of ileus and pain after surgery. Furthermore, especially while gaining experience, open conversion to RPE can be done in the familiar environment of the retropubic space.

In 2003 we described our initial experience with 70 EERPE by an entirely extraperitoneal retropubic approach for RPE [7]. Since then we have continuously sought to improve the technique, and it has been standardized as a first-line therapy for localized prostate cancer [8]. With increasing experience in EERPE, we were able to develop a nerve-sparing approach (nsEERPE) which we applied routinely in selected patients [9]. In addition, a puboprostatic ligament sparing technique was developed, enhancing early continence after surgery, without hindering the final oncological outcome of the procedure [10]. Currently our experience is based on a series of 1900 patients who have had minimally invasive RPE using this entirely extraperitoneal retropubic approach.

Increasingly many technical modifications were proposed to improve clinical outcomes and minimize perioperative complications. To aid this, a detailed understanding of the anatomy of bladder neck and urethra

is mandatory [11]. Correct handling of puboprostatic ligaments, external urethra sphincter, prostatic fasciae and neurovascular bundle (NVB) diminishes the disturbance to urogenital function after RPE. Based on our anatomical studies we were able to develop an intrafascial nsEERPE as another technical modification. During the intrafascial technique, the magnification of the laparoscope allows a dissection plane to be located on the prostatic capsule, freeing laterally the prostate from its thin surrounding fascia, which contains small vessels and nerves [12]. The technique enables preservation of intact puboprostatic ligaments, endopelvic fascia, periprostatic fascia and NVBs.

PLANNING AND PREPARATION

The indications for EERPE do not differ from those of open retropubic RPE; the two main indications for treatment are clinically localized prostate cancer (T1 and T2) and a life-expectancy of ≥10 years. Technically, EERPE is feasible in clinical T3 cancer but requires greater surgical experience. Beginners should also avoid salvage RPE after brachytherapy, external beam radiotherapy or after high-intensity focused ultrasound.

There are no specific selection criteria or special contraindications for EERPE. Previous abdominal surgery does not compromise the overall operative duration or complication rates [13]. Mesh placement from previous totally extraperitoneal hernioplasty or transabdominal preperitoneal hernioplasty has been previously considered a hazardous field for LRPE [14]. Nevertheless, although technically demanding, it is feasible and safe to perform EERPE, by adapting port placement and surgical technique [15].

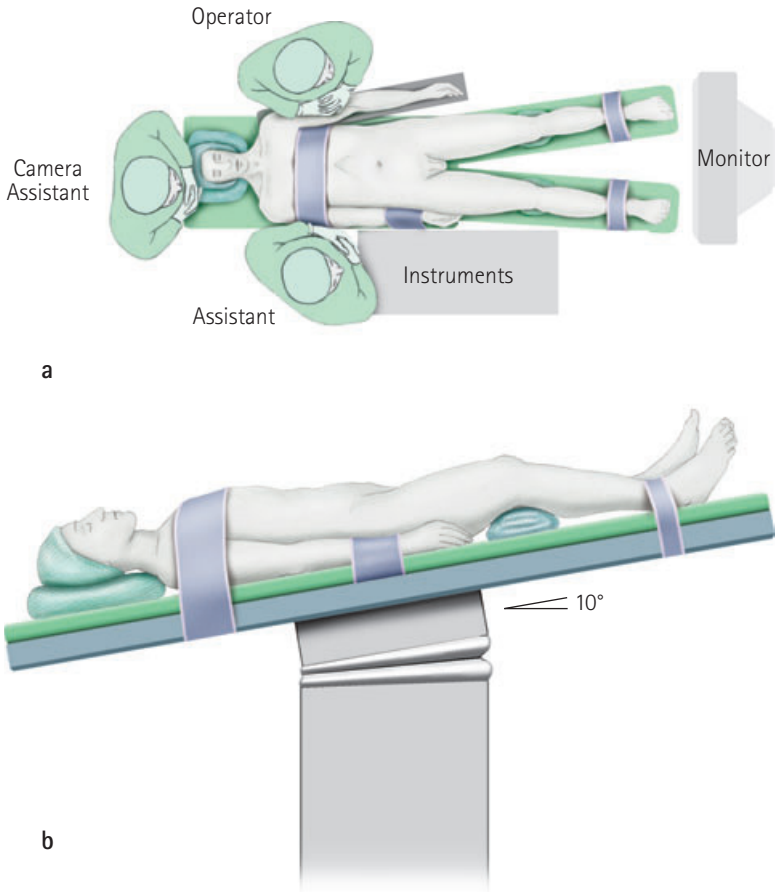
PATIENT PREPARATION

We administer an enema on the evening before surgery and one early in the morning of the day of surgery; no further bowel preparation is necessary. The risk of requiring a blood transfusion in our series is <1%, and therefore patients are not advised to donate autologous blood. Broad-spectrum antibiotics are administered peri-operatively.

SURGICAL STEPS OF INTRAFASCIAL nsEERPE

Figure 1

EERPE is usually done with the patient under general anaesthesia [16]; the patient is placed supine with the legs slightly apart. The laparoscopic tower is placed at the bottom of the operating table and the patient in a Trendelenburg position with a 10° head-down tilt. Both arms must be well protected, positioned on the body of the patient. The surgeon stands to the left of the patient with an assistant opposite. The camera-holder stands behind the head of the patient. The patient is secured to the operating table with a chest belt. In addition, both legs are draped securely to the table, minimizing the possibility of the patient's dislocation during the procedure. The left arm is accessible by the anaesthesiologist and the i.v. cannulae are inserted there, while the right arm is draped adherent to the patient's body. A Foley catheter is inserted under sterile conditions.



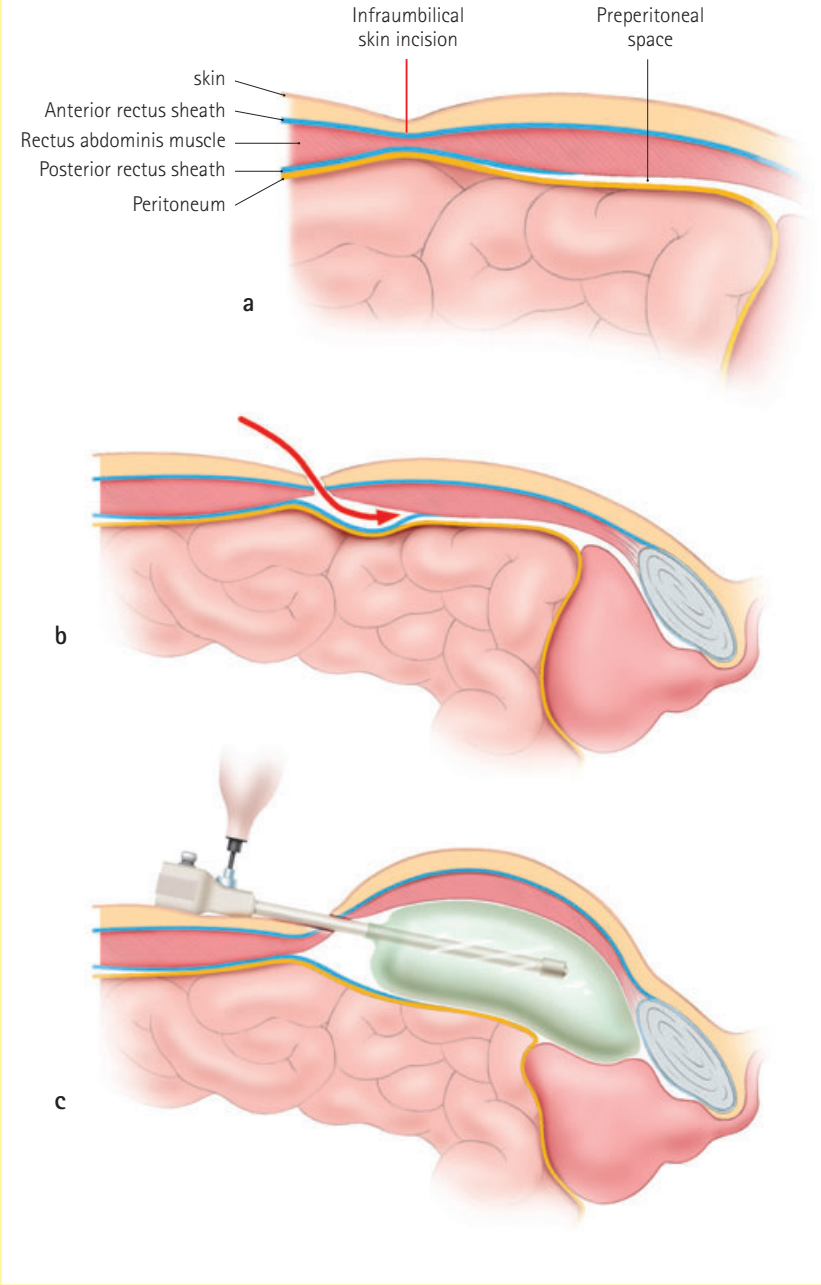


Figure 2

A 15-mm incision is made in the infra-umbilical crease laterally to the midline and carried down to the anterior rectus fascia. The anterior rectus fascia is horizontally incised exposing the rectus muscle. The rectus muscle fibres are vertically separated by blunt dissection, exposing the posterior rectus fascia. The space between the rectus muscle and the posterior rectus sheath is bluntly developed by finger dissection in the direction of the pre-peritoneal space (Fig. 2b). The posterior rectus sheath is absent inferior to the arcuate line (level of superior iliac spine). The pre-peritoneal space is formed mainly by loose areolar tissue and a variable amount of fat crossed by a few small vessels. It lacks tensile strength, thus allowing easy insufflation. A balloon trocar with a 10-mm optical channel is inserted into the pre-peritoneal space tangentially to the cutaneous plane towards the pubis. A 0° optical system is inserted into the balloon trocar. The balloon is slowly inflated with air under direct vision to ascertain the right plane in which the balloon is inflated (Fig. 2c). As a landmark, the inferior epigastric vessels can be identified ventrally. Once the pre-peritoneal space has been created, the balloon trocar is deflated and removed. Stay sutures of polyglactin 2/0 are placed in the anterior rectus fascia and the Hassan-type optical trocar is placed just beneath the rectus muscle and anterior to the peritoneum. The 0° optical system combined with a video system is placed in this trocar and used during the whole procedure. High-flow carbon dioxide insufflation is started up to 12 mmHg and is maintained at this pressure throughout the procedure.

Figure 3

Trocar no. 2 (5 mm) is placed 4 cm left and lateral to the midline, a third of the distance from the umbilicus to the pubic symphysis (3–4 cm below the umbilicus). All subsequent trocars are placed in a hypothetical line between the umbilicus and the anterior superior iliac spine as shown in Fig. 3. Two 5-mm trocars are placed on the right side of the abdomen; trocar no. 3 at 4 cm medially to the right superior iliac spine, and trocar no. 4 in the right pararectal line. The fourth trocar position has to be varied medially or laterally to avoid epigastric vessel injury. Another way to reduce the risk of injury is to use a Versastep trocar (Tyco Healthcare, Gosport, UK).

Operating bimanually through trocars 3 and 4, the dissection is continued to the left pre-peritoneal space. Follow the pubic arch from right to left and then identify the iliac vessels and spermatic cord. Dissect underneath the epigastric vessels. Trocar 5 (12 mm) is placed ≈ 6 cm medial to the left anterior superior iliac spine. This trocar should not be placed too distally or too close to the iliac spine, because this can cause problems during apical dissection and anastomosis. The position of all trocars is summarized in Fig. 3b). In extremely obese or very tall patients, all trocars should be placed 1–3 cm caudally for optimal access to the retropubic space.

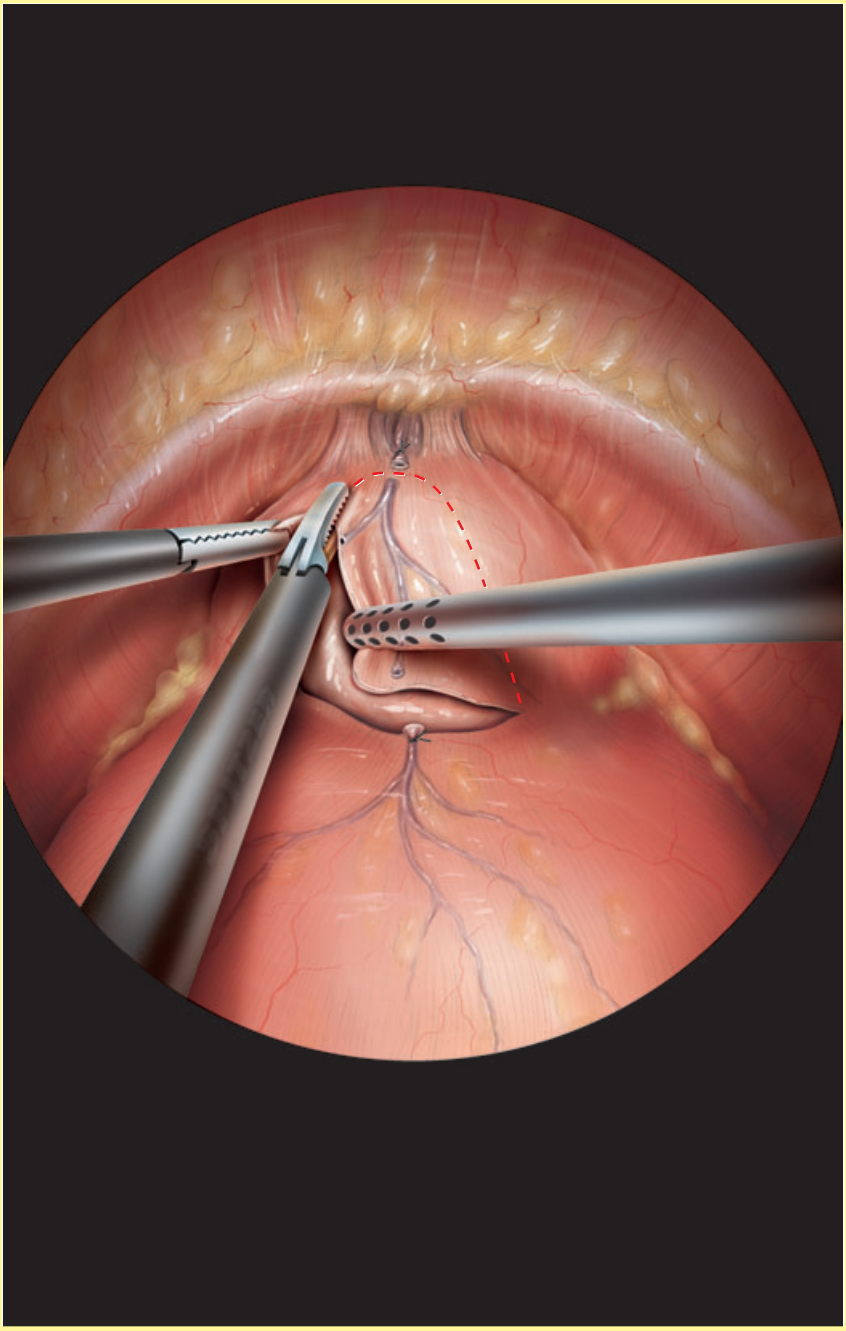


Figure 4

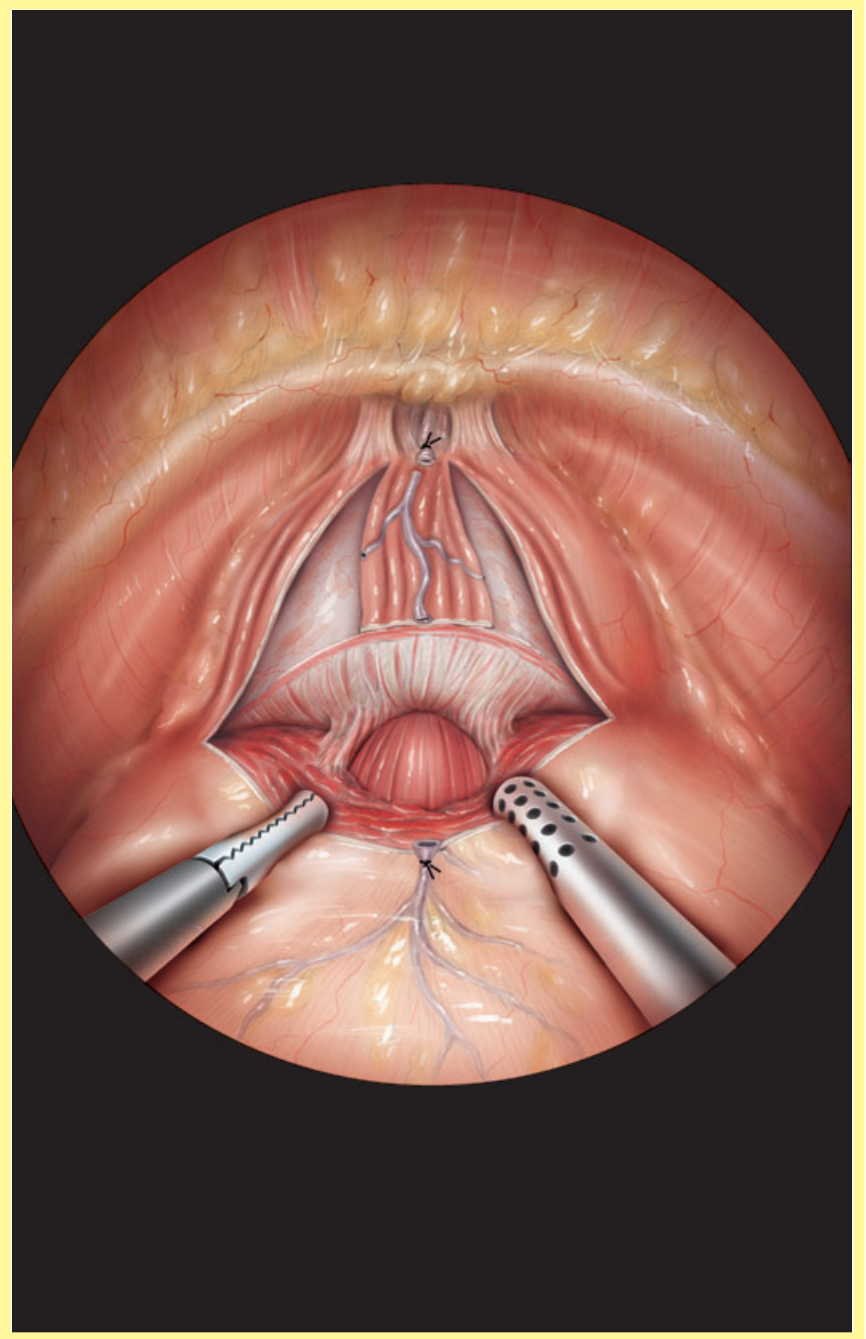
The anterior surface of the bladder neck and prostate and the endopelvic fascia are exposed and the fatty tissue overlying these structures is gently swept away. The superficial branch of the deep dorsal vein complex is fulgurated with bipolar forceps and divided. The endopelvic fascia is not incised and Santorini's plexus is not ligated at the beginning of the procedure.

Starting from the bladder neck, make a bilateral sharp incision of the superficial fascia overlaying the prostate distally toward the apex medial to the puboprostatic ligaments. A plane is developed between the prostate and its thin overlaying fascia (periprostatic fascia). The main goal is to develop the right plane and finally detach the prostate from its 'envelope' leaving intact the puboprostatic ligaments, the periprostatic fascia, and the endopelvic fascia as a continuous structure. The development of the plane is easier towards the apex (descending fashion) and continued in an ascending fashion towards the bladder neck.

Figure 5

The bladder neck is dissected gradually, aiming to define the longitudinal musculature of the bladder neck, using blunt and sharp dissection. A transverse incision is made from the 10 to 2 o'clock position with the SonoSurg device (Olympus KeyMed, Essex, UK). This superficial incision is enlarged and deepened from the 10 to 2 o'clock position to identify the longitudinal musculature of the bladder neck; this is only evident surrounding the urethra at the bladder neck. Once the longitudinal musculature of the bladder neck has been fully defined, the catheter is evident within the urethra.

When cutting the bladder neck, the assistant and the operator have to push the bladder dorsally. It is completely incised and the catheter becomes visible. The balloon-catheter is then pulled up into the retropubic space by the assistant, under continuous tension. The bladder neck dissection is now continued in the lateral direction, in the plane between bladder neck and prostate, taking care not to involve the lateral tissue attachments of the prostate and bladder.



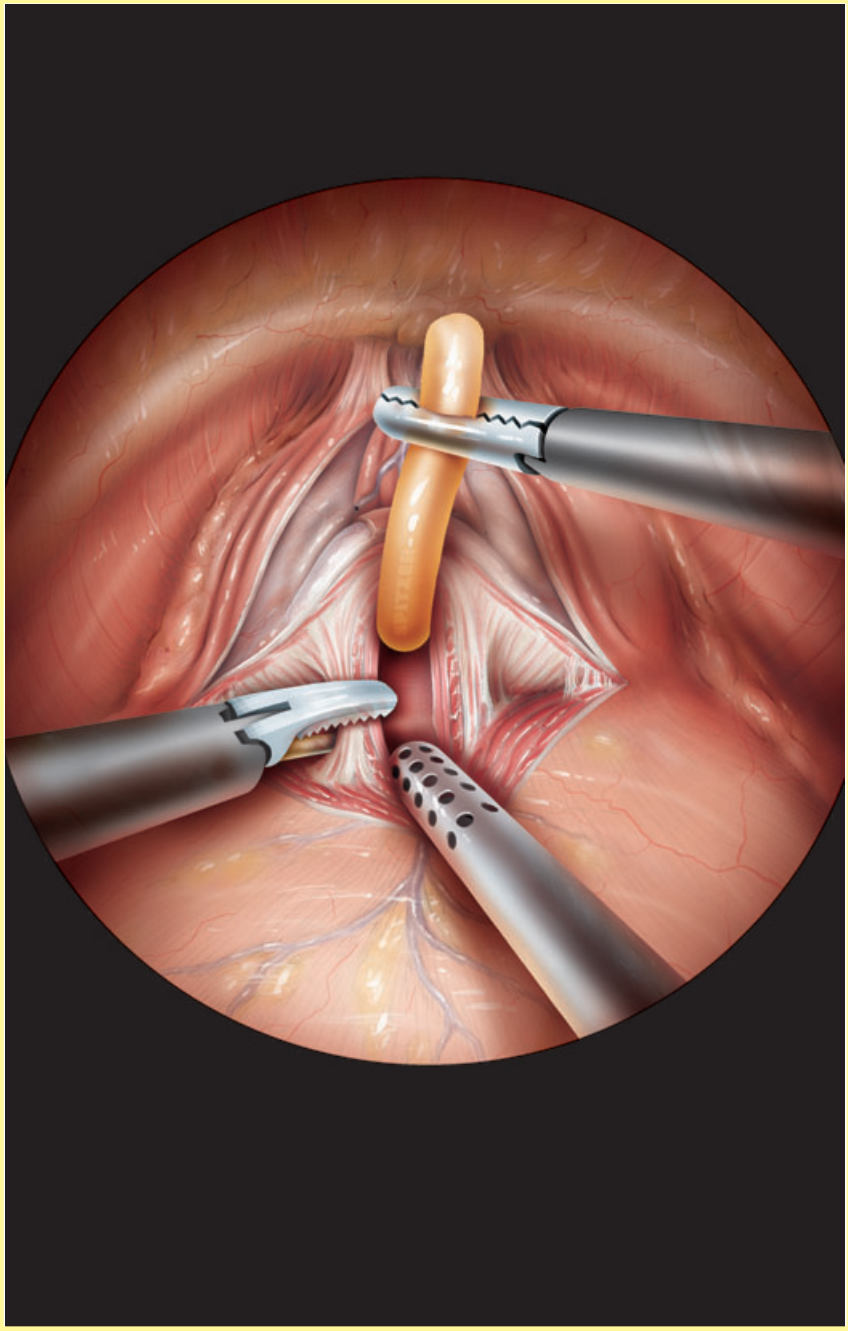
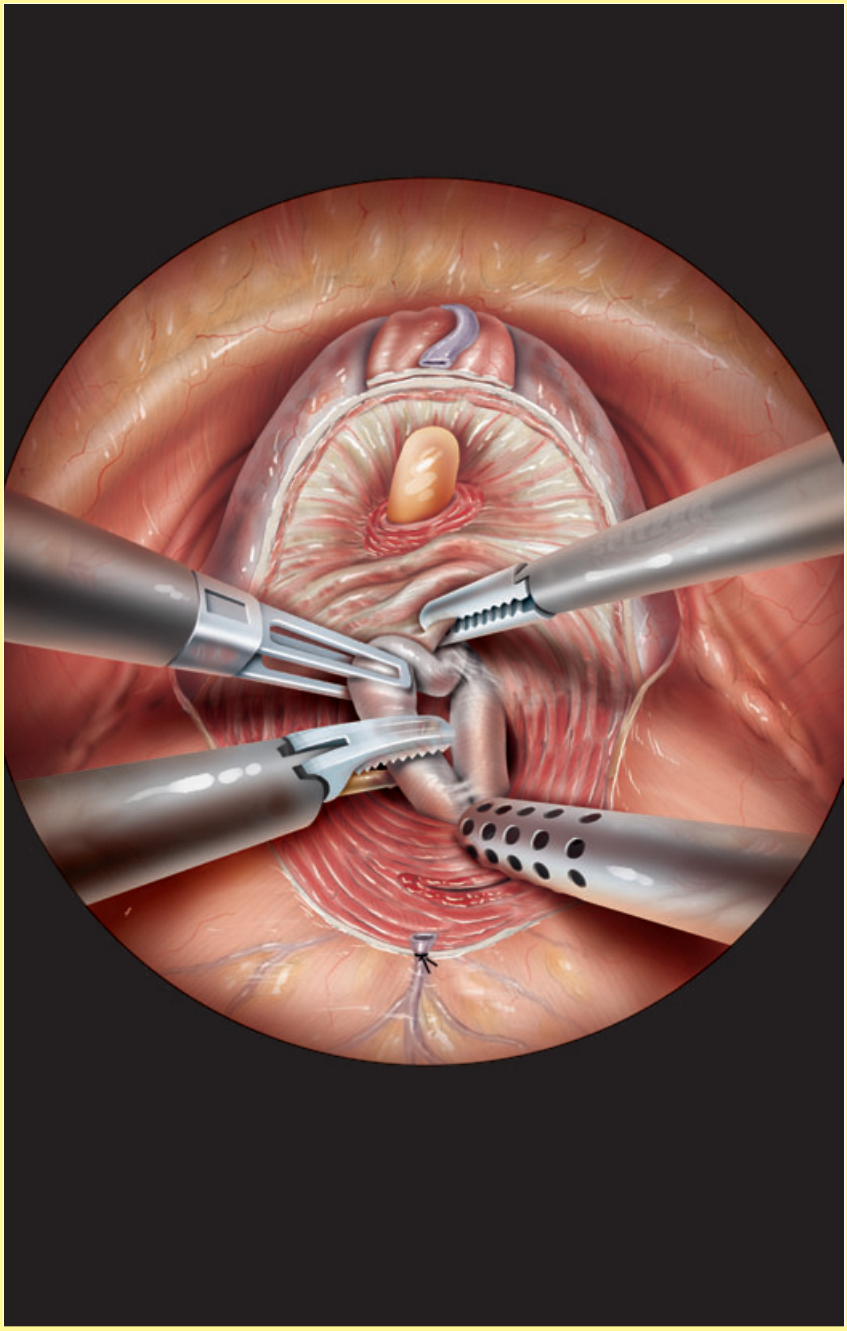


Figure 6

Before starting the posterior bladder neck dissection, make sure that the natural groove between the bladder mucosa and prostate in the dorsal direction can be identified. The posterior bladder neck is transected using the SonoSurg. The dissection needs to follow a perpendicular plane to obtain access to the vas and seminal vesicles. It is important to avoid oblique dissection because the dissection might intrude within the prostate. The posterior bladder neck is first completely divided between the 5 and 7 o'clock position (Fig. 6). Note the restricted space (window) due to the lateral attachments (fasciae, nerves and vessels); this space is then bluntly enlarged by the surgeon, and usually with no problem. If this dissection is not feasible, re-assess whether it is possible that the wrong plane of dissection has been chosen. The assistant should release the catheter tip, grasp the posterior part of the prostate and pull it under tension cranially. Then the surgeon must go back to midline and visualize the bladder neck and start the dissection again.

Figure 7

After complete dissection of the posterior bladder neck, the anatomical landmarks of the ampullary segments of the vas become visible. The next step of the procedure is the dissection of the left vas. Once the left vas is dissected, the assistant grasps and pulls it contralaterally towards the pubic bone. The lateral superficial attachments to the bladder are dissected. The same manoeuvre is used on the contralateral side.



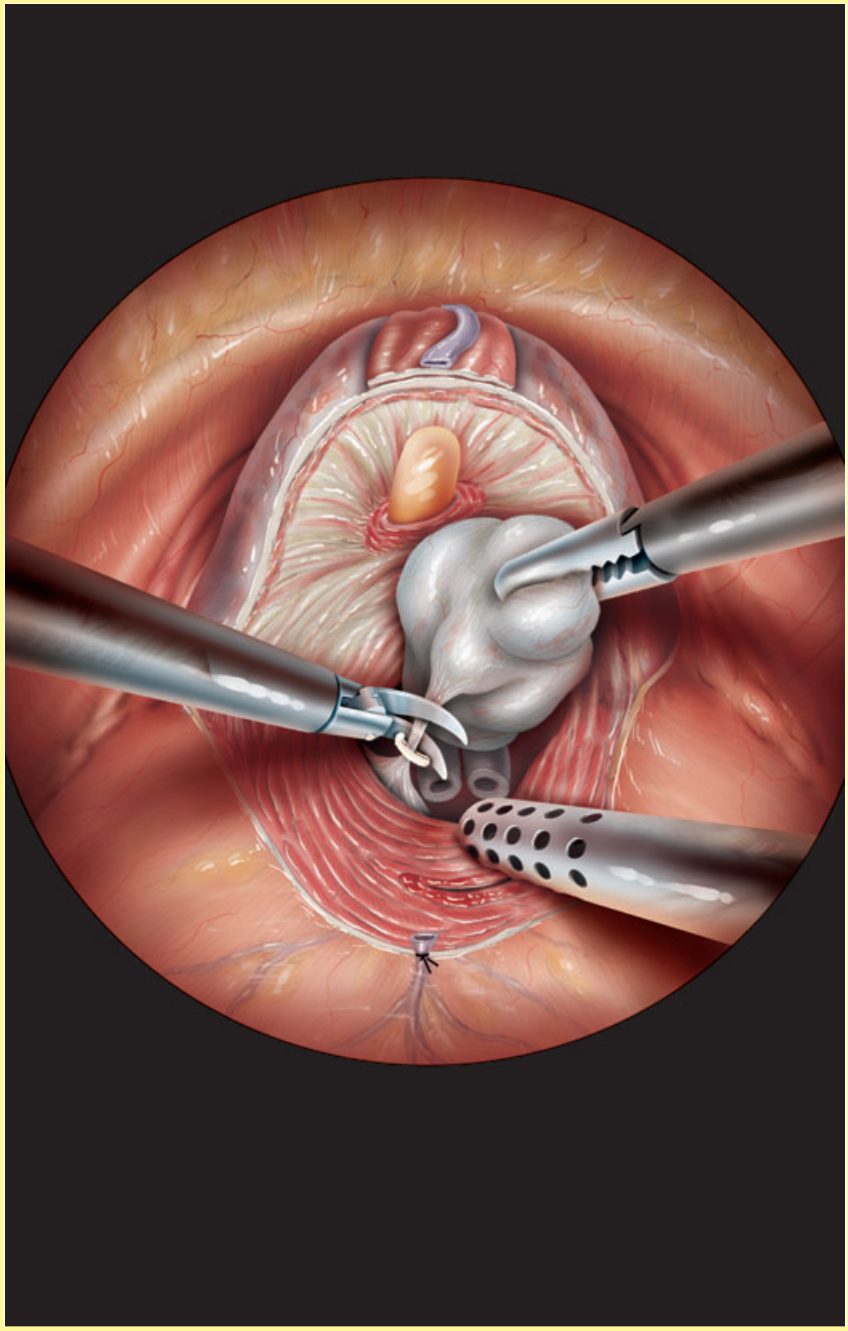


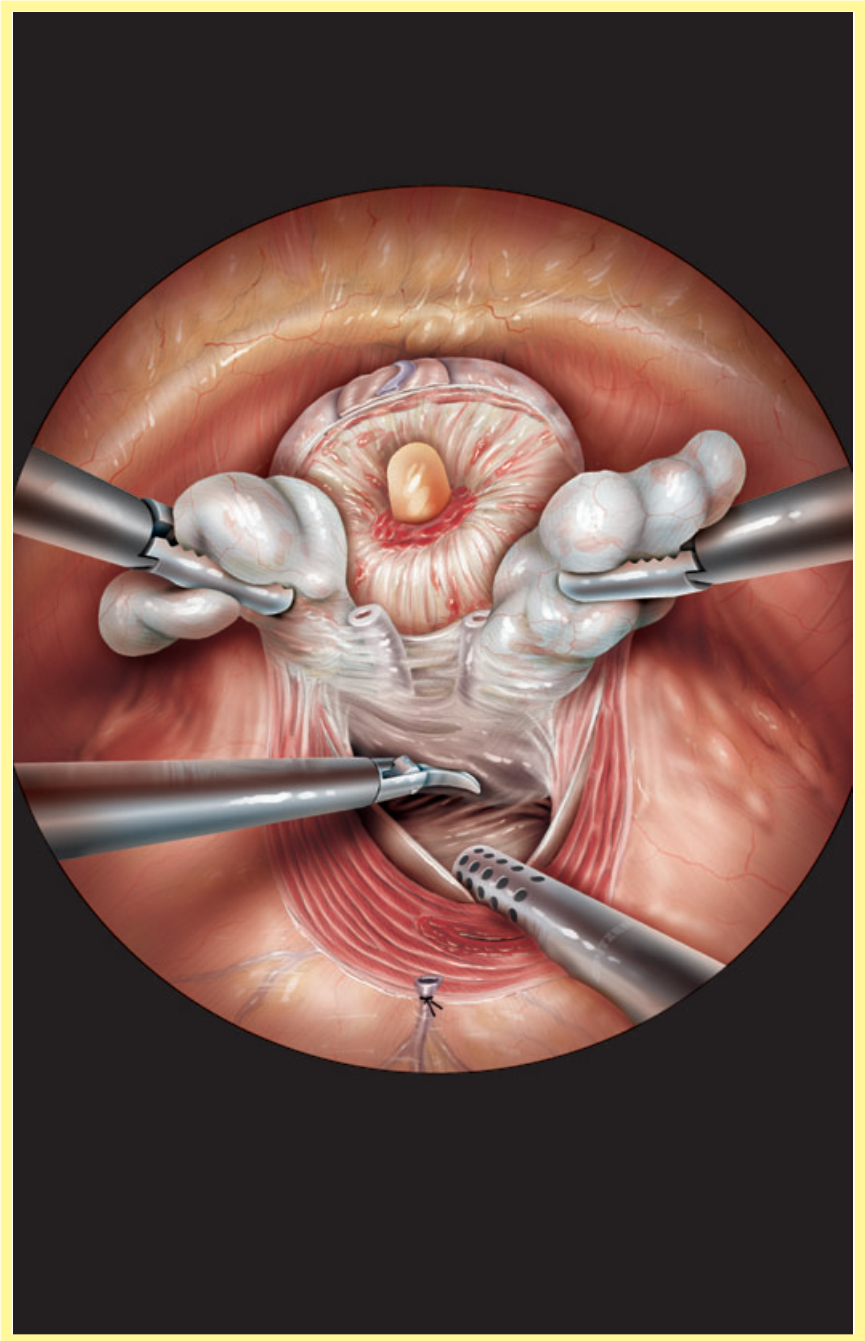
Figure 8

The seminal vesicles can be identified in a slightly lateral and caudal direction. The magnification of the laparoscope helps to reveal the arteries supplying the seminal vesicles. Care is taken when dissecting near the seminal vesicles to avoid injuring the NVBs that are situated just lateral to the seminal vesicles. Blunt and sharp dissection, avoiding the use of electrocautery, is recommended, especially during dissection of the tip of the seminal vesicles. We recommend the use of clips. Both seminal vesicles are completely freed.

Figure 9

After completing the seminal vesicle dissection, the posterior layer of Denonvilliers' fascia is visible. Both the surgeon and the assistant retract the seminal vesicles in a craniolateral direction, exposing the posterior layer of Denonvilliers' fascia. We do not incise the fascia in intrafascial nsEERPE. The desired plane of dissection is between Denonvilliers' fascia and the prostatic capsule.

The appropriate plane is found by blunt dissection and by stripping down Denonvilliers' fascia from the prostatic capsule (most cases). When such dissection is not possible, a small incision can be made to facilitate the process. For further dissection towards the apex, return to the posterior capsular surface of the prostate. The blunt dissection is continued as far as possible towards the apex of the prostate, strictly in the midline, to avoid injury to the NVBs. Denonvilliers' fascia and all adhesive tissue are completely mobilised in the lateral direction, to gain medial access to the prostatic pedicle and NVBs. The rectum is continuously pushed down by the assistant.



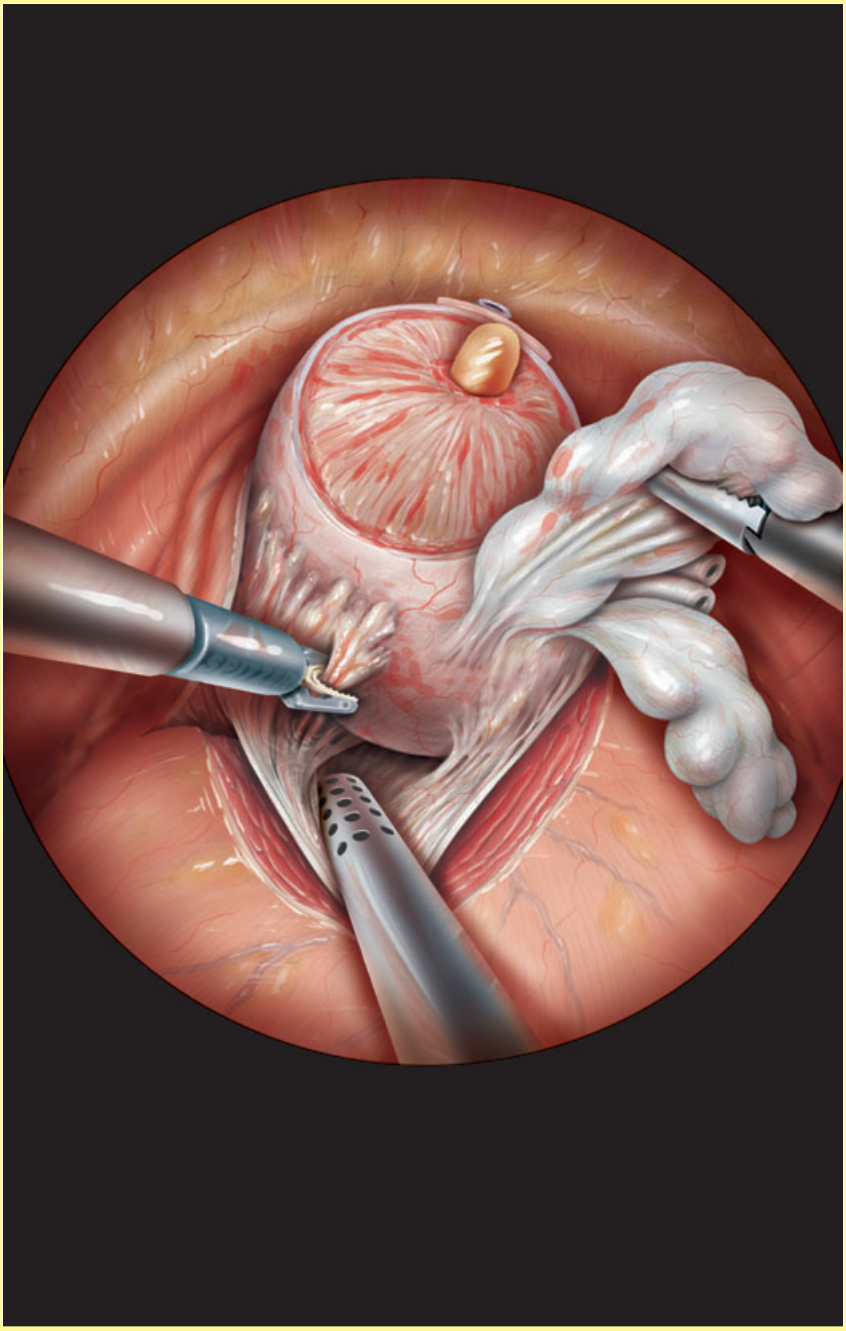


Figure 10

The mobilization of the periprostatic fascia from the prostatic capsule is continued, by blunt and sharp dissection, to obtain lateral access to the prostatic pedicles and the NVB. For this step, the prostate must be pushed laterally by the assistant. The prostate is now free from its surrounding fasciae and is anchored by the pedicles and the apex. Traction on the left seminal vesicle is made contralaterally by pulling it out of the pelvis. The left prostatic pedicle is clearly visible, and is clipped and divided very close to the surface of the prostate.

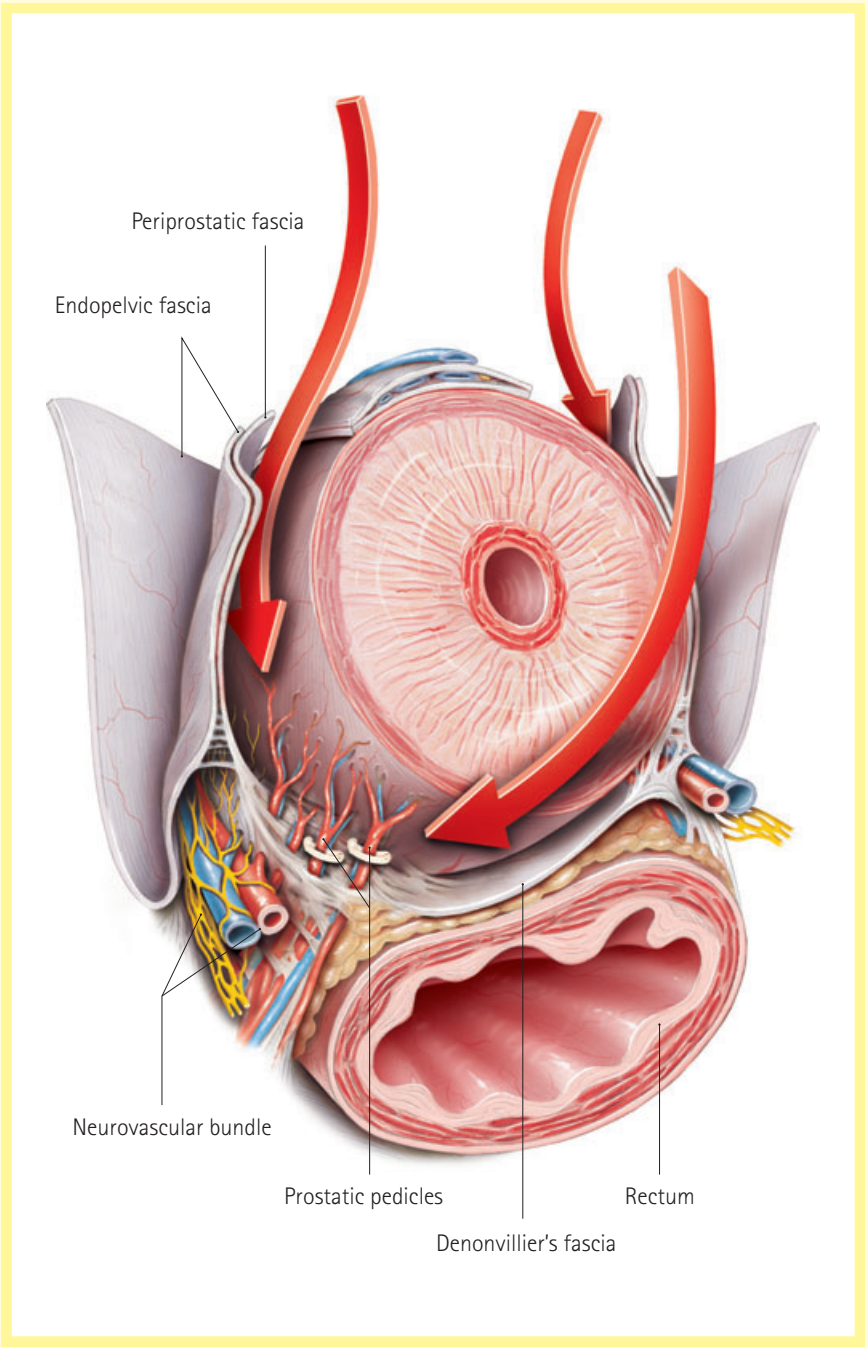
The prostatic pedicle must be clipped and cut step by step; it is not possible to include the entire pedicle within one clip. Care must be taken to avoid inadvertent injury to the NVB. It is advisable to proceed with clipping and cutting in small steps. When the left-side dissection is completed, the same process is repeated on the right side. The surgeon uses the scissors with the right hand and the grasper with the left.

When the main prostatic pedicle has been fully dissected, the remaining NVB and periprostatic fascia can be detached from the prostatic capsule, in most cases bluntly. Electrocautery (bipolar forceps) to control the vessels should be avoided. The SonoSurg device is only used for blunt dissection, to avoid damage to the nerve structures. The posterior aspect of the apex can be seen when the blunt dissection is completed.

Figure 11

Very often the terms extrafascial, interfascial and intrafascial are used to describe different dissection techniques, without clarifying the anatomical structures behind these terms. During non-nerve-sparing RPE the endopelvic fascia is incised laterally close to the levator ani allowing the 'wide excision' of the prostate, including its surrounding fasciae and the NVBs. During the intrafascial nsEERPE we incise the endopelvic fascia only ventrally, medial to the puboprostatic ligaments. Then we dissect on the prostatic capsule, laterally freeing the prostate from its thin surrounding fascia (periprostatic fascia) containing small vessels and nerves, as shown in the diagram. Dorsally, the dissection plane is between Denonvilliers' fascia and the prostatic capsule.

The difference between the interfascial and intrafascial nsRPE is: the endopelvic fascia is incised and the NVBs are spared posterolateraly between the endopelvic fascia and the periprostatic fascia in the interfascial technique, i.e. the periprostatic fascia remains on the prostate. In the intrafascial technique the endopelvic fascia, the periprostatic fascia and Denonvilliers' fascia are not a part of the specimen because the dissection plane is directly on the prostatic capsule.



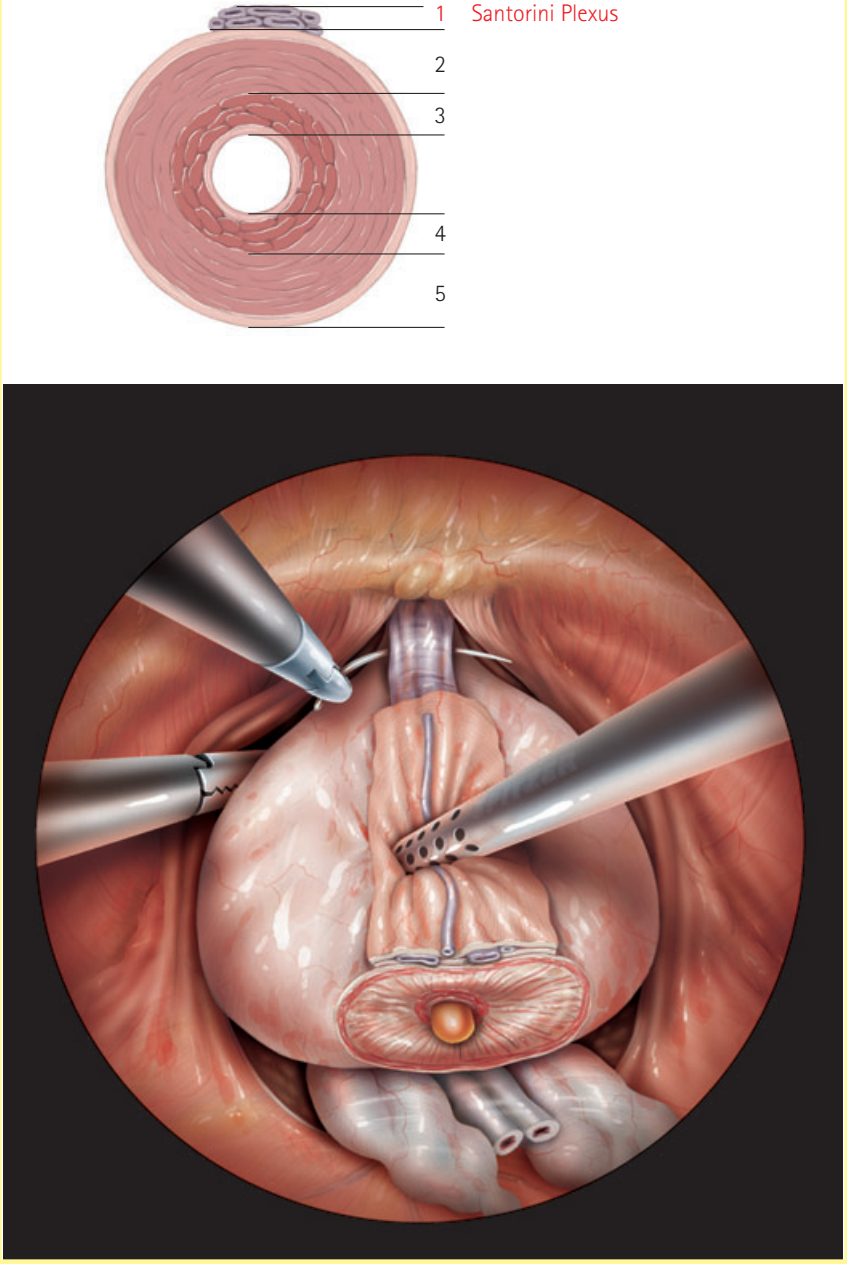


Figure 12

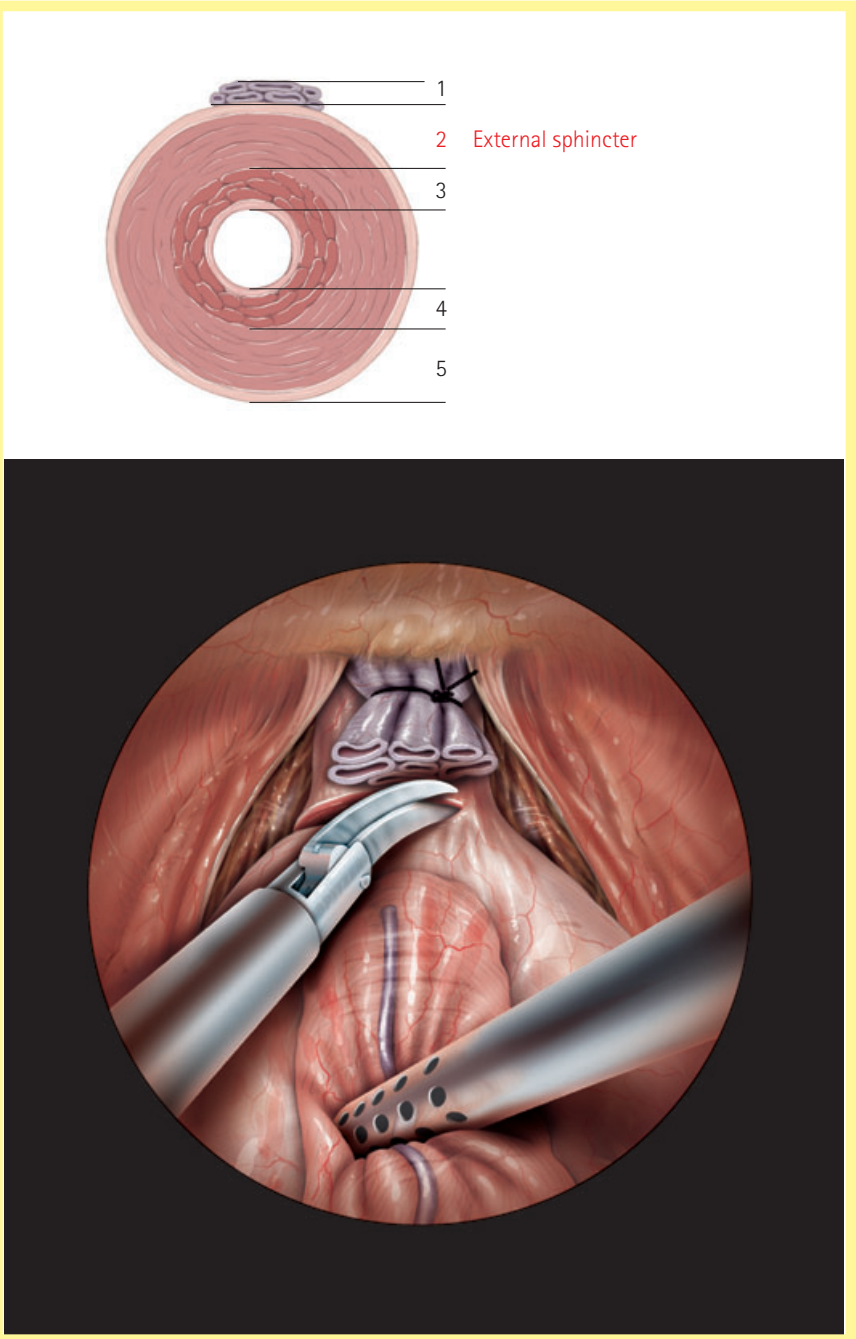
The prostate is now pushed into the pelvis contralaterally to provide good access to the apex and the urethra. The mobilized puboprostatic ligaments and the remaining puboprostatic fascia on the lateral surface of the prostate are now completely detached from the urethra and the apex.

After full mobilization of the prostate, Santorini's plexus is clearly visible from the lateral side. A 2–0 Polysorb GS-22 needle (Tyco Healthcare, slightly straightened) is then used and guided from left to right in the plane below the dorsal venous complex, and the plexus is thus ligated. During this step the assistant pushes the prostate dorsocranially to elongate the urethra. If the initial ligation is not safe, do not hesitate to suture a second time with the same needle. When a suture is considered to be positioned too deep toward the urethra (very seldom), the urethral catheter should be moved, precluding its entrapment by the suture.

Figure 13

For the apical dissection use Metzenbaum scissors, respecting the shape of the prostate and the course of the external sphincter, which overlaps the prostate ventrally, to protect as many striated muscle fibres of the external sphincter as possible. Note that the prostate extends more dorsally than ventrally. For this reason the dissection is not perpendicular. For the entire apical dissection make sure that the catheter is inserted within the urethra and visible at the proximal prostatic end.

The apical dissection is a five-step procedure. The first step is the division of the dorsal vein plexus. The second (Fig. 13) is the division of anterior urethral wall (junction between external striated sphincter and apex of the prostate).



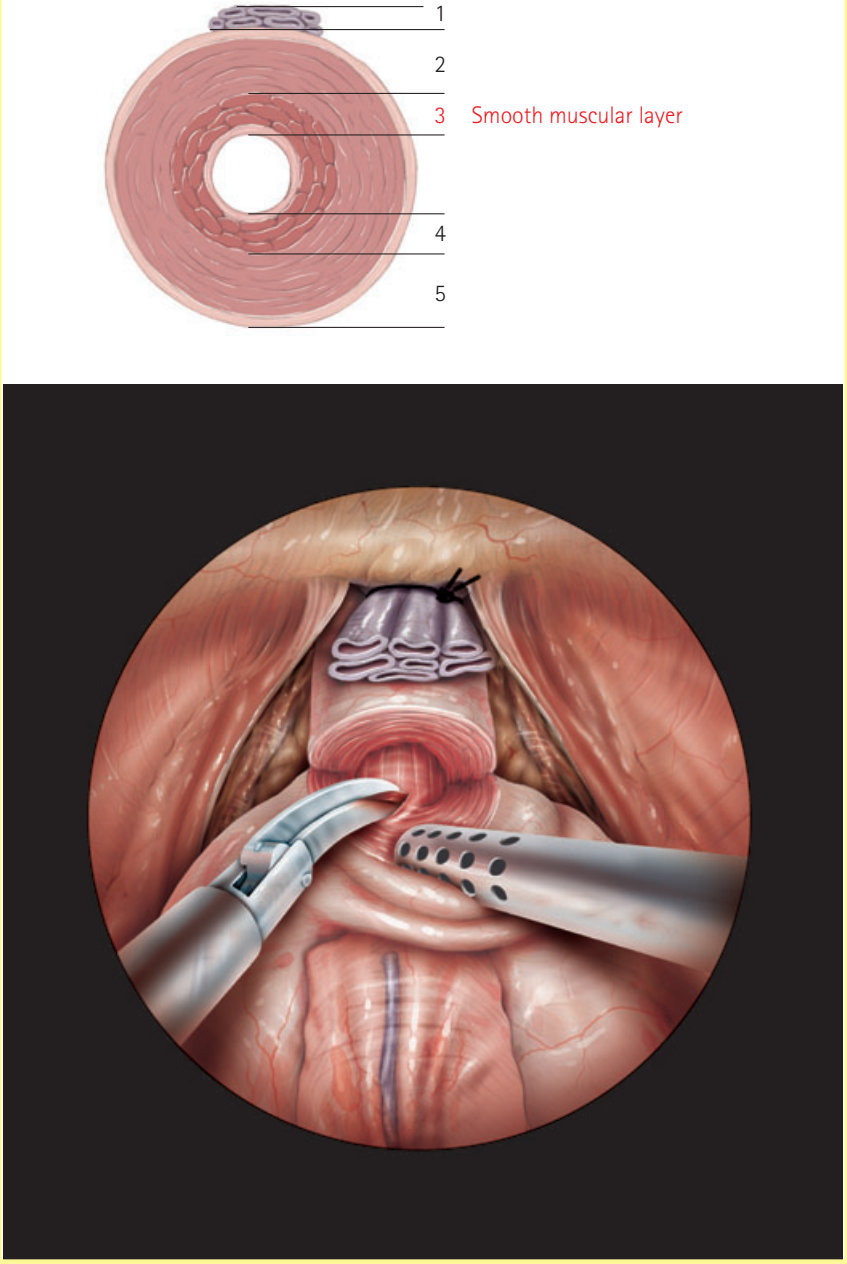
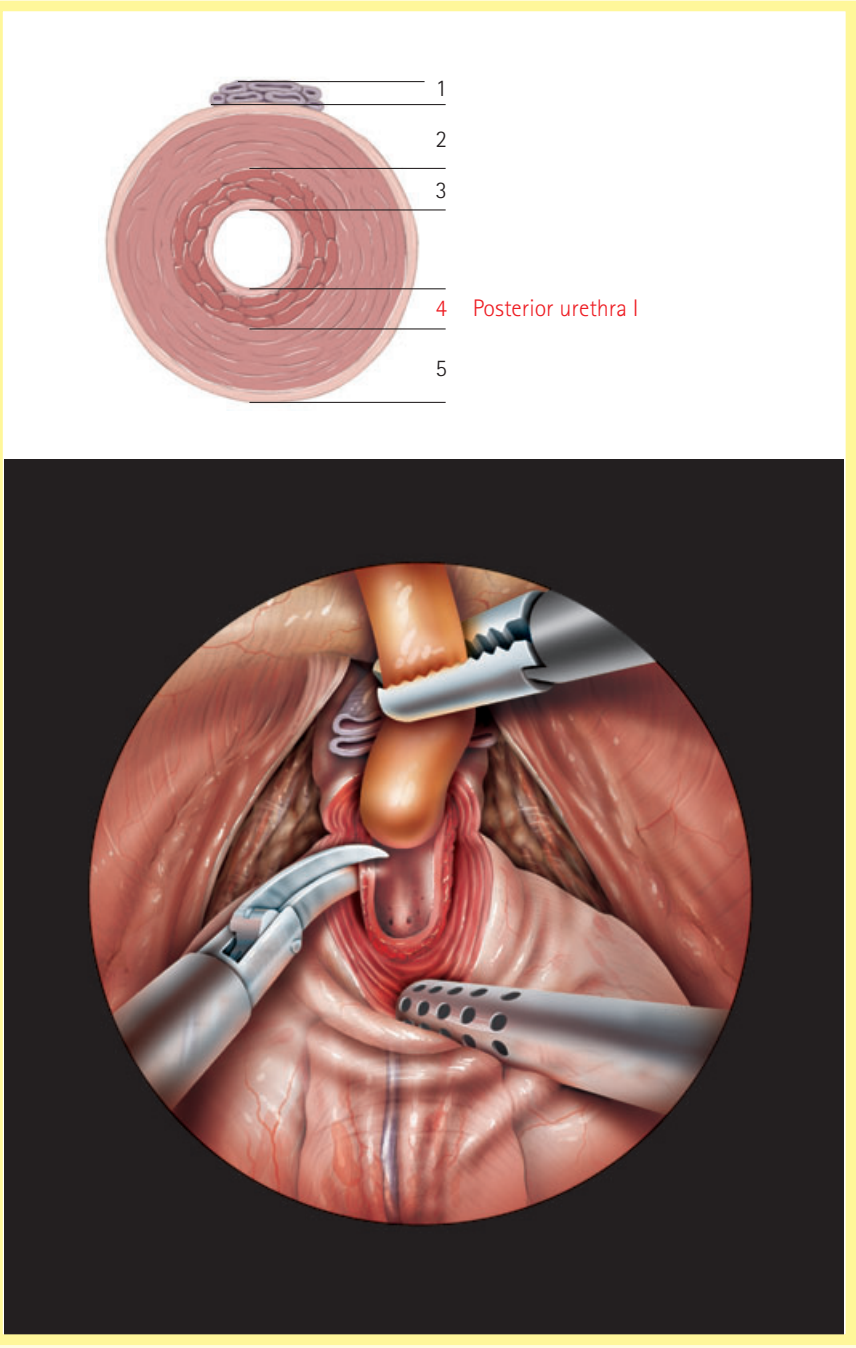


Figure 14

The third step of the apical dissection is the identification, preservation and opening of the longitudinal smooth muscle layer of the urethra anteriorly. The anterior urethra is then dissected proximally very close to the prostate, to preserve the urethra as long as possible.

Figure 15

As soon as the urethral catheter becomes visible, the assistant retracts the catheter towards the symphysis with the forceps in the right hand, and pushes the prostate down with the suction in the left hand. The urethral mucosa and the seminal collicle (verumontanum) are now clearly visible. The posterior urethra is dissected caudally to the verumontanum.



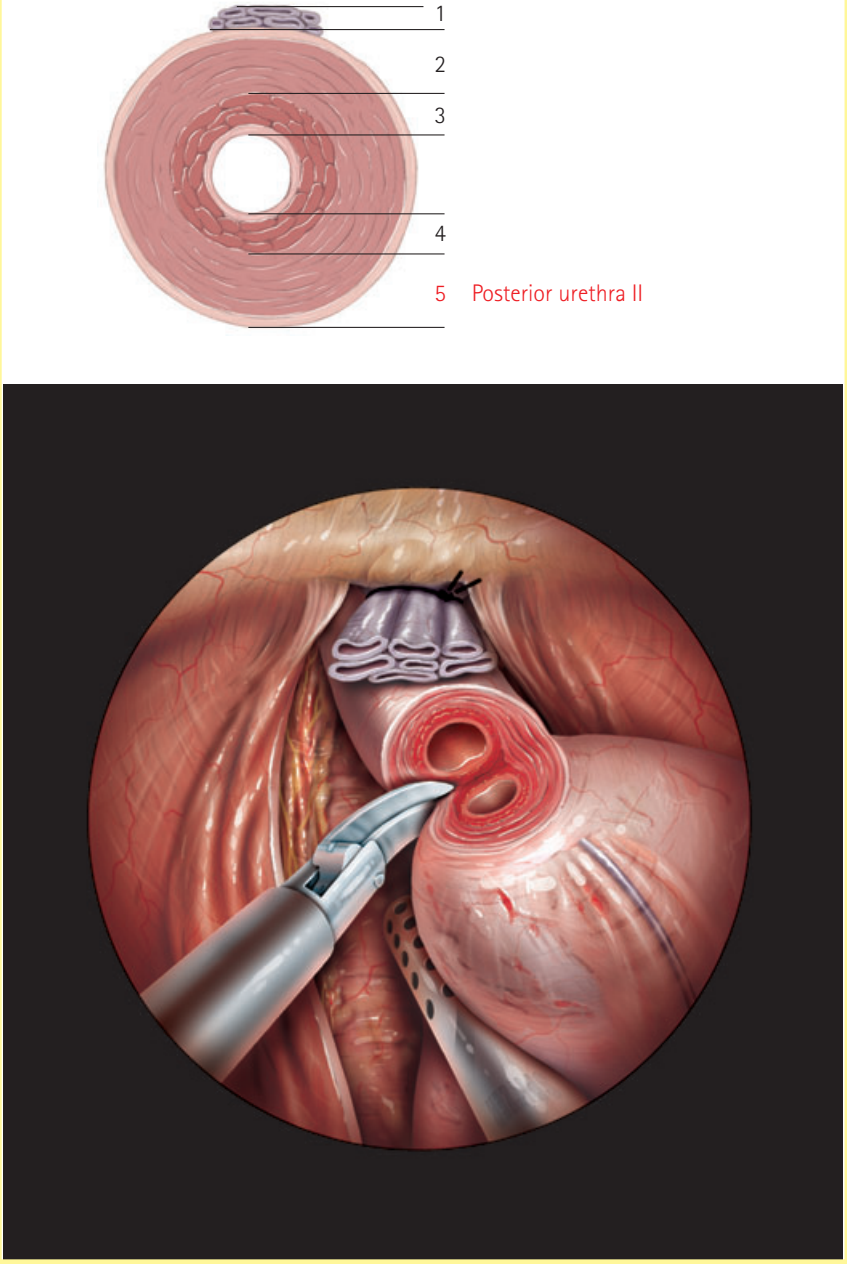
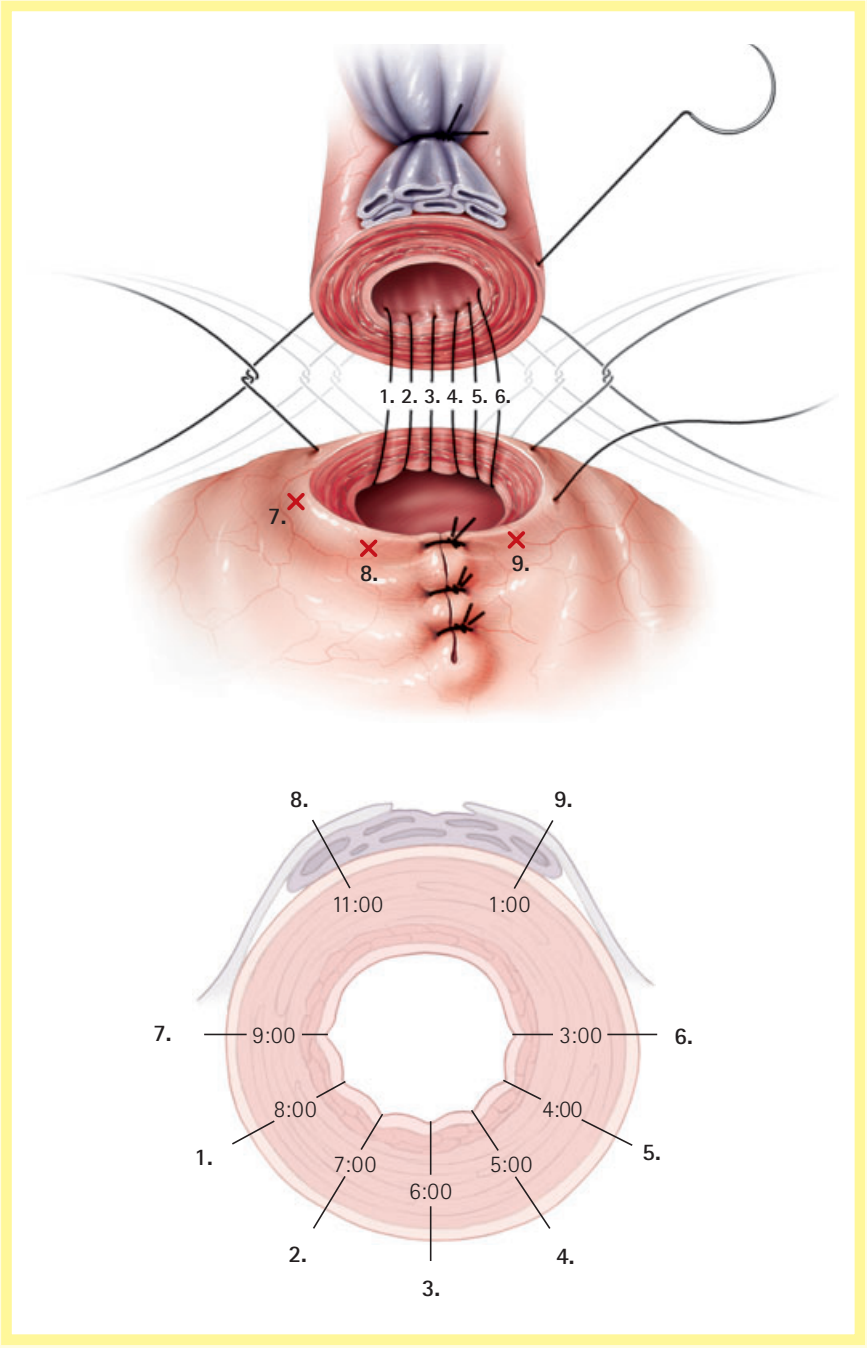


Figure 16

The posterior urethra is finally detached dorsolaterally to avoid any injury to the NVBs and the rectum. The use of 'cold' scissors is recommended. The assistant retracts the seminal vesicle contralaterally out of the pelvis and pushes the prostate dorsolaterally. When the prostate is completely freed and dissected from its surrounding structures, it is then placed in an endoscopic retrieval bag. The bag containing the prostatic specimen is partly extracted through the trocar site and clamped with a Kocher clamp. The trocar is then reinserted parallel to the bag, which is located in the left iliac fossa.

If there is minor bleeding from the NVB (surface haemorrhage and slow venous oozing), use TachoSil® (Nycomed GmbH, Linz, Austria). The TachoSil sponge is carefully folded with the active yellow side on the outside and introduced through the 12-mm port. Alternatively, the sponge can be introduced with the help of a laparoscopic introducer sheath. When inside, unfold and position it within the prostatic fossa overlaying the NVBs, with the yellow active side in direct contact with the bleeding site. Pressure must be applied for 3–5 min. Arterial bleeding will not be controlled by any haemostatic agent other than clips or sutures.

Figure 17



The anastomosis is made with a 2–0 Polysorb on a GU-46 needle (or UR-6 needle, 2–0 polyglactin). The bladder neck is always sutured first. All sutures are placed 'outside-in' at the bladder neck and 'inside-out' at the urethra, and thus the sutures are always tied extraluminally. In Fig. 17 the site of each suture is marked in a clockwise fashion (internal numbers). Externally located numbers show the actual suturing sequence.

The first suture starts at the 8 o'clock position (backhand-backhand) followed by sutures at the 7, 6 and 5 o'clock positions (forehand at the bladder neck, backhand at the urethra). After each urethral suture, the catheter needs to be pulled back to preclude fixation by the anastomotic suture. The 4 o'clock suture is then made forehand (bladder neck)-forehand (urethra). After the dorsal circumference has been completed, the final silicon catheter is placed into the bladder. Two further sutures are placed at the 3 o'clock (forehand-forehand) and 9 o'clock (backhand-backhand) positions. If during the bladder neck dissection a bladder-neck preserving technique is not feasible, a bladder neck reconstruction is deemed necessary at the 12 o'clock position at this point of the procedure.

The final two anastomotic sutures are placed at the 11 and 1 o'clock positions. (left side, backhand-backhand; right side, forehand-forehand). At this level, when suturing the urethra one should not include the whole tissue of the urethra. The sutures should include Santorini's plexus, connective tissue and the puboprostatic ligament (not through the mucosa and the musculature of the urethra), thus avoiding potential damage to the external (urethral) sphincter and its blood supply, and fixing the 'new' bladder neck to its anatomical position.

The watertightness of the anastomosis is finally checked and a 16 F Robinson drainage catheter is placed into the retropubic space. Finally, the endoscopic bag containing the specimen is retracted through the 12-mm trocar site at the end of the procedure.

The drain is removed 24–48 h after surgery and the catheter removed 5–6 days after surgery.

FROM SURGEON TO SURGEON

If the middle lobe is large or there is previous extensive TURP, insertion of JJ catheters is helpful to avoid injury to the ureteric orifices during surgery.

If there is injury to the epigastric vessels (mostly caused by incorrect trocar placement into the right pararectal line), use coagulation, clips or suturing (long and straight needle, suture from outside into the pre-peritoneal space and return, extracorporal knot tying, and cut the suture 2 days later).

To place trocars in patients with extensive adhesions of the pre-peritoneal space (previous surgery in the lower abdomen, including hernia repair with mesh placement), a partial intraperitonealization of the procedure is helpful. The adherent peritoneum is incised for 2–3 cm to make placement of the lateral trocars possible under visual control.

If there is reduced pre-peritoneal space, check for sufficient muscle relaxation of the patient with the anaesthesiologist (a peritoneal injury with resulting capno-peritoneum alone does not minimize the pre-peritoneal space).

For bleeding from Santorini's plexus, the initial increase in gas insufflation to 20 mmHg is suggested (up to 10 min). Minor bleeding can be controlled with bipolar forceps if necessary. We recommend additional suturing instead of extensive use of the bipolar coagulation. We prefer to use 2–0 Polysorb on a GU-46 needle for better manoeuvrability.

Rectal injury; most rectal injuries occur toward the end of the procedure when dissecting the apex dorsally, especially in patients with a previous history of prostatitis or fibrotic prostate. In case of doubt during dissection, the use of rectal insufflation with air, combined with filling the operative field with water, is recommended. Rectal injury will allow air bubbles, which can be easily detected. If the injury is identified, endoscopic correction with a two-layer suture line must be used (first layer mucosa, invert the mucosa with the second layer).

If there is lymphocele after removing the drainage, and it is asymptomatic, then use antibiotic prophylaxis (2–3 weeks). If it is symptomatic, use ultrasonography-guided puncture plus drainage for 3–5 days, and laparoscopic fenestration if the problem persists.

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Abbreviations: **(ns)(EE)(L)RPE**, (endoscopic) (extraperitoneal) (laparoscopic) radical prostatectomy; **NVB**, neurovascular bundle.