# 12 Robot-Assisted Radical Prostatectomy

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Radical prostatectomy (RP) is the surgical removal of the prostate and seminal vesicles for the treatment of prostate cancer. The National Comprehensive Cancer Network (NCCN) recommends RP as an option for men in all risk groups of localized disease. With an initial series dating back to 2001, robot-assisted radical prostatectomy (RARP) was one of the earliest robotic procedures to reach clinical practice and remains one of the most commonly performed [1]. From a technical and procedural standpoint, the transperitoneal approach to RARP represents a paradigm shift away from traditional open retropubic RP. Over time, refinements to the surgical technique have evolved, although basic principles of RARP have endured. The widespread dissemination of RARP worldwide has continued despite a scarcity of high-level evidence for its superiority compared to other surgical approaches. Outcomes exceeding 10 years post RARP have now been published reporting biochemical recurrence-free survival of 73% and cancer-specific survival of 99% [2]. A systematic review of the literature showed reduced blood loss and transfusion rates with RARP with possible improvements in continence and potency recovery [3–5].

## Patient Selection

Patients who are candidates for other surgical approaches such as open or laparoscopic RP would generally also be considered candidates for RARP. However, since Trendelenburg positioning is typically used for the procedure, patients with certain neurologic or cardiopulmonary comorbidities may not be ideal candidates. Cases that can present more of a technical challenge include patients with morbid obesity, patients with previous prostate surgery such as transurethral resection of the prostate (TURP), those with a large median lobe or bulky high-stage tumors, and those who have had previous pelvic surgery or radiation.

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## Room Setup and Positioning

Antibiotic prophylaxis is recommended with first- or second-generation cephalosporins, if possible. Patients are placed on the operating room table supine with legs in stirrups or in the split-leg position. Sequential compression devices are used, and the buttocks are positioned at the very end of the table. Foam padding secured to the table can help prevent the patient from sliding cephalad. The arms are tucked to the side and padded. The table is then shifted into the Trendelenburg position to allow the bowel to fall away from the pelvis and increase instrument working space. Patients are prepped from the chest to the mid-thigh and then draped. A Foley catheter is inserted sterilely. Because patients in the extreme Trendelenburg position for prolonged periods of time develop increased intraocular pressure, an alternative that may reduce this risk is a modified Z-Trendelenburg position [6].

## Port Placement

Port placement depends on whether a transperitoneal or extraperitoneal approach is used. Figure 12.1 depicts some examples of port placements, depending on approach and assistant side preference. While either approach is suitable in experienced hands, the transperitoneal technique is more commonly performed. The extraperitoneal approach may reduce operative time but is associated with higher $CO_2$ reabsorption and risk of acidosis [7, 8]. Trocars are typically placed at least a handbreadth apart in order to prevent internal and external clashing of instruments. Since the bedside assistant is a critical member of the operative team, optimization of assistant ports is also important. Assistant ports may be placed either on the right or left side of the patient.


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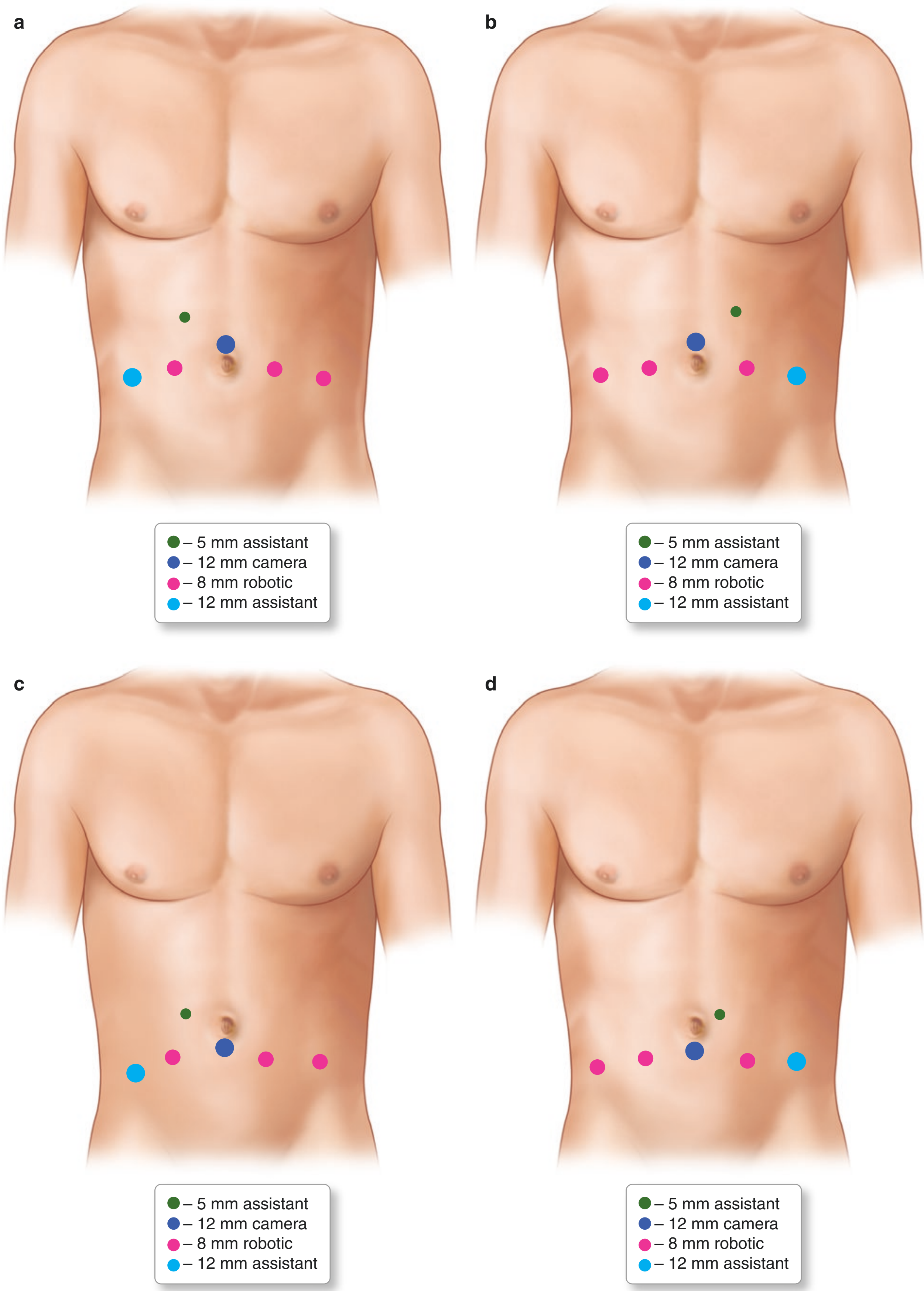


**Fig. 12.1** Port placements for robot-assisted radical prostatectomy. (**a**) Transperitoneal with right assistant ports. (**b**) Transperitoneal with left assistant ports. (**c**) Extraperitoneal with right assistant ports. (**d**) Extraperitoneal with left assistant ports (Camera ports may also be 8 mm if Da Vinci Xi robot is used)

### Transperitoneal

Pneumoperitoneum can be attained using a Veress needle or with the open access Hassan technique. Generally the camera port is placed above the umbilicus except in patients with excessive distance between the pelvis and umbilicus (>25 cm). Once the camera is inserted, the other ports are placed under direct vision. Three robotic ports and two assistant ports are placed as indicated (Fig. 12.1a, b). For the suction to reach the pelvis from the upper assistant port, an extra-long suction tube is needed. The view of the pelvis from a transperitoneal approach can be seen in (Fig. 12.2).

### Extraperitoneal

Extraperitoneal access is first obtained through a skin incision routinely made below the umbilicus. Through this incision, the posterior rectus sheath is developed and the preperitoneal space is further expanded using blunt dissection and a balloon dissector. Once the space is sufficient, robotic ports are placed similarly under direct vision (Fig. 12.1c, d).

For both transperitoneal and extraperitoneal surgeries, the pneumoperitoneum is usually maintained at 15 mm Hg but can be increased during active or anticipated bleeding or decreased in order to monitor for hemostasis or prevent cardiopulmonary effects of pneumoperitoneum. The robot is then docked between the legs or alternatively alongside the patient [9]. When using the Xi robot, side docking is used. Also an 8-mm robotic cannula is substituted for the camera port.

## Steps of Operation

### Dissection of the Vas Deferens, Seminal Vesicles, and Posterior Prostate

This stage of the procedure involves dissection and removal of the vas deferens and seminal vesicles as well as mobilizing the prostate off the rectum. It can be performed initially or after bladder neck transection. Of importance is complete or partial removal of the seminal vesicles, depending on disease stratification.

#### Posterior Approach

If performed initially, an incision is made in the peritoneum at the rectovesical pouch a few centimeters above the visualized rectum (Fig. 12.3). This starting point often can be confirmed by following the course of the vas deferens as it courses behind the peritoneum. The incision is deepened through areolar tissue following a plane below the vas deferens and seminal vesicles. The posterior plane can be developed superficial to

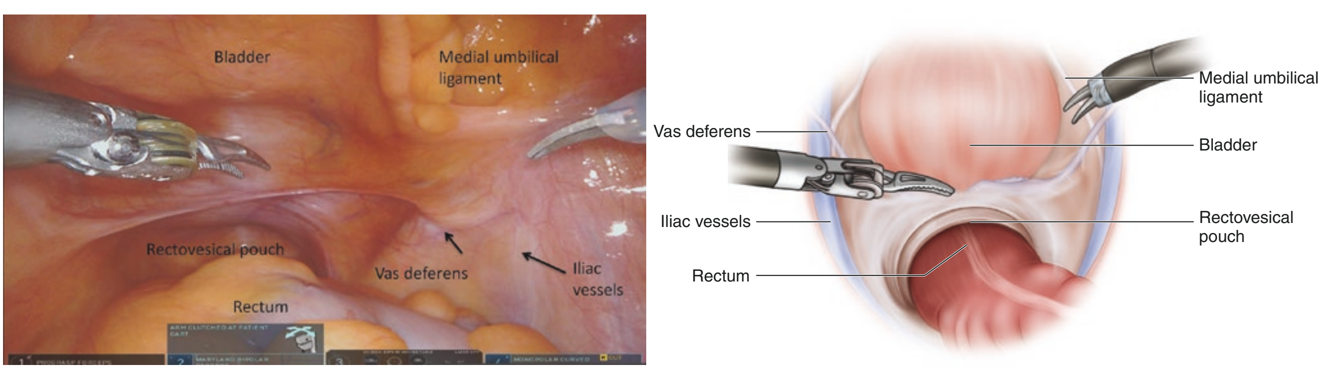


**Fig. 12.2** Initial anatomic view of the pelvis with transperitoneal robot-assisted radical prostatectomy

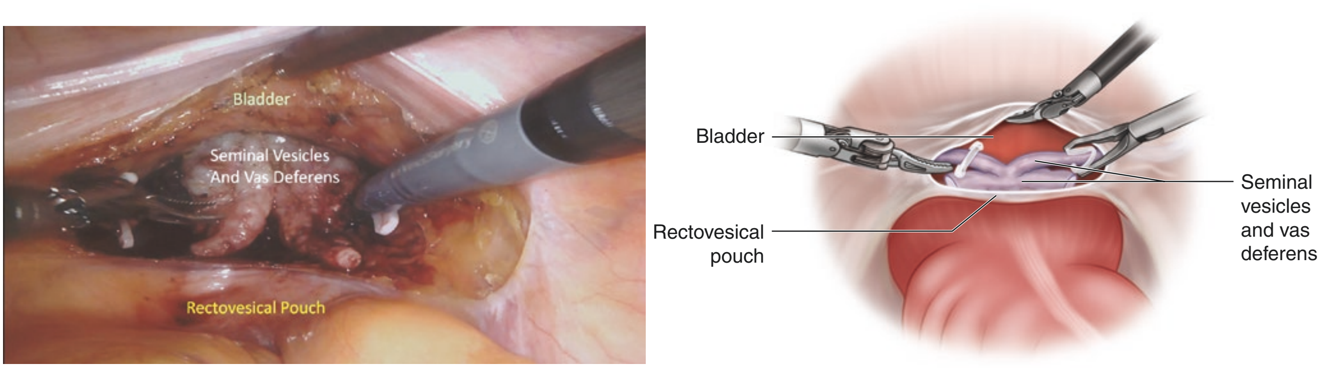


**Fig. 12.3** Dissection of the vas deferens and seminal vesicles through a posterior approach

the posterior layer of Denonvilliers fascia in lower-risk disease or completely below the fascia in higher-risk disease. Once the posterior plane is sufficiently created, the anterior surface of the ampulla of the vas deferens and seminal vesicles is dissected in order to clearly visualize the anatomic boundaries of the seminal vesicles. The vas deferens is divided laterally, and the dissection continues around the tip and lateral border of the seminal vesicles up toward the base of the prostate. This dissection can be performed without cautery with the aid of clips to prevent thermal injury to adjacent structures.

### Anterior Approach

If not performed initially but instead approached after bladder neck transection, the anterior layer of Denonvilliers fascia covering the vas deferens and seminal vesicles is incised. This exposes the structures for dissection. Upward traction of the prostate using the fourth robotic arm or assistant allows for dissection around the edges of the seminal vesicles. Once the vasa are dissected and mobilized, they can also be used as a handle for the seminal vesicle dissection. After division of the vasa, dissection proceeds around the lateral edge of the seminal vesicles, continuing toward the base of the prostate.

## Dissection behind the Prostate

The dissection posterior to the prostate is a critical step of RARP, in particular when treating high-volume, bulky tumors or patients who have had previous radiation therapy. Since the intent is to avoid inadvertent injury to the rectum, limited use of cautery to optimize visualization of the perirectal fat plane is prudent. The plane posteriorly is developed sharply and bluntly all the way to the apex of the prostate. Changing back to the zero degree lens for this portion of the operation improves the ability to dissect toward the apex. This dissection also aids in setting up the prostate pedicles and preservation of neurovascular bundles.

## Development of the Retzius Space

In transperitoneal RARP, extended pelvic lymph node dissection (see Section "Pelvic Lymph Node Dissection") can be performed next; otherwise the operation proceeds with the development of the space of Retzius in patients at low risk for nodal metastases. The space is initially entered by incising the peritoneum above the dome of the bladder and lateral to the medial umbilical ligaments. This is carried down following the shape of the pelvis to the level of the pubic symphysis. Once the bladder is mobilized enough to drop below the pubic bone, the endopelvic fascia as well as the anterior prostatic fat should be easily visible. The superficial dorsal vein can be controlled with bipolar cautery and the anterior prostate fat cleared off the surface of the prostate because it occasionally harbors lymph nodes. Excising this fatty tissue also improves visualization for the subsequent dissection of the bladder neck. The endopelvic fascia can be opened at this point, although this this is optional. When opened, the incision is followed toward the puboprostatic ligaments. In up to 30% of patients, an accessory pudendal artery can be encountered during this dissection; its preservation may assist with erectile function recovery [10]. The dorsal venous complex (see Section "Dorsal Venous Complex Control") can be controlled at this time or alternatively prior to urethral transection.

## Bladder Neck Dissection

Preoperative imaging with computed tomography, magnetic resonance imaging (MRI), or ultrasound can provide information about the volume and shape of the prostate as well as the presence of asymmetric lobes or an enlarged median lobe. A 30-degree down lens can assist with bladder neck dissection and in identifying the junction between the prostate and bladder. During this step, the primary goal is separation of the prostate from the bladder. The optimal dissection leaves no prostate behind so as to avoid a positive margin, cancer recurrence, or postoperative detectable prostate-specific antigen (PSA). Although magnified visualization is superb with RARP, bladder neck dissection can present challenges in that tactile feedback commonly used to identify the prostatovesical junction during open RP is lacking robotically. Also in high-risk disease or in patients with large median lobes or asymmetric prostates, determining the exact plane between prostate and bladder can be challenging.

Initially, the shape and size of the prostate is visually gauged, and the Foley balloon can be deflated to show where the collapsed bladder ends and the prostate begins. Alternatively, lifting up the bladder anteriorly with careful observation of where the catheter balloon seats when pulled back and forth can also show the junction. Early high anterior release of the neurovascular bundles is another way to prospectively identify the prostate border. Visual cues and tissue feedback are important during dissection to provide assurance of the correct dissection plane. Continued and active cranial retraction of the bladder with frequent repositioning using the fourth robotic arm also helps delineate prostate glandular tissue from the muscular bladder fibers. If the correct plane is not entered, entry into the bladder, injury to the ureters, or cutting into the prostate can occur.

### Anterior Bladder Neck Dissection

Dissection is begun anteriorly through the bladder neck using cautery with a transverse incision that is deepened along the junction between bladder and prostate until the catheter is reached (Fig. 12.4). The catheter can then be deflated and retracted anteriorly using the fourth robotic arm or the assistant. The posterior bladder neck is thus identified, which allows incision through the remainder of the bladder. Identification of the trigone and ureteral orifices is important to confirm absence of injury to the ureters. Carrying this dissection through the posterior bladder neck reveals the anterior Denonvilliers fascial layer that covers the vas deferens and seminal vesicles (see Section “Dissection of the Vas Deferens, Seminal Vesicles, and Posterior Prostate”) or the posterior space if dissection of the vas deferens and seminal vesicle has already been performed. In situations in which there is a large median lobe, a stitch can be used to retract the lobe out of the bladder [11].

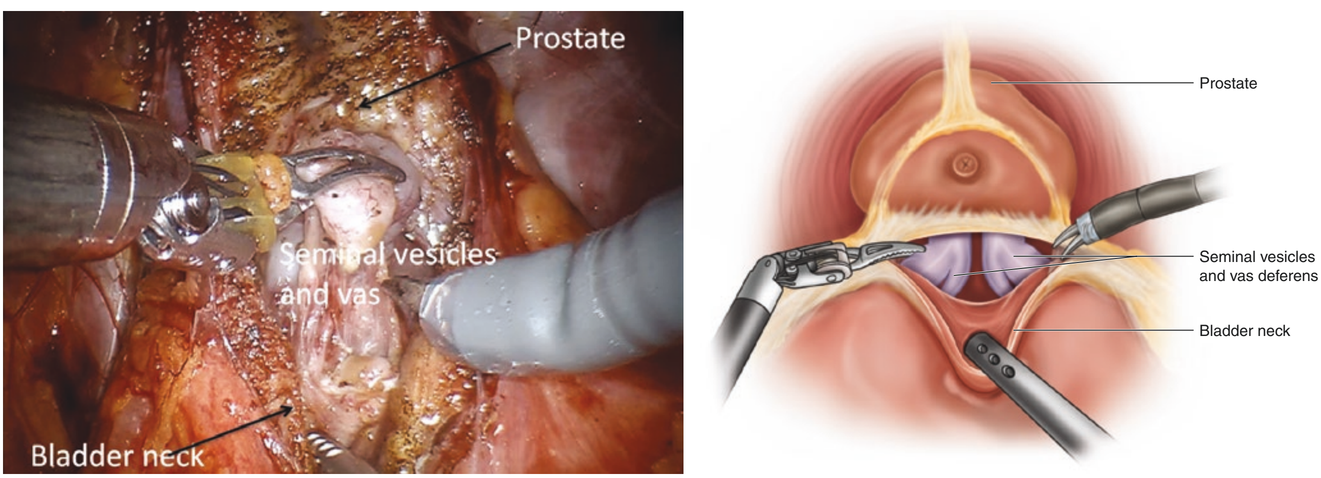


**Fig. 12.4** Dissection of the vas deferens and seminal vesicles after bladder neck dissection

## Perivesical Fat Space Dissection Technique

An alternative technique used for bladder neck dissection approaches the prostatovesical junction from the anterolateral direction. This blunt dissection through the perivesical fat allows for preservation of the bladder neck as it funnels into the prostate and for preemptive detection of large median lobes. The bladder is retracted with the fourth arm to the contralateral side and cephalad to expose the angle of dissection. The perivesical tissue lateral to the bladder neck is developed bluntly under direct vision until the posterior space created during seminal vesicle dissection is encountered. Laparoscopic traction to separate the prostate and bladder tissue is provided by the assistant. Next, the plane funneling to the bladder neck between the base of the prostate and the bladder neck is developed with a combination of cautery and blunt dissection. The junction of the prostate and bladder neck can be identified by the tissue differences between the bladder neck fibers and the firmer more defined prostatic tissue. The same technique is applied to the contralateral side as shown in (Fig. 12.5). Once the dissection is completed laterally and posteriorly on both sides, the anterior bladder neck is opened. The Foley catheter is retracted back into the prostatic urethra, and the posterior bladder neck is transected. This technique preserves the anatomic bladder neck. In the case of a large median lobe, the posterolateral plane can be developed around the median lobe and the bladder neck can still be preserved.

## Neurovascular Bundle Preservation

Anatomic nerve sparing has been shown to improve continence and potency after surgery [12, 13]. Nerve sparing can be variably performed depending on preoperative cancer risk and stratification, patient age, and preoperative functional status. Clinical staging and tumor appearance on MRI may guide the surgeon to perform wider dissection in order to achieve an oncologic resection. While the importance of nerve sparing to functional outcomes has been well reported, preservation of the bundle should not supersede performing an oncologically sound operation.

Numerous descriptions of nerve sparing during RARP have been reported in the literature. Savera and colleagues described the neurovascular bundles as not just posterolateral nerve bundles but as a "Veil of Aphrodite" that incorporates the lateral prostatic fascia [14]. This supports using a high anterior release of the prostatic fascia to preserve the nerves in this location. Tewari described a graded nerve-sparing technique that corresponded to postoperative return of sexual function. Risk stratification by nomograms, MRI, and clinical staging can be used to determine the extent of nerve sparing for the individual patient [15].

The cavernous nerves may be injured by transection, use of the cautery, and excessive traction. Therefore the delicate nature of this portion of the operation supports minimizing handling of the bundle tissue, avoiding excessive traction on the bundle and cautery in order to prevent thermal injury to

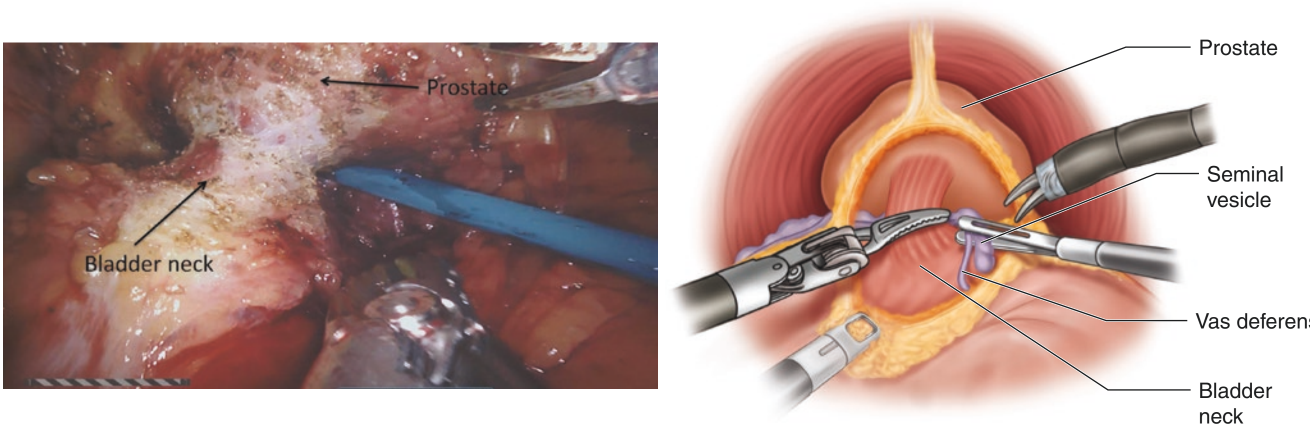


**Fig. 12.5** Bladder neck dissection using a perivesical fat space dissection technique

the bundle. Nerve sparing can be performed in antegrade fashion from the bladder to the prostatic apex or in retrograde fashion from the prostatic apex to the bladder [16]. During either form of nerve sparing, intraoperative frozen sectioning, as described in the NeuroSAFE technique (Martini-Klinik, Hamburg, Germany), has been used to maximize nerve sparing while minimizing positive margins [17].

## Antegrade Nerve Sparing

Using a zero-degree lens, the vasa and seminal vesicles are retracted anteriorly by the fourth arm or the assistant. The pedicles should be seen posterior and lateral with the prostate retracted anteriorly as in (Fig. 12.6). These prostate pedicles can be controlled with plastic or metallic clips. At this point, if a nerve-sparing procedure is performed, the prostatic fasciae are released high on the lateral prostate with sharp dissection. Depending on the patient's risk factors, graded nerve sparing may be performed leaving little to no tissue on the prostatic capsule. The neurovascular bundle is dropped with a combination of blunt and sharp dissection as shown in (Fig. 12.7). The dissection is continued following the contour of the prostate while continuously assessing for tissue irregularities that could suggest extracapsular disease. Toward the apex, the neurovascular bundle can be gently teased off the prostate. The lateral edge of the urethra is then visualized.

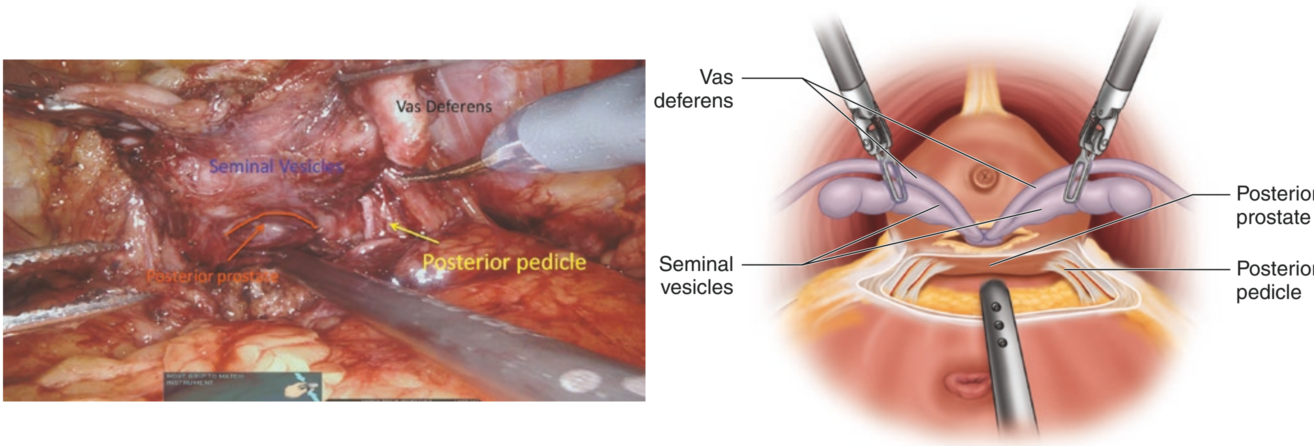


**Fig. 12.6** Anterior retraction of the seminal vesicles and vas deferens in order to expose the posterior prostate and posterolateral pedicles

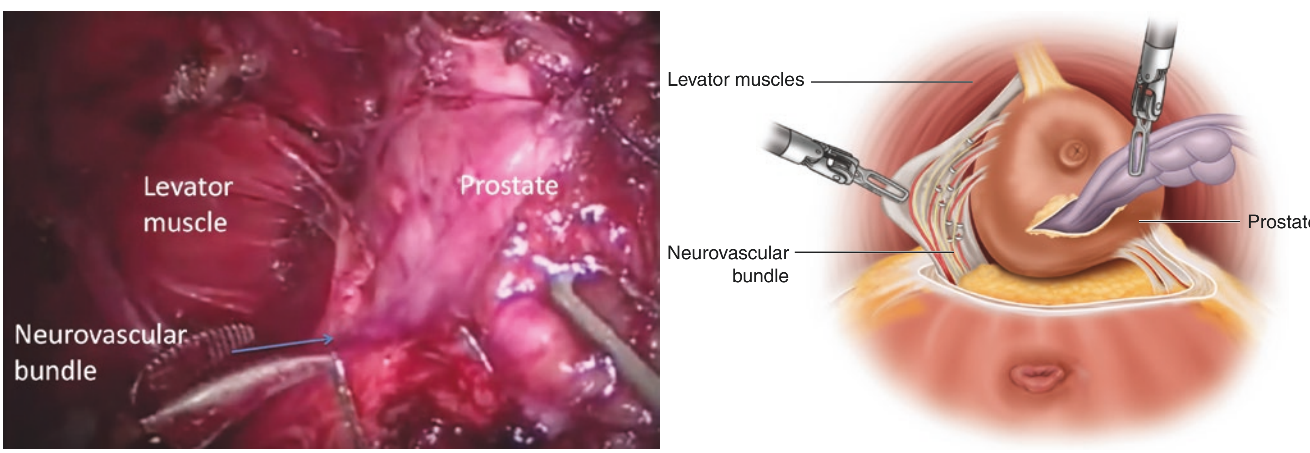


**Fig. 12.7** Nerve-sparing procedure performed on the left side showing the location of the bundle relative to the levator muscles and prostate

## Retrograde Nerve Sparing

With the retrograde approach, the neurovascular bundle is released anteriorly and near the apex, and the urethra is incised. Through the open urethra, the transected catheter is delivered into the pelvis and used for traction. The distal end of the catheter is cut to shorten its length. The prostate is then freed off the rectum using sharp dissection from the apex toward the base. Once the prostate pedicles are reached, these can be divided using plastic or metallic clips.

## Lymph Node Dissection (LND)

Removal of lymph nodes during RP is the most accurate means of lymph node staging and assessment. Such data are important for prognosis and guiding additional therapy. In addition, LND often removes metastatic cancer, particularly with more aggressive disease. Whether this contributes to survival is as yet unknown.

The NCCN recommends that a pelvic LND be performed concomitantly if predicted probability of lymph node metastasis from nomograms is greater than or equal to 2%. The European Association of Urology guidelines recommend a LND if predicted probability is greater than 5%. Both guidelines suggest that an extended LND be performed if dissection is indicated, although the optimal extent of LND for prostate cancer also remains unknown. Balancing the real and theoretical benefits of LND against the time and comorbidity to perform the procedure is important.

Commonly used boundaries for extended LND include the common iliac artery and ureteral crossing proximally, the lateral border of the external iliac artery laterally, the bladder medially, the node of Cloquet distally, and the pelvic floor inferiorly. The use of cautery and clips may decrease the risk of lymphatic leak. A stepwise dissection from proximal to distal involves first prospectively identifying the course of the ureter as it crosses over the iliac vessels [18]. This is noted as the proximal extent of dissection. In thinner patients this may be visible through the peritoneum, but in others it may require incising the peritoneum to identify this landmark. The peritoneal incision is then carried alongside the lateral border of the external iliac artery, keeping the vas deferens tented up anteriorly. The crossing of the circumflex iliac vein over the artery is used as a distal limit. Larger lymphatics can be clipped and divided. The lymphatic tissue is then mobilized in order to skeletonize the external iliac vessels. The internal iliac artery is identified with the obliterated umbilical artery retracted medially to mark the medial extent of dissection. Lymphatic tissue along the internal iliac (hypogastric) artery is similarly removed. Retraction using the fourth arm of the obliterated umbilical artery allows blunt dissection between this and the obturator packet. This blunt sweeping is carried down to the endopelvic fascia. The node of Cloquet is then clipped and used as a handle to dissect beneath the external iliac vein and in the obturator fossae. The obturator vessels and nerve are preserved with hemostatic control of the surrounding lymphatic tissue. Similar dissection is carried out on the contralateral side. Completed bilateral anatomic extended LND is shown in (Fig. 12.8a, b).

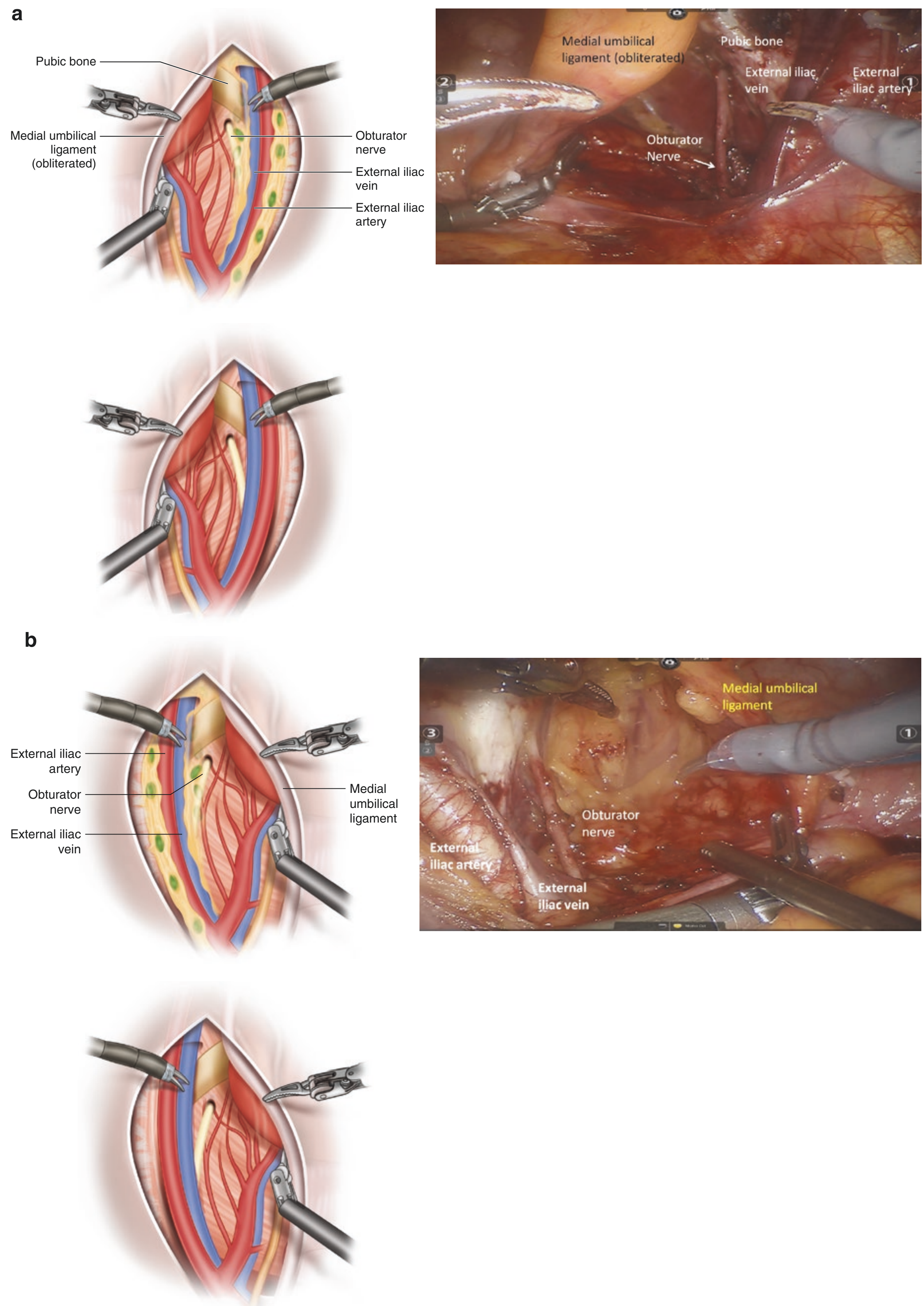


**Fig. 12.8** Completed extended pelvic lymph node dissection. (**a**) Right side. (**b**) Left side

## Dorsal Venous Complex Control

The deep dorsal veins drain deoxygenated blood away from the penis and can present a troublesome source of bleeding during RP. Venous complex control can be performed at various time points during RARP such as after the endopelvic fascia incision or just prior to apical dissection. During RARP the pneumoperitoneum, especially if temporarily increased, may reduce active bleeding during this step of the operation. Control of the dorsal venous complex (DVC) during RARP may be achieved in various ways. Reports have described suture ligation, cutting the complex followed by suturing, or cautery or stapling of the complex. A zero-degree lens is used for this portion of the procedure. Dissection on either side of the DVC in order to isolate it by endopelvic fascia opening or nerve sparing prepares the anatomy for DVC ligation. Sharp and blunt dissection drop the levator muscles away from the DVC so that what remains attached anteriorly is this venous complex.

## Staple Control

When stapling, an Endo GIA stapler (Medtronic-Covidien, Minneapolis, MN) is brought through the lateral assistant port and articulated to straddle the grooves along either side of the DVC. The orientation of the stapler is adjacent to the course of the pubic bone in order to leave some anterior tissue on the prostate. Once the stapler traverses the DVC for a few centimeters, it can be closed, as seen in (Fig. 12.9). Care is taken to ensure that the Foley catheter and urethra are not caught in the staple line by moving the catheter in and out of the urethra freely after the stapler is clamped. Once just the DVC is within the jaws of the stapler, the complex is stapled and divided.

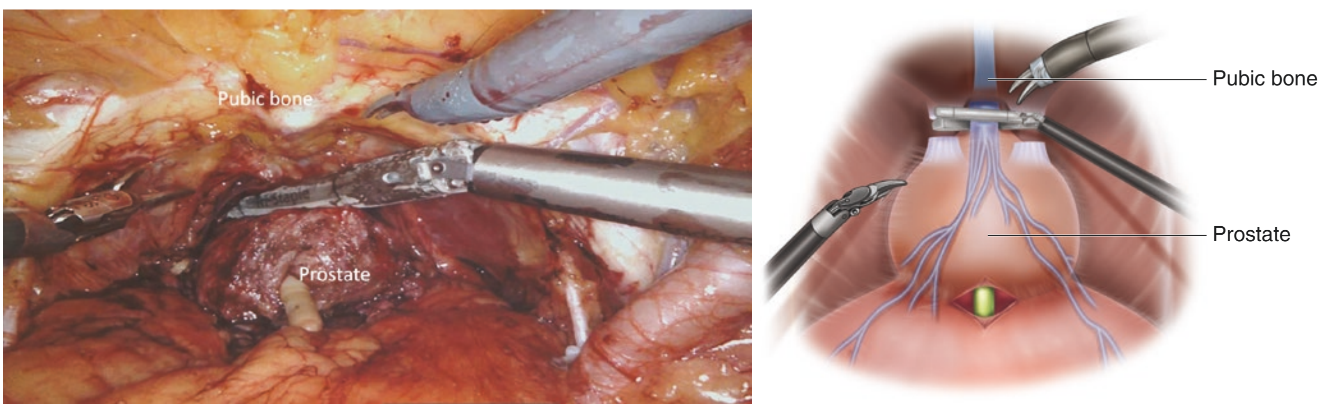


**Fig. 12.9** Dorsal venous complex control using an Endo GIA stapler

## Suture Control

When suturing, a large absorbable stitch such as 1 or 2-0 Vicryl (Ethicon, Cincinnati, OH) on a CT needle can be used. The needle is carefully passed anterior to the urethra so as not to injure the urethra or sphincter mechanism. The trajectory for passing the needle from side to side is completely horizontal. An additional pass of the suture more anteriorly is used to secure the complex before tying down. Once adequately suture ligated, the complex can be divided sharply or with cautery. Alternatively, the DVC can also be transected sharply and then similarly oversewn with an absorbable suture with the pneumoperitoneum turned up briefly to 20 mmHg.

After division of the DVC and completion of nerve sparing, the urethra is prepared and divided beyond the apex of the prostate. Functional urethral length can be important for recovery of continence. However, division of the urethra too close to the prostate may lead to positive apical margins. The anterior portion of the urethra is first divided, maximizing the urethral stump. A holding stitch of 3-0 Vicryl can be placed in the posterior urethra at 6 o'clock before posterior division in order to allow easier identification of the posterior urethral stump and prevent urethral retraction. This time point provides an excellent opportunity for the entire operative field to be examined for hemostasis.

## Vesicourethral Anastomosis

After the prostate is removed and the specimen bagged, the bladder must be sutured down to the urethra in order to allow for normal micturition. Similar to open RP, the key principle of creating a watertight anastomosis that is not under tension is important to prevent anastomotic leak. A difference of RARP is that the visualization is superb in the deep pelvis, which assists with accurate suture placement and visual assurance of tissue apposition.

Prior to urethral suturing, posterior reconstruction can be considered for hemostasis and to assist with performing the vesicourethral anastomosis. Initially described by Rocco [19], the posterior musculofascial reconstruction helps to reduce tension of the anastomosis and may aid in early recovery of continence. A 3-0 barbed or Vicryl suture is used to bring the posterior musculofascial plate behind the urethra to the cut edge of the Denonvilliers fascia as shown in (Fig. 12.10). An additional suture from the plate to the midline posterior bladder can reduce tension between the urethra and bladder.

Once again, inspection of the bladder trigone and ureteral orifices is important to identify possible ureteral injuries. The vesicourethral anastomosis is then performed. If a previous 6 o'clock posterior urethral stitch was used, it is placed in the corresponding 6 o'clock position of the bladder neck. Next,

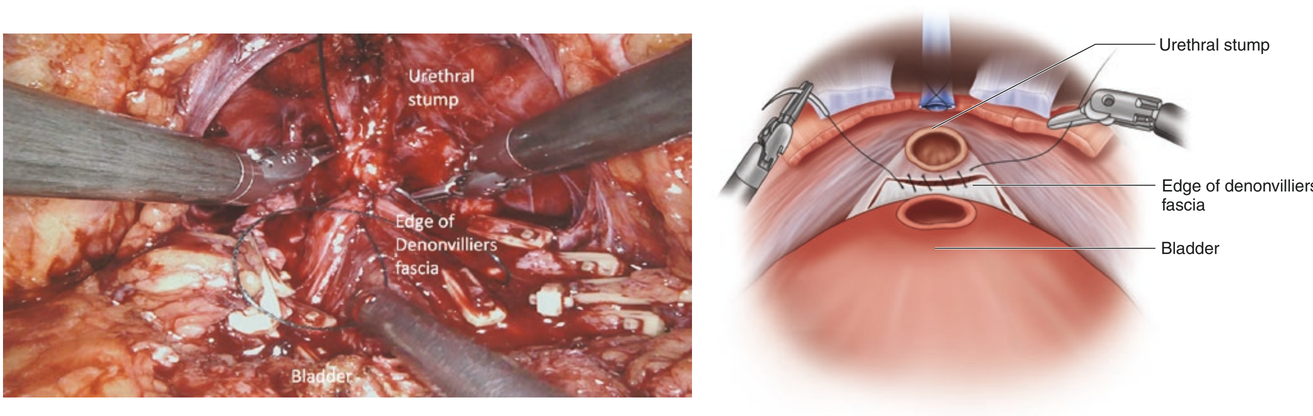


**Fig. 12.10** Posterior reconstruction with suture connecting the posterior musculofascial plate of the urethra to the cut edge of Denonvilliers fascia

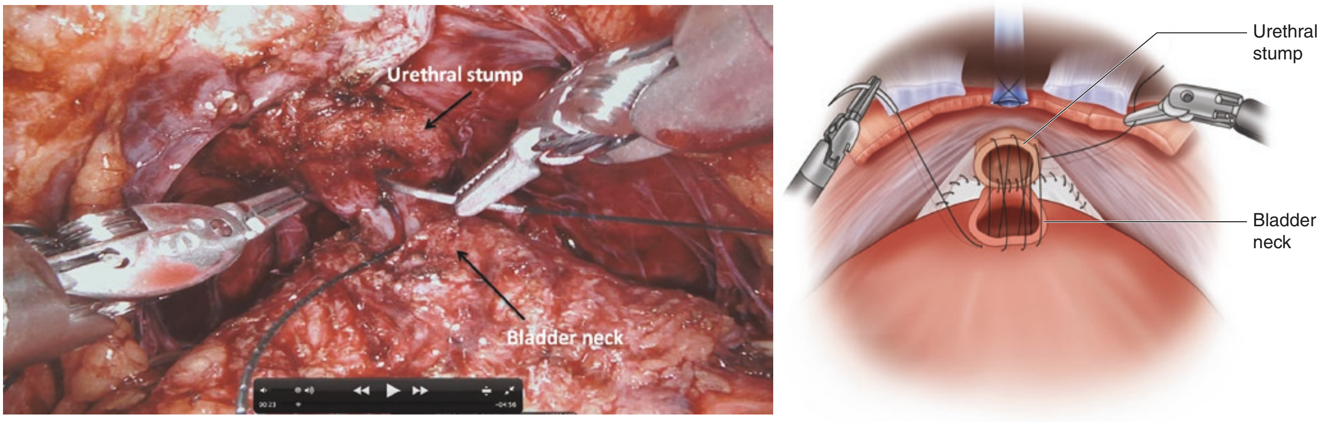


**Fig. 12.11** Vesicourethral anastomosis using barbed suture (posterior urethral stitch already complete)

the anastomosis can be completed with absorbable suture in running or interrupted fashion as shown in (Fig. 12.11). The Van Velthoven is a common anastomotic technique wherein double 3-0 Vicryl or barbed sutures are tied together to run the anastomosis from 6 to 12 o'clock in both counterclockwise and clockwise fashion with the sutures tied at the 12 o'clock position [20]. A Foley catheter or sound is used to identify the lumen of the urethra in order to assist with accurate urethral stitch placement. Tensioning of the suture in between needle passes brings the mucosal edges of the urethra and bladder together. Recently, several meta-analyses examining the use of barbed suture for completion of the vesicourethral anastomosis found similar complication and continence rates with reduced operative time [21, 22].

In patients with a wide bladder, it may be necessary to reduce its caliber to sew down to the urethra. Posterior or anterior tennis racket closure with sutures in the midline posterior and anterior bladder away from the trigone can reduce the size of the bladder neck. Alternatively, approximation of the bladder edges lateral to the ureteral orifices with absorbable suture achieves reduction in the aperture of the bladder neck. Once the anastomosis is finished, the bladder is filled with saline to test for an anastomotic leak. A new urethral catheter or suprapubic catheter is then inserted into the bladder and inflated [23]. A temporary pelvic drain can then be inserted into the pelvis through one of the lateral port sites if desired.

## Extraction and Closure

The 12-mm assistant port is closed under direct vision or with a laparoscopic closure device. The remainder of the ports can be removed under vision in order to inspect for internal bleeding from the port tract. The specimen is then extracted through the midline camera port by extending the skin and fascial incisions. After the specimen is removed, the fasciae and skin are closed.

### Conclusions

RARP is a reproducible, effective treatment option for prostate cancer. The operation can be divided into logical steps in order to produce consistent outcomes. Complete dissection of the seminal vesicles is particularly important in aggressive disease. Bladder neck dissection separates the prostate from the bladder and relies heavily on visual cues to preserve a functional bladder neck. Nerve sparing is a meticulous dissection wherein the surgeon continually differentiates prostate tissue from nonprostate tissue. Keen knowledge of prostate anatomy is important to assess for variations that could be related to extraprostatic tumors. Lymph node dissection is essential for staging purposes and removes micrometastatic disease. Finally the vesicourethral anastomosis reconstitutes the urinary tract to allow for physiologic micturition.

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