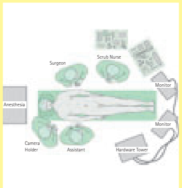
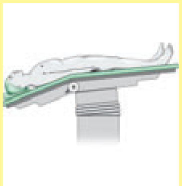
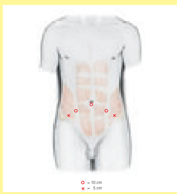
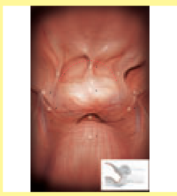
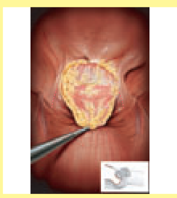
Surgery Illustrated

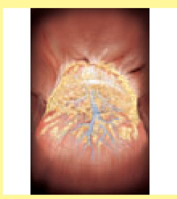












Surgical Atlas

Radical nerve-sparing laparoscopic prostatectomy

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

INTRODUCTION

Laparoscopic radical prostatectomy was first reported by Schuessler *et al.* [1] in 1992 and has recently become a routine procedure at specialized centres [2–4]. Current accepted indications are clinical T1 and T2 cancers. Reported benefits of the laparoscopic approach include less blood loss and pain, a shorter hospital stay and convalescence, and improved cosmesis [3,4]. Also, the magnified view of the laparoscope may allow better visualization of the anatomy, translating into more precise and less traumatic dissection of vital structures. We initially began using the Montsouris technique [3,4] but our experience has expanded and we have made several modifications to the operation. We report the details of our technique of laparoscopic nerve-sparing radical retropubic prostatectomy.

PREPARATION

The patient is instructed to stop any aspirin products 10 days before the planned surgery. Warfarin therapy is discontinued at least 5 days before surgery, after consultation with the patient's primary medical physician. On the day before surgery the patient is maintained on a clear liquid diet and instructed to drink a light mechanical bowel preparation at 14.00 hours, and to use an

Instruments	Hardware
Laparoscopes, 0° and 30°	High-flow insufflator
Veress needle	Chip camera
Trocars: 5 and 10 mm	Video recorder
Bipolar forceps	Photo printer
Scissors	Light source
Harmonic scalpel	Suction/irrigation
Needle holders	Harmonic scalpel generator
Graspers/dissectors	Bipolar and monopolar
Clip appliers	Retractors
Staplers	Generator
Retrieval bags	
Carter-Thomason needle	
Open surgical tray	

TABLE 1
The instruments required

enema at 19.00 hours. After midnight the patient discontinues any oral intake, other than normal medications with a sip of water. The patient is given intravenous antibiotics before the skin incision.

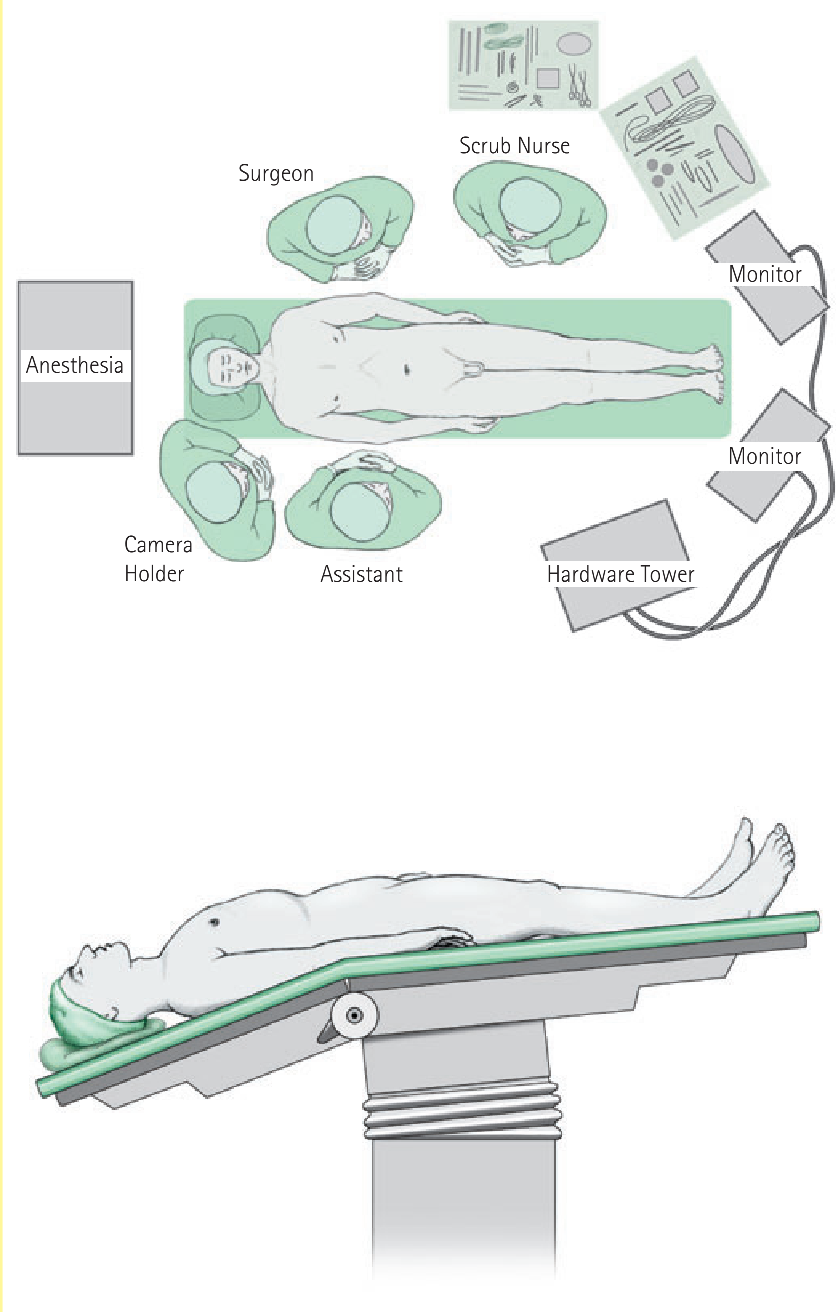
As with any surgical procedure, properly functioning equipment and hardware is essential for a smooth operation; this is accentuated in complicated laparoscopic procedures. The devices and instruments needed for successful laparoscopic prostatectomy (Table 1) are used to provide visual access to the operative field, maintain a blood-free environment, meticulously dissect the surrounding structures, reconstruct the urinary tract, remove the specimens, and close the access sites. Properly functioning instruments and hardware are essential. The surgeon and entire operating team should be familiar with all equipment, to manage any malfunctions that may occur. Extra equipment should be available if a replacement is needed.

Figure 1

Once adequate general anaesthesia is instituted an orogastric tube is placed to deflate the stomach. The patient is positioned supine on the operating table with both arms tucked at the side. Care is taken not to obstruct intravenous lines. All areas of pressure are meticulously padded. The table is extended ≈15° at the level of the umbilicus to facilitate exposure of the pelvic contents. Once proper alignment is confirmed the patient is secured to the table at the level of the chest and mid-thighs, using silk tape for safety if rotation of the table is needed during the procedure. The table is placed in 30° of Trendelenburg tilt to allow the bowel to fall into the upper abdomen.

The patient is prepared in the standard way; drapes are placed lateral to the anterior superior iliac spines, superior to the umbilicus, and at the level of the symphysis pubis. A small hole is cut in the inferior drape and the prepared penis delivered onto the surgical field. A large drape is placed over the patient, with care to maintain space for the surgeon and assistants on either side from the level of the mid-thigh to just superior to the patient's head. A Foley catheter is placed into the bladder for gravity drainage.

The surgeon stands at the patient's left side, and the scrub technician stands on the patient's left at the level of the mid-thigh. The assistant stands on the patient's right side. If a second assistant is used to hold the laparoscope, they are positioned on the patient's right side at the head of the table. The laparoscopic tower (containing the light source, camera unit, video recorder, colour printer, insufflator, electrocautery and harmonic scalpel generators) is placed at the foot of the table on the patient's right side. Monitors are placed at the foot of the table. Our laparoscopic operating rooms have all hardware attached to movable, suspended arms, such that monitors and equipment towers can easily be positioned around the patient. Once the patient is prepared and draped, the camera cord, light cord, electrocautery devices, suction tubing, and insufflation tubing are secured to the centre of the drape at the level of the patient's knees.



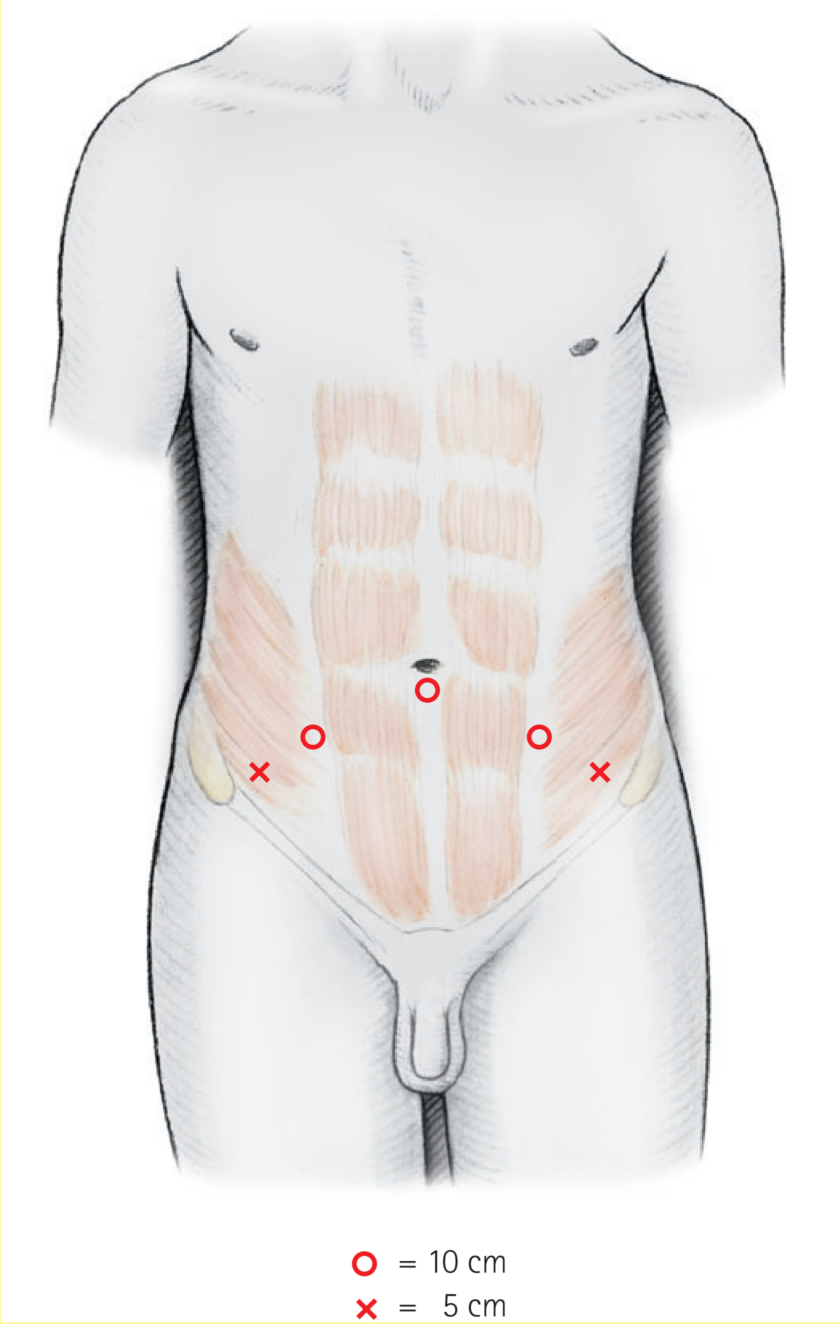


Figure 2

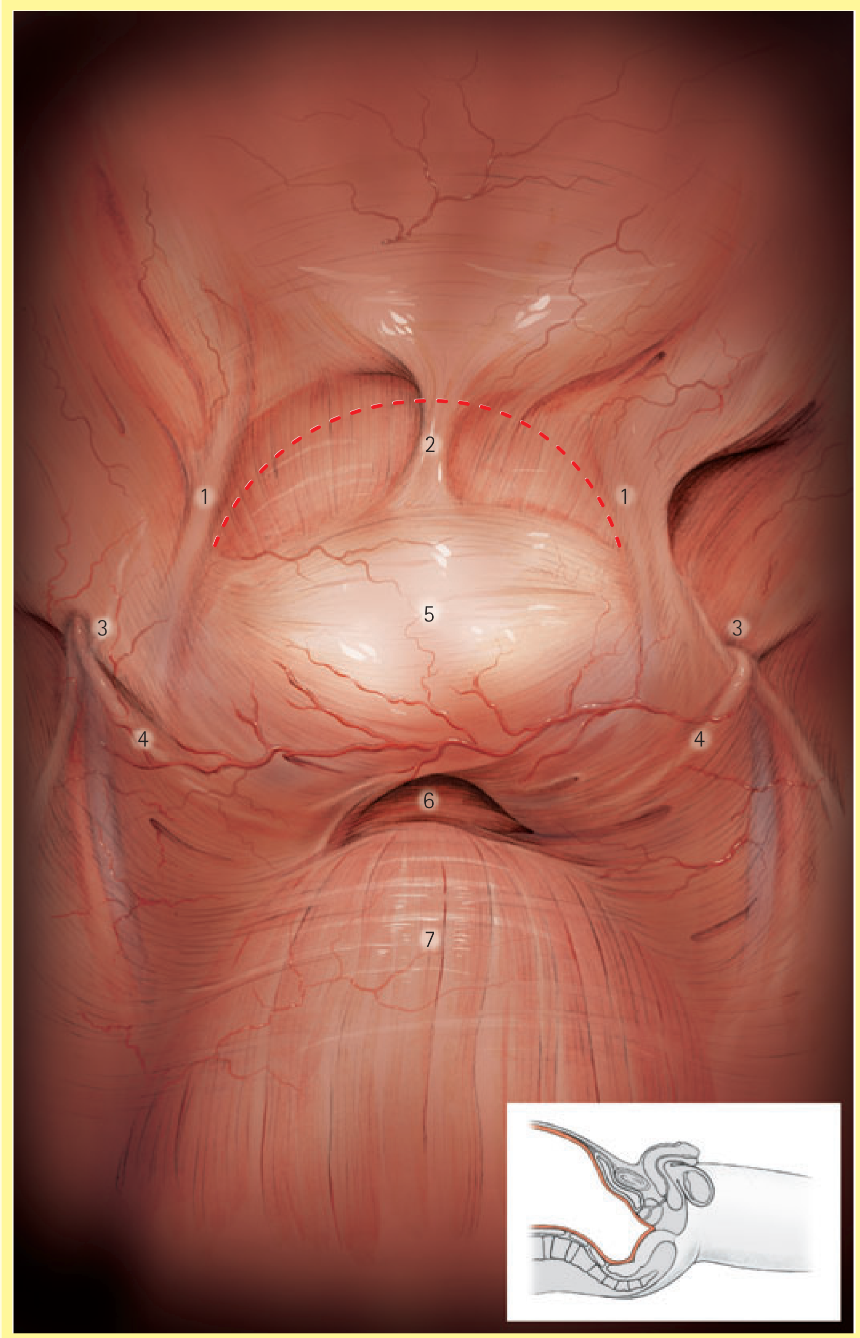
A 1.5-cm curvilinear, infra-umbilical incision is made through the skin. A Veress needle with CO_2 insufflation set at 2 L/min flow and 15 cmH_2O pressure is placed through the incision and into the peritoneum, using the surgeon's dominant hand while the subordinate hand is used to lift the lower abdominal tissue further anteriorly. Low-pressure flow is an indication of correct positioning of the Veress needle. Once pneumoperitoneum is generated, a 10-mm trocar is placed into the abdomen at 45° inferiorly and posteriorly towards the patient's sacrum. Once the trocar is placed, a 0° laparoscope is quickly used to inspect the abdomen for any inadvertent trauma to the abdominal contents. Once this is assured, four trocars are placed in a fan-shaped array towards the patient's pelvis. Two lateral 5 mm trocars are placed ≈2 cm medial and superior to the anterior superior iliac spines and two para-rectal 10 mm trocars placed ≈2 cm medial and superior to the 5 mm ports.

If clinically indicated, pelvic lymph nodes are dissected on both sides, with nodes removed from the umbilical port site and the specimens sent for sectioning.

Figures 3 and 4

(1) Medial umbilical ligament
(2) Median umbilical ligament
(3) Internal inguinal ring
(4) Vas deferens
(5) Bladder
(6) Pouch of Douglas
(7) Rectum

We begin the dissection at the superior portion of the bladder. An atraumatic grasper is used through the right lateral port to retract the anterior abdominal wall superiorly and anteriorly. Monopolar scissors in the surgeon's right hand through the left para-rectal port, and bipolar forceps in the surgeon's left hand through the left lateral port, are used to transect the urachus close to the umbilicus. The space of Retzius is dissected, allowing the bladder to fall posteriorly. The dissection is continued laterally to the medial umbilical ligaments (dotted line), inferiorly to the level of the vas deferens, and anteriorly to the abdominal wall, pubic rami, and symphysis pubis. The endopelvic fascia on either side of the prostate is fully defined and cleaned of any overlying fat.



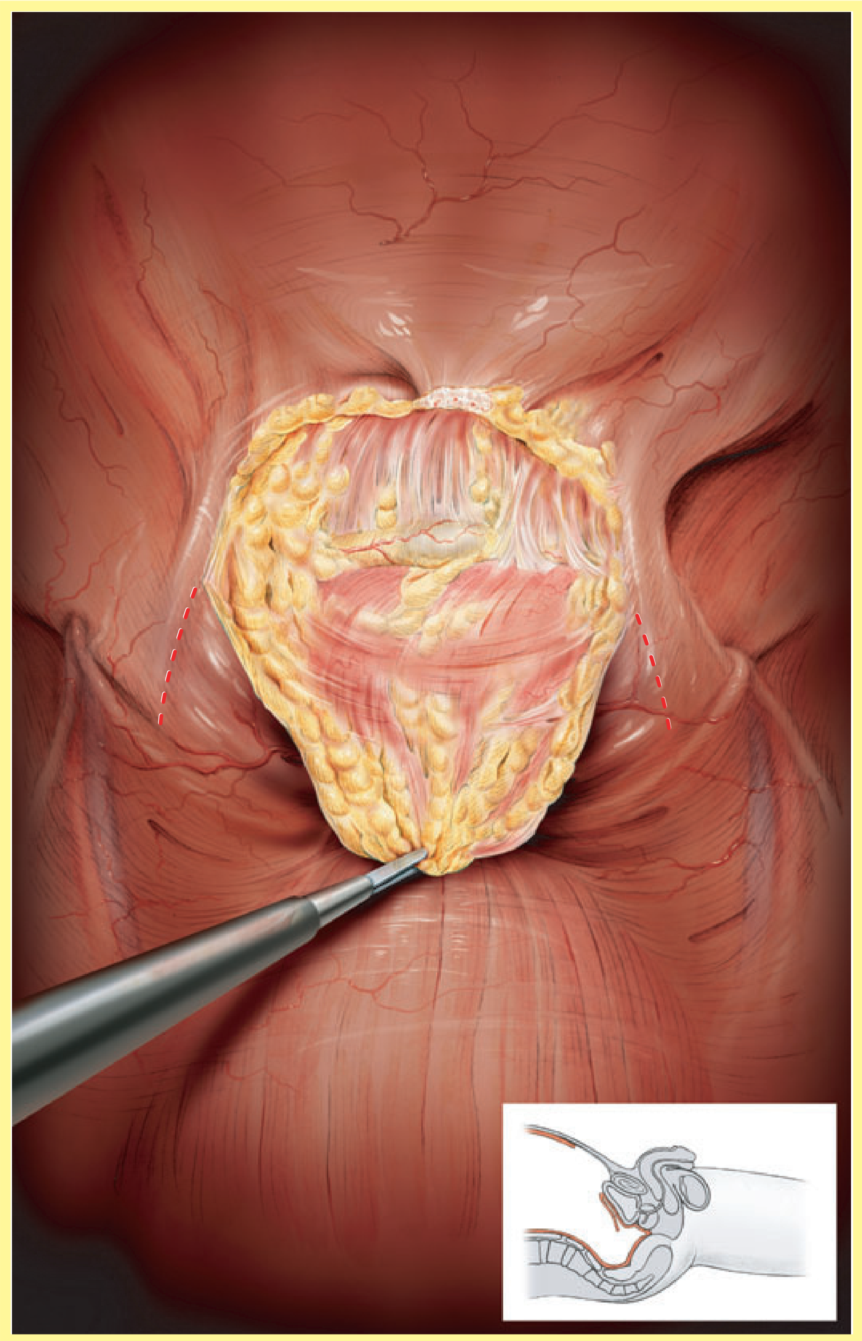
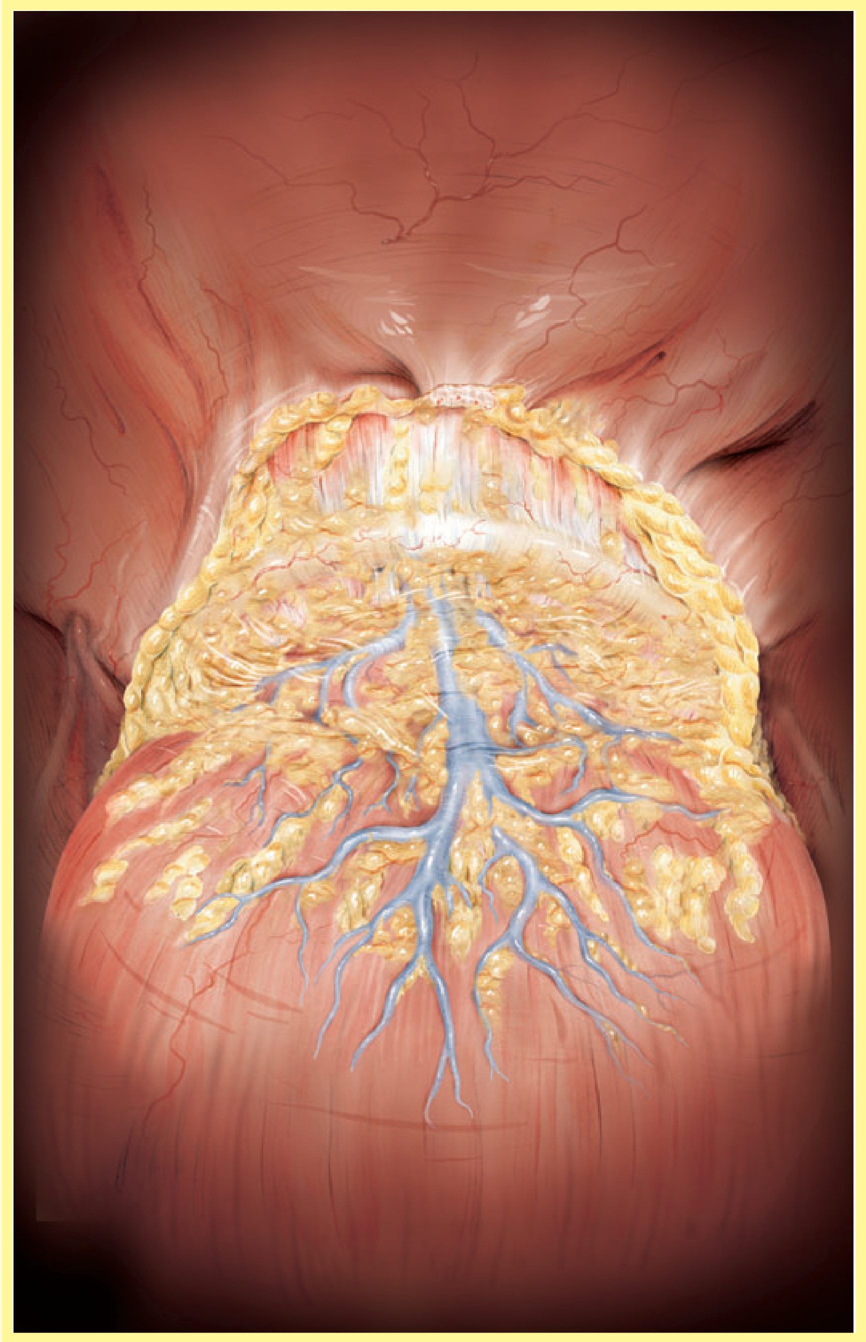


Figure 5

The superficial dorsal vein is controlled with bipolar electrocautery and transected sharply. The assistant now places a fan retractor through the right para-rectal port and retracts the bladder with a Foley catheter balloon posteriorly and superiorly to further expose the anterior portion of the prostate. A suction drain is placed through the right lateral port to evacuate smoke and to provide counter-traction for further dissection.



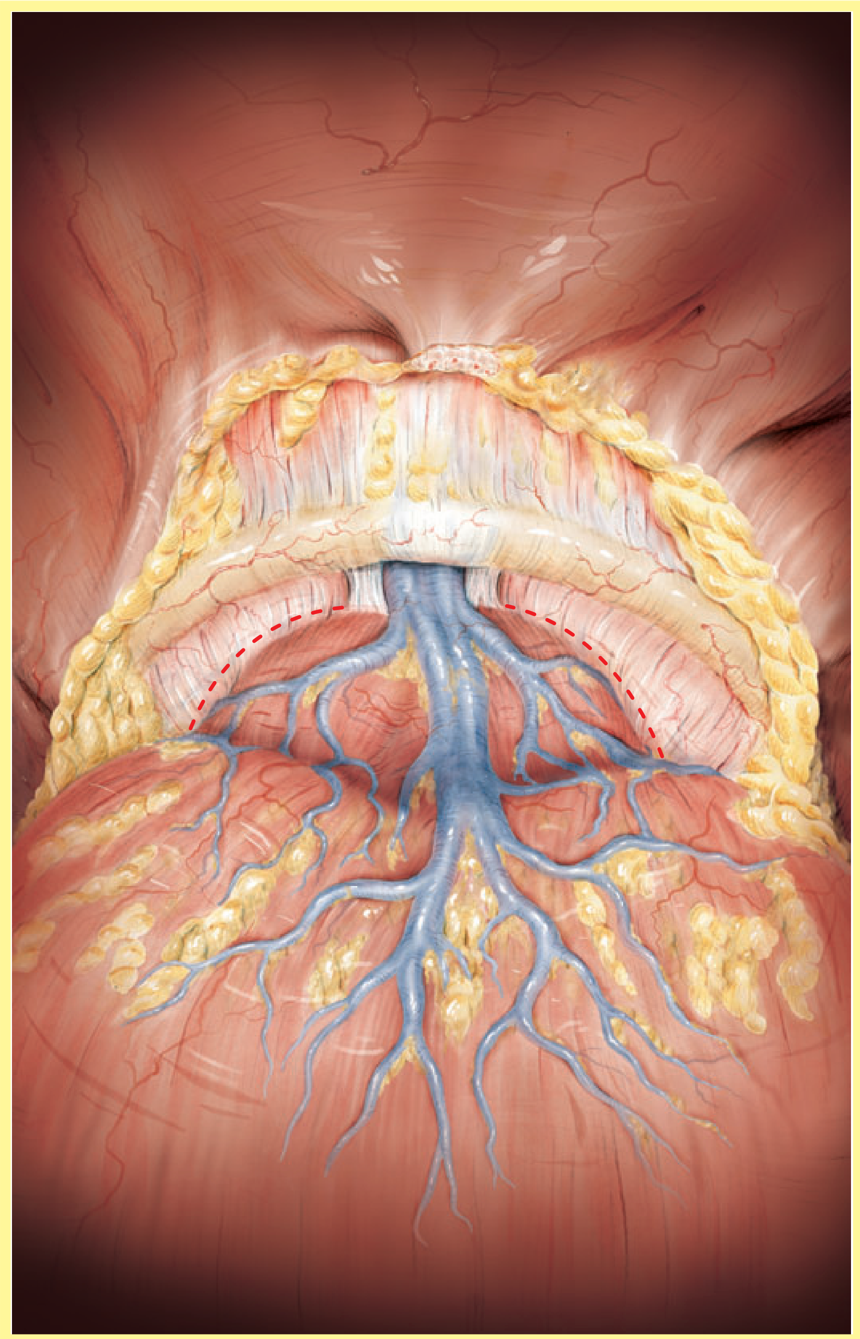
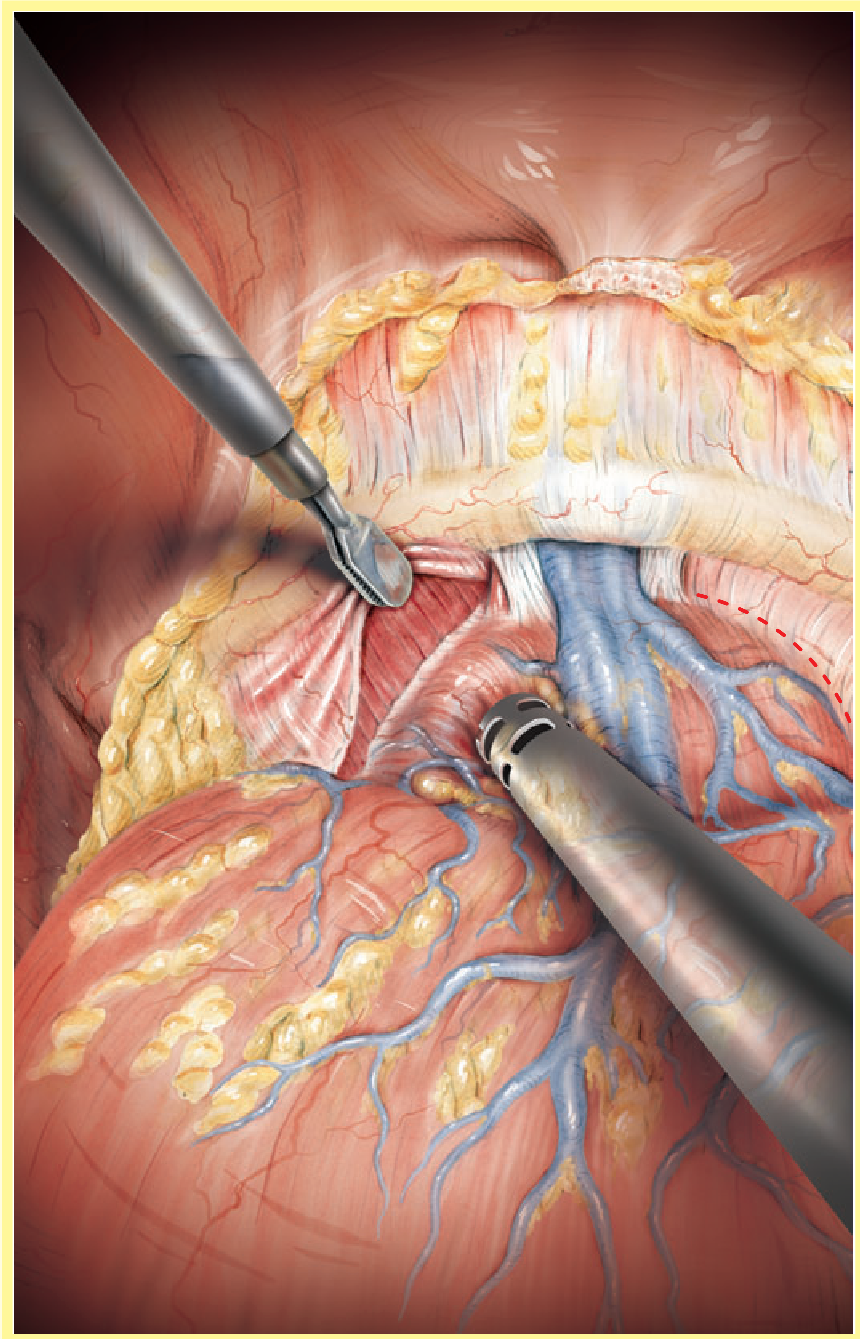


Figure 6

The endopelvic fascia is incised bilaterally from the level of the puboprostatic ligaments anteriorly to the prostatovesical junction posteriorly (dotted line). We preserve the puboprostatic ligaments during this dissection.

Figures 7 and 8

The levator ani muscles are gently swept laterally from the prostate capsule along the entire length of the prostate. Meticulous dissection of the lateral apex of the prostate gland is performed. This will help define the plane between the urethra and dorsal vein complex.



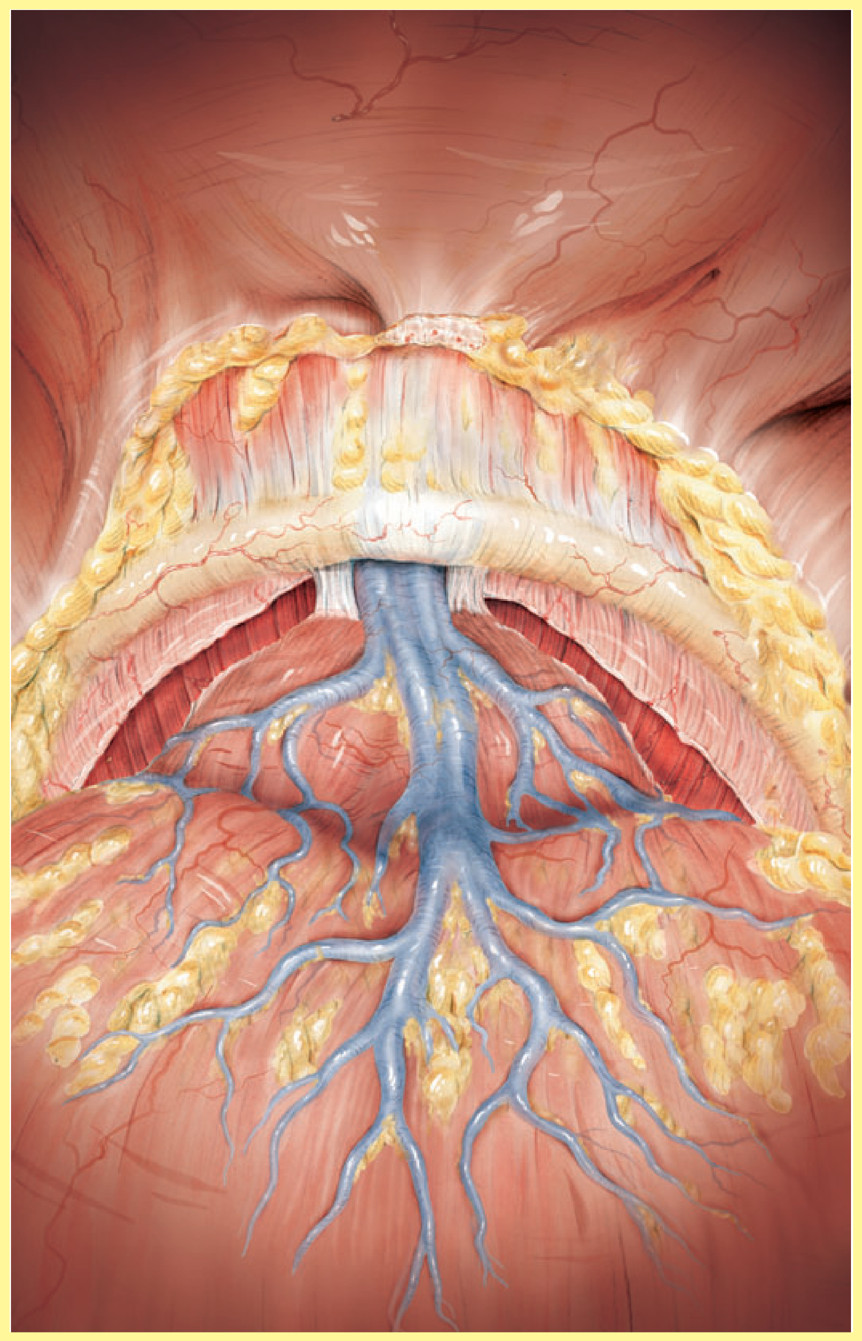
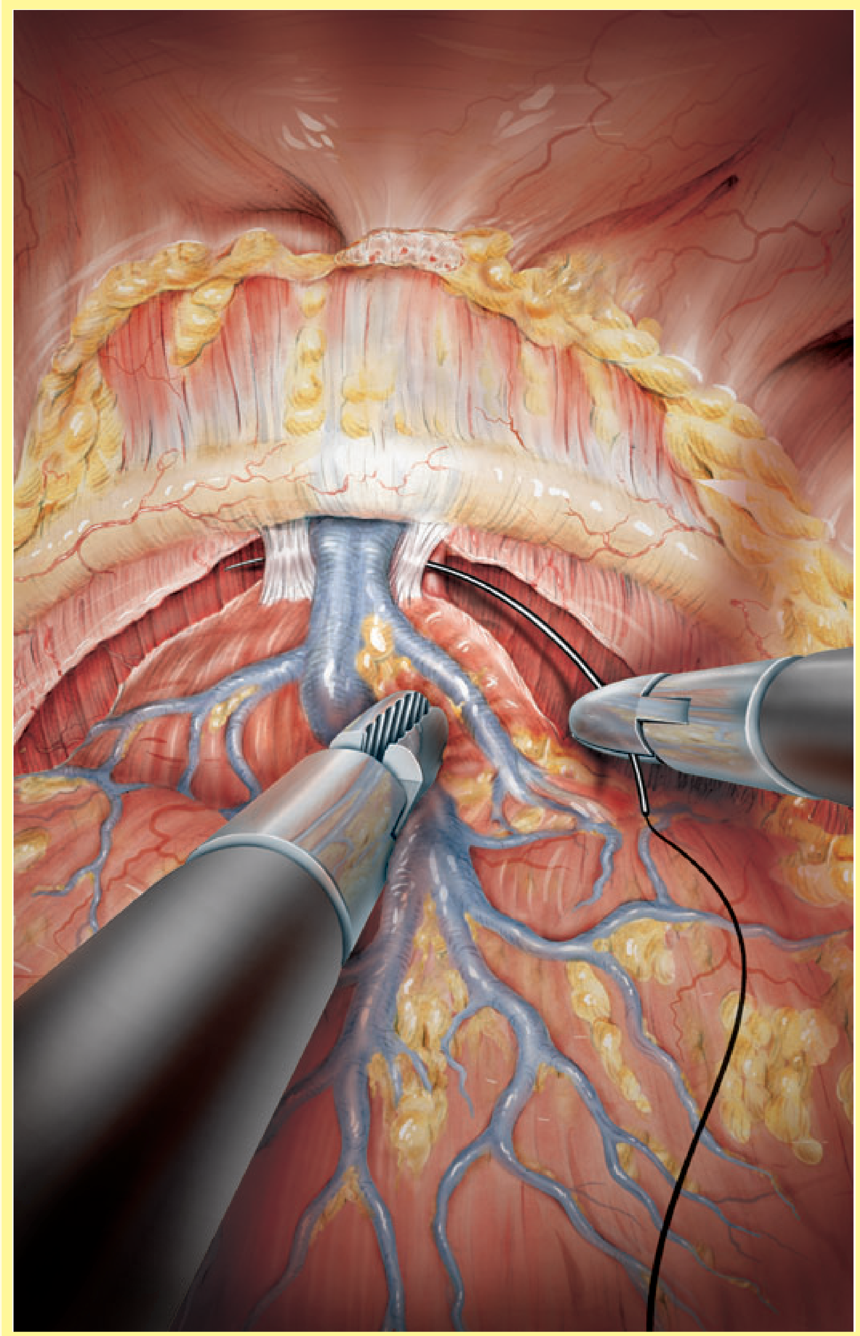


Figure 9

A 0-polyglactin suture cut to 20 cm on a CT1 needle is used to ligate the dorsal vein complex. We gently bend the needle manually so the curve of the needle is extended. We have found that this more accurately approximates the path between the urethra and dorsal vein complex. The suture is placed in one direction between the urethra and dorsal vein complex. The correct plane is often difficult to visualize. Introducing a metal sound into the urethra may be helpful, by providing visual clues to the location of the urethra, as well as tactile clues if the needle hits the sound during needle placement. The suture is passed just distal and ventral to the apex to avoid the urethra.



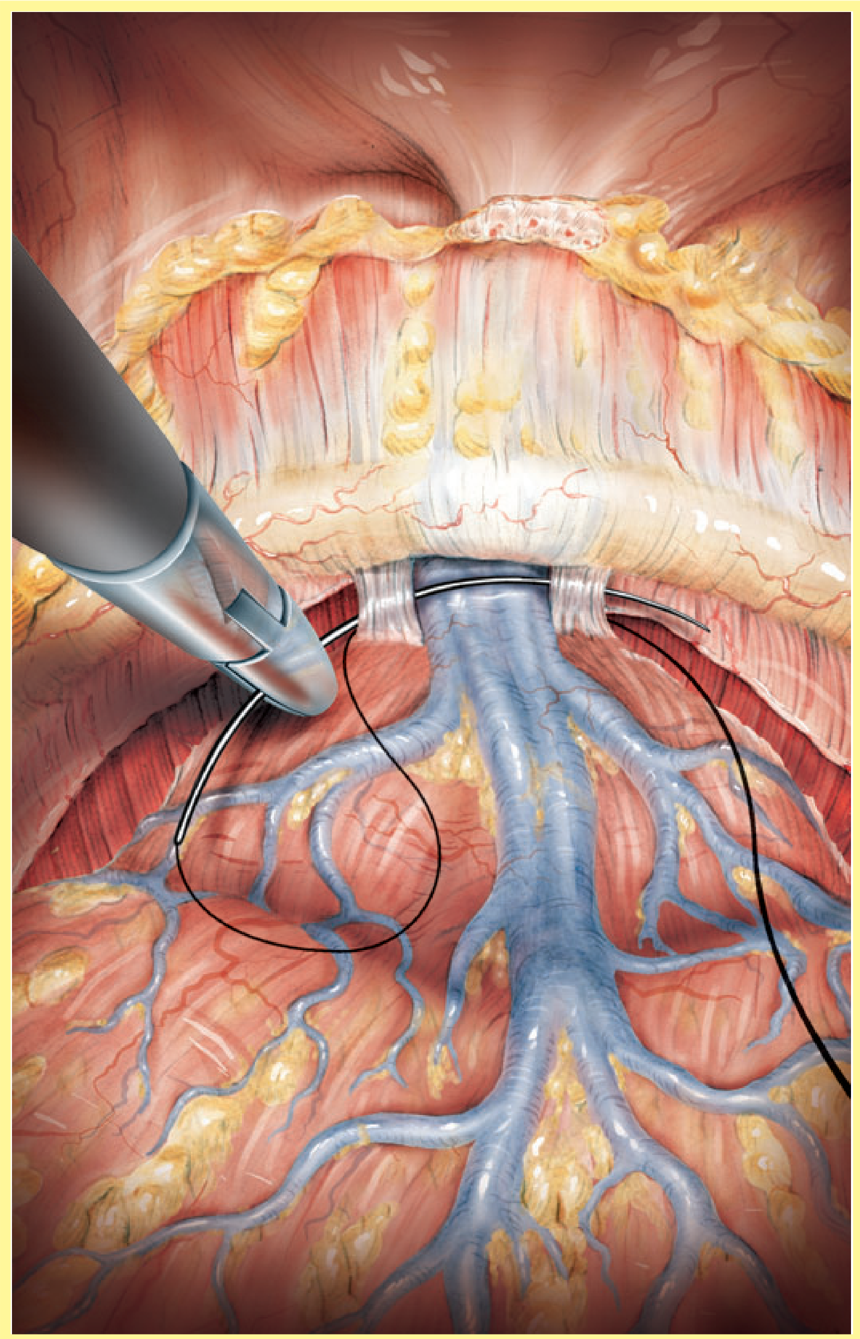
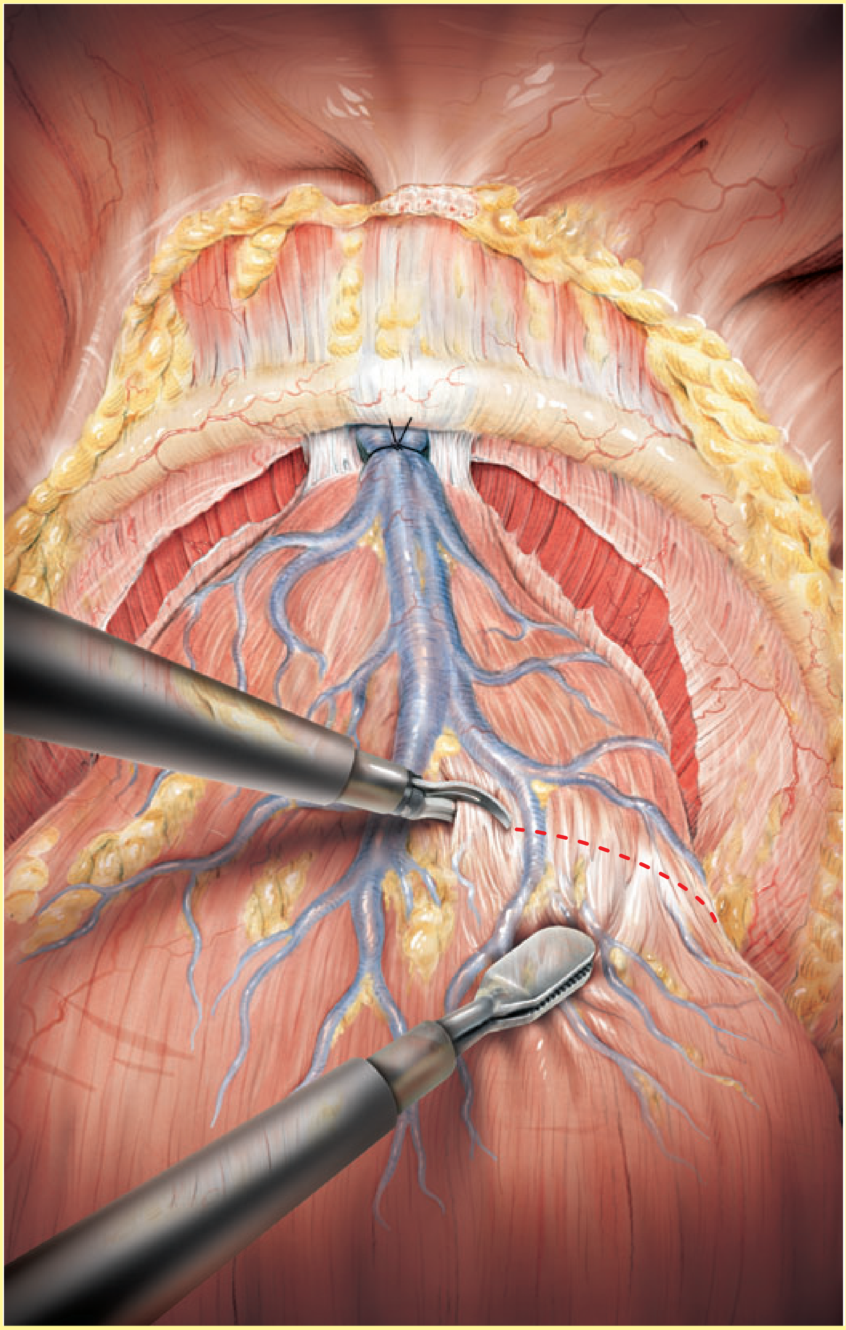


Figure 10

The suture is then passed back in the other direction between the dorsal vein complex and the puboprostatic ligaments, sparing the ligaments. The suture is tied intracorporeally. The suture is cut and the needle is removed from the abdomen.

Figure 11

Attention is now paid to the bladder neck transection. The prostatovesical junction is identified visually as a slight divot between the prostate and bladder laterally. The plane of dissection can often be elusive. Gentle traction of the bladder superiorly as well as palpating the lateral base of the prostate gland can help to identify the correct area for transection. Traction on the Foley catheter externally tends to be more detrimental than helpful in defining this plane. The balloon of the catheter will bulk the bladder neck on the side of the balloon that is away from the surgeon, thus making dissection more difficult. We prefer to place a fan retractor through the right pararectal port, and gently retract the bladder and catheter balloon superiorly. The surgeon's right hand uses a harmonic scalpel through the left pararectal port to transect the tissue between the bladder and the prostate down to the level of the bladder mucosa. The surgeon's left hand switches between the bipolar forceps and the suction device to control any areas of bleeding and maintain a clean operative field. Meticulous and gentle blunt dissection using the tips of the harmonic scalpel, as well as the suction device before tissue transection, allows the correct plane to be identified. Maintaining a blood-free operative field permits the detrusor fibres to be discriminated from the capsule of the prostate gland. The harmonic scalpel, bipolar electrocautery and suction help considerably in this regard.



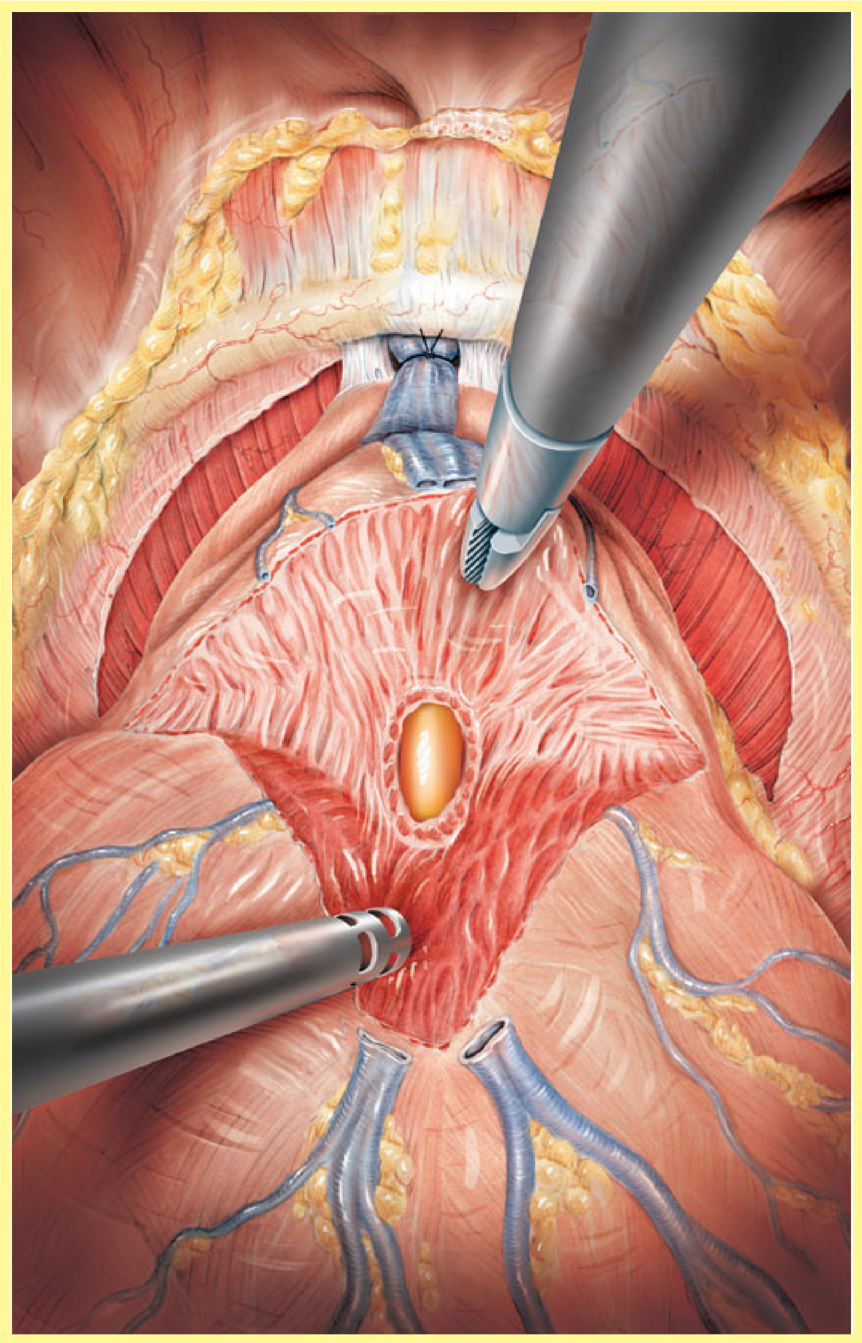
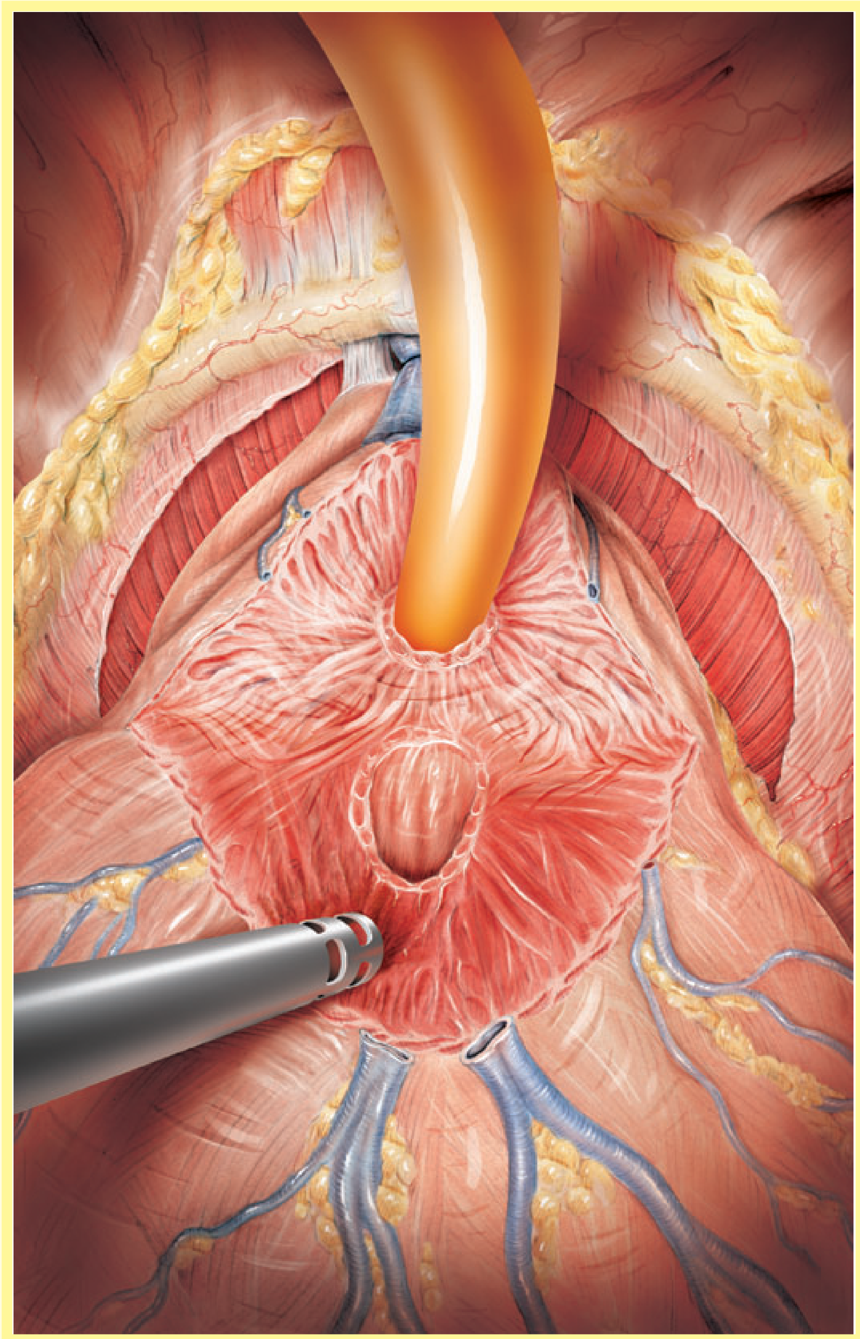


Figure 12

Once the level of the bladder mucosa is reached anteriorly, this is transected using the harmonic scalpel.

Figure 13

The Foley catheter balloon is deflated and a clamp placed across the external portion of the catheter to prevent leakage of pneumoperitoneum. The catheter is gently retracted until the tip can be passed through the prostatovesical opening and into the abdomen. The assistant places a locking forceps through the right lateral port and firmly grasps the tip of the catheter. The catheter is gently pulled out of the patient until the forceps is pulled snugly against the prostate. The external clamp on the Foley catheter is then placed close to the urethral meatus to prevent the catheter from being pulled further into the abdomen. This allows the assistant to retract the prostate gland anteriorly and laterally for further dissection. The dissection of the bladder neck is continued laterally to the level of the prostatic pedicles.



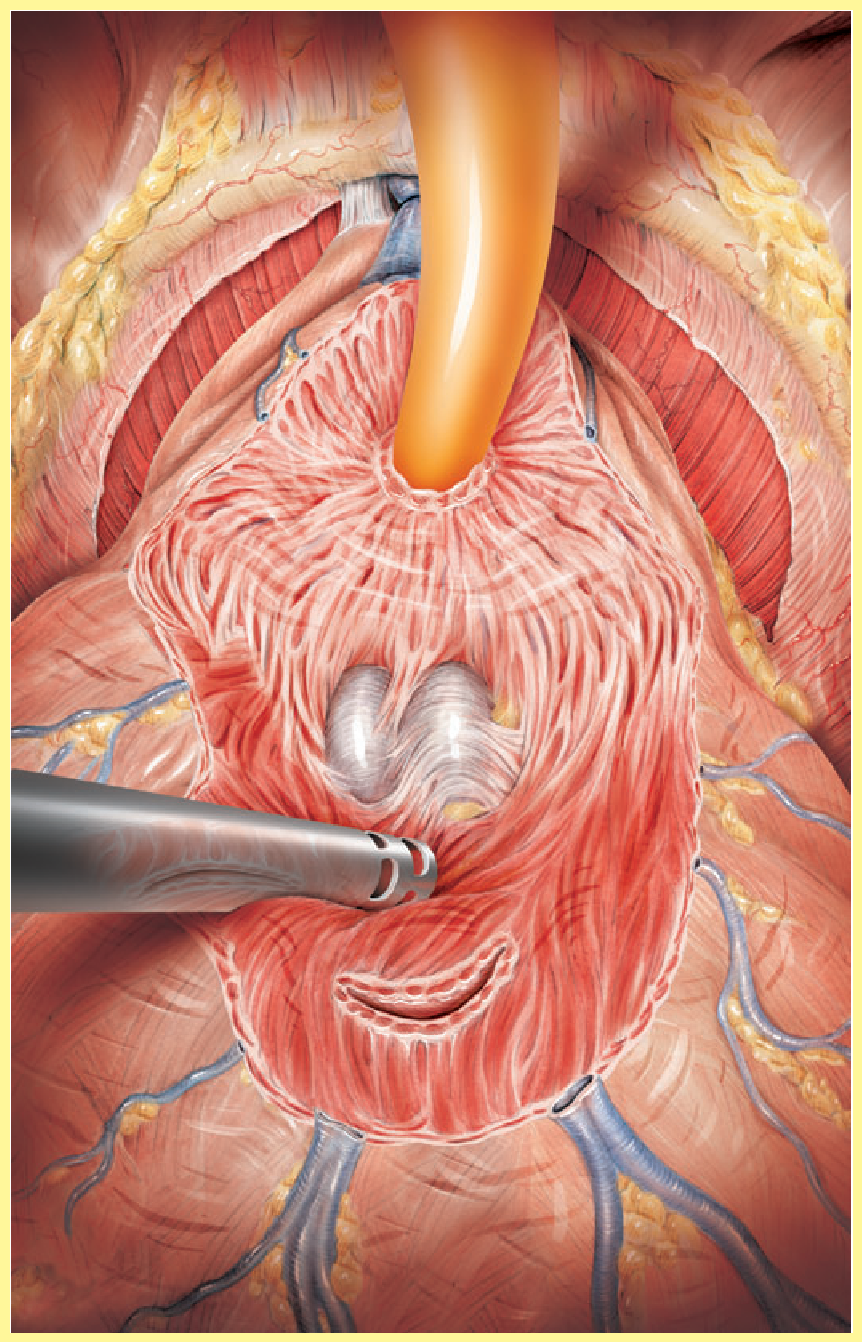
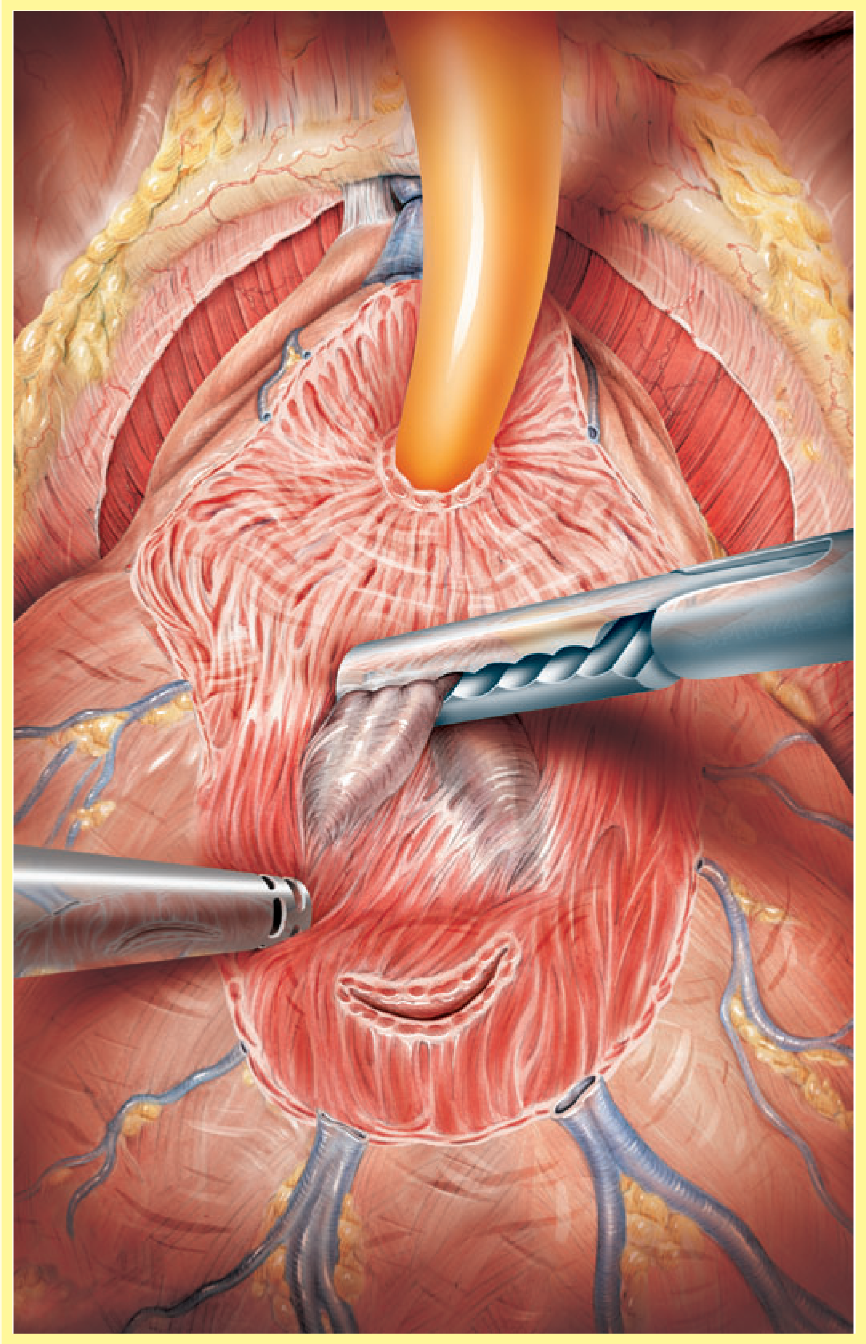


Figure 14

The posterior wall of the bladder neck is now fully visible through the anterior cystotomy. The mucosa of the posterior bladder neck is transected with the harmonic scalpel. This can help to further define the plane between the detrusor and prostate capsule, as the surgeon can often be operating within a small hole near the prostate pedicles. If a middle lobe of prostate tissue is present, this is gently dissected from the mucosa. The middle lobe is then held by the assistant with a locking grasper and used to retract the gland ventrally. The dissection is continued, dividing the detrusor from the capsule between the pedicles of the prostate. In this way the entire bladder neck is preserved. The dissection continues until the ampulla of the vas deferens and the insertion of the seminal vesicles appears inferior to the prostatic urethra.

Figure 15

The vas deferens are bluntly dissected free from the surrounding tissue and transected using the harmonic scalpel. Once this is done the catheter is released from the locking grasper and gently pulled into the urethra.



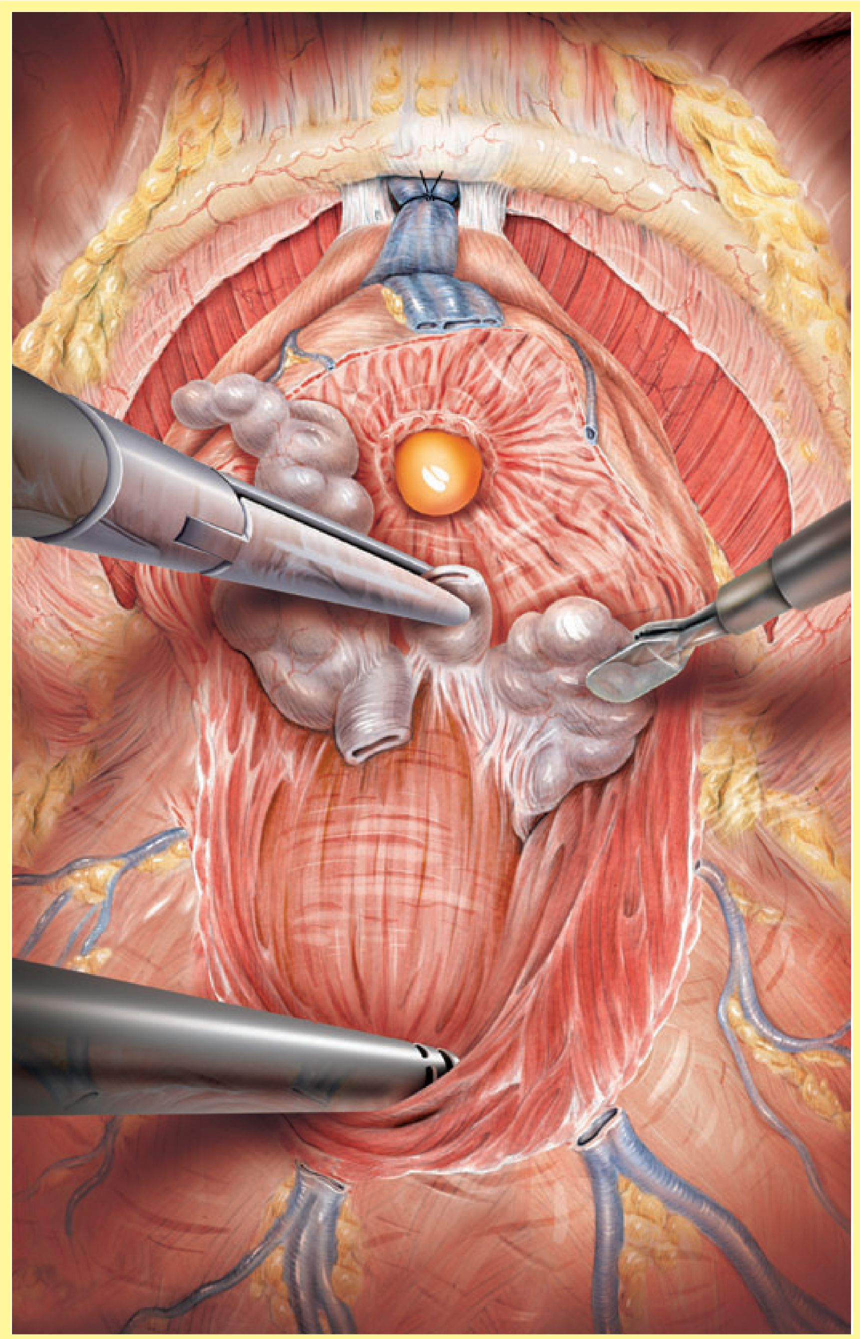
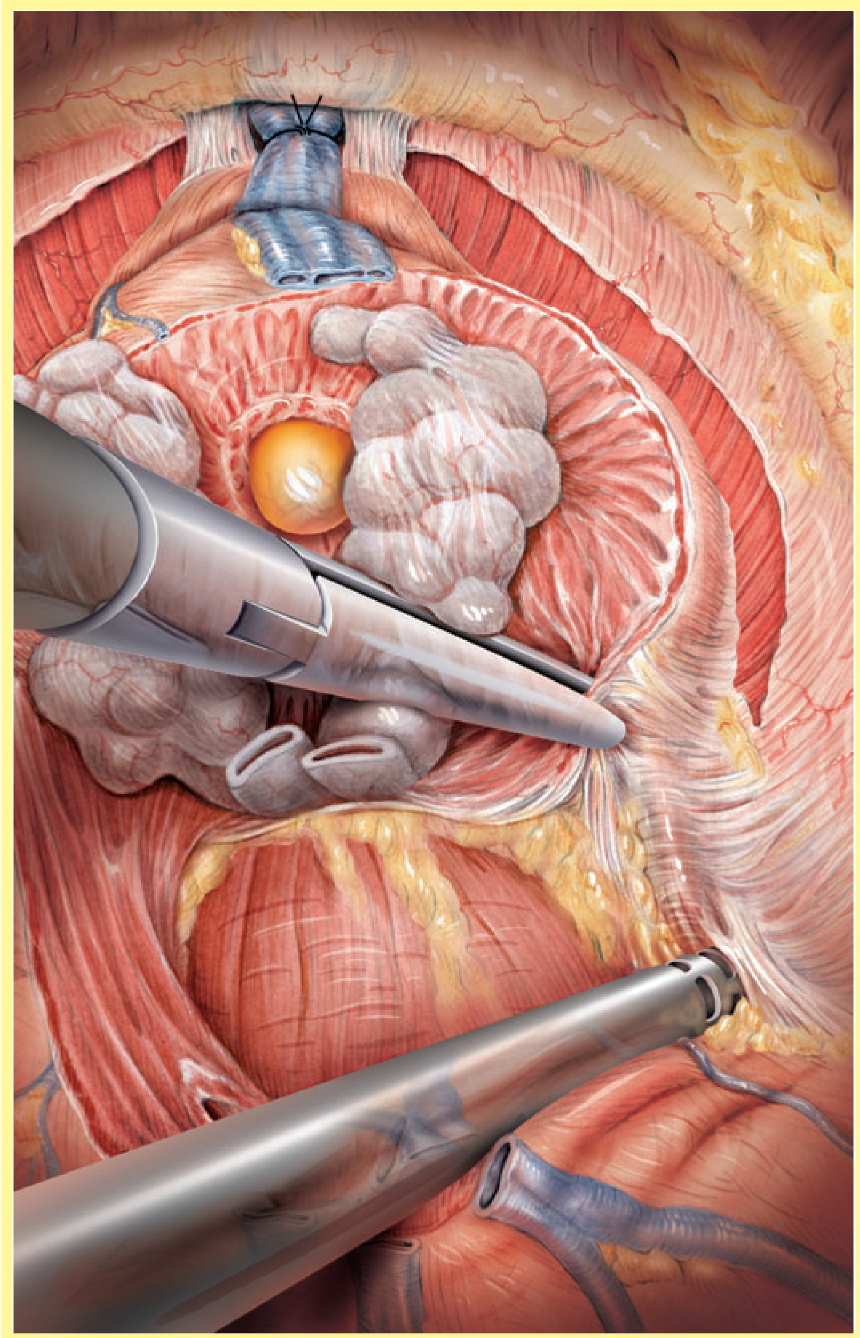


Figure 16

The assistant then grasps the ampulla of the vas deferens for anterior and lateral retraction. Care must be taken not to tear the vas deferens from the prostate, as this tissue is very fragile. The fan retractor is removed and the suction device moved from the surgeon to the assistant at the right pararectal port. The suction device is used to evacuate smoke and to provide counter-traction by pulling the bladder neck posteriorly and the lateral pedicles further laterally during dissection of the seminal vesicles. The surgeon then places the bipolar forceps through the left 5 mm port. The bipolar forceps are used to gently grasp the seminal vesicles and pull ventrally. The harmonic scalpel is used to transect any tissue tethering the seminal vesicles posteriorly. Care is taken when dissecting at the lateral and apical portion of the seminal vesicles, as the neurovascular bundles run very close to these areas. Once both seminal vesicles are fully dissected, the assistant grasps them along with the ampulla of the vas for retracting.

Figure 17

Denonvilliers' fascia is then incised on the base of the prostate using the harmonic scalpel and the prostate is carefully dissected from the rectum. Laterally, the pedicles of the prostate are now fully defined. The harmonic scalpel is used to transect the lateral pedicles close to the prostate. Gentle, blunt dissection with the tips of the harmonic scalpel should allow accurate identification of the plane between the prostate and neurovascular bundles. The magnified view from the laparoscope allows better identification of this anatomy than during open prostatectomy. Once this plane is entered, the surgeon can easily push the bundles off the prostate. Small perforating vessels that course from the bundles to the prostate can be transected using the harmonic scalpel. We do not use monopolar electrocautery during this stage of the dissection, but bipolar electrocautery only sparingly, to prevent damage to the neurovascular bundles. Each subsequent transection of tissue allows the neurovascular bundles to fall laterally and posterior to the next area of pedicle transection. Now the prostate is tethered only by the urethra and surrounding apical tissue.



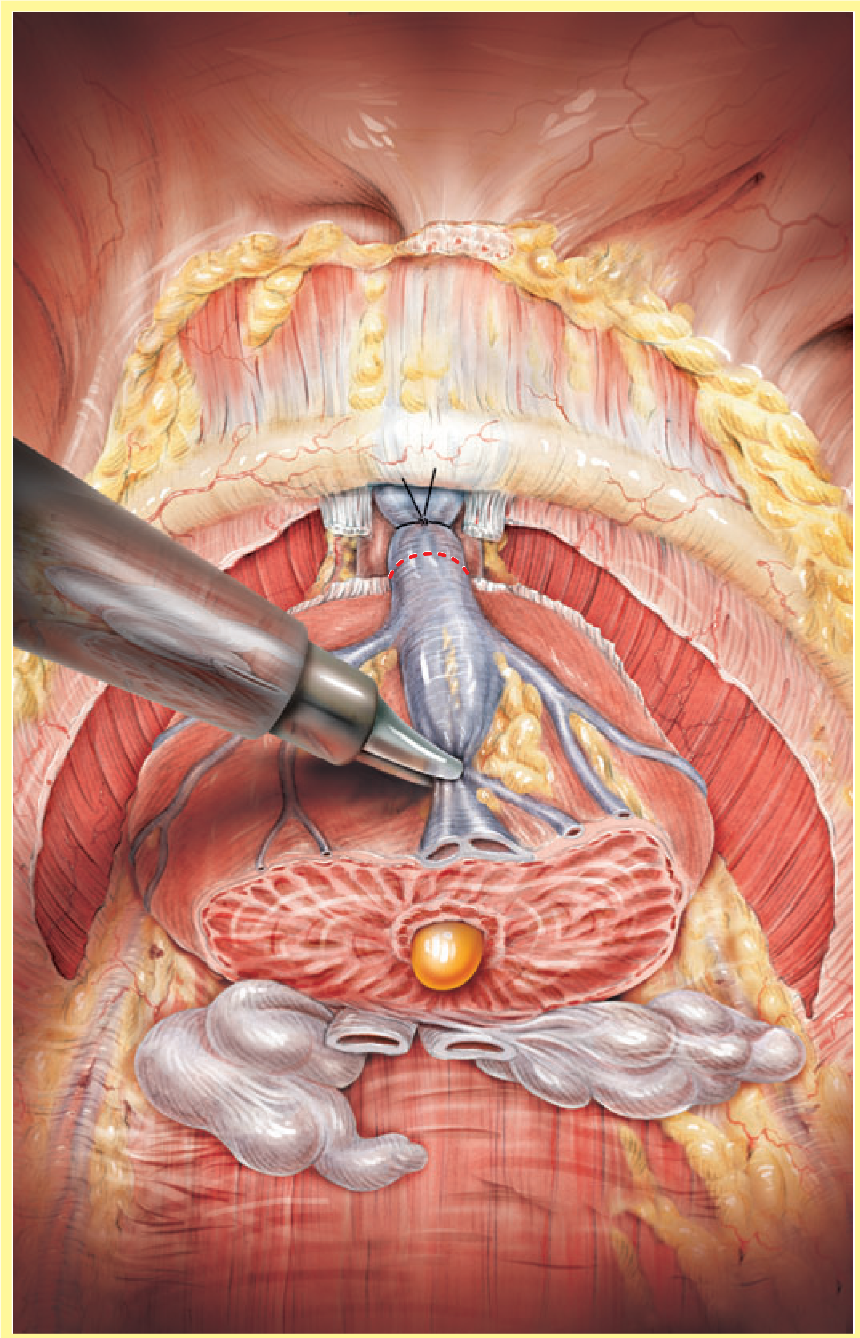
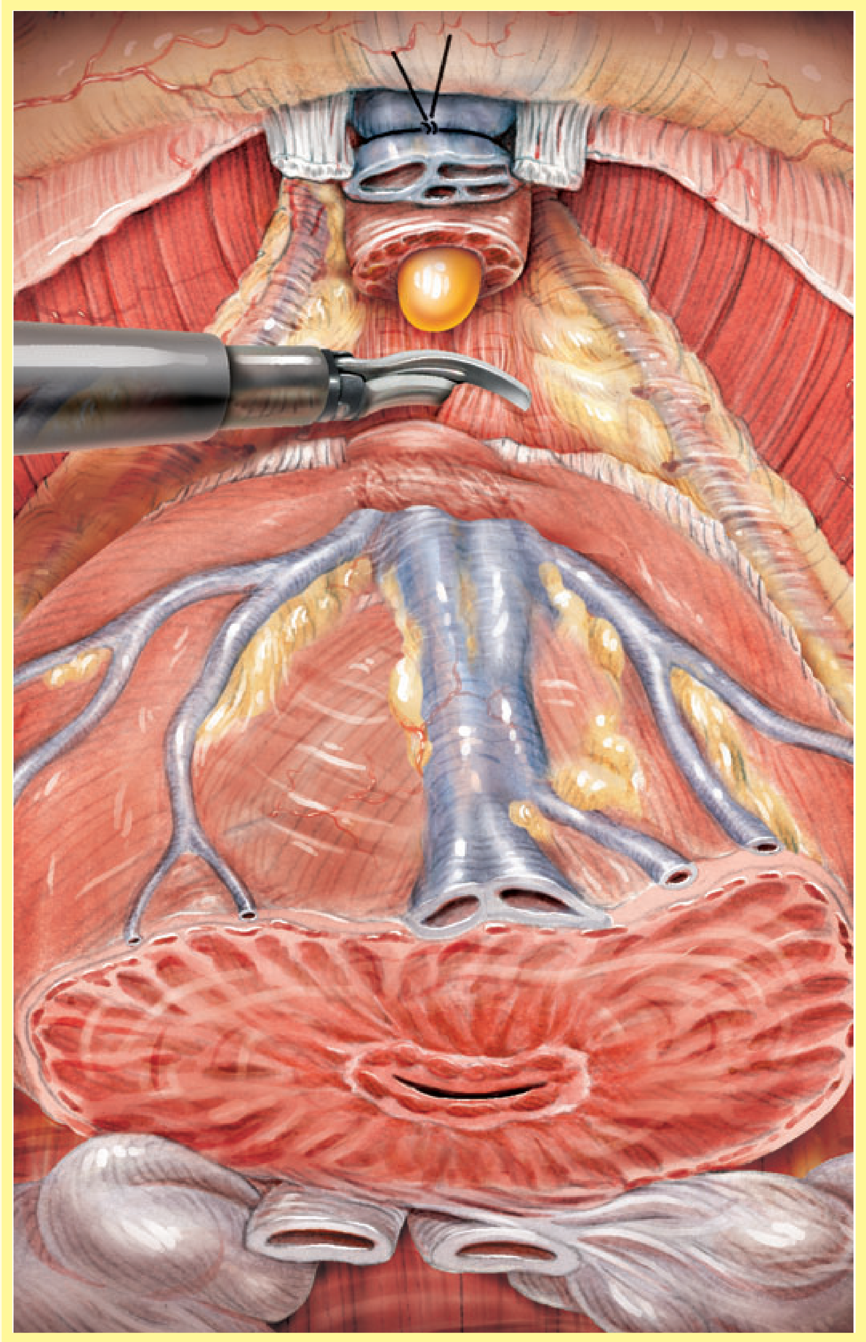


Figure 18

The seminal vesicles and ampulla are released and the locking grasper used to gently pull the anterior surface of the prostate superiorly and posteriorly, to put some tension on the dorsal vein complex. The puboprostatic ligaments are transected close to the prostate. The dorsal vein complex (dotted line) is then transected to the level of the urethra using the harmonic scalpel. Once the anterior portion of the urethra is identified, the remaining apical tissue is transected laterally. The assistant retracts the prostate in the contralateral direction to expose the lateral tissue to the surgeon.

Figure 19

Once all peri-urethral tissue except the recto-urethralis is dissected, the urethra is divided sharply with scissors on the anterior surface. The Foley catheter is retracted further into the urethra and the posterior urethra sharply divided using scissors. The harmonic scalpel is then used to transect the recto-urethralis. The prostate is now free, and is placed in the patient's left lower quadrant for later extraction at the end of the procedure.



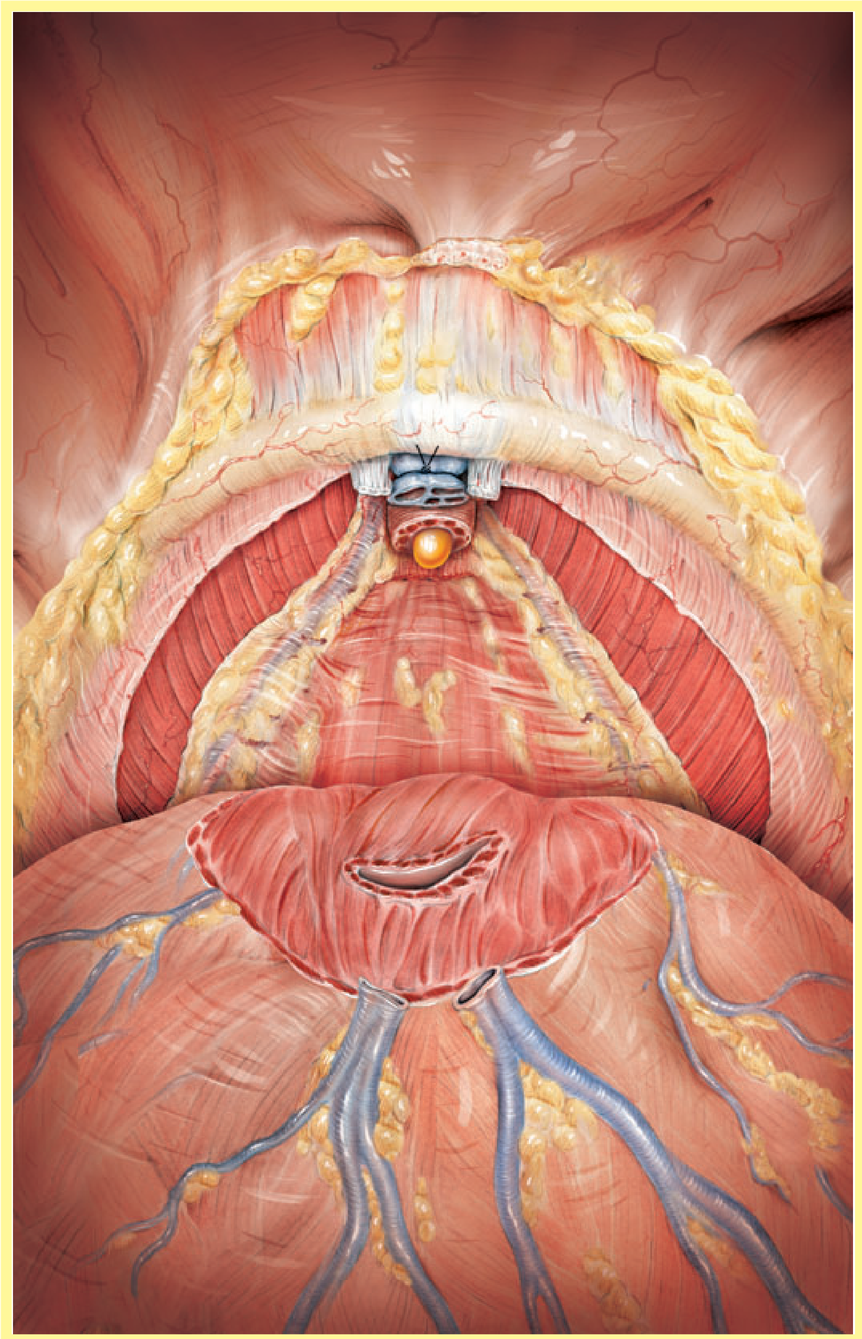


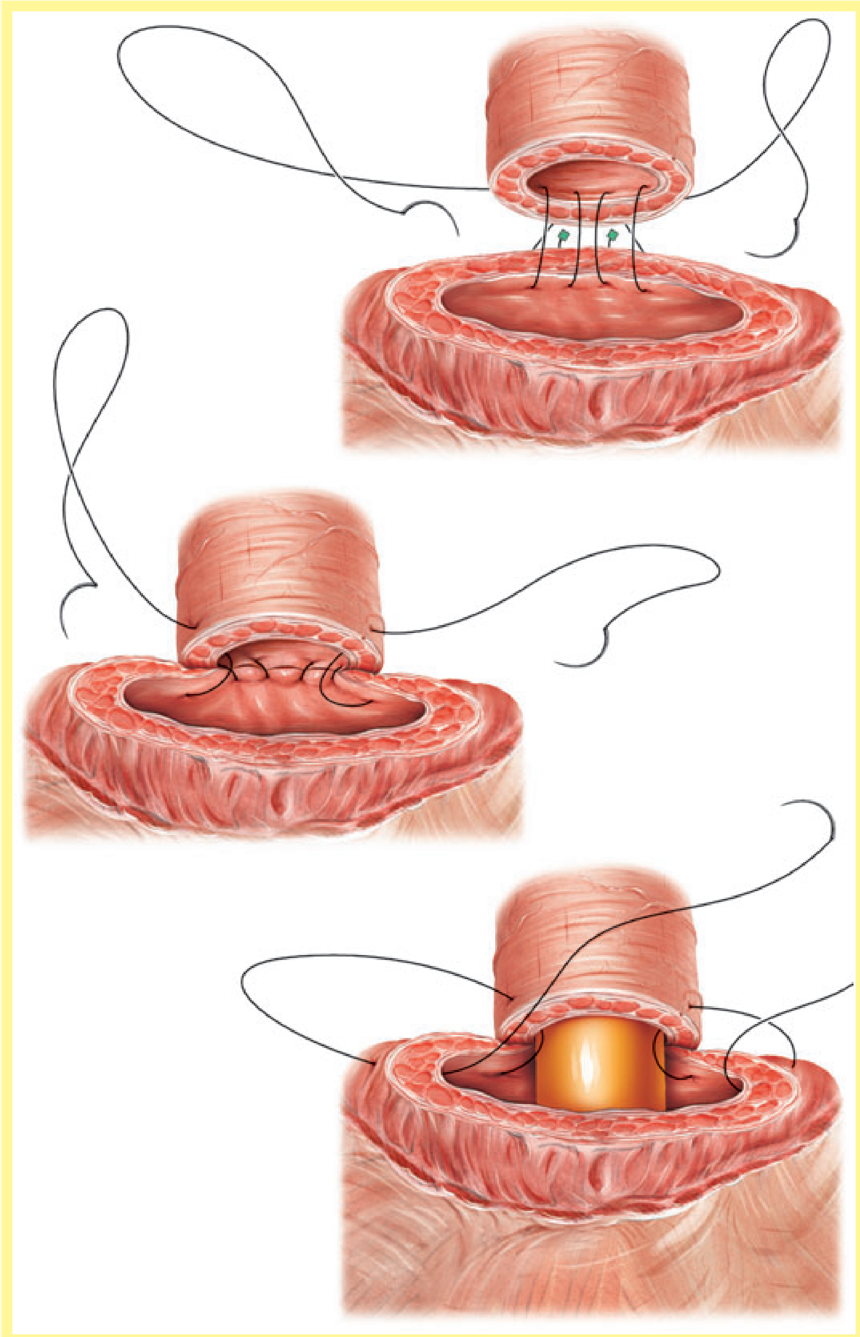
Figure 20

Meticulous haemostasis is visually assured. Care is taken to minimize the use of electrocautery near the neurovascular bundles and monopolar electrocautery is never used near the bundle or on the surface of the rectum. FloSeal matrix (Baxter Healthcare, USA) is placed on the neurovascular bundles as needed, and the assistant can gently compress the bladder into the prostatic fossa to facilitate haemostasis as the surgeon prepares for the urethrovesical anastomosis.

Figure 21

Two sutures of 2–0 poliglecaprone on UR6 needles cut to 20 cm are used for the urethrovesical anastomosis. The extended curve of the UR6 needle allows the anastomotic sutures to be placed accurately in their various locations when using standard intracorporeal techniques. Lapra-ty™ (Ethicon, USA) absorbable suture clips are placed on the free ends. The surgeon places the needle holder with the left hand through the left lateral port, and places one suture from outside to the inside at the posterior area of the bladder neck. The assistant again grasps the catheter near the urethral stump and gently retracts anteriorly to expose the posterior edge of the urethra. The surgeon then places this suture from inside to outside at the corresponding section of the urethral stump. This is repeated on the right side with the needle holder in the surgeon's right hand through the right lateral port.

Each running suture is placed further laterally through the bladder neck and the urethral stump before tightening the anastomosis. The sutures are now fixed at four points on the bladder neck and the urethra. Gentle traction on the sutures is used to approximate the bladder neck to the urethra. This 'parachute' technique helps to prevent any one suture from pulling through either the urethral or bladder neck mucosa.



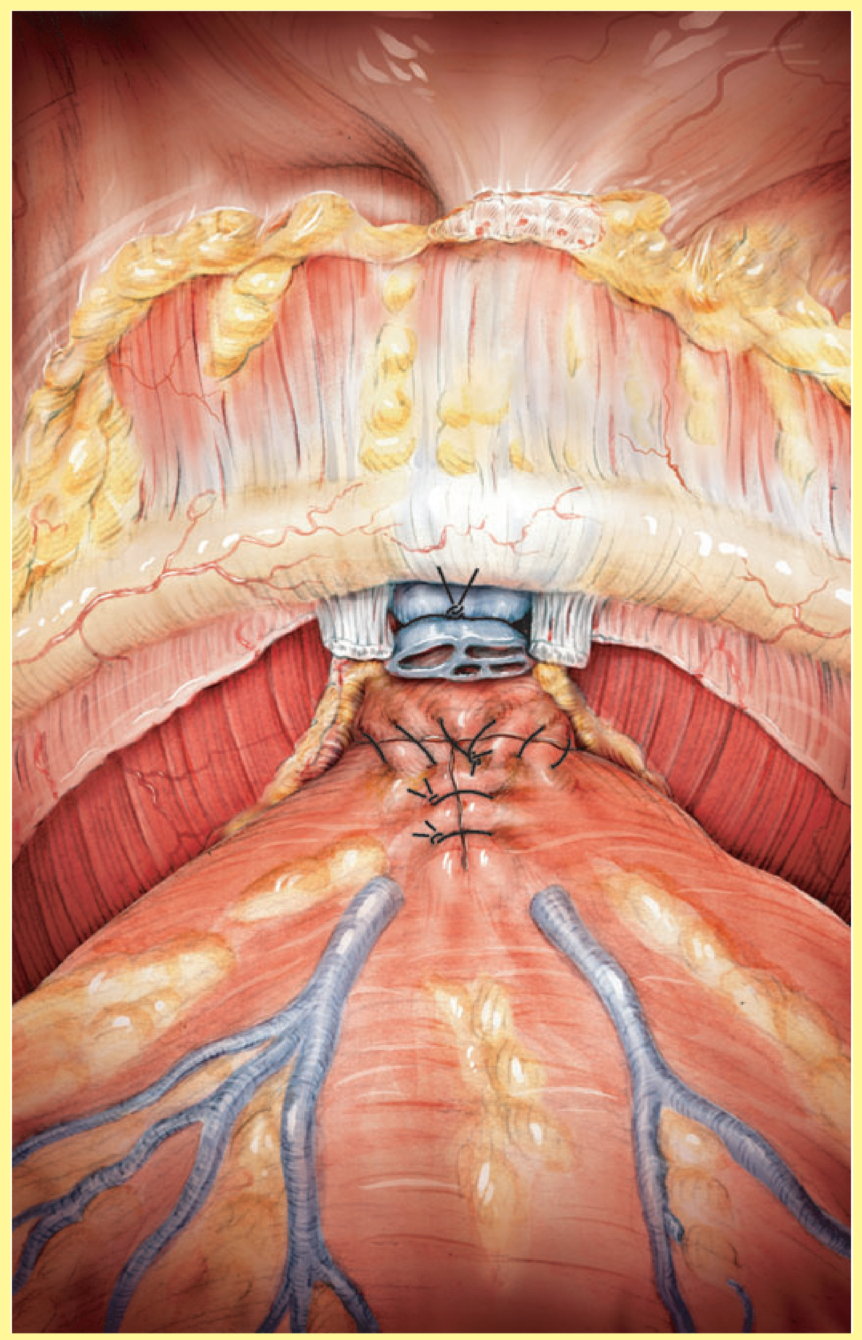


Figure 22

Each suture is then continued around to complete the urethrovesical anastomosis. The surgeon must alternate between left and right hand, as well as forehand and backhand suturing techniques. The urethral catheter is intermittently passed into the operative field to assure patency of the anastomosis. One of the sutures is then passed a final time through the bladder neck, such that there is one suture on either side of the anastomosis. The needles are removed from the suture and are placed near the prostate for removal with the surgical specimen. The anastomotic sutures are tied intracorporeally.

A Silastic Foley catheter is placed gently into the bladder and the balloon inflated with 15 mL of sterile water. The bladder is subsequently filled with 250 mL of sterile saline to check for anastomotic leakage. Once the integrity of the anastomosis is assured, the bladder is gently hand irrigated for any possible clots and the catheter placed to gravity drainage.

SPECIMEN REMOVAL AND CLOSURE

The specimen and anastomotic needles are placed in a specimen bag and removed through the umbilical port, by extending the incision as needed. This incision is then closed in two layers with 0-polyglactin for the fascia and 4–0 poliglecaprone (subcuticular) for the skin. The abdomen is again fully inspected to assure haemostasis. A passive drain is placed through the left lateral port and draped over the urethrovesical anastomosis. The two pararectal port sites are closed in two layers. A Carter-Thomason needle is used to facilitate closure of the fascia with 0-polyglactin sutures. Before the last port is removed the pneumoperitoneum is fully reduced, and before skin closure the wounds are infiltrated with local anaesthetic. The skin layers are closed with 4–0 poliglecaprone sutures in a running subcuticular fashion. The drain is sutured to the skin with a 2–0 Nylon suture. Each port site is dressed with sterile strips and dry gauze dressings. The drain is covered with dry, sterile gauze. The Foley catheter is secured to the patient's right leg. The patient is given intravenous nonsteroidal analgesia before extubation, then extubated and transported to the recovery room.

POSTOPERATIVE CARE

Patients are immediately placed on their preoperative medications and are allowed to have sips of clear liquids. Analgesia is maintained with intravenous nonsteroidal medication with intravenous opioids for 'breakthrough' pain. Patients are advanced to full clear liquids on the first day after surgery and a regular diet thereafter. A daily suppository is given to stimulate gastrointestinal activity. Patients are quickly converted to oral analgesics. Patients are taught about care of the catheter on the first day. Drains are removed when output is minimal. Patients are instructed to continue Kegel exercises. Once tolerating oral intake, comfortable on oral medications, and ambulating well, patients are discharged from the hospital.

'SURGEON TO SURGEON'

Previously, we used a classic Montsouris technique by incising the peritoneum between the bladder and rectum. The pouch of Douglas was entered and the seminal vesicles and ampulla of the vas deferens dissected. Subsequently, the bladder was reflected posteriorly and the dissection was continued anteriorly through the space of Retzius. Several patients developed small anastomotic leaks, detected on cystography, that communicated with the peritoneal cavity. We have since modified our procedure to eliminate this dissection of the pouch of Douglas, and dissect the seminal vesicles and vas deferens through the anterior dissection. The peritoneal incision probably contributed to the intraperitoneal leaks. Since changing the dissection of the seminal vesicles and the vas deferens there have been no intraperitoneal leaks.

Previously we made the urethrovesical anastomosis with interrupted sutures, each tied intracorporeally. We noticed that significant tension was placed on the initial anastomotic sutures. Several times the initial suture pulled through either the urethral mucosa or the bladder neck. Since changing to a running 'parachute' technique, this has been eliminated.

CAVEATS AND SURGICAL TIPS

It should be intuitive that the experience of the surgeon and entire laparoscopic team is vital to the success of a smooth operation. All those involved with the patient should be familiar with the laparoscopic hardware and instruments, should a malfunction occur, and should be able to troubleshoot all the devices used during the procedure. The surgeon should have precise, ambidextrous laparoscopic skills. This includes the ability to place the needle intracorporeally and knot-tying techniques. Most of the dissection is done using the left ports for the surgeon and the right ports for the assistant. However, the surgeon should be able to use all the ports as needed during the procedure. This is most relevant for placing the urethrovesical anastomotic suture; this task is arguably the most technically difficult to master. The assistant should have appropriate laparoscopic skills to facilitate exposure of the dissection and to maintain a dry field should bleeding occur. It is obvious that all those involved with the operation should have an accurate knowledge of each step, to anticipate instrument changes and possible complications that may change the course of the procedure.

Several factors may be used to predict a difficult case. Morbid obesity, previous abdominal surgery, especially colorectal, previous TURP, a history of prostatitis, a prostate of >120 g, or a history of pelvic radiation should warn the surgeon that access and dissection could be difficult. However, none of these should be considered an absolute contraindication for the laparoscopic approach. Initially, surgeons should tackle the uncomplicated cases. With increasing experience, more difficult cases can be attempted.

Injury to bowel, vascular structures or other abdominal contents can occur during all steps of the procedure. As in all surgery, recognising the injuries in a timely fashion is essential. If small bowel is injured, the surgeon should determine if a primary repair is appropriate. These injuries can be repaired with laparoscopic closure. If the rectum is injured, it can be repaired intracorporeally. However, if the pelvis has received previous radiation, a diverting colostomy should be seriously considered. If there is a vascular injury the surgeon should rapidly determine if conversion to open repair is needed. If the injury can be adequately visualized, primary laparoscopic repair can be attempted. If the injury is not visualized adequately or if blood loss is rapid, then compression should be applied with laparoscopic instruments and an open incision rapidly made.

Dissecting the apex and placing the dorsal vein complex suture can be difficult to master; knowledge of the apical anatomy is essential. Meticulous and bloodless dissection, as well as the magnification of the laparoscope, helps to identify the correct planes of suture placement. As previously mentioned, a metal urethral sound can be very helpful in identifying the urethra.

Dissecting the bladder neck can be very difficult. Once again, maintenance of a blood-free field is needed to visually identify the correct plane between detrusor and prostate. Once the bladder neck has been opened, the ureteric orifices may be visualized and injury to the ureter prevented. If the patient has a large prostate or a large middle lobe, the surgeon should proceed carefully, knowing that the distal ureters may be displaced from their normal path. Dissecting a large middle lobe may be very difficult and an experienced surgeon is then vital. If the bladder neck is significantly larger than the urethral cuff, as often occurs with a large middle lobe, it may be reconstructed as necessary with intracoporeal suturing. We have done this along the base and along the anterior bladder neck. This should be determined by the surgeon's experience and preference, as well as the patient's anatomy. It is often easier to visualize the anterior surface of the bladder neck as this area is closer to the laparoscope.

The vas deferens and seminal vesicles should be dissected very gently, as these structures are prone to tearing from vigorous traction. Monopolar electrocautery should not be used and bipolar electrocautery should be minimized to prevent inadvertent trauma to the neurovascular bundles. Careful and active retraction of these structures by the assistant is extremely helpful.

Dissecting the base of the prostate from the rectum can be difficult; inflammatory reaction is often encountered. The perirectal fat plane can be a welcome visual clue to guide the dissection. Again, monopolar cautery should not be used in this area, to prevent thermal injury to the rectum.

When the lateral pedicles are dissected, the perforating vessels to the prostate can persistently bleed. Careful identification of these vessels and transection using the harmonic scalpel can prevent significant blood loss. Gentle pressure can be used at all times to control this bleeding, as the remainder of the pedicle is transected. We have found the use of pro-coagulation materials, mainly FloSeal matrix, has been very helpful in maintaining a dry field. Again, the surgeon should know that any use of electrocautery in this region can cause thermal injury to the neurovascular bundle.

The urethrovesical anastomosis can be difficult to make; previous experience in intracorporeal suturing and practice in pelvic trainers can be very helpful. The surgeon should have precise ambidextrous skills and be able to use all of the ports to place the anastomotic sutures accurately. Care should be taken to prevent any tearing of the urethra or bladder neck. As previously noted, we now use a running 'parachute' technique to prevent any one suture from tearing the tissue.

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