Laparoscopic surgery in urology: nephrectomy and prostatectomy

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Urological laparoscopic techniques have received great attention in the past decade. With the development of improved laparoscopic instrumentation, approaches to kidney and prostatic diseases have been successfully performed. Laparoscopic nephrectomy and prostatectomy are discussed. Awareness of these evolving technologies is critical for all surgeons with an interest in laparoscopy.

During the last decade, the field of urology has embraced laparoscopy as a feasible alternative to a vast number of urological procedures. Laparoscopy was initially used as a diagnostic tool for paediatric urologists in an attempt to localize non-palpable testes. With the advancement of laparoscopic skills and instruments urologists have been able to perform an ever-increasing number of urological procedures previously approachable only by open surgery. Two such surgeries are laparoscopic nephrectomy and prostatectomy.

LAPAROSCOPIC NEPHRECTOMY

The effort to expand the applications of laparoscopic urological surgery to the kidney and ureters was made possible by the development of a surgical entrapment sac and tissue morcellator to remove the kidney from the abdomen, reliable 9 mm clips for adequate control of the renal artery and the availability of the Endo GIA 30 (Ethicon, Cincinnati, Ohio, USA) vascular stapler for occluding and transecting the renal vein (Gomella and Albala, 1994). These developments led to the first nephrectomy by Clayman et al in 1990 (Clayman et al, 1991a). One year later the same team performed the first nephroureterectomy (Clayman et al, 1991b). Based on their pioneering work, laparoscopic nephrectomy has been performed in many centres around the world (Gill et al, 1995; Cadeddu et al, 1998; Rassweiler et al, 1998).

Laparoscopic nephrectomy was initially performed for benign diseases such as chronic pyelonephritis or for intractable pain from chronic obstruction. Today, however, the majority of laparoscopic nephrectomies are undertaken for renal malignancies. This has also been fuelled by the widespread use of ultrasound, computed tomography and magnetic resonance imaging leading to increased detection of renal masses. Laparoscopic nephrectomy is the most commonly performed laparoscopic urological procedure. A great number of series (Cadeddu et al, 1998; Gill et al, 2000; Portis et al, 2002) for both the transabdominal and retroperitoneal approaches have been reported in the literature with excellent results. This has led many to believe that the laparoscopic approach should be the standard of care for certain renal masses (Gill et al, 2000; Portis et al, 2002). The development of hand-assisted devices has also greatly contributed to making laparoscopic nephrectomy more accessible to urologists without extensive laparoscopic experience.

The benefits of open surgery and tactile manipulation of tissue – whether it is for blunt dissection, locating pathology or palpation or compression of bleeding vessels – are maintained. The advantages seen with laparoscopy such as decreased pain, absence of postoperative ileus and short convalescence are also maintained (Rozet et al, 2002). The small incision used for the hand allows intact removal of the kidney and preserves tissue architecture for pathological evaluation. The learning curve with hand-assisted laparoscopy is not as steep as the pure laparoscopic approach, allowing more urologists to adopt this technology in their practice.

Complications of laparoscopic nephrectomy

Uncontrolled haemorrhage is the most common result for lack of progression and conversion during laparoscopic nephrectomy. Laparoscopic nephrectomy performed for benign diseases has a complication rate of 12% as opposed to 34% when performed for tumours (Gill et al, 1995,

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2000). Complication rates have improved with increased experience. Overall complication rate is currently 23%, broken down to 7% for major complications and 16% for minor complications (Gill et al, 2000). Major complications include vascular injury, postoperative bleeding, postoperative myocardial infarction and cerebral vascular accidents. Minor complications include wound infections, pneumonia, pulmonary oedema, urinary retention and paralytic ileus. The open conversion rate during transperitoneal laparoscopic nephrectomy is approximately 4% (Gill et al, 2000).

Outcome of laparoscopic radical nephrectomy

When compared to open techniques, laparoscopy is associated with decreased blood loss, decreased analgesic requirements and rapid return to normal activities. In many instances, patients can be discharged home within 24 hours of surgery. The initial laparoscopic nephrectomy data reported longer operative time when compared to the open approach. With increased surgeon experience, however, operative time has become comparable. Laparoscopic nephrectomy also has a 5-year recurrence-free survival which is comparable to the classical open technique (Portis et al, 2002). It is now considered to be first-line therapy for all T1 and several T2 (7–13 cm in diameter) renal tumours at several centres (Portis et al, 2002).

Laparoscopic radical nephrectomy, performed retroperitoneally, transabdominally or hand assisted, duplicates established open techniques. With preservation of oncological principles, cancer control is similar to the open method while overall morbidity is decreased.

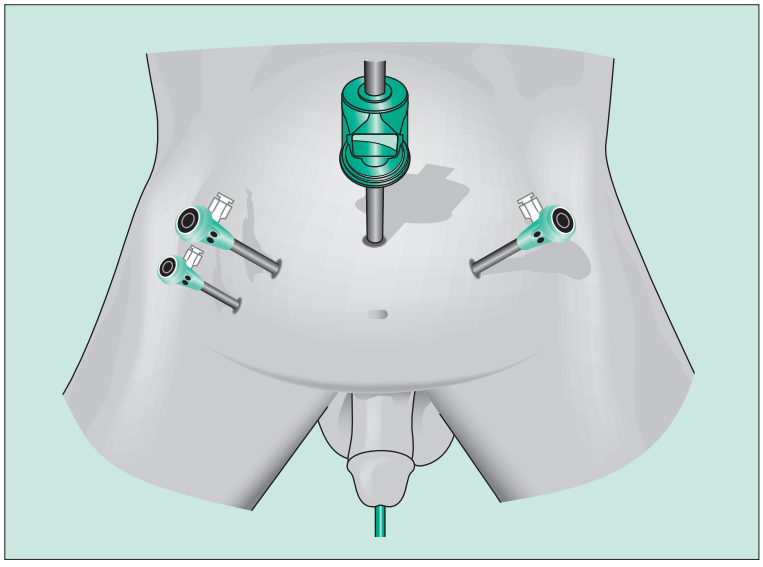

Figure 1. Port placement for laparoscopic prostatectomy.

LAPAROSCOPIC RADICAL PROSTATECTOMY

The steady broadening of laparoscopy in the field of urology has recently included radical prostatectomy. The increasing excitement in the urological community with the use of laparoscopy for prostate cancer goes beyond the most common benefits of laparoscopy including shorter hospitalization and convalescence, less perioperative pain and improved cosmetic results. The fact that laparoscopic surgery allows anatomical visualization at a magnification impossible with the naked eye has led some urologists to believe that laparoscopic prostatectomy might be associated with higher postoperative potency and continence rates.

Current indications for laparoscopic prostatectomy include patients with clinically localized prostate cancer, with well over 1000 successful cases reported in the literature. Although there is no specific contraindication to the laparoscopic method, the preliminary series (Guillonneau and Vallancien, 2000; Rassweiler et al, 2001; Guillonneau et al, 2002) suggest that unclear anatomy, improper visualization of tissue planes as seen with stage T3 disease, or a prostate with small (20 g) or large (80 g) volume can have a higher rate of complications and an increased need for surgical conversion. Early series of laparoscopic radical prostatectomy have excluded patients with previous laparoscopic mesh hernia repair because of the extensive fibrotic reaction obliterating the necessary tissue planes. The authors have performed laparoscopic prostatectomy following laparoscopic mesh herniorrhaphy with no adverse events.

Techniques of laparoscopic radical prostatectomy

The transabdominal technique popularized by Guillonneau and Vallancien (2000) is the most widely used. It has been standardized in seven steps:

1. Freeing the seminal vesicles (posterior dissection of the prostate)
2. Anterior dissection of the prostate
3. Bladder neck dissection
4. Lateral dissection of the prostate
5. Apical dissection of the prostate
6. Urethrovesical anastomosis
7. Closure.

Pneumoperitoneum is achieved by placing a Veress needle at the umbilicus. A 10 mm camera port is placed at the umbilicus followed by insertion of three or four additional trocars in the lower abdomen (*Figure 1*). The table is placed in a steep Trendelenburg position to help move the bowels out of the pelvis. The ampulla of the vas

and seminal vesicles are dissected behind the bladder. Denonvilliers' fascia is then incised to establish the plane between the prostate and the rectum. The bladder is subsequently dissected from the abdominal wall to expose the space of Retzius. The endopelvic fascia is opened followed by ligation of the dorsal vein bundle.

The prostate is separated from the bladder neck, which leads to the identification of the previously dissected seminal vesicles. The lateral pedicles of the prostate are controlled using bipolar coagulation or the harmonic scalpel. The neurovascular bundles are pushed posterolaterally in a nerve-sparing procedure. Thermal injury to the bundle can be avoided by systematic bipolar cauterization of vessels entering the prostate. The apical dissection involves transecting the dorsal vein bundle and urethra. The prostate and seminal vesicles are placed in an endocatch bag, which is retrieved from the abdomen at the end of the procedure. The urethrovesical anastomosis is usually made with interrupted or running 3-0 absorbable sutures tied intracorporally.

Rassweiler and colleagues (2001) have performed an alternative method, the Heilbronn technique, which is designed to copy the well-documented and standardized procedure of open radical prostatectomy. This is an ascending technique, which starts with control of the dorsal venous plexus, dividing the urethra and the distal pedicles, followed by transection of the bladder neck and transvesical access to the seminal vesicle. Although the ascending technique allows for early identification of the neurovascular bundle as well as excellent exposure to the bladder neck and seminal vesicle, it has been associated with a higher risk of bleeding because of the difficulty of the initial control of Santorini's plexus and immediate division of the urethra (Rassweiler et al, 2001). Extraperitoneal laparoscopic radical prostatectomy has also been described and is routinely performed at several centres (Bollens et al, 2001). The results with the extraperitoneal approach are comparable to those performed via the transperitoneal route.

Complications of laparoscopic radical prostatectomy

Guillonneau et al (2002b) have published the world's largest series of laparoscopic radical prostatectomy and reported an overall complication rate of 17.1%. Anastomotic leakage is one of the most common complications that can occur as a result of a defect or disruption of the suture line secondary to poor technique or the inability to perform a watertight anastomosis because of anatomical difficulty in patients with narrow pelvices.

In addition, the laparoscopist should remember that the magnification afforded by the laparoscope tends to make the suture look superficial because of the lack of three-dimensional depth perception during laparoscopy. This can result in an inadequate amount of tissue being taken during the placement of the interrupted sutures at the anastomotic site resulting in a leaky anastomosis. Patients usually present postoperatively with persistent drainage from the pelvic drain. The urinary leakage can cause a urinoma or disseminate intraperitoneally causing a reflex ileus and an elevated serum creatinine level. If a leakage is suspected, the first step should be verification of a functioning intravesical Foley catheter. Most leaks will heal by secondary healing after prolonged urinary drainage.

Overall, actual access-related and postoperative thromboembolic, pulmonary, infectious, urinary or gastrointestinal complications are similar to those that occur in other transabdominal urological laparoscopic procedures. Specific intraoperative and postoperative complications and complications leading to surgical conversion during laparoscopic prostatectomy are listed in *Table 1*. Vascular injury has been reported to be a serious complication leading to surgical conversion because of the inability to control haemorrhage and continuation of the procedure. The main sites of bleeding during laparoscopic prostatectomy are from the dorsal venous complex and inferior epigastric artery. Although the laparoscope will magnify the dorsal venous complex, extreme care should be exercised when performing the anterior and lateral dissection of the prostate.

Another serious intraoperative complication during laparoscopic prostatectomy is rectal injury. This has been attributed to the lack of tactile perception during laparoscopy compared to open surgery. Rectal injury may occur during dissection of the prostatic apex and during the incision of the deep layer of Denonvilliers' fascia. After freeing the seminal vesicles a small horizontal incision is made into Denonvilliers' fascia. It is helpful when the mobilized seminal vesicles and vas deferens are retracted anteriorly and the sigmoid colon is retracted posteriorly and cephalad maximally exposing Denonvilliers' fascia. Rectal perforation can occur during any one of these steps of the procedure.

The correct space for the horizontal incision into Denonvilliers' fascia is 2–3 mm directly posterior to the junction of the seminal vesicles. A more anteriorly located incision risks entry into the prostate (creating a positive surgical margin) while a more posteriorly located incision risks entry directly into the underlying rectum. In addition,

rectal injury can occur if the posterior dissection has not been performed sufficiently close to the prostatic apex. As the posterior dissection is extended towards the lateral margins of the prostatic apex, the traction that is exposed on the prostate pulls on the underlying rectum making it susceptible to tearing. To decrease the chances of rectal injury a rectal bougie or an assistant's finger can be inserted in the rectum to help detect the anterior limits of the rectal wall. If a rectal injury is identified, it should be immediately repaired laparoscopically in two layers without the need for a colostomy. Usually this immediate closure, coupled with conservative management including a delayed residue-free diet and broad-spectrum antibiotics, ensures proper convalescence.

TABLE 1.
Complications reported during laparoscopic radical prostatectomy

Intraoperative	Vascular	Bleeding from epigastric vessels
		Bleeding from Santorini venous plexus
	Rectal injury*	
	Injury to ureter or urinary bladder	
	Urethrovesical anastomotic leak† or fistula	
Postoperative	Gastrointestinal	Prolonged ileus
		Cholecystitis
		Small bowel herniation or perforation
		Peritonitis secondary to bowel injury from electric burn or trocar perforation
		Rectourethral fistula
		Perirectal abscess‡
	Pulmonary embolism	
	Femoral thrombophlebitis	
	Obturator nerve damage§	
	Trocar site hernia or wound dehiscence	
	Urinary	Urinary tract infection
		Urinoma
		Urinary incontinence
		Transient urinary retention
		Vesico-urethrocutaneous fistula
		Bladder neck (anastomotic) stricture
	Fluid collections	Lymphorrhoea
		Urinoma
		Retroperitoneal haematoma
Surgical conversion	Unclear anatomy or improper visualization of tissue planes	Caused by large T3 tumours
		Caused by small (<20 g) or large (>80 g) prostatic volumes
	Haemorrhage from Santorini's venous plexus and inferior epigastric artery adherent and/or undissectible tissue	Caused by past transurethral surgery
		Caused by fibrotic perivesicular or periprostatic tissue
		Caused by prior external beam radiation therapy or patients on neoadjuvant chemotherapy
	Difficult or impossible urethrovesical anastomosis	
	Rectal injury unamenable to laparoscopic repair	
	Delayed complications	Urinary incontinence
		Impotence

* Injury can occur when Denonvilliers' fascia is incised at the posterior aspect rather than at the base of the bladder and/or during the dissection of the lateral margins of the prostate. Incidence can be reduced by placing a Hegar intrarectal bougie which helps identify the plane between Denonvilliers' fascia and the limits of the rectal wall. †Usually presenting as continued (> 24 hours) drainage from the suction drain. ‡Occurred after intraoperative rectal injury and ultimately necessitated temporary intestinal diversion. §Occurred during pelvic lymphadenectomy

Outcome results

The ultimate goal in any treatment of prostate cancer is cancer control, maintenance of continence, and preservation of potency. Several series have reported early oncological results of laparoscopic radical prostatectomy to be equivalent to the open approach. Guillonneau et al (2002b) reported data on over 800 patients with an overall positive margin rate of 18.5%, which is comparable to the open approach. Positive margin rates (as expected) were higher for higher stage disease (stage T4 = 100%; stage T3b = 31%; stage T3a = 23%; stage T2b = 23%; stage T2a = 5%).

The laparoscope allows complete visualization of the urethrovesical anastomosis which is not possible via the standard open retropubic technique. The watertightness of the anastomosis can be assessed with additional sutures placed if necessary. This contributes to the rapid removal of the catheter, and perhaps a quicker return of continence. Overall incontinence rates after prostatectomy vary because of the variability in the definition of continence. Using a patient self-administered questionnaire, Salomon et al reported continence rates of 68.3% and 82.5% at 6 months and 1 year respectively (Salomon et al, 2002). These results are very encouraging when compared to their open prostatectomy series with continence rates of 50.5% at 6 months and 60.8% at 1 year postoperatively.

The 10–15x magnification of the laparoscope is believed to help in visualizing and dissecting the neurovascular bundles. Potency rates of 58.6% at 1 year are seen with the laparoscopic approach (Salomon et al, 2002) compared to 49.6% with the open retropubic series of Abbou and his associates (Salomon et al, 2002). Currently, with the procedure at its infancy, it is difficult to derive any conclusions about the long-term results of preservation of potency and continence.

Short-term cancer control, continence and potency by laparoscopic means have been achieved with comparable outcome to open surgery. Increased experience at several centres in Europe and the United States of America has shown that laparoscopic prostatectomy is not

only feasible but has become an alternative to open radical retropubic prostatectomy. At the Institute Mutualiste Montsouris, in Paris, France, which has the world's largest experience, laparoscopic prostatectomy has become the standard of care for patients presenting with organ-confined prostate cancer (Guillonneau et al, 2002a,b).

CONCLUSION

Laparoscopic techniques performed in the urological setting have received great attention in the last decade. The benefits of laparoscopy include decreased morbidity, decreased hospitalization and overall decreased convalescence. These have been well documented and will continue to spur the growth of laparoscopy in the management of both benign and malignant urological disorders. However, it is important to remember that laparoscopy is an alternative access technique for the same underlying problem.

Although laparoscopy is minimally invasive it is not minimal surgery and the potential for devastating complications is highly significant. Therefore, laparoscopic nephrectomy and prostatectomy should only be performed in centres with advanced laparoscopic expertise. One must also realize that laparoscopy should not be performed in every patient. Proper patient selection is necessary for a successful outcome. Some cases will remain a challenge or may even be impossible via the open approach. HM

Conflict of interest: none.

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KEY POINTS

- With the advancement of laparoscopic skills and instruments urologists have been able to perform an ever-increasing number of urological procedures previously approachable only by open surgery.
- Although laparoscopic nephrectomy was initially performed for benign diseases such as chronic pyelonephritis or for intractable pain from chronic obstruction, currently the majority of laparoscopic nephrectomies are undertaken for renal malignancies.
- Laparoscopic nephrectomy is associated with decreased blood loss, decreased analgesic requirements, and a more rapid return to normal activities compared with the open conventional operative procedure.
- Laparoscopic nephrectomy for renal cancer has a similar 5-year recurrence free survival, allowing it to be first-line therapy for all stage T1 and several stage T2 renal tumours at several centres.
- Increased experience has shown that laparoscopic prostatectomy is an alternative to open radical retropubic prostatectomy. Short-term cancer control, continence and potency by laparoscopic means have been achieved with comparable outcome to open surgery.
- The fact that laparoscopic surgery allows anatomical visualization at a magnification impossible with the naked eye has led some urologists to believe that laparoscopic prostatectomy might be associated with higher postoperative potency and continence rates.