

Chapter 3

Robotic Prostatectomy

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Abstract: In the USA, approximately 77,000 radical prostatectomies are performed yearly for the treatment of prostate cancer. Although a number of alternative treatment options are available for organ-confined prostate cancer, retropubic radical prostatectomy (RRP) remains the gold standard demonstrating a reduction in disease-specific mortality for affected patients.

However, the procedure has inherent morbidity associated with it. Therefore, less invasive surgical techniques have been sought; one such alternative is robotic-assisted laparoscopic radical prostatectomy (RALP). In recent years RALP has become a forerunner in treatment options, yielding comparable medium-term perioperative and functional outcomes.

Robotic-assisted prostatectomy has allowed urologists to enter the realm of minimally invasive surgery by incorporating open-surgery movements to a laparoscopic environment. Current RALP data from several series yield perioperative and functional outcomes comparable to the gold standard. However, long-term data is needed in order to establish its true efficacy.

Using MEDLINE we performed a search for publications on perioperative and functional outcomes related to RALP. We present a review of the available literature.

Keywords: Prostatectomy, Margins, Continence, Potency#

3.1. Introduction

Cancer of the prostate remains the most common malignancy of the male genitourinary tract. It accounts for nearly 33% of all newly diagnosed cancers in men (Meng et al. 2003). For patients with organ-confined disease a number of treatment alternatives are available. However, RRP remains the gold standard for long-term cure (Myers 2001).

Since its first description in 1905 by H. H. Young this procedure has been associated with significant intraoperative and perioperative morbidity (Young 2002). The technique was revised by Patrick Walsh in the 1980s with an increasing knowledge about the basis of surgical anatomy and has become a refined procedure with acceptable cancer control rates and improved functional outcomes (Reiner and Walsh 1979; Walsh and Lepor 1987). However, it is challenging due to the small confines of the pelvis and its association with higher surgical morbidity caused by the large abdominal incision, postoperative pain, the need for strong narcotic analgesia, and the prolonged recovery period as was reported in a patient complications survey (30% incontinence, 60% erectile dysfunction, and 20% secondary surgical treatments for urethral strictures) (Fowler et al. 1993).

In the minimally invasive surgery era new approaches were being sought after in order to minimize patient morbidity while improving both functional and oncologic outcomes. One viable option was the laparoscopic technique.

The concept of a laparoscopic approach for the treatment of prostate cancer is not new. In the early 1990s Schuessler et al. (Schuessler et al. 1991) described the laparoscopic pelvic lymph node dissection technique. Later, in 1992, Kavoussi and Clayman joined this group to describe their first successful laparoscopic radical prostatectomy (LRP) (Schuessler et al. 1997). Early results were less than promising, with prolonged operative times and no major advantages over conventional surgery (Salomon et al. 2004).

However, the procedure was revived in the late 1990s as European surgeons reevaluated LRP and reported feasibility with results comparable to the open surgical approach (Guillonneau and Vallancien 2000; Rassweiler et al. 2001a; Turk et al. 2001; Eden et al. 2002; Salomon et al. 2002; Rassweiler et al. 2003a). While the technique has become more refined over a 15-year period, it has still failed to become a part of mainstream urology mainly because of its limitations: steep learning curve (minimum of 50–100 cases) and long mean operative times, making it unrealistic for most surgeons. When compared to the open approach, the first series of patients demonstrated no benefit regarding tumor removal, length of hospital stay (LOS), convalescence, continence, potency, or cosmesis (Guillonneau et al. 1999) but since then multiple groups have reported their experiences with outcomes comparable to the former (Guillonneau et al. 2002; Rassweiler et al. 2003b; Trabulsi et al. 2003; Rassweiler et al. 2004).

While the concept of a minimally invasive approach to prostatectomy was attractive, LRP provided certain technical challenges that limited its feasibility, growth and overall rate of adoption. These limitations included two-dimensional vision, counterintuitive motion of the surgeon and non-wristed instrumentation in the confines of the pelvis. It was believed that advances in surgical technology would be necessary to catapult laparoscopy into mainstream urology for prostatectomy. Robotic-assisted surgery has such a potential.

The first robotic prostatectomy was performed in 2000 by Binder in Germany (Binder and Kramer 2001). Subsequently, the procedure has undergone significant innovation and improvement. Menon, Guillonneau, and Vallancien refined the technique at Henry Ford Hospital later in that same year (Pasticier et al. 2001) and its growth has been exponential since then. We present a review of the current state of robotic-assisted laparoscopic prostatectomy (RALP).

3.2. Technique

RALP can be performed via a transperitoneal or preperitoneal technique. The transperitoneal approach is performed by using either a Veress needle or Hasson technique to access the peritoneal cavity. The abdomen is insufflated using CO₂ at 15 mmHg and trocars placed under direct vision, as shown in Fig. 3.1. The patient is then placed in a lithotomy, steep Trendelenburg position and the robot docked (Fig. 3.2).

The procedure is begun using the zero degree binocular lens and the following instruments: monopolar scissors (right arm), PK dissecting forceps (left arm) (Gyrus Group, PLC), and the grasper (4th arm).

The anterior peritoneum is incised (bladder takedown) to enter the retropubic space of Retzius. The endopelvic fascia is then opened bilaterally and the ani levator fibers peeled off the prostate. Ligation and placement of a suspension stitch with Monocryl 1 on a CT1 needle then follows to stabilize the periurethral complex and aid in early recovery of continence (Fig. 3.3).

Next step in the procedure is the dissection of the bladder neck. This is accomplished by changing the scope to a 30° down angle to improve visualization. Determining the

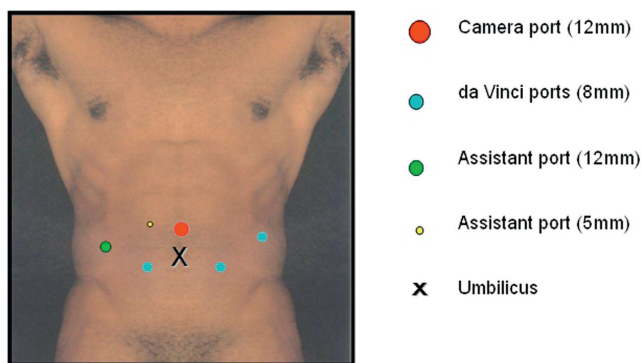


FIGURE 3.1. Port placement.



FIGURE 3.2. Lithotomy and steep Trendelenburg position.

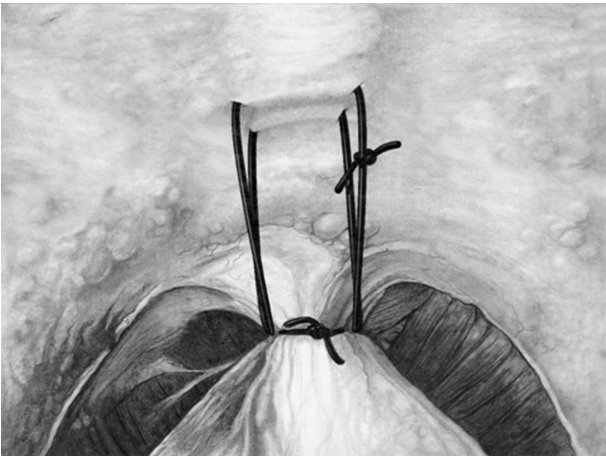


FIGURE 3.3. Ligation and placement of the suspension stitch from the dorsal venous complex to the pubic tubercle. The endopelvic fascia has been opened clearly visualizing the fibers of the levator ani.

boundaries of the prostate and bladder neck can be challenging. A general rule to accomplish this is locating the area where the bladder fat reaches the prostate (no fat on the anterior surface of the prostate). Careful dissection in a downward direction is undertaken until reaching the urethra and catheter. The posterior aspect of the bladder neck is initiated by first retracting the Foley catheter (upward with the 4th arm) and dissecting following the bladder fibers at the precise junction until reaching the vas deferens and seminal vesicles which are transected and dissected, respectively. Denonvillier's fascia is then incised and the posterior rectal plane developed completely leaving the prostate attached only by the pedicles and urethra.

Following the dissection of the posterior plane is the preservation of the neurovascular bundles (NVB) and ligation of the prostate pedicle. These are often a hybrid of various techniques depending on the approach given: antegrade, retrograde, or a combination of the two. Regarding the use of energy during this step, dissection can be athermal or thermal (monopolar, bipolar, harmonics). Another variable factor is the approach to the fascial layers surrounding the prostate at the site of the neurovascular bundle. The approach can be extrafascial, interfascial, intrafascial, or high intrafascial depending on the tumor burden and location.

At our institution, our approach is athermal with an early retrograde release of the NVB that allows precise delineation of the path of the NVB and its relation to the prostate pedicle during ligation of the latter with hemostatic clips reducing the possibility of inadvertent injury during this step (Fig. 3.4).

The apical dissection is then performed using cold scissors to divide the dorsal venous complex (DVC) and urethra. The vesicourethral anastomosis is performed using a modified van Velthoven technique. A single continuous running suture using two 20-cm 3-0 Monocryl sutures (RB1 needle) of different colors are tied together with ten knots. The posterior anastomosis is performed with one arm of the suture beginning at the 5-o'clock position running clockwise to the 10-o'clock position. The anterior anastomosis is completed

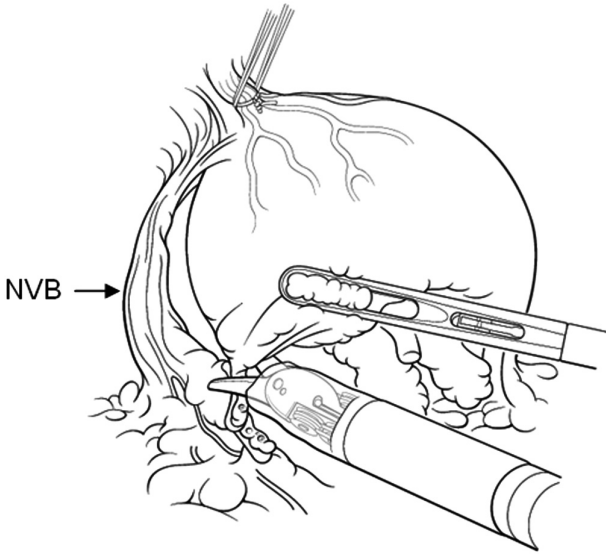


FIGURE 3.4. The path of the neurovascular bundle (NVB) clearly delineated decreasing the possibility of inadvertent injury during ligation of the prostate pedicle with hemostatic clips.

with the second arm of the suture starting in the 5-o'clock position and proceeding in a counterclockwise fashion. Both sutures are tied in the 10-o'clock position on the urethral stump. A Foley catheter is left in place for 4–7 days.

3.3. Outcomes

3.3.1. *Operative Time (OR)*

A direct comparison between operative times of various series is somewhat difficult due to variations in reporting operative times including setup and/or pelvic lymph node dissection. The mean operative time for reported robotic series ranges from 141–540 min (Abbou et al. 2001; Binder and

Kramer 2001; Pasticier et al. 2001; Rassweiler et al. 2001; Menon et al. 2002a,b; Ahlering et al. 2003; Bentas et al. 2003; Menon and Tewari 2003; Menon et al. 2003; Wolfram et al. 2003; Ahlering et al. 2004; Patel et al. 2005). In our experience, operative time declined from a mean of 202 min for our first 50 cases to 141 min for the last 50 in a series of 200 cases (Patel et al. 2005). Analysis of our current data of 1500 consecutive cases shows that OR times have been further reduced to less than 90 min (Palmer et al. 2007). This is also confirmed by Ahlering et al. who reported similar experience-related reduction with a mean of 184 min for their last ten cases compared to an overall of 207 min (Ahlering et al. 2004).

3.3.2. Estimated Blood Loss (EBL) and Transfusion Rate

Traditionally RRP has been associated with higher EBL and transfusion rates. In a comparative study, Menon et al. reported a significantly higher rate of transfusion after RRP (67%) compared to RALP (0%) (Menon et al. 2005a,b). Although diminished blood loss has been the hallmark of laparoscopic prostatectomy, other RALP series have reported mean EBL ranging from 75–900 ml with most being less than 200 ml (Menon and Tewari 2003) and a transfusion rate ranging from 0–16.6% (Abbou et al. 2001; Binder and Kramer 2001; Pasticier et al. 2001; Rassweiler et al. 2001; Menon et al. 2002a,b; Ahlering et al. 2003; Bentas et al. 2003; Menon and Tewari 2003; Menon et al. 2003; Wolfram et al. 2003; Ahlering et al. 2004; Patel et al. 2005).

Several studies have demonstrated that pneumoperitoneum exerts a tamponade effect that aids in diminishing blood loss from venous sinuses. With increasing experience large RALP series like the Vattikuti Institute's and The Ohio State University's report transfusion rates ranging from 0 to 0.4%, respectively (Menon et al. 2007; Palmer et al. 2007).

3.3.3. Length of Hospital Stay

Length of hospital stay is an important component of convalescence after surgery and is often considered a measure of patient well-being. A shorter LOS indicates subjectively a lower degree of morbidity and a faster recovery varying and depending upon the type of surgery, clinical pathway, surgeon practice patterns, and cultural differences. The usual LOS after RRP varies between 1 and 3 days (Kundu et al. 2004). In a single surgeon comparative study, Ahlering et al. reported shorter LOS in patients after RALP compared to RRP (25.9 h vs. 52.8 h) (Ahlering et al. 2004). Similar findings were reported by Tewari et al. with a mean LOS of 1.2 days for the RALP group versus 3.5 days for the RRP group (Tewari et al. 2003). Our current data of 1500 consecutive cases demonstrates a mean LOS of 1.1 days with 97% of the patients being discharged on postoperative day one (Palmer et al. 2007).

3.3.4. Postoperative Pain

As with most minimally invasive procedures, RALP is performed through several small incisions and is associated with minimal postoperative pain. In the few published studies, there are conflicting reports on reduction in postoperative pain with RALP. Menon et al. report that there was a statistically significant difference in visual analog pain score on postoperative day 1 with RALP having a mean score of 3 (1–7) compared to RRP with a mean score of 7 (4–10) (Menon et al. 2007). Webster et al., reported no statistical difference in pain on day of surgery using the Likert pain scale with RALP having a mean score of 2.52 compared to 2.88 in the RRP group (Webster et al. 2005).

3.3.5. Continence

Earlier series of RRP defined incontinence based on patient-reported surveys being as high as 50% (Fowler et al. 1993).

Walsh et al. (Walsh et al. 2000) reported continence (no pad usage in past 4 weeks) to be 54% at 3 months, 80% at 6 months, 93% at 12 months, and 93% at 18 months. The pad free rate after RRP after 3 months of follow-up has been reported to be between 50–76% (Walsh et al. 2000; Lepor et al. 2001; Ahlering et al. 2004).

It has been proposed that RALP can potentially improve continence rates or earlier return of continence by better visualization and preservation of the urethral sphincter and its length. Magnified visualization grants a better and improved preservation of the urethral sphincter allowing the surgeon precise delineation between this structure and the prostatic apex (Smith 2004).

Menon et al. reported a 95.2% continence rate after 12 months following lateral prostatic fascia-sparing RALP in 2652 patients. They also noted that 33% of patients had a >3-point improvement in the IPSS. Continence was defined as “no pads or a single pad for security purposes only and failure to leak urine on provocative maneuvers.” At the time of catheter removal 25% of patients were pad free (Menon et al. 2007).

Our initial series of 200 patients was evaluated 2 years ago and we reported continence rates of 47, 82, 89, 92, and 98% at 1, 3, 6, 9, and 12 months, respectively. It was demonstrated that 27% of patients were continent immediately after catheter removal. Continence was defined as “no pads” and the data was collected by an independent third party (Patel et al. 2005).

Ahlering et al. reported on their first 45 RALP cases and subsequently on case numbers 46–105. Sixty-three percent and 81% of patients in their first 45 cases were pad free at 1 and 3 months, respectively. An additional 25% and 14% used a security pad at 1 and 3 months and in the following 60 cases, 76% were pad free at 3 months (Ahlering et al. 2003). Questionnaires were either patient-reported or administered by a nonclinical research associate. In their first 72 RALP cases, Carlsson et al. report that 90% of patients were pad free at 3–6 months postoperatively. Information was gathered by self-administered patient questionnaires (Carlsson et al. 2006).

Analysis of our current series of 1500 cases shows a continence rate of 27, 92, 97, and 97.8% immediately after catheter removal, and at 3, 6, and 12 months, respectively (Palmer et al. 2007). However, in an effort to improve early continence rate we have made several modifications to our technique. The incorporation of a retropubic suspension stitch after ligating the dorsal venous complex we believe stabilizes the periurethral complex and aids in the early recovery of continence. This stitch is passed from right to left between the urethra and DVC, through the periosteum on the pubic bone in a figure-of-eight and then tied (Fig. 3.5). Forty percent of patients who underwent this modification recovered continence in less than 1 month and 92.8, 97.9, and 97.9% at 3, 6, and 12 months, respectively, demonstrating a statistically significant benefit at 3 months ($p = 0.013$). No complications were reported.

Rocco F et al. published data regarding early recovery of continence after RRP by reconstructing the posterior aspect of the rhabdosphincter (Rocco et al. 2007a,b). The technique provides posterior support for the sphincteric mechanism and prevents caudal retraction of the urethra. Continence was defined as the use of no pads or one diaper per day. The early continence rate was 62.4% using this definition. The authors compared the results to a historical group of 50 patients who underwent radical prostatectomy without reconstruction of the rhabdosphincter. The continence rates were significantly better during the first 3 months for the reconstruction group. However, there was little difference following one year. This technique was also applied to LRP by Rocco et al. (Rocco et al. 2007a,b). He performed a prospective trial in which 31 patients had reconstruction while 31 patients had standard laparoscopic prostatectomy. Continence was defined as no pads or the use of one diaper per day. Three days following catheter removal 74.2% of patients in the reconstruction group were continent compared to 25.8% of patients in the standard group. There was a statistically significant better continence rate immediately and 1 month postoperatively.

We have recently incorporated the technique during RALP. Our complete “*early continence*” rate (defined by use

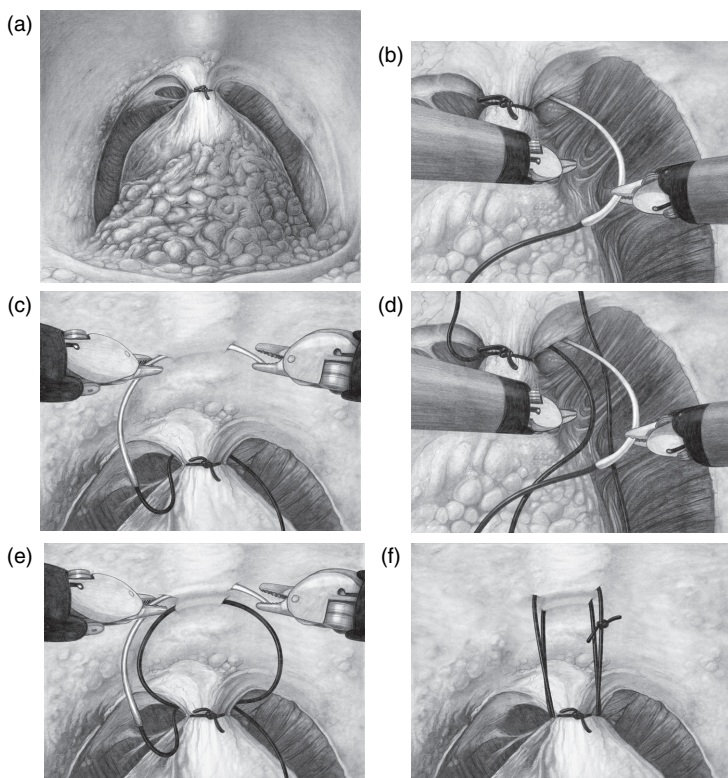


FIGURE 3.5. Retropubic suspension stitch: **a** Vision after the endopelvic fascia has been opened and DVC ligated; **b** CT1 needle held at a 90° angle passed from right to left between the urethra and DVC; **c** stitch placed through the periosteum on the retropubis; **d, e** Second pass through DVC and periosteum; **f** final stitch tied.

of no pads) of 58% at 1 week is encouraging. If the definition of continent is broadened to that of Rocco et al. (0 or 1 pad per day) the rate is 72%. We felt there was a learning curve of approximately 20 cases to perform this modification optimally. During this time we learnt precise identification of the target anatomy and the technical refinements to both the reconstruction and the following urethrovesical anastomosis.

Correct anatomic placement of the distal sutures was the most challenging aspect.

3.3.6. *Potency*

Theoretically, de novo erectile dysfunction after radical prostatectomy occurs by injury of the neurovascular bundles: thermal or traction, direct incision, or incorporation of the NVBs into hemostatic sutures and/or clips. Several studies have demonstrated that younger age, preoperative potency, comorbidities, and nerve-sparing techniques are key factors affecting the recovery of erectile function (Catalona et al. 1999).

Menon et al. at the Vattikuti Institute in Detroit, recently described and reported potency results for their technique of lateral prostatic fascia-sparing (Veil of Aphrodite) RALP (Menon et al. 2005a,b). These men were evaluated with a self-administered SHIM questionnaire preoperatively and at 12 months postoperatively. Recovery of normal erections was defined as a SHIM score >21. Intercourse was defined by an answer of >2 (sometimes or more often) on question 2 (“when you had erections from sexual stimulation, how often were your erections hard enough for penetration?”). Using these criteria, 70 and 100% of men with a preoperative SHIM score >21 reported normal erections and intercourse at 12 and 48 months, respectively. Fifty percent of them attained normal SHIM score without medication.

Chien et al. reported early sexual outcomes using a clipless nerve-sparing RALP technique. Sexual outcomes were evaluated with the use of a self-reported validated questionnaire preoperatively and at 1, 3, 6, and 12 months postoperatively. While 80 patients underwent RALP during this study period, 35 patients were excluded from final analysis due to either follow-up <3 months, open conversion, or incomplete questionnaires. It was found that after 1 month postoperatively the patient’s sexual function scores had returned to 47% of their

preoperative scores. This increased to 54, 66, and 69% at 3, 6, and 12 months postoperatively. Also reported was a subjective sexual potency, defined as “the ability to penetrate and complete intercourse with or without the use of oral PDE-5 inhibitors.” Using this definition, 50% (ten men) of patients undergoing bilateral nerve sparing RALP were potent and 44% (eight men) of patients undergoing unilateral bilateral nerve sparing RALP were potent (at 6 months follow-up) (Chien et al. 2005).

After a 9-month follow-up of their first 45 RALPs, Ahlering et al. reported that one out of three patients who were preoperatively potent had satisfactory postoperative sexual function with sildenafil (Ahlering et al. 2003). Using a cautery-free neurovascular bundle dissection, they also reported early potency outcomes. A comparison was made between patients undergoing unilateral or bilateral nerve preservation (23/45) and 36 “controls” (standard bipolar cautery dissection). Erectile function was assessed through self-administered questionnaires and defined as erections sufficient for vaginal penetration with or without PDE-5 inhibitors. After 3 months of follow-up, 43% of men in the cautery-free group were potent compared with 8.3% of the control group. While longer follow-up for the cautery-free group is awaited, the authors commented that at 16 months follow-up 60% of the control group were potent (Ahlering et al. 2005).

At our institution the approach to prostatectomy is antegrade in the standard manner. However, we have modified our nerve-sparing technique in order to provide the least trauma to the neurovascular bundle. Our approach to the nerve sparing is athermal with early retrograde release of the NVB, interfascial or intrafascial depending upon tumor burden and location (Fig. 3.6).

Between March 2006 and December 2006, 332 patients with localized prostate cancer underwent nerve-sparing RALP by the modified technique (Palmer et al. 2007). A bilateral nerve-sparing procedure was performed in 201 (60.5%) patients, unilateral nerve sparing in 60 (18.2%)

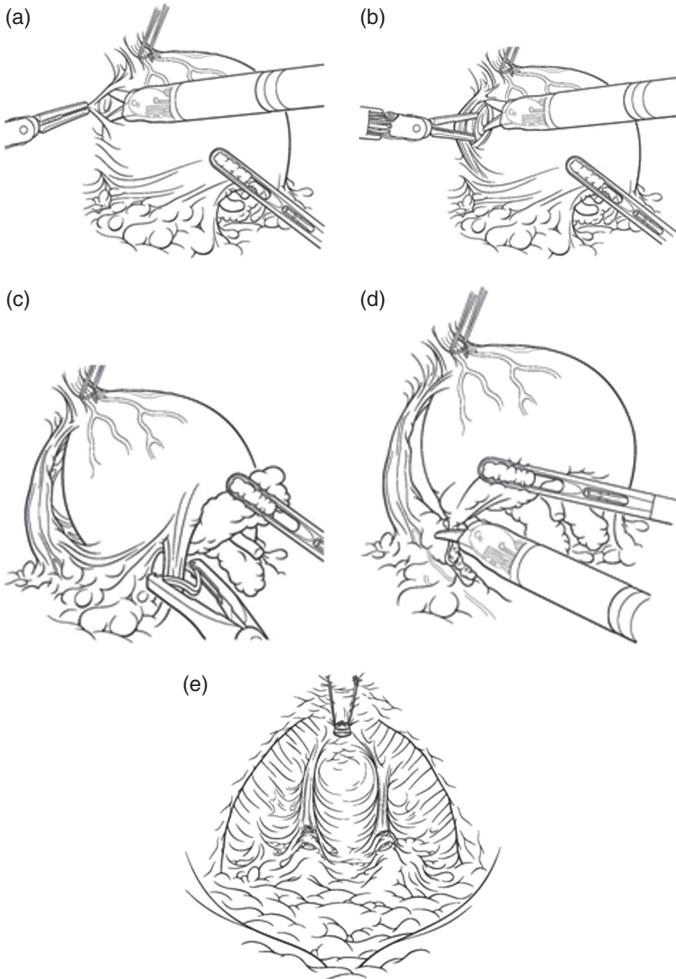


FIGURE 3.6. Neurovascular bundle (NVB) preservation. **a** A first incision is made in the mid-lateral aspect of the prostatic fascia; **b** Dissection plane is encountered with minimal bleeding from small tributary vessels; **c** Ligation of the prostate pedicle with hemostatic clips; **d** NVB has been completely dissected and prostate pedicle clipped and transected; **e** Bilateral NVB preservation after removal of the prostate specimen.

and non-nerve sparing in 71 (21.3%) patients. Out of these patients, 167 patients with preoperative SHIM score >17 , who underwent a unilateral or bilateral nerve-sparing procedure and had at least 3 months of postoperative follow-up, were included in the review. Out of 167 patients, 134 (80%) patients were potent with or without use of PDE 5 inhibitors. Fifteen (9%) patients were potent immediately after catheter removal, 46 (27.5%) were potent at 1-month follow-up, 115 (68.8%) were potent at 3-months follow-up, 133 (79.6%) were potent at 6-months follow-up, and 134 (80%) were potent after 12 months of follow-up.

In their first 100 RALP, Mikhail et al. report obtaining 68% and 79% of potency in patients who underwent unilateral or bilateral nerve preservation, respectively, after a 12-month follow-up excluding those with preoperative impotence, sural nerve grafting, or those with nonsparing procedures (Mikhail et al. 2006).

Some authors have conducted single institute comparisons between RALP and either RRP or LRP. Tewari et al. reported a prospective comparison between 100 RRP and 200 RALPs demonstrating a more rapid return of erections with RALP (50% at a mean follow-up of 180 days vs. 50% at a mean of 440 days after RRP) as well as a quicker return to intercourse with RALP (50% at 340 days vs. 50% at 700 days for RRP). While this study has many strong points, the authors do acknowledge that one team performed the RALPs while eight different surgeons performed the RRP (Tewari et al. 2003). Joseph et al. retrospectively compared 50 LRP and 50 RALPs. While their data was immature 22% of the LRP patients reported erections compared to 40% in the RALP group (Joseph et al. 2005).

3.3.7. Oncologic Outcomes

The reported positive margin rates (PMR) after RALP series range from 0–36%. When stratified by stage, PMRs following RALP range from 0–17% for T2a,

0–33% for T2b, 0–82% for T3a, 20–50% for T3b, and 33–67% for T4 (Guillonnet et al. 2002). Although no statistical significance was demonstrated, Ahlering et al. reported a trend toward a higher rate of PMRs in the RRP group (20%) compared to the RALP group (16.7%) (Ahlering et al. 2004).

In our first series of 200 patients the PMR for T2, T3a, T3b, and T4 tumors was 5.7, 29, 20, and 33%, respectively (Patel et al. 2005). As our technique was refined and after the current 1500 consecutive cases we have seen a reduction in our PMRs: 4% for pT2, 34% for T3, and 40% for pathologic stage T4. The distribution of positive surgical margins was: apex (23%), bladder neck (14.5%), posterolateral (36.7%), and multifocal (26%). When analyzing the rate of positive margins based on final pathologic prostate volume, we found that in patients with prostate volumes of less than 50 g, 50–99 g, and greater than or equal to 100 g, positive margin rates were 14.3, 9.4, and 5.9%, respectively.

For RALP to be accepted as a satisfactory alternative to the current gold standard, oncologic outcomes must be proven to be uncompromised.

3.3.8. *Safety*

Experience has shown that patients often seem concerned about the safety of using the robot. We conducted a multi-institutional study in which experienced surgeons reported failures of the da VinciTM surgical system. Data collected comprised a total case volume of 6426 and median surgeon experience of 460 cases (325–1500). Critical failures of the system that led to canceling ten cases and conversion to one laparoscopic and nine open procedures occurred in 20 cases (0.3%; range 0–1.1%) and recoverable failures occurred in 124 cases (2.2%). The most common sites of system malfunction were the optical system and surgical arms. Although technical problems can occur, this study demonstrates that robotic equipment malfunction is extremely rare in

institutions that perform high volumes of RALPs (Lavery et al. 2007).

There are currently over 600 robotic systems in the United States and over 30,000 robotic procedures have been performed (personal communication with Intuitive Surgical, Inc. VRP). Twenty-five percent of all prostatectomies were performed robotically in 2005 and it is estimated that about 60% will be performed this way in 2007.

Our review represents a comprehensive analysis of our data and of that of other series available in the surgical literature. Perioperative and functional outcomes provided by larger series for robotic radical prostatectomy are encouraging. In addition, there appears to be a trend toward earlier return of function in those undergoing robotic surgery. While this is encouraging we acknowledge that the data is short term and longer follow-up is needed in these patients. As techniques continue to evolve and an increasing number of larger series are published, we anticipate that the results of robotic radical prostatectomy will continue to improve.

3.4. Conclusions

Robotic-assisted laparoscopic radical prostatectomy is a procedure in evolution. Our review of the literature suggests that it is associated with shorter OR time, decreased blood loss and transfusion rate, shorter LOS, less pain and promising continence, potency and oncologic outcomes when compared to contemporary RRP and LRP series. Although robotics is still in its infancy and there are no long-term follow-up studies, many international series have demonstrated that there appears to be an earlier return of continence and recovery of potency in patients undergoing this type of surgery. More information will be available as series continue to mature. With continued refinement of the operative technique we will see further improvement in outcomes.

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