

Robotic Prostatectomy: What We Have Learned and Where We Are Going

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Radical prostatectomy became a mainstay of treatment for prostate cancer in the United States after the pioneering work of Walsh in defining the nerve sparing technique. Efforts to reproduce this operation in a minimally invasive fashion resulted in slow progress that recently have flourished with the application of the daVinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) by Menon and colleagues. This article summarizes the origins of robotic prostatectomy, some of the current data regarding this operation and potential future directions.

Key Words : Robotic surgery, prostatectomy, prostate cancer, minimally invasive surgery, laparoscopy

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INTRODUCTION

Robot assisted radical prostatectomy (RARP) is one of the most common treatments for prostate cancer in the United States. The adoption of this procedure has been very rapid. The first reported procedure was in 2000¹ however in 2007 more than 60% of all radical prostatectomy cases were robotically assisted (Intuitive Surgical data, Sunnyvale, CA, USA). The focus of this paper will examine the reported outcomes of this technology including our centers' experience. Future directions will also be explored.

BACKGROUND

The first reported radical prostatectomy was performed by Hugh Hampton Young in 1904 via a perineal approach.² The retropubic approach was first performed by Terrence Millen in 1947.³ However, the morbidity of these operations caused both patient and surgeon alike to avoid this curative treatment. External beam radiation provided a viable alternative albeit a less efficacious one with its own set of morbidities.

Patrick Walsh's revolutionary contributions in defining the anatomy of the prostate and its surrounding structures began to turn the tide.⁴ No longer was the treatment more harmful than the disease. Patients could undergo radical prostatectomy and have an excellent chance of regaining continence and potency postoperatively. Over the years since Dr. Walsh's seminal work, many centers have developed expertise with open radical prostatectomy. The operation including the concepts of suturing the dorsal venous complex and nerve sparing had become the mainstay of treatment for men with organ confined prostate cancer.

However, the advent of large organ ablative urological surgery was dawning in the early 1990's heralded by Dr. Ralph Clayman's report of the first laparoscopic nephrectomy.⁵ Later careful examination demonstrated the benefits of the laparoscopic nephrectomy with less pain, less blood loss, quicker return to work and shorter hospital stay.⁶ Dunn and

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colleagues reported on a 9-year experience with 61 laparoscopic radical nephrectomy cases. The cohort was compared to an open counterpart of radical nephrectomy. Blood loss was cut from 451 cc to 172 cc. Hospital stay was 3.4 versus 5.2 days. Pain medication requirement and time to normal activities were much improved. Most importantly however, cancer recurrence rates were identical. Oncological soundness has been demonstrated in this and other large studies.⁷

Laparoscopic radical prostatectomy was later explored by Clayman and Schussler.⁸ However they concluded from their series of 9 laparoscopic cases that the procedures were too difficult with very long operative times with a mean of 9.4 hours. Of the 9 patients, 1 had a positive margin and 6 were continent. However, there were significant complications consisting of cholecystitis, thrombophlebitis, and a small bowel port site hernia. Thus, they concluded that the potential benefits of a minimally invasive procedure are lost since the morbidity of the open surgical wound is well tolerated.

However, further improvement in laparoscopic skills and refinement of techniques allowed Guillonneau to report on the Montsouris experience in 2000.⁹ The results of their technique were very encouraging. The average OR time was 3 hours. Estimated blood loss was 250 cc. The conversion rate was zero. Patients were typically discharged to home on day 3 or 4 without a Foley catheter. Thus, the race began to reproduce the results of this series. However, Kavoussi published an editorial questioning the wisdom of tackling prostatectomy with a laparoscopic approach until the procedure became better established by centers of excellence.¹⁰ While reports suggested early continence and improved convalescence for the laparoscopic approach, data regarding cancer control in regard to margins and prostate-specific antigen (PSA) recurrence was still immature.

The advent of robot assisted radical prostatectomy

One center attempting to reproduce the results of Guillonneau reported on their frustration and subsequent solution. Menon and colleagues reported on their first difficult steps of laparoscopic prostatectomy. They added the daVinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) and their outcomes began to improve.¹¹ Their initial report focused on 48 standard laparoscopic prostatectomies and 50 robotic assisted cases in a 12-month period. Preoperative characteristics were identical. Most of the postoperative outcomes were very close, however, even in this early series, robotic cases had a lower mean estimated blood loss. Also of note, the operative (OR) case time trend seemed to continue to improve using the robotic technique while time improvement seemed to have plateaued with the standard laparoscopic approach.

The benefits the robotic surgical system are well touted. Wristed instrumentation, tremor filtration, three dimensional vision and an ergonomic surgeon console clearly benefit surgeons with minimal laparoscopic experience to quickly feel

comfortable with even complex laparoscopic reconstructive tasks.

Menon followed this initial report with other maturing data from their series. In a report of their initial 1,100 cases, Menon compared his mature series of open radical prostatectomy to his large experience of the new robotic technique.¹² They found that their OR was actually faster with the robot. Blood loss was markedly improved as were complication rates, catheter time, hospital stay, postoperative pain score and times to continence and potency.¹²

Menon's group most recently reported their series of over 2,700 patients. Their now very mature series demonstrates excellent functional outcomes with 93% of men wearing 1 pad or less per day and 79.2% of men who underwent bilateral nerve sparing were able to have successful sexual intercourse by defined as a positive response to question 2 of the Sexual Health Inventory for Men (SHIM) questionnaire. Perioperative data remained consistent with a mean estimated blood loss (EBL) of 100 cc, 96% day 1 discharge rate, and mean OR time of 154 minutes. Most importantly, however, the 5 year actuarial biochemical free survival was 84%.¹³

Spurred by Menon's initial work, Perer et al.¹⁴ reported on a their initial experience with robotic prostatectomy. In another article, Ahlering demonstrated excellent proficiency over his learning curve for a surgeon who was laparoscopically naïve. The time to 4-hour proficiency was 12 cases. Mean blood loss was 145 cc. Early continence was excellent with zero pad continence being gained by 81% of patients at 3 months. The mean positive margin rate was 35.5% however this number has dropped substantially in the University of California (UCI) experience. Using a distinct technique change of using a stapler to divide the dorsal venous complex, the pT2 margin rates dropped to 4.7%.¹⁵

Smith has also shown an experienced open radical prostatectomist can be successful with a robotic approach. Although in early reports of their work they did not see a difference in length of hospital stay¹⁶ or transfusion¹⁷ rate, Smith et al. did note a significantly lower positive margin rate with use of the robotic approach than with their very large open radical prostatectomy experience at Vanderbilt. They examined the last 200 cases of open against their last 200 robot prostatectomy cases.¹⁸ Although there was a trend toward higher percentage of tumor to gland involvement in the open cases, the margin rate was lower (15% to 35%) for robotic prostatectomy. For pT2 margins, the difference was striking; 9.4% with the robot versus 24.1% for the open procedure. The location of the positive margins was not different with the apex being the most common area for both approaches.

The penn experience

The author's own experience of robot prostatectomy at the University of Pennsylvania has now reached over 1,300 cases to the date of this writing. My personal experience is now over

1,800 cases overall. In regard to perioperative data, the mean OR time is 120 minutes. We prefer a transperitoneal 6 port approach. The bladder is dropped initially and the dorsal venous complex is divided with a stapler (Fig. 1). The bladder is divided from the prostate and the seminal vesicles are approached anteriorly. The rectum is thoroughly dropped away from the posterior surface of the prostate and the pedicles are controlled with clips (Fig. 2). A running anastomosis is employed for the vesicourethral anastomosis (Fig. 3). We do not routinely leave Jackson Pratt (JP) drains.

Patients are discharged on postoperative day #1 96% of the time. Patients are encouraged to ambulate the first night of the operation. Diet is held at clear for the first day and then advanced to a regular diet in the AM. Pain medication consists of toradol around the clock with additional narcotic available on a prn basis.

Foley catheters are removed on postoperative day 6 or 7 without cystograms. Patients typically return to work in 2 to 3 weeks and are allowed to assume unrestricted activity by 3 weeks.

The major complications rate has been less than 2% consisting of transfusions (10), rectal injury (5), Veress needle injury (1), symptomatic lymphocele requiring drain placement (8), prolonged urine leak requiring drain placement (3), and bladder neck contracture (5). One of these bladder neck contractures has required an open repair.

In regard to continence requiring zero pads or a security pad, approximately 20% of patients are continent on catheter removal, 50% by one month and 80% by 3 months. Patients with a preoperative SHIM of 22 or more and aged 55 or less have been able to have successful intercourse with the help of phosphodiesterase5 (PDE5) inhibitors at a rate of 80% by 18 months postoperatively.

Our margin rates have steadily been improving. Early in our experience within the first 200 cases, the overall margin rate was 20% with a pT2 margin rate of 10%. However, with consistent communication with our genito urinary (GU) pathologists and technical modifications consisting of an interfascial nerve sparing technique, early retrograde release of the neurovascular bundles and continued use of a stapler for division of the dorsal venous complex, our margin rates for the last 500 cases has been 11% with a pT2 margin rate 4.5% and pT3 margin rate of 35%.

Robotic prostatectomy has improved the open approach

However, likely the most important factor for success with radical prostatectomy is not so much approach but rather surgeon experience. Scardino has shown the surgeon experience is an independent predictor for success during radical prostatectomy. Eastham et al.¹⁹ reported lower positive margins rates are encountered by more experienced surgeons during open radical prostatectomy. When 26 surgeons were examined and patient characteristics such as PSA level, extracapsular extension, Gleason score, surgery date and surgical volume

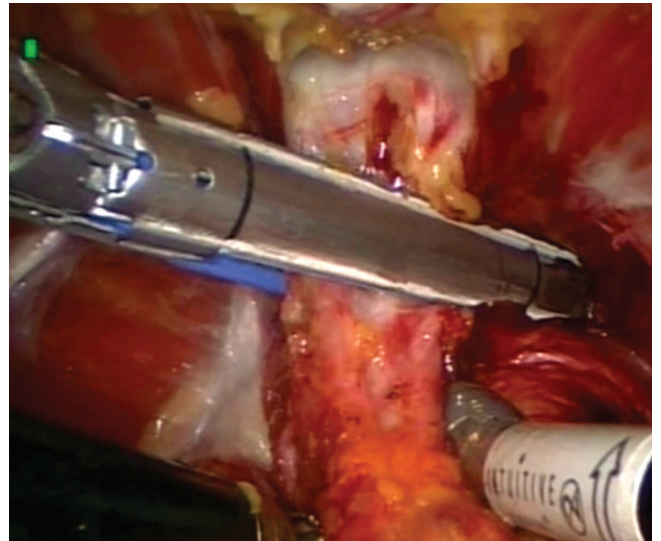


Fig. 1. Photograph of laparoscopic stapler placed across the dorsal venous complex.

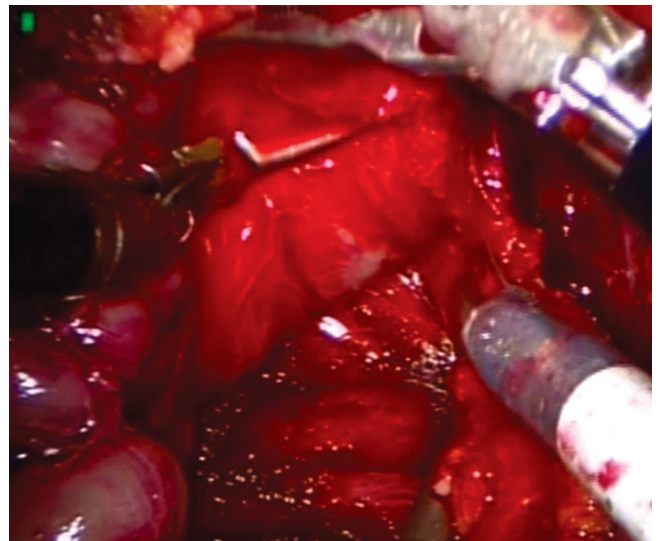


Fig. 2. The right neurovascular bundle is being dissected away from the prostate in an interfascial technique.

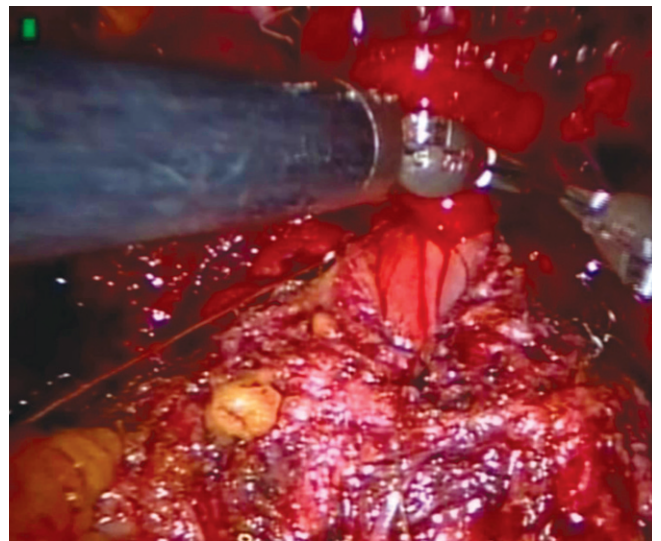


Fig. 3. View of the apposition of the bladder to the urethra during vanVelthoven anastomosis.

were controlled for, surgeon volume was a clear independent risk factor for a positive surgical margin. Furthermore, PSA recurrence in a similar study by Klein revealed a similar result.²⁰ As such, as the robotic prostatectomy surgical experience broadens, the outcomes should continue to improve.

However, the robotic and laparoscopic approaches have brought innovation to radical prostatectomy. The vanVelthoven anastomosis was made possible by a laparoscopic approach; the technique involves the creation of the urethrovesical anastomosis by a double armed suture that is initiated at the 6 o'clock position and run continuously to the 12 o'clock position with a single knot at the top.²¹ This technique has proved reliable, rapid with a minimum of complications such as urine leak or bladder neck contractures.

Menon has reported the Veil of Aphrodite technique of nerve sparing where the prostatic fascia is incised very anteriorly. The goal of the approach is to spare anterior accessory nerves that may be important for potency. Improved potency was indeed demonstrated for men with normal preoperative potency in a small study comparing these patients to a historical control of standard nerve sparing.²² However, the controversy surrounded this technique despite the positive outcomes due to a concern of closer margins. However, these data led to a comparative study by Walsh where he examined a high anterior fascia release (HAR) to his standard technique of nerve sparing. He noted clearly improved outcomes where HAR patients had a higher chance of regaining a SHIM score of 16 (93% to 77%). He also did not see an increase in the positive margin rates but theorized that the success of this technique was not improved number of nerves spared but decreased traction on the neurovascular bundle during dissection.

Future directions

Attempts to further decrease morbidity and increases in computing power and technological innovations will continue to drive progress in robotics and computer assisted surgery. The development of single port surgery is a clear fit with robotic technology. Gettman²³ reported transvaginal laparoscopic nephrectomy in the porcine model where a single 5 mm transabdominal port was used in conjunction with a multiple ports placed through the vagina. Successful nephrectomy was performed in 5 out of 6 animals. The relatively rudimentary devices used in this report have been improved with development of articulating instruments and single site access ports that allow multiple instrument passage. Kaouk²⁴ has reported on laparoscopic single port prostatectomy in 4 patients. Mean OR time was 285 minutes and EBL was 288 cc. No intraoperative complications occurred. One patient did develop a rectourethral fistula. Refinement of robotic tools will allow further exploration and refinement of this challenging technique.

Other scientific breakthroughs will lead to the ability to 'see' structures that cannot be seen with the naked eye. Boyette et al.²⁵ has reported on optical real time imaging of cavernous

nerves with confocal microscopy. This technique was initiated with the creation of a fluorescent nerve tracer. This tracer was injected into the penis of a group of rats. *In vivo* imaging during laparoscopy using a fiber wand attached to a confocal microscope was able to visualize these nerves in the pelvis. In the future, it may be possible to label specific structures that can literally 'light up' during a robotic approach. This could enable sparing of certain structures such as nerves and definitive removal of other cancerous tissues.

CONCLUSIONS

The robotic prostatectomy has indeed become the most common extirpative operation performed for prostate cancer in the United States. However, the development and refinement of this procedure has led to improved outcomes for patients undergoing either robotic or open radical prostatectomy. Future improvements are inevitable and soon our imagination will be our only limit to the progress of surgery.

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