

Robotic Radical Prostatectomy: Operative Technique, Outcomes, and Learning Curve

Jay D. Raman, MD, Steven Dong, MD, Adam Levinson, MD,
David Samadi, MD, Douglas S. Scherr, MD

ABSTRACT

Objective: To report the operative technique, oncologic and therapeutic outcomes, and learning curve from our initial series of over 140 patients treated by robotic radical prostatectomy.

Methods: Between January 2003 and May 2005, 143 patients with clinically localized prostate cancer underwent a robotic radical prostatectomy. Prospective data collection included patient age, body mass index (BMI), clinical T stage, biopsy Gleason score, and prostate-specific antigen (PSA). Operative outcome measures included operative time, estimated blood loss (EBL), and complications. Post-operative outcomes were length of hospital stay, catheter duration, pathology, margin status, biochemical recurrence, and return of continence.

Results: Mean operative time was 241 minutes with an EBL of 274 mL. Five patients (3%) required conversion to open surgery. The average hospitalization was 1.8 days, and Foley catheters were removed after 8.9 days. Twenty-four of 141 men (17%) had a positive surgical margin, with a decrease from 23% in the first half of our experience to 11% in the latter half. Patients with an extracapsular extension had a significantly higher positive surgical margin rate than did those with organ-confined disease (47% vs 15%). Over 40% of the positive margins were located posteriorly. At a mean follow-up of 11 months, 96% of patients had a PSA < 0.2 ng/mL. The median time to complete continence was 3.5 months, and over 95% of patients were fully continent at 1 year.

Conclusion: Robotic radical prostatectomy is an effective treatment modality for clinically localized prostate cancer. Although a learning curve needs to be overcome, patients

experienced benefits in convalescence with early oncologic and functional outcomes comparable to those of the open approach. Longer-term results are needed; however, patient outcomes in our series are encouraging.

Key Words: Robotic radical prostatectomy, Prostate cancer, Urologic oncology, Operative techniques, Learning curve.

INTRODUCTION

Since the initial description by Walsh and Donker in 1982 regarding the anatomic basis for erectile function, urologists have continuously explored technical advances that would improve both the oncologic and quality of life outcomes following radical prostatectomy.¹ Anatomical nerve-sparing methods have become mainstream practice with resultant improvements in erectile function rates following what was once considered a morbid procedure.² Although some interval modifications have been achieved in the radical retropubic prostatectomy operation, the next most significant advancement in surgical technique has been the introduction of laparoscopy. In the late 1990s, Guillonnet and Vallancien³ introduced laparoscopic radical prostatectomy as a viable surgical alternative for treating prostate cancer. Subsequently, several centers have gone on to incorporate laparoscopic prostatectomy into their surgical armamentarium with successful outcomes.^{4,5} Having set the stage for laparoscopy in the surgical treatment of prostate cancer, urologists then sought to improve upon such techniques with the use of robotics and the implementation of robotic radical prostatectomy.^{6,7}

Throughout the evolution of technology and treatment strategies, the urologic community has stringently emphasized the need to demonstrate both oncologic and therapeutic efficacy of procedures. The acceptance of changes in surgical technique has always been predated by demonstrable evidence from multiple institutions, regarding both the clinical and pathologic criteria that are essential for the successful treatment of prostate cancer. As such, we have entered the robotic age in the treatment of prostate cancer with encouraging reports from a few centers of excellence.⁸⁻¹¹

Department of Urology, The New York-Presbyterian Hospital, Weill Medical College of Cornell University, New York, New York, USA (Drs Raman, Dong Scherr).

Columbia University College of Physicians and Surgeons, New York, New York, USA (Drs Levinson, Samadi).

Address reprint requests to: Jay D. Raman, MD, New York-Presbyterian Hospital-Weill Cornell Medical Center, Department of Urology, 525 East 68th St, Starr 900, New York, NY 10021, USA. Telephone: 212 517 3291, Fax: 212 746 8153, E-mail: jay_d_raman@yahoo.com

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Here then, we hope to further diversify the experience in robotic prostatectomy and enrich the confidence of treating urologists by reporting our operative technique, oncologic and therapeutic outcomes, and learning curve from our initial series of over 140 consecutive patients treated by robotic radical prostatectomy.

METHODS

Patient Selection

Between January 2003 and May 2005, 174 consecutive patients with clinically localized prostate cancer underwent a robotic radical prostatectomy performed by 2 surgeons (DSS and DS) at the New York-Presbyterian Hospital. Thirty-one patients with a follow-up period of less than 3 months were excluded from analysis in this study. The remaining 143 patients were then analyzed for the purposes of assessing outcomes. All patients had biopsy proven adenocarcinoma of the prostate and were staged according to the 2002 American Joint Committee on Cancer (AJCC) classification.¹²

Operative Technique

All patients underwent a robotic radical prostatectomy with the da Vinci surgical system (Intuitive Surgical Inc., Sunnyvale, CA). The procedure was performed as described by Menon et al¹¹ with a few modifications.

Briefly, following induction of general endotracheal anesthesia, the patient was placed in the lithotomy position with a steep Trendelenberg. The abdominal and groin areas were prepped and draped, intravenous antibiotics were administered before skin incision, and a 20-F, 30-cc urethral catheter was placed. A 1.5-cm incision was made to the left of the umbilicus, and a Veress needle was used to insufflate the abdomen with CO₂ to a pressure of 15cm H₂O. A 10/12-mm trocar for the camera was placed at the umbilicus, two 8-mm trocars for the robotic arms were placed just lateral to the medial umbilical ligaments, a 5-mm suction port was introduced to the right of the umbilicus, and 10/12-mm and 5-mm trocars were introduced 2 fingerbreadths above the iliac crest on the patient's right and left side, respectively. Overall, 6 ports were used, and the da Vinci robot was docked.

Starting with a 30° angle-up lens, the medial umbilical ligaments were incised up the anterior abdominal wall allowing cephalad reflection of the bladder and entry into the space of Retzius. The adipose tissue overlying the endopelvic fascia was cleared. The lens was changed to a

0° angle, and the endopelvic fascia was opened in a cautery-free manner to expose the apex of the prostate. The levator muscles were swept posterolaterally, and the puboprostatic ligaments were sharply divided to gain further length beyond the apex of the prostate. The superficial and deep dorsal veins were ligated with a 0-vicryl stitch, and a second 0-vicryl stitch was then placed for back bleeding over the anterior surface of the prostate.

The 30° angle-down lens was used for the bladder neck dissection. The anterior bladder neck was divided, and the ureteral orifice position and presence of a median lobe were assessed, and then the posterior bladder neck was divided. The vas deferens and seminal vesicles were then identified. The vasa were divided and the seminal vesicles were dissected in a cautery-free manner to avoid potential injury to the neurovascular bundles. The posterior layer of Denonvillier's fascia was divided allowing for identification of perirectal fat, which served as a guide between the prostate and rectum. To optimize nerve sparing, all prostatic pedicles were clipped and sharply divided without using electrocautery. The lateral prostatic fascia was incised on each side allowing the neurovascular bundles to fall posterolaterally, and a bilateral nerve-sparing procedure was performed when possible.

The neurovascular bundle was released distally to the level of the urethra and prostatic apex. At this point, the only remaining attachments of the prostate were the dorsal vein complex (DVC) and the urethra. The DVC and urethra were then divided rendering the prostate free, and the specimen was placed in a 10-mm endocatch bag. Intraoperative frozen sections was used judiciously to help decrease the incidence of positive surgical margins.

The urethrovesical anastomosis was performed in a running fashion by using a double-arm 2-0 Monocryl suture. An 18-Fr, 10-mL urethral catheter was placed and irrigated to ensure a water-tight anastomosis. A bilateral pelvic lymph node dissection was performed following completion of the urethrovesical anastomosis in patients with a greater than 2% chance of positive lymph nodes as obtained from the Partin predictive tables. Borders of the node dissection were the external iliac vein anteriorly, obturator nerve posteriorly, bifurcation of common iliac artery superiorly, and Cooper's ligament inferiorly. A #10 flat JP drain was placed into the pelvis and brought out through the left-side 5-mm port. The da Vinci robot was then undocked, all trocars were removed under direct vision, and the specimen was removed through the camera port. The fascia at the extraction site was closed with

a 2–0 vicryl suture, and all skin incisions were closed with a 4–0 Biosyn stitch.

Follow-up

Patients were seen approximately 1 week postoperatively for catheter removal. Cystograms were not routinely obtained before catheter removal. Postoperative PSA values, urinary continence, and erectile function were evaluated 6 weeks postoperatively, every 3 months for the first year, every 6 months for the second year, and yearly thereafter.

Data collection, Outcomes, and Statistical Analysis

Before surgery, all men were evaluated with the following data recorded: age, BMI, clinical T stage, biopsy Gleason score, and prostate-specific antigen (PSA). Operative outcome measures included operative time, estimated blood loss (EBL), and complications. Postoperative outcomes were length of hospital stay, catheter time, pathology, margin status, biochemical recurrence, and return of continence. The chi-square (χ^2) log-rank test with the Yates correction factor and the unpaired 2-tailed Student *t* test were used to compare variables between the first and second 70 patients in our series.

RESULTS

The demographic data of the patient population are summarized in **Table 1**. **Table 2** outlines the operative data from our series of patients. The mean operative time was 241 minutes (range, 120 to 540), with a decrease of over 100 minutes when comparing our initial series of 70 with our more recent 70 patients (318 vs 209, $P < 0.001$). The mean estimated blood loss (EBL) was 274 mL (range, 10 to 800), with a significant decrease in our more recent series of patients (387 vs 155, $P < 0.001$). In 127 men, data regarding nerve sparing were available. One hundred and nine of 127 men (86%) had a bilateral nerve-sparing operation, whereas 13/127(10%) had unilateral nerve-sparing, and 5/127(4%) had bilateral nerve resections. Sixty-six of the last 70 patients (94%) had bilateral nerve-sparing operations. Two individuals underwent robotic-assisted genitofemoral nerve grafts. Five patients (3%) had a conversion to open surgery for bleeding,¹ large intravesical median lobes,² adherence to the rectum,¹ and robot malfunction.¹ Only 1 of our last 70 patients (1%) required an open conversion.

Table 3 summarizes the postoperative data. The mean hospital stay was 1.8 days (range, 1 to 10). Of our most recent 70 patients, 65 (93%) were discharged within 24

No. Patients	143
Age (range)	60.4 (43–75)
BMI (kg/m ²) (range)	26.8 (18–38)
Serum PSA (ng/mL) (range)	6.7 (1–60)
Gleason Score (%)	
5	1 (1)
6	75 (52)
7	53 (37)
8	9 (6)
9	5 (4)
No. Clinical Stage (%)	
T1c	97 (67)
T2a	44 (31)
T2b	2 (2)
Family History of Prostate Cancer (%)	16 (11)

hours of surgery. The urethral catheter was removed at a mean time of 8.9 days (range, 1 to 29). At a mean follow-up of 11 months, 96% of patients (137/143) had a PSA < 0.2 ng/mL. Four patients had postoperative complications including an ileus,² small bowel obstruction¹ requiring reoperation, and a urethral stricture¹ requiring repeat dilatation.

Table 4 outlines the postoperative pathology data across our cohort of patients. Two patients (1%) did not have any tumor identifiable in the final pathology specimen, 1 of whom received preoperative hormonal deprivation therapy. Organ-confined (OC) disease (pT2) was present in 122/141 patients (87%) and extracapsular extension (ECE) was present in the final pathology analysis (pT3/T4) of 19/141 (13%) patients. Twenty-four of 141 men (17%) in our series had a positive margin on examination of the specimen, with a decrease from 23% (16/70) to 11% (8/70) when comparing our more recent 70 patients with the initial 70 ($P = 0.07$). Patients with ECE had a significantly higher rate of positive surgical margins than did those with OC disease (47% vs 12%, $P < 0.001$). When exclusively considering pT3 disease, we further noted a decrease in positive margins when comparing our first 70 patients (5/9; 56%) with our latter 70 (2/8; 25%). No significant difference existed in positive margin rates in the Gleason ≤ 7 cohort (19/122, 16%) and the Gleason > 7 group (4/19, 21%) ($P = 0.55$). Over 40% (14/33) of the positive margins were located in the posterior aspect of

		P Value*
Operative Duration (mins) (range)		
Overall	241 (120–540)	<0.001
First 70	318 (150–540)	
Second 70	209 (120–474)	
Estimated Blood Loss (mL) (range)		
Overall	274 (10–1800)	<0.001
First 70	387 (50–1800)	
Second 70	155 (10–600)	
Nerve Sparing [†] (%)		
Bilateral	109 (86)	
Unilateral	13 (10)	
Non-nerve sparing [‡]	5 (4)	
Open Conversions (%)		
Overall	5 (3)	0.17
First 70	4 (6)	
Second 70	1 (1)	

*Comparison of first 70 cases versus second 70 cases in series.

[†]Data available for 127 patients.

[‡]Two of these 5 patients underwent robotic genitofemoral nerve grafts.

Mean Follow-up (mos) (range)	11 (3–26)
Hospitalization Days (range)	
First 70	1.9 (1–10)
Second 70	1.1 (1–7)
Days Foley Catheterization (range)	8.9 (1–29)
Postop PSA <0.2 ng/mL (%)	96
Postop Complications (%)	
Ileus	2 (1)
Bowel obstruction	1 (1)
Urethral stricture	1 (1)

the prostate. The number of positive apical, anterior, and posterior positive margins remained unchanged as experience matured in this series; however, margin positivity at the bladder neck decreased from 7 in the first cohort of patients to 2 in our latter operative experience.

Pathologic Stage	
T0 (no tumor)	2 (1)
T2a	15 (10)
T2b	24 (17)
T2c	83 (58)
T3a	12 (8)
T3b	5 (3)
T4	2 (1)
Gleason Score (%)	
P0 (no tumor)	2 (1)
5	1 (1)
6	43 (30)
7	78 (55)
8	8 (6)
9	11 (8)
Perineural Invasion (%)	
	38 (27)
No. Positive Margins (%)	
Overall	24 (17)
First 70	16 (23)
Second 70	8 (11)
Location Total (1st 70/2nd 70)*	
Apex	5 (2/3)
Bladder neck	9 (7/2)
Anterior	5 (3/2)
Posterior	14 (7/7)
Pos. Margins by Stage (%)	
pT2a	2/15 (13)
pT2b	0/24 (0)
pT2c	13/83 (16)
pT3a	5/12 (42)
pT3b	2/5 (40)
pT4	2/2 (100)
Pos. Margins by Gleason (%)	
≤7	19/122 (16)
>7	4/19 (21)

*Total number of positive margin sites identified in all specimens. Several patients had more than 1 site of positive margins.

Figure 1 graphically depicts the return of full urinary continence across the entire cohort. Patients requiring no urinary pads were considered continent, and the use of even one pad per day for occasional stress urinary incon-

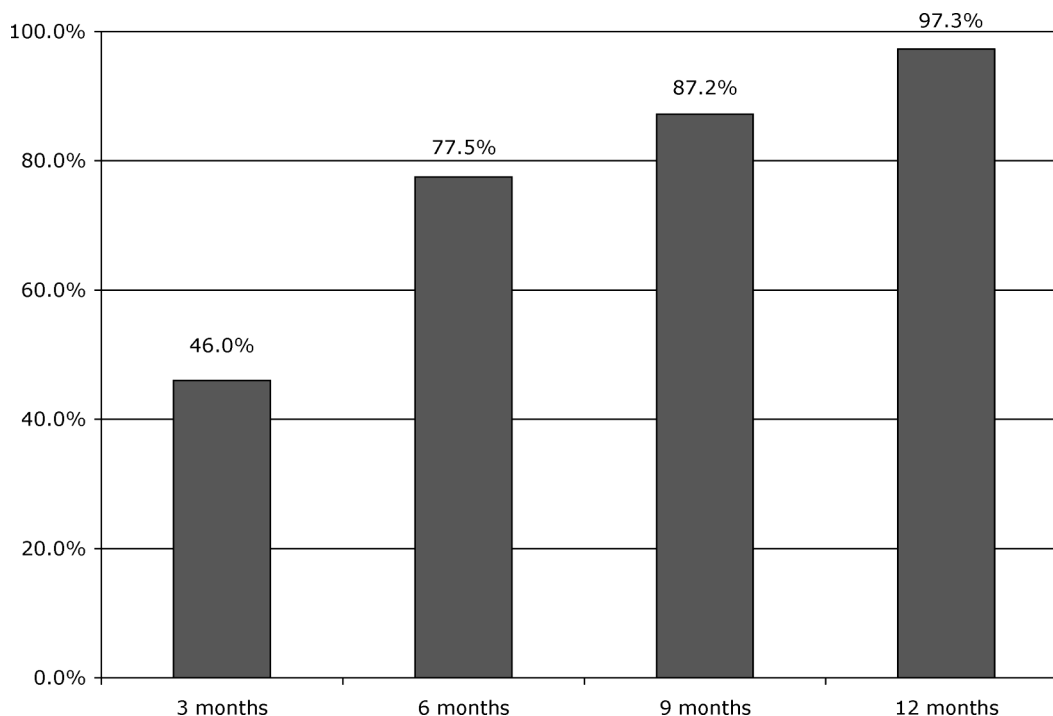


Figure 1. Time to full continence.

tinence was not considered continent for the purposes of our analysis. The median time to complete continence was 3.5 months, and over 95% of patients were fully continent at 1-year follow-up. Because our data are awaiting maturity, we will hold off on reporting potency data in this analysis.

DISCUSSION

As robotic surgery becomes a more accepted treatment modality for clinically localized prostate cancer, many urologists are struggling to incorporate this technique into their therapeutic armamentarium. Increasingly, surgeons are foregoing open retropubic approaches with a technically challenging robotic-assisted technique for which efficacy data are currently limited but growing. It is the intent of our analysis to objectively analyze the robotic approach from an oncologic standpoint, and in doing so, to characterize the oncologic and therapeutic efficacy of this relatively new and growing technology.

Although the ultimate measure of any intervention is the ability to prolong long-term survival, modifications in surgical technique can be assessed in the short-term by analyzing pertinent oncological principles. One such variable is pathology margin status. It is generally agreed that a positive margin is indicative of incomplete tumor resec-

tion and bears significant prognostic importance. Several institutions have demonstrated the independent prognostic significance of positive surgical margins across all stages of disease.^{13–15} Han et al¹⁶ further point out that the rate of positive surgical margins has declined dramatically from around 40% during the early 1980s to less than 10% more recently. Although these observations are likely multifactorial, the lower positive margin rates over the past decade are largely attributable to the stage migration that has occurred in the era of PSA screening. It is imperative, however, to also consider contemporary refinements in preoperative planning, biopsy strategies, and surgical technique.¹⁷ As we embark on the robotic age for the treatment of prostate cancer, it is essential that we adhere to surgical principles learned over the last 3 decades.

In this study, we report an overall positive margin rate of 17%. During the first half of our experience, we noted a 23% positive margin rate, which declined to 11% over our last 70 consecutive patients. Further, no difference existed in the pathologic distribution of tumors between our initial 70 patients and our latter 70 (9 vs 10 cases of ECE). Collectively, these data suggest that the decline in the positive margin rate is most attributable to an improved surgical skill set in the robotic technique rather than a decrease in the number of biologically aggressive tumors.

Subset analysis of the data also notes a significantly lower incidence of positive margins when comparing specimens with organ-confined disease with those with extracapsular extension (12% vs. 47%, $P < 0.001$). Noteworthy, however, is the decrease in positive margin rates from 56% to 25% in the pT3 subgroup of tumors during the evolution of our experience. This underscores that robotic prostatectomy is a reasonable surgical alternative for organ-confined, as well as pT3 disease. Thus, even in our initial robotic experience, the results compare favorably with those of other reported robotic series, as well as with the current oncologic gold standard open retropubic approach.^{18,19}

The specific location of positive margins is explainable both by surgical experience and technique. As depicted in **Table 4**, bladder neck positive margins declined over 3-fold when comparing the first half of our robotic experience and our most recent surgical series. The antegrade approach utilized during a robotic prostatectomy can be quite challenging and choosing the appropriate location for incision of the bladder neck can be difficult. As our experience in robotic surgery has matured, we have learned to take a wider bladder neck and robotically reconstruct the bladder as necessary. This modification has probably resulted in decreased positive bladder neck margins as our experience increased. In terms of the anterior and apical margins, we noted that 15% (5/33) of all positive margin sites were at each of these 2 anatomic locations, respectively. This compares favorably with other published reports in which the apical positive margin rates range from 5% to 28%.²⁰ We believe that the anterior and apical dissection is enhanced with the robotic approach likely due to the use of an angled lens resulting in improved visualization of the dorsal vein/urethral complex.

At 1-year follow-up, 97% (139/143) of men were fully continent without the requirement of any pads. This compares favorably with continence data published following the open retropubic approach. Our 3-month follow-up data, however, indicate that less than 50% of patients are fully continent at this time point. Anecdotally, this is lower than the continence rates we have observed for our contemporary open retropubic prostatectomy series. One possible explanation is that the enhanced robotic visualization may result in excessive dissection of the striated sphincter complex beyond the apex of the prostate. To improve the early continence rates, we have made several modifications in our current technique including tacking the urethra to the periosteum of the pubis and avoiding excessive dissection beyond the apex of the prostate. With such modifications, our short-term continence rates have

improved in a more contemporary group of patients (data not shown).

CONCLUSION

Robotic-assisted radical prostatectomy is an effective modality for the treatment of clinically localized prostate cancer. We acknowledge that a learning curve needs to be overcome; however, with a rigorous, focused robotic educational program, early oncologic functional results compare favorably with results of the open retropubic approach.

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