ELSEVIER

ROBOTIC RADICAL PROSTATECTOMY AND THE VATTIKUTI UROLOGY INSTITUTE TECHNIQUE: AN INTERIM ANALYSIS OF RESULTS AND TECHNICAL POINTS

MANI MENON, ASHUTOSH TEWARI, AND MEMBERS OF THE VATTIKUTI INSTITUTE PROSTATECTOMY TEAM

ABSTRACT

We have performed >350 robotic radical prostatectomies in the last 2 years. A single surgeon (MM) performed 250 of these procedures using a technique developed at our institution, the Vattikuti Urology Institute. This article summarizes the technical highlights and interim results of the Vattikuti Institute Prostatectomy (VIP) technique. We prospectively collected baseline demographic data, such as age, race, body mass index (BMI), serum prostate-specific antigen values, prostate volume, Gleason score, percentage cancer, TNM clinical staging, and comorbidities. Urinary symptoms were measured with the International Prostate Symptom Score, and sexual health with the Sexual Health Inventory of Males. In addition, patients received the Expanded Prostate Inventory Composite at baseline and at 1, 3, 6, 12 and 18 months after the procedure via mail. Data collection is complete on 200 of the first 250 patient cases. Gleason score ≥7 was noted in 40% of patients. The average BMI was high (28), and 86% patients were classified as pathologic stage pT2a to pT2b. The mean operative time was 160 minutes and the mean blood loss was 153 mL. No patient required blood transfusion. At 6 months, 82% of the men who were <60 years of age and 75% of those >60 years of age had return of sexual function, and 64% and 38%, respectively, had sexual intercourse. At 6 months, 96% patients were continent. UROLOGY **61:** 15–20, 2003. © 2003, Elsevier Science Inc.

Robotic assistance offers an open surgeon sophisticated tools to perform complex laparoscopic surgery. A technologically advanced ergonomic operation is achieved because of 3-dimensional visualization; wristed instrumentation; intuitive, finger-controlled movements; and a comfortable seated position for the surgeon. We started performing robotic prostatectomy in November 2000[1,2] and have done 350 such operations as of December 2002. Our current approach—Vattikuti Institute Prostatectomy (VIP)—is based on the palimpsest of conventional anatomic "open" prostatectomy, overwritten by technical nuances that are derived from robotic technology as elaborated by the da Vinci surgical system (Intuitive Surgical, Sunnyvale, CA). An early version of this approach based on our first 30 cases has been published.[3] In this article, we expand on newer modifications and provide an update of our preliminary results.

From the Vattikuti Urology Institute, Henry Ford Health System, Detroit, Michigan, USA; and Department of Urology, Case Western Reserve University School of Medicine, Cleveland, Ohio, USA.

Reprint requests: Mani Menon, MD, Vattikuti Urology Institute, Henry Ford Hospital, 2799 West Grand Boulevard, K-9, Detroit, Michigan 48202. E-mail: mmenon1@hfhs.org

PATIENTS AND METHODS

PATIENTS AND DATA

Men with Gleason score >5 prostate cancers with a Charlson comorbidity score of <3 are candidates for this procedure. We prospectively collected baseline demographic data, such as age, race, body mass index (BMI), serum prostate-specific antigen, prostate volume, Gleason score, percentage cancer, 1992 TNM clinical staging, comorbidities, and previous abdominal surgery. Urinary symptoms were measured with the International Prostate Symptom Score (IPSS), and sexual health with the Sexual Health Inventory of Males score. In addition, the patients were interviewed on the telephone by a third party and were also mailed the Expanded Prostate Inventory Composite, a quality-of-life instrument.[4] The quality-of-life instruments have been validated previously in patients with prostate cancer.[4–6] The local Institutional Review Board approved the study and consent forms. Questionnaires were collected at baseline and at 1, 3, 6, 12, and 18 months after the procedure.

0090-4295/03/$30.00
doi:10.1016/S0090-4295(03)00116-X

Data Collection

Details of each surgical procedure were entered on a comprehensive data collection sheet, which was completed by a third party. These details included the times of entry into the operative room, induction of anesthesia, and the various steps of the operation: (1) port placement, (2) development of retroperitonal space, (3) lymph node dissection, (4) ligation of the dorsal venous complex, (5) retroapical release, (6) bladder neck transection, (7) exposure of vas and seminal vesicles, (8) control of pedicles, (9) incision of posterior layer of Denonvillier fascia, (10) neurovascular bundle release, (11) urethral transection, (12) apical biopsies, and (13) anastomosis.

Additional data elements that were measured were (1) blood loss (determined by the anesthesiologist), (2) the postoperative pain score (using a visual analog score), (3) days of hospitalization, (4) hemoglobin levels at discharge, and (5) duration of catheterization. Any untoward event within 30 days of surgery was recorded as a perioperative complication.[7]

Histopathologic Analysis

The surgical specimen was inked and processed for histopathologic analysis.[8] Margins were considered positive if there was tumor present at ink. For the apex, margins were considered positive if the margins of the apical biopsies (see "Results" section), which represent the actual margin of the apical dissection, showed cancer. Positive margins were either focal ($\leq$1 mm cancer) or extensive ($>$1 mm cancer).

Data Analysis

Data were entered in a custom-made Access software (Microsoft Corporation, Redmond, WA) database and analyzed using Statistical Analysis System (SAS) data analysis software (SAS Institute Inc., Cary, NC).[9] Between-group comparison of nominal variables were done using Fisher exact test and χ^2 analysis, and continuous variables were compared using analysis of variance. The days to continence, erection, and intercourse were recorded and used in the time-dependent survival analysis using the Kaplan-Meier method.

Technical Video Storage

The intraoperative video footage was recorded using a digital video camera and stored in miniature digital video and digital storage devices. Nonlinear editing was performed using a Macintosh computer (Apple Computer, Inc., Cupertino, CA).

RESULTS

The da Vinci system (Video Clip 1: The da Vinci System; http://www.goldjournal.net) uses a sophisticated master-slave robot that incorporates 3-dimensional visualization, scaling of movement, and wristed instrumentation. The system has 3 multijoint robotic arms: 1 arm controls a binocular endoscope, and the other 2 arms control articulated instruments. In addition, 2 lenses—0° or 30°—are used, and 2 finger-controlled handles (the "masters") housed in a mobile console control the 2 robotic arms. Together with a foot pedal, the arms move the lens and visual field. Instrument movement can be scaled from 1:1, which allows exact finger movements to be transmitted to the instrument tip, to 1:3 and 1:5, which scale down the movements to allow precise and delicate dissection.

Surgical Team

The VIP team includes 1 console-side and 1 patient-side team. The operating surgeon sits at the console and is not scrubbed.

Patient Positioning and Port Placement

We place the patient in the Trendelenburg position, and pneumoperitoneum is created with a Veress needle (Ethicon Endo-Surgery, Inc., Albuquerque, NM) introduced through a left periumbilical puncture. As previously described, 6 ports are used[3] (Video Clip 2: Patient positioning and port placement; http://www.goldjournal.net).

Surgical Step Modifications: Points of Technique

The steps have been described previously; we will highlight modifications from the original description.

Development of the Extraperitoneal Space, Apical Dissection and Control of Dorsal Venous Complex. For the VIP approach, the initial incision is made just above the pubic symphysis. The incision should be as low as possible, but high enough to avoid entering the dome of the bladder. It may be useful to start the incision on either side of the medial umblical ligaments, and to end with urachal transection. The extraperitoneal space is developed (Video Clip 3: Development of the extraperitoneal space; http://www.goldjournal.net), and the bladder is "dropped" posteriorly. The same exposure can be obtained with a purely extraperitoneal placement of the ports. In our hands, the VIP approach combines the virtues of a large working space with those of an extraperitoneal dissection.

Early in our experience, we would transect the puboprostatic ligaments and dissect out the posterior urethra and the dorsal vein complex. For the last 12 months, we have adopted a minimalist approach, leaving the puboprostatic ligaments intact and dissecting out as little of the urethra as is necessary to place the dorsal vein stitch (Video Clip 4: Apical dissection and control of dorsal venous complex; http://www.goldjournal.net). This approach has improved our early continence results. The prostatic stitch is placed primarily for traction and rotation of the prostate during posterior dissection, not to decrease back bleeding.

Preservation of Neurovascular Bundles. Although we initially used electrocautery for the entire posterior dissection, we now avoid use of electrocautery. This has been associated with a clear improvement in early potency rates. We use articulated robotic scissors to incise the prostatic fascia ante-

rior and parallel to the neurovascular bundles. Once the correct plane is entered, most of the dissection occurs in a relatively avascular plane.[10] Appropriate traction of the prostate is important to identify the correct plane of dissection (Video Clip 5: Preservation of neurovascular bundles; http://www.goldjournal.net).

Bladder Neck Transection, Dissection of Vas and Seminal Vesicle, Control of Lateral Pedicles. We continue to be satisfied with the 30°-angled lens for viewing this part of the procedure. We start the dissection laterally, where there is a clear plane between the bladder and the prostate. This plane is not present at the midline where the bladder mucosa is continuous with the mucosa of the prostatic urethra. There should be no oozing at this stage of the operation. If there is, the surgeon may be in the prostate. Err on the side of the bladder rather than the prostate.

After the anterior bladder neck is incised, the Foley balloon is deflated and the second assistant pulls the catheter firmly toward the ceiling. This helps identify the posterior bladder neck. The posterior bladder neck should be incised precisely, maintaining a clean detrusor margin for the subsequent urethrovesical anastomosis. The anterior layer of Denonvillier fascia is incised, exposing the vasa and the seminal vesicles. The assistant on the left grasps the cut fascial end and pulls it up firmly, releasing the catheter. This facilitates the vasal and vesical dissection (Video Clip 6: Bladder neck transection, dissection of vas and seminal vesicle, control of lateral pedicles; http://www.goldjournal.net).

Incision of Dorsal Vein Complex, Intraoperative Apical Biopsies and Removal of Specimen. The posterior dissection plane, at least at the prostatovesical junction, is within layers of Denonvillier fascia. In this location, the magnified field shows that there are multiple layers of fascia. In conventional radical prostatectomy, this dissection is carried out behind all layers of Denonvillier fascia, and between the rectum and the fascia. We were concerned that we may have a high incidence of positive margins with this approach: however, this has not been the case. Therefore we continue to dissect in this plane because it leaves an added protective fascial layer over the rectum.

In our series, as well as in most open radical prostatectomy series, the most common location of positive margins is at the apex.[11] The articulated scissors and 3-dimensional visualization allow us to take precise periurethral biopsies without sacrificing urethral length. These biopsies are sent for frozen section. In the rare instance (5% for us) in which they are positive, additional biopsies are taken from the appropriate location. This approach will lower positive apical margins significantly. This is an important modification (Video Clip 7: Incision of dorsal vein complex and removal of specimen; http://www.goldjournal.net).

Urethrovesical Anastomosis. The tails of a 6-in dyed and a 6-in undyed RB1 (3-0 braided, Monocryl suture on a 17-mm taper needle; Ethicon) suture are tied together to create a single 12-in suture with a knot in the middle and a needle at either end. Using the dyed end, the anastomosis is started by passing the needle outside in at the 4-o'clock position on the bladder and inside out on the urethra. We continue suturing clockwise up to the 10-o'clock position. The assistant holds the stitch taut. We then start with the undyed end of the suture, passing it outside in on the urethra and then inside out on the bladder. This suture is run counterclockwise up to the 11-o'clock position. The needles are cut off, and the free dyed and undyed ends are tied together. This stitch allows us to complete the entire urethrovesical anastomosis with a single intracorporeal knot. With this approach, our anastomosis time has been decreased by 10 to 15 minutes. Importantly, the anastomosis is usually watertight, and we seldom use a drain (Video Clip 8: Urethrovesical anastomosis; http://www.goldjournal.net).

PRELIMINARY RESULTS

Data collection is complete on 200 of the first 250 patients (surgery performed by MM). Table I summarizes some of the variables. A Gleason score of ≥ 7 for cancer was noted in 40% of patients. The average BMI was high (28), and 86% patients had pathologic stage pT2a to pT2b, and remaining patients were classified as pT3. The mean operative time was 160 minutes, and the mean blood loss was 153 mL. No patient required blood transfusion, and the mean hematocrit value at discharge was 39%. (The discharge hematocrit is 30% to 32% in many open series, as well as in our own open cases.) Patients do not feel as fatigued as when they have postoperative anemia. (Paradoxically, this also results in less reimbursement for the hospital.)

Table I also lists the perioperative complications. The port site hernias and ileus were seen in our earlier cases. We have had 1 ileus and no hernias in the last 150 cases. The return of sexual function is summarized in the last section of Table I. We noted that at 6 months, 82% men who were <60 years of age had return of sexual function and 64% had sexual intercourse. The return of continence is summarized in Figure 1. At 6 months, 96% patients were either free of having to wear pads or were using a liner for security reasons, and 4% were using ≥ 1 pads. Patients who were dry or us-

TABLE I. *Baseline, operative, oncologic, and postoperative variables (single team's experience of first 200 cases)*

	Continuous Variables/ Percentage for Categorical Variables
Variables	
Age (yr), mean ± SD (range)	59.9 ± 7.1 (42–76)
BMI, mean ± SD (range)	27.7 ± 2.8 (19–38)
Serum PSA (ng/mL), mean ± SD (range)	6.4 ± 2.47 (0.6–41)
Clinical stage, n (%)	
T1c	80 (49.7)
T2a	17 (10.6)
T2b	64 (39.6)
Gleason scores (biopsy), n (%)	
6	135 (66.5)
7	56 (27.6)
8	8 (3.9)
9	4 (1.9)
Pathologic stage, n (%)	
T2a	28 (14.7)
T2b	137 (72.1)
T3a	13 (6.8)
T3b	12 (6.3)
Gleason scores (histopathologic specimen), n (%)	
6	135 (66.5)
7	56 (27.6)
8	8 (3.9)
9	4 (1.9)
Specimen weight (cm^3)	45.3 ± 12.3 (18–122)
Percentage cancer, mean ± SD (range)	19 ± 9.8 (1–80)
Node status (%)	0.5
Positive margins (%)	6
Focal	5
Extensive	1
Operative time (min), mean ± SD (range)	160 ± 28 (71–315)
Intraoperative blood loss (mL)	153
Blood transfusions (%)	0
Mean hemoglobin at discharge (g/dL)	13
Pain score at first postoperative day	3
Catheterization time (days)	7
Hospitalization days	1.2
Undetectable postoperative PSA at 6 mo (%)	92
Discharged within 24 hr (%)	93
Complications (n)	
Port hernia	3/200
Ileus	3/200
Delayed bleeding	1/200
DVT	1/200
Potency after VIP using an EPIC quality of life instrument	
Any sexual activity* (%)	
Men <60 yr	
3 mo	65
6 mo	82
Men >60 yr	
3 mo	50
6 mo	75
Sexual intercourse (%)	
Men <60 yr	
3 mo	25
6 mo	64
Men >60 yr	
3 mo	10
6 mo	38

BMI = body mass index; DVT = deep vein thrombosis; EPIC = expanded prostate inventory composite; PSA = prostate-specific antigen; VIP = Vattikuti Institute Prostatectomy.

**Return of sexual activity included patients who had definite return of erections and had participated in a wide variety of sexual activities, excluding intercourse.*

ing a liner were "mostly satisfied" to "delighted" with the quality of life because of urinary symptoms, whereas those wearing pads were "mostly dissatisfied" or "unhappy" with the quality of life. In addition, 4% of patients undergoing VIP had a 4-point increase in IPSS score and 33% had a 4-point decrease in IPSS score.

COMMENTS

We have summarized technical nuances and contemporary results of the VIP. Currently, we can perform 3 procedures a day. Based on the encouraging results that we found in this cohort of patients, we have started a program of outpatient VIP. Subsequently, 30 of 32 eligible patients have chosen this approach and have been discharged within 4 to 6 hours of surgery. There have been no readmissions in this group. Although new, VIP appears to be a promising approach to the treatment of localized prostate cancer. It compares favorably with published series of laparoscopic[7,12–14] and conventional radical prostatectomies.[15–26] However, our results must be reproduced or improved on before the technique can be accepted widely.

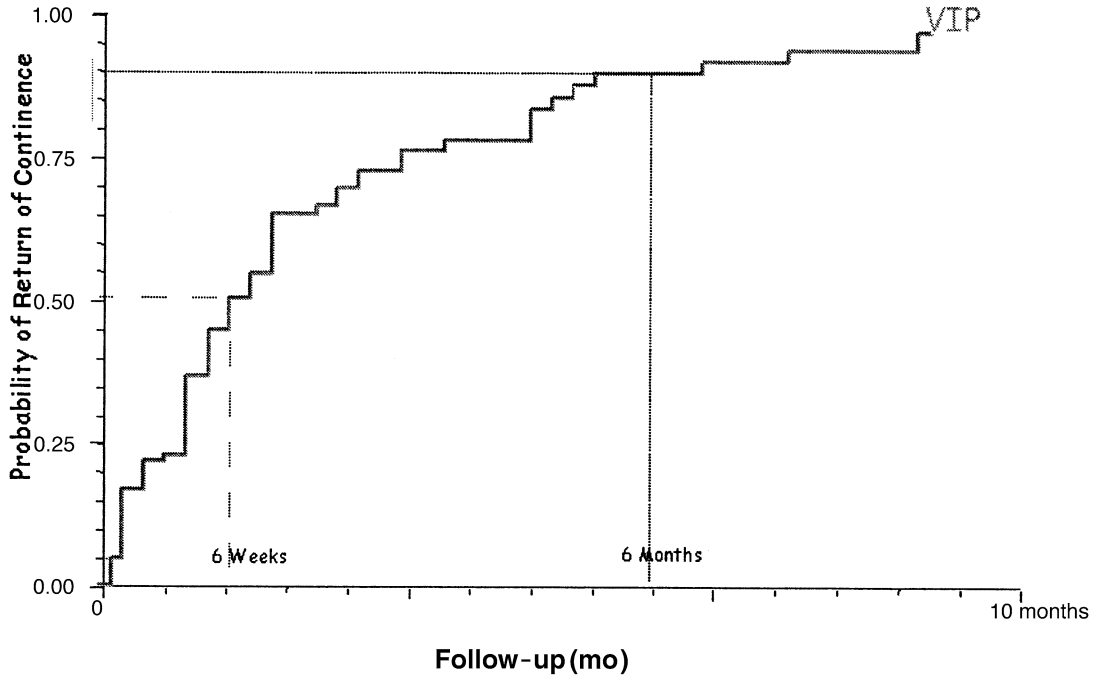

FIGURE 1. *Actuarial curve showing return of continence in Vattikuti Institute Prostatectomy (VIP) patients (n = 200).*

REFERENCES

1. Menon M, Shrivastava A, Tewari A, *et al*: Laparoscopic and robot assisted radical prostatectomy: establishment of a structured program and preliminary analysis of outcomes. J Urol **168:** 945–949, 2002.

2. Menon M, Tewari A, Baize B, *et al*: Prospective comparison of radical retropubic prostatectomy and robot-assisted anatomic prostatectomy: the Vattikuti Urology Institute experience. Urology **60:** 864–868, 2002.

3. Tewari A, Peabody J, Sarle R, *et al*: Technique of da Vinci robot-assisted anatomic radical prostatectomy. Urology **60:** 569–572, 2002.

4. Wei JT, Dunn RL, Litwin MS, *et al*: Development and validation of the expanded prostate cancer index composite (EPIC) for comprehensive assessment of health-related quality of life in men with prostate cancer. Urology **56:** 899–905, 2000.

5. Day D, Ambegaonkar A, Harriot K, *et al*: A new tool for predicting erectile dysfunction. Adv Ther **18:** 131–139, 2001.

6. Namasivayam S, Minhas S, Brooke J, *et al*: The evaluation of sexual function in men presenting with symptomatic benign prostatic hyperplasia. Br J Urol **82:** 842–846, 1998.

7. Guillonneau B, Rozet F, Cathelineau X, *et al*: Perioperative complications of laparoscopic radical prostatectomy: the Montsouris 3-year experience. J Urol **167:** 51–56, 2002.

8. Ohori M, Wheeler TM, Kattan MW, *et al*: Prognostic significance of positive surgical margins in radical prostatectomy specimens. J Urol **154:** 1818–1824, 1995.

9. SAS/STAT(R) SII: Users Guide. Cary, NC, SAS Institute, 1999.

10. Tewari A, Peabody J, Menon M: An anatomic map to assist identification of the neurovascular bundle during laparoscopic radical prostatectomy, in Hemal A (Ed.), Recent trends in laparoscopic urology. New Delhi, BI Churchill Livingstone, 2002, pp 297–304.

11. Epstein JI: Pathologic assessment of the surgical specimen. Urol Clin North Am **28:** 567–594, 2001.

12. Abbou CC, Salomon L, Hoznek A, *et al*: Laparoscopic radical prostatectomy: preliminary results. Urology **55:** 630–634, 2000.

13. Guillonneau B, Cathelineau X, Doublet JD, *et al*: Laparoscopic radical prostatectomy: assessment after 550 procedures. Crit Rev Oncol Hematol **43:** 123–133, 2002.

14. Rassweiler J, Sentker L, Seemann O, *et al*: Heilbronn laparoscopic radical prostatectomy: technique and results after 100 cases. Eur Urol **40:** 54–64, 2001.

15. Catalona WJ, Carvalhal GF, Mager DE, *et al*: Potency, continence and complication rates in 1,870 consecutive radical retropubic prostatectomies. J Urol **162:** 433–438, 1999.

16. D'Amico AV, Whittington R, Malkowicz SB, *et al*: Biochemical outcome after radical prostatectomy or external beam radiation therapy for patients with clinically localized prostate carcinoma in the prostate specific antigen era. Cancer **95:** 281–286, 2002.

17. Gerber GS, Thisted RA, Chodak GW, *et al*: Results of radical prostatectomy in men with locally advanced prostate cancer: multi-institutional pooled analysis. Eur Urol **32:** 385–390, 1997.

18. Gerber GS, Thisted RA, Scardino PT, *et al*: Results of radical prostatectomy in men with clinically localized prostate cancer. JAMA **276:** 615–619, 1996.

19. Han M, Partin A, Pound C, *et al*: Long-term biochemical disease-free and cancer-specific survival following anatomic radical retropubic prostatectomy: the 15-year Johns Hopkins experience. Urol Clin North Am **28:** 555–565, 2001.

20. Han M, Partin AW, Piantadosi S, *et al*: Era specific biochemical recurrence-free survival following radical prostatectomy for clinically localized prostate cancer. J Urol **166:** 416–419, 2001.

21. Hull GW, Rabbani F, Abbas F, *et al*: Cancer control with radical prostatectomy alone in 1,000 consecutive patients. J Urol **167:** 528–534, 2002.

22. Lepor H: Radical retropubic prostatectomy. Urol Clin North Am **28:** 509–519, 2001.

23. Lepor H, Nieder AM, and Ferrandino MN: Intraopera-

tive and postoperative complications of radical retropubic prostatectomy in a consecutive series of 1,000 cases. J Urol **166:** 1729–1733, 2001.

24. Walsh PC: Risk of positive margins and biochemical recurrence in relation to nerve-sparing radical prostatectomy. J Urol **168:** 1641, 2002.

25. Walsh PC: Variations in morbidity after radical prostatectomy. J Urol **168:** 1642, 2002.

26. Walsh PC, Marschke P, Ricker D, *et al.:* Patient-reported urinary continence and sexual function after anatomic radical prostatectomy. Urology **55:** 58–61, 2000.

APPENDIX: MEMBERS OF THE VATTIKUTI INSTITUTE PROSTATECTOMY TEAM

Ashok Hemal, MD, MCh; Ram Dasari, MD; James Peabody, MD; Richard Sarle, MD; Alok Shrivastava, MD, MCh; Kathleen Vershave, RN; Nancy Welkes, RN; and Brad Baize, RN.

Video Clips cited in this article can be viewed on the Internet at: http://www.goldjournal.net.