

Clinical Science: Second Prize

Pelvic Neuroanatomy and Innovative Approaches to Minimize Nerve Damage and Maximize Cancer Control in Patients Undergoing Robot-Assisted Radical Prostatectomy

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Abstract

Robot-assisted radical prostatectomy is an option for surgical management of clinically localized prostate cancer. There have been theoretical concerns, however, regarding lack of anatomic data with specific relevance to robot-assisted prostatectomy, use of thermal or electrical energy during nerve sparing, and lack of tactile feedback. To address these concerns, we have revisited anatomic foundations and have incorporated a few modifications and strategies in the technique of robot-assisted prostatectomy to maximize cancer control, preserve neurovascular tissue, and emulate time-tested steps of anatomic radical prostatectomy. We present our findings about neural anatomy, modified technique, and oncologic and functional outcomes from patients who have undergone this procedure at our institution.

Introduction

THERE HAS BEEN RECENT interest in robot-assisted prostatectomy, a technique pioneered by Menon and associates^{1,2} in the management of clinically localized prostate cancer. The technique^{3,4} and results of robot-assisted radical prostatectomy (RRP) have been published elsewhere.³⁻⁶

Single-center studies have established the safety and short-term effectiveness of RRP. There have been theoretical concerns, however, regarding lack of anatomic data relevant to RRP, use of thermal or electrical energy during nerve sparing procedures, and lack of tactile feedback. To address these concerns, we revisited anatomic foundations and have incorporated modifications and strategies in technique of RRP to maximize cancer control, preserve neurovascular tissue, and emulate time tested steps of radical prostatectomy (RP). We present our findings about neural anatomy, modified technique, and oncologic and functional outcomes from patients who have undergone this procedure at our institutions.

Patients and Methods

Study design and collaborative institutions

The overall goal of this study was to address concerns mentioned in the Introduction. We took an integrated approach of revisiting anatomic foundations, collaborating with seasoned open prostatectomy surgeons, with review of video footage to identify areas of concern and modification of our technique to change certain aspects of the procedure.

The specific aims of this study were achieved by a close collaboration between Cornell Institute of Robotic Surgery, New York, NY, the Institute of Urology at the University of Innsbruck in Austria, and the University of Kobe, Japan.

The study involved 1) performance of fresh cadaveric dissections at Cornell Institute of Robotic Surgery,⁷ 2) a team from Cornell Institute of Robotic Surgery visiting Innsbruck to perform and standardize the athermal technique in 15 patients under supervision of GB, 3) review of videos with open prostatectomy surgeons at Innsbruck (GB) and at Cornell

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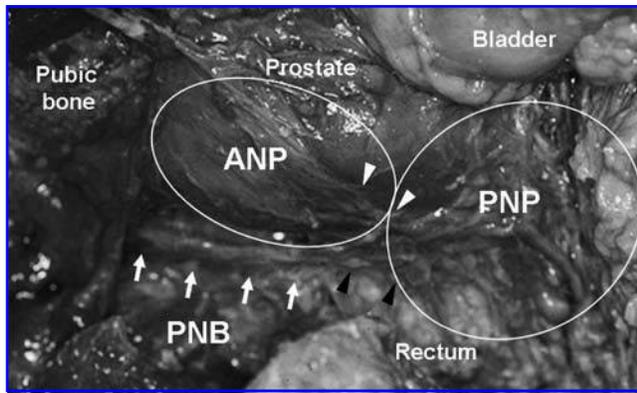


FIG. 1. Dissection showing trizonal distribution of nerves, the proximal neurovascular plate (PNP), neurovascular bundle (NVB), and its relations to the prostate, bladder, and prostatic apex. ANP = accessory neural pathways.

(EDV), 4) use of a modified technique on 215 patients at Cornell in 2005, 5) performance of intraoperative thermal mapping, and 6) collection of outcomes data to evaluate oncologic and functional recovery.

Patient studies

Preoperative workup and clinical staging were performed based on American Urological Association guidelines.

Decision-making for nerve sparing. Based on the combination of factors and previously recommended criterion,⁸ patients were grouped as low-risk, intermediate-risk, and high-risk categories. Special emphasis was placed on intraoperative digital examination to evaluate palpability, location, and size of the tumor. To understand the usefulness of the intraoperative digital examination, immediate reexaminations were performed soon after the specimen was retrieved. This technique used detailed examination of the specimen for integrity, adequacy of surrounding tissue, fascial sheath, area of nerve preservation, indurations, capsular breach, apical contour, shape and completeness, seminal vesicles, vas, and lymph nodes. Intraoperative frozen sections were taken to supplement visual clues while deciding about wide excision of neurovascular bundles (NVB).

Technique of RRP

The surgical approach was based on previously published techniques by Menon and associates.^{1,2,9,10} A few modifications were made by the authors and the Innsbruck team, including 1) use of a specialized maneuver to identify the prostatovesical junction (bladder neck pinch),¹¹ 2) appreciation and preservation of the proximal neurovascular plate (PNP),⁷ 3) restriction of the bladder neck dissection to the midline to avoid damage to the PNP, 4) athermal dissection of seminal vesicles and neurovascular structures, 5) use of antegrade, retrograde, or synchronous release of the NVB based on the patient's unique cancer variables, 6) adaptation of an incremental nerve-sparing approach while dealing with extracapsular extension, 7) control of the dorsal vein complex (DVC) using a ligament-sparing stitch, 8) use of anatomic reconstruction of the pelvis after vesicourethral anas-

tomosis,^{12,9} use of scissors for the entire procedure, and 10) integration of the examination of the specimen before completion of the procedure.¹³

This technique also differs from other authors' techniques,¹⁴ which use staplers for the control of the DVC or vascular clamps for the control of pedicles, or bipolar energy during dissection of seminal vesicles. The authors' technique (as reported in video presentations at several meetings, instructional courses, and publications)^{7,11,13,15} avoids cautery beyond the bladder neck dissection in nerve-sparing procedures. In line with principles of anatomic RP, the authors' technique included performance of obturator lymph node removal in all patients and more extensive¹⁶ lymph node dissection in high-risk patients (Kattan nomograms risk >1.5%).

Strategies for nerve sparing. Nerve-sparing surgery is an approach rather than a step during RP. Learning from the anatomic studies,^{11,15,17} we appreciate trizonal neural architecture. Based on a patient's unique oncologic and anatomic variables, we attempt to preserve all of the components of the neurovascular tissue around the prostate. As described,

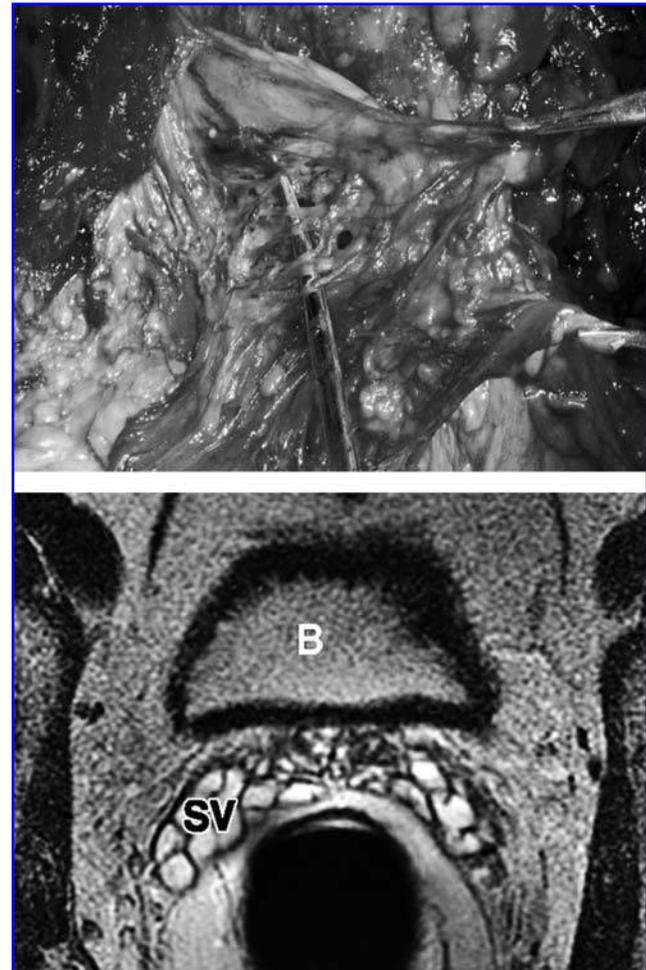


FIG. 2. Dissection from a cadaver (*top*) and MRI of a patient (*bottom*) showing close proximity of the nerves to the seminal vesicle (SV) and relation to the prostate and rectum. B=bladder.

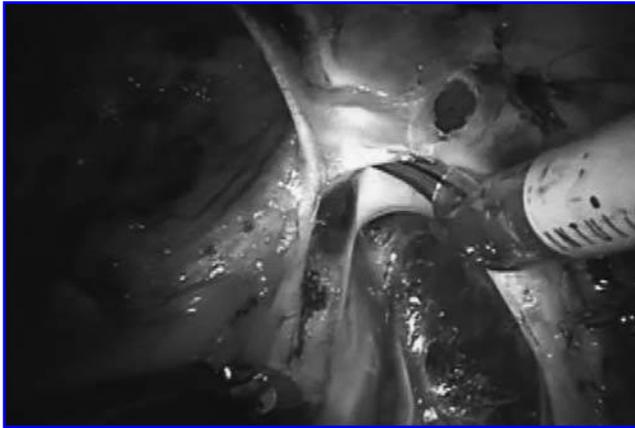


FIG. 3. Intraoperative photo showing the medially placed incision on the endopelvic fascia.

trizonal architecture includes the PNP, the predominant neurovascular bundles (PNB), and accessory neuronal tissue. Strategies to preserve each structure are listed.

Preservation of PNP (Fig. 1). As seen in Fig. 1, the PNP is located dangerously close to the proximal prostate, bladder neck, seminal vesicles (Fig. 2), prostatic pedicle, and the origin of the PNB.

PNP and proximal prostate. The PNP covers a significant part of the proximal prostate on its lateral aspect. The PNP can become injured when the endopelvic fascia is opened (Fig. 3); therefore, there is a need to perform meticulous periprostatic dissection. We use scissors and sharply open the endopelvic fascia medially (Fig. 3) and then meticulously dissect a plane between the capsule and prostatic fascia medial to the arcus tendineus. The dissection is performed under vision, saving all visible nerve fibers. To safeguard main trunks of neurovascular tissue, we avoid going into the depth of the crevice between the prostate and levator ani while performing periprostatic dissection.

PNP and bladder neck. Because the PNP is located lateral to the prostatovesical junction, we approach the bladder neck in the center, using the bladder neck pinch.¹¹ We place a stitch with 0 polyglactin on the anterior surface of the prostate proximal to the puboprostatic ligaments to prevent back bleeding and also for traction. Another bunching stitch is placed in the bladder superficially for traction. Using robotic forceps and scissors, the prostate is trapped on both sides and pulled proximally and medially with gentle distal traction on the Foley catheter until there is a sudden feeling of giving way at the junction of the prostate with the collapsed bladder.

At this point the prostatovesical junction can be easily identified. The surface is scored to precisely mark the prostatovesical junction anteriorly. The anterior bladder neck is then incised in a curvilinear manner. We use a Maryland bipolar forceps and hot shears with 1:1 scaling for adequate coagulation of the bleeders. The dissection is deepened until the Foley catheter is seen. The catheter is delivered out of

the bladder. The Foley balloon is deflated, and the left-side assistant grasps the tip of the catheter with firm anterior traction. With traction on the shaft of the catheter, the exact location for the posterior incision becomes visible, and the mucosa of the posterior bladder neck is now incised precisely.

Every precaution is taken to preserve the anatomic bladder neck as far as possible and avoid injury to the ureteral orifices. The posterior incision is modified according to the size and configuration of the prostate. The incision is deepened, keeping tangential to the prostate and avoiding any undermining into the substance of the prostate. Vertical downward dissection also protects against inadvertent undermining of the trigone or buttonholing of the bladder. Brisk bleeding from fibromuscular tissue at this stage is a warning that dissection may have extended into the prostate.

The catheter is withdrawn into the urethra, and the left-side assistant retracts the posterior prostatic base anteriorly. We then develop a plane behind the posterior wall of the bladder neck that exposes the retrotrigonal layer.¹⁸ Cutting this layer opens up a window through which the vasa and the seminal vesicles are seen. Electrocautery use is avoided from this point on.

PNP and seminal vesicle dissection. As seen in Fig. 1, PNP is located 5 to 10 mm (average 5 mm) lateral to the seminal vesicles and is in danger of being damaged thermally, thus temporarily or permanently affecting recovery of erectile function. Therefore, this part of the dissection is performed athermally by developing small pedicles and controlling them with minute 5-mm surgical clips close to the surface of the seminal vesicle. The vasa are grasped and surrounding vessels are controlled with 5-mm surgical clips, and electrocautery is not used. The proximal vasa are clipped with Hemo-Lock clips and then divided (Fig. 2).

Dissection of seminal vesicles starts by medially opening the layers of fascia. This medial plane is usually avascular and helps in mobilizing the seminal vesicles without use of cautery. This plane usually leads to the tips of the vesicles,

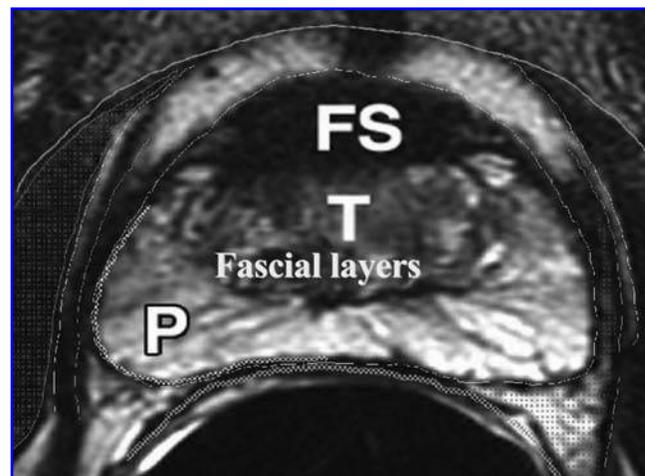


FIG. 4. MRI showing the distribution of the fascial layers around the prostate. FS=fibromuscular stroma; P=peripheral zone; T=transition zone.

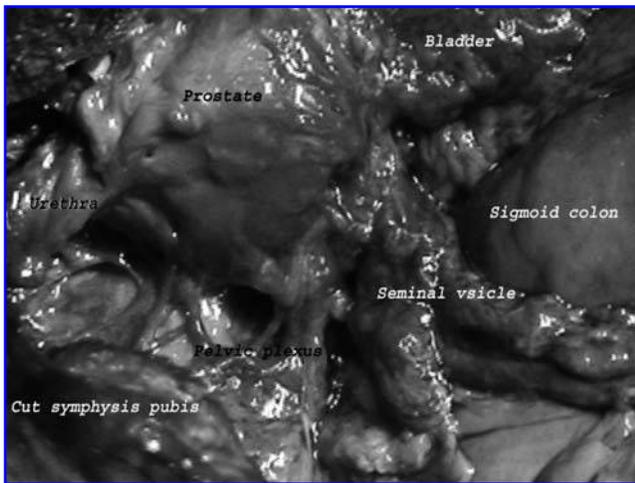


FIG. 5. Dissection from a cadaver showing the lie of the sympathetic and parasympathetic nerves to the pelvis.

which are tethered by vesicular vessels. These vessels are dissected and clipped. Both seminal vesicles and vasa are lifted up to expose the posterior surface of the prostate.

PNP and posterior dissection and incision of Denonvilliers' fascia. The PNP is loosely intermingled in the tissue, which forms two lateral arches with the prerectal space in the center. Distally, PNB are located in the lateral edge of the prerectal space, enclosed within the layers of periprostatic fascia. It is important to open this space by sharp incision of Denonvilliers' fascia and gently develop a space in the prerectal plane. We have often seen cross-communicating nerve fibers in this plane; thus, we avoid use of any thermal energy to control hemostasis in this part of the procedure. While incising the Denonvilliers' fascia laterally, we leave a small strip at left attached around the NVB. Remaining fascia is removed with the specimen (Fig. 4).

Preservation of PNB. As seen in Fig. 1, PNB is located in a posterior-lateral groove on the side prostate.⁷ There are significant variations in the location, shape, course, and composition of this bundle, which challenges us to individualize our technique of nerve sparing to suit patient-specific anatomic and oncologic variables. From a practical standpoint, PNB usually is well formed in approximately 50% of patients; in the remaining patients, nerve fibers are scattered around the prostate, intermingled within layers of periprostatic fascia as a continuation of PNP or isolated nerve fibers traveling distally in the periprostatic space or as a plexus on or within the layers of Denonvilliers' fascia behind the seminal vesicles, prostate base, or apex (Figs. 4 and 5). Therefore, while we talk about nerve sparing as a step, it is an approach in continuum.

PNB and fascia around the prostate. There are a few important fascial layers around the prostate that envelop the PNB. The outer layer lines the levator ani muscle (levator fascia). The inner layer covers the capsule (prostatic fascia). Between these two layers, there are a few additional flimsy layers, and neurovascular tissue resides in this plane along

with some fat and veins. Safe nerve sparing should leave prostatic fascia on the specimen while leaving the remaining tissue in the body.

There are a few additional nomenclatures that are currently used in relation to nerve sparing: Extrafascial, outside the levator fascia; interfascial, the plane between the fascial layers (Fig. 6); and intrafascial, the plane deeper to the prostatic fascia. The prostatic fascia is almost in continuation with the prostatic capsule and the superficial capsular vessels.

PNB and lateral pedicle control. The relationship between the prostatic pedicle and the PNB is one of the most challenging aspects of nerve sparing. The PNB is not clearly defined at this location, which results in significant difficulty in separating the NVB from components of the prostatic pedicle. The issue is further compounded because of wide variation in thickness, shape, and extent of the prostatic pedicle, which results from differences in anatomy and more specifically from variations in prostate size and shape. To address these concerns, we devised two broad approaches: Antegrade and synchronous antegrade and retrograde.

For antegrade release of PNB, we finish the development of the retroprostatic space, hold the prostate base, and give a gentle retraction toward the contralateral side. This defines the medial aspect of the pedicle, which supplies the base of the prostate near the seminal vesicles. Using sharp and blunt dissection with Maryland bipolar forceps and scissors, this pedicle is developed and controlled with a 5-mm clip (Fig. 7).

The orientation, size, and extent of the pedicle vary significantly, depending on prostate anatomy and cancer-induced neovascularization. Hence, sufficient time should be invested in dissecting the pedicle. After this, the anterolateral aspect of the prostate is visualized, and a sharp incision is made in the periprostatic fascia parallel to the NVB. Based on the anatomy and extent of cancer, the incision is made either quite anteriorly,¹⁹ or closer to the PNB.⁷

It is important to think about the PNP at this point in the procedure, because it now continues as the PNB, varies in

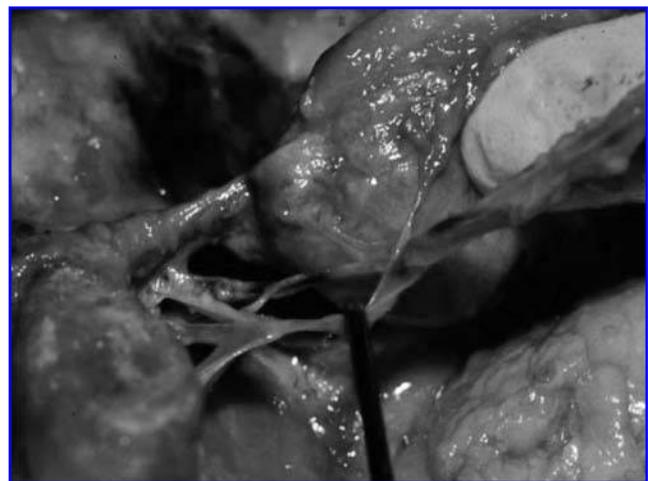


FIG. 6. Dissection on a cadaver showing the posterolateral lie of the nerves in relation to the prostate.

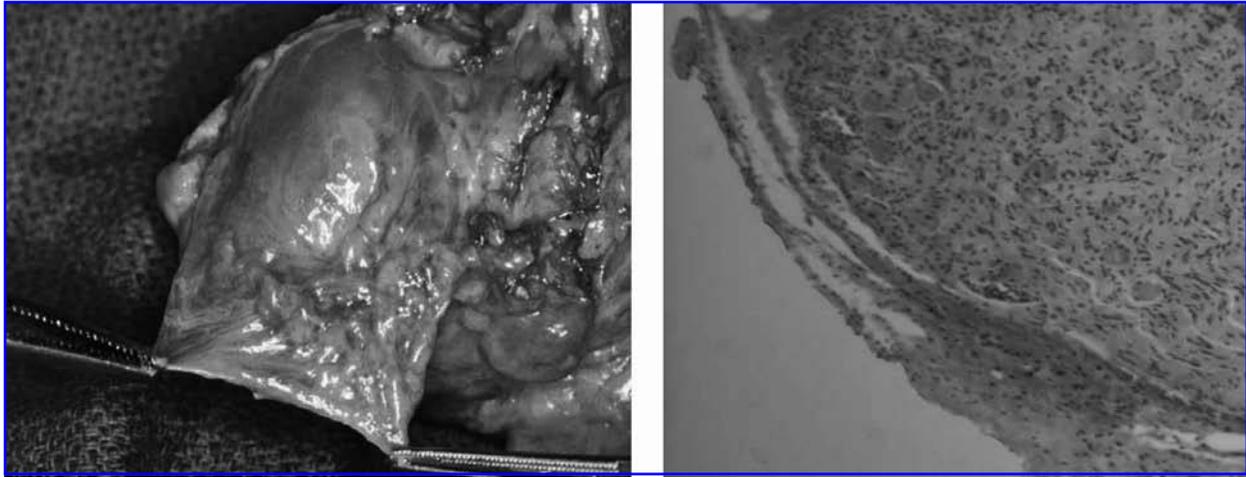


FIG. 7. Fascial layers around the prostate.

shape, and often intermingles with the prostatic pedicles. This release of fascia defines the location of the PNB and clarifies the outline of the prostatic pedicle. The prostatic pedicle is now controlled with 5-mm clips and released. At this point, the neurovascular triangle spring opens and a pearly white plane develops. Small venous and occasionally arterial branches may require selective control by clip. They are usually present near the apex. This release is repeated on the contralateral side. The prostate is lifted up and the retroapical area is gently freed, keeping in mind communicating fibers of the apical plexus (Fig. 7).

Preservation of accessory pathways. This is a unique concept that has emerged in the last few years. Several authors have noted significant variation in the course and composition of the intrapelvic part of the cavernous nerves destined to supply the erectile tissue. The most important realization is that in a significant number of persons, there are accessory nerves that are dispersed around the prostate between the prostatic and lateral prostatic fascia. There is another set of nerves that form a meshwork posterior to the prostate deeper and sometimes within layers of Denonvilliers' fascia.

To preserve the anterolateral pathways, investigators have described a novel approach that is called the veil technique.¹⁹⁻²¹ Nerves are present around the prostate in several planes between layers of various fascia: Lateral to the levator fascia; between the levator and prostatic fascia; between the prostatic capsule and prostatic fascia; and within layers of the surgical capsule. While there is an ongoing discussion about the physiologic significance of these nerves, it is difficult not to argue that some of them are the cavernous nerves, some supply the musculature, a few go to the sphincter, and deeper ones may be involved with prostatic secretions and smooth muscle contractility.

The question is, which one is going to the erectile tissue and sphincter? This question is being answered by staining properties of the nerves and intraoperative stimulation techniques.

Nerve preservation and apical dissection. Apical dissection is the critical step for functional integrity (Figs. 8 and 9). This is the final common pathway for exit of sexual and possibly continence nerves. The PNB and accessory pathways

(both anterolateral and posterior) are intimately related to the components of the apicourethral junction—distal prostate, dorsal venous plexus, urethral tube, periurethral muscles, puboperinealis, ligaments, fascial layers, and distal vascular pedicle to the prostate and NVB. These important structures are all packed closely in a small area and are hidden deep behind the pubic bone.

This part of the procedure necessitates some preparation, planning, and appreciation of the various anatomic components and secures control of the dorsal venous plexus. The prostate is freed of all attachments by sharp and blunt dissection. The urethra and its supporting structures—the endopelvic fascia laterally, the puboprostatic ligaments anteriorly, and the puboperinealis muscle as a posterior hammock—are left intact.

Gentle traction is exerted on the prostate, and the DVC is sutured with 1-0 polyglactin. The suture is passed over the dorsal vein and underneath the puboprostatic ligaments on the right and then brought out on the left over the dorsal vein and underneath the ligament. Two or three such throws are taken and then tied. Thus, the DVC is sutured, taking

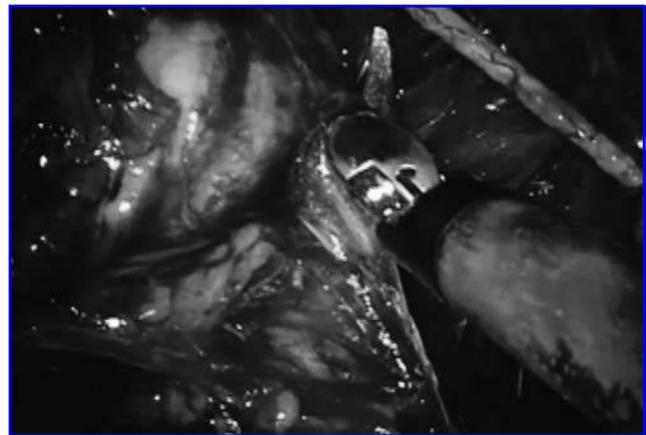


FIG. 8. Intraoperative photograph showing progressive dissection laterally and posteriorly.

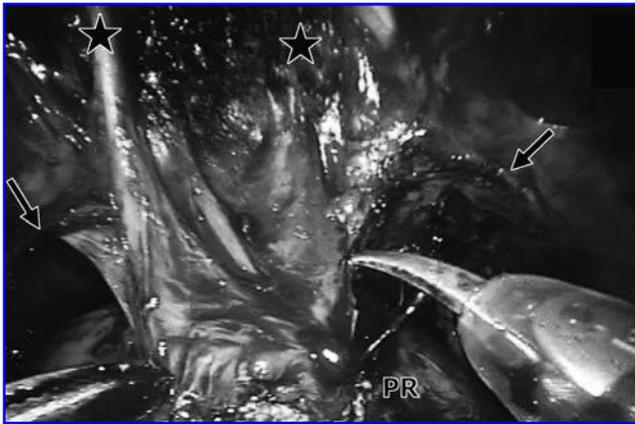


FIG. 9. Dissection of the apex. Star, puboprostatic ligament; arrows, neurovascular bundle; PR, prostate.

every precaution to avoid including the puboprostatic ligaments and always being cognizant of the rhabdosphincter and the neural branches for continence and erectile function.

The prostate is held under proximal traction and, using the Endowrist round-tip scissors, the DVC and the anterior urethra are cut proximal to the puboprostatic ligaments. The posterior urethra is then cut, ensuring dissection and separation of the NVB and being cognizant of the accessory pathways posteriorly (i.e., the posterior plexus). Care is taken to leave as long a urethral stump as possible without compromising cancer control. The arcus tendineus, the lateral leaflet of the endopelvic fascia, and the preserved puboprostatic ligaments on either side form a collar of tissue around the urethral stump left behind after prostatectomy.

Almost the entire neurovascular tissue converges at the apex, and the distal and posterior plexus can be damaged during urethral transection and anastomosis. The visual angles are changed several times to allow identification of both bundles and their relationship with the sphincter (Fig. 10). For urethrovesical anastomosis, we follow the same technique described by other authors.⁴

Pathologic examinations

Pathologic staging was reported by a referee uropathologist at Cornell (JT) using the 1997 Tumor, Node, Metastasis classification.²² Cancer location, capsular invasion, extracapsular extension, perineural invasion (PNI), high-grade prostatic intraepithelial neoplasia (HGPIN), lymphovascular invasion, positive surgical margins (PSM) (defined as a malignant gland at the inked margin), seminal vesicles involvement, and lymph node spread were detailed in a synoptic report.

Postoperative outcomes evaluation

The patients signed an informed consent to participate in a protocol approved by the Weill Cornell Institutional Review Board that evaluated outcomes in patients who were undergoing RRP by a single surgeon. The preoperative, intraoperative, and postoperative outcomes were recorded in the study forms.

Data collection. Data were prospectively collected using specifically designed preoperative, intraoperative, and post-

operative forms. Functional data were collected using specifically developed and previously validated health-related quality-of-life instruments [Expanded Prostate Cancer Index Composite (EPIC), International Index of Erectile Function] at baseline, and 1, 3, 6, 9, 12, and 24 months after surgery. To ensure thoroughness of data collection, periodic third-party telephone reminders, interviews, and chart abstractions were used to supplement mail questionnaires.

Data analysis. Data were entered in a dedicated computer database (Access) and exported to SPSS statistical software. Standardized exploratory statistical analysis was performed to compute means, median, mode, standard deviation, and confidence intervals. Analysis of variance was used to calculate the *P* value for continuous data while the chi square test was performed for the nominal variables. Survival analysis was performed for time-dependent variables to account for censoring and logistic regression, and the Cox proportional hazard models were used to compute relative risk ratios.

Results

The results of the 215 patients who underwent procedures in this period are summarized in Tables 1–5. As seen in Table 1, the mean age of the patients was 60 years, and the serum PSA level was less than 10 ng/mL in 92.5% of patients. The majority of patients had a Gleason score of 6 (72.6%), and 4.7% of patients had a Gleason score of 8 or more. Using pre-described criteria, 80% of patients qualified for bilateral nerve sparing using our trizonal-athermal technique.

The pathologic stage is summarized in Table 2. Approximately 47% of patients had a Gleason score of 6 or less. Capsular invasion was seen in 36 (17%) patients, PNI in 104 (48%) patients, and HGPIN in 55 (26%) patients. PSMs were found in 14 (6.5%) patients. The stage distribution is seen in Table 3. The most common location of PSMs was the apex (25% of all positive margins) (Table 4). The overall PSA recurrence was seen in 7% (Table 5).

Our continence rate at 1 year was 92%. Of patients who were potent preoperatively (Sexual Health Inventory for

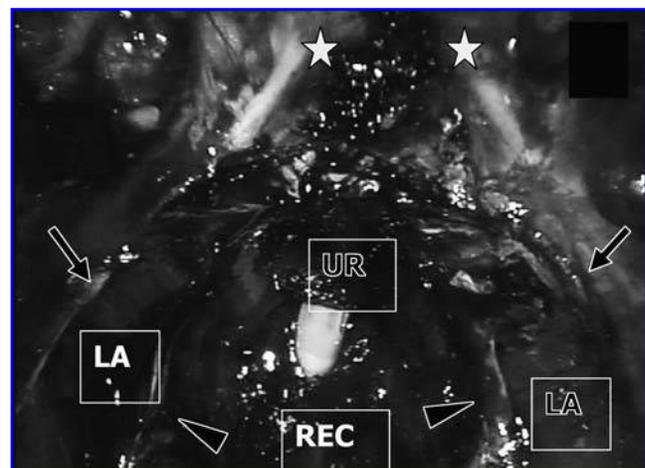


FIG. 10. Final view after removal of the prostate. LA, levator ani; REC, rectum; UR, urethra; arrowheads, neurovascular bundle; stars, puboprostatic ligament; arrows, arcus tendineus.

TABLE 1. PATIENT CHARACTERISTICS

Median age ± SD (range)	60 ± 6 (45–75)
No. preop PSA (ng/ml) (%)	
<2.5	19 (8.9)
2.6–4.0	43 (20.2)
4.1–10.0	135 (63.4)
10.1–20.0	12 (5.6)
>20	4 (1.9)
No. clinical stage (cTNM) (%)	
T1a-b	1 (0.5)
T1c	159 (74.6)
T2a	29 (13.6)
T2b	10 (4.7)
T2c	12 (5.6)
T3a	1 (0.5)
T3c	1 (0.5)
No. Gleason biopsy (%)	
6	154 (72.6)
3 + 4	36 (17.0)
4 + 3	12 (5.7)
≥8	10 (4.7)
No. + perineural invasion (%)	16 (7.5)
No. high grade PIN (%)	38 (17.9)
Median no. cores ± SD (range)	12 ± 8 (1–32)
Median no. cores ± SD (range)	2 ± 2 (1–15)
No. 1 core + (%)	
Median Gleason	84 (39.1)
6	
No. 2 core + (%)	
Median Gleason	58 (27.0)
6	
Median max % tumor ± SD (range)	15 ± 25 (1–95)

Men score >22) and who had nerve-sparing surgery, 80% were able to have an erection firm enough for intercourse, or were actively having sexual intercourse, at 1 year of follow-up.

Discussion

We describe our technique for nerve sparing and provide anatomic rationale for this approach. The main findings could be summarized as 1) nerves are much more complex than we previously thought; 2) there are accessory pathways both on the side and posterior aspect of the prostate; 3) PNP is important for complete nerve preservation; 4) apical dissection may be the most crucial part of nerve preservation; 5) an athermal technique that uses sharp dissection and miniaturized clips provides 82% probability of return of intercourse ability; and 6) approximately 95% of patients achieve negative margin rates.

The approach to the management of prostate cancers was revolutionized by the work performed by Walsh and Donker.²³ Since that time, a better understanding of the pelvic anatomy and variations in the lie of the NVB has necessitated the use of magnification²⁴ to identify the nerve bundles and protect them from damage. Variations in the anatomy of the NVB were redescribed with its levator and anterior rectal components,²⁵ which, according to the author make accurate graft anastomosis to the proximal and distal segments very difficult, thereby increasing the need to pre-

serve the nerves or use some form of nerve advancement. Our own studies have described similar variations while noting the trizonal distribution of these nerves.^{7,15,26}

Because these neural communications are delicate, any stretch or thermal damage may affect the return of erectile function; this may be temporary or permanent. The current trend is shifting toward the use of athermal techniques.^{13,27} We routinely use clips and combine this with blunt and sharp dissection. In one series of patients who were previously potent and underwent either unilateral or bilateral nerve preservation, it was seen that use of bipolar diathermy in the region of the nerves resulted in lower rates of potency at 3 months.²⁷

Continence and potency

The mechanisms that contribute to continence have been examined. The puboprostatic musculoligamentous complex is composed of two key components that surround and support the urethra: Fascioligamentous tissue in the periapical area of prostate, including puboprostatic ligaments and arcus tendineus, and the puboperinealis muscular component.

Fascioligamentous component. The arcus tendineus is the lateral condensation of the endopelvic fascia that extends from the puboprostatic ligament to the ischial spine. The puboprostatic ligaments are the pyramid-shaped dense medial portions of the distal endopelvic fascia that fix bladder, prostate, and membranous urethra to the pubic symphysis. They are composed of a pubourethral component, which

TABLE 2. PATHOLOGICAL DATA (SPECIMEN)

Median prostate weight ± SD (grams) (range)	48 ± 34 (16–346)
No. pathological stage (%)	
pT2a	37 (17.3)
pT2b	7 (3.3)
pT2c	144 (67.3)
pT3a	16 (7.5)
pT3b	8 (3.7)
PT4	2 (0.9)
No. specimen Gleason (%)	
<6	2 (1.0)
6	98 (46.0)
3 + 4	88 (41.3)
4 + 3	13 (6.1)
≥8	12 (5.6)
No. clinical stage (cTNM) (%)	
T1a-b	1 (0.5)
T1c	159 (74.6)
T2a	29 (13.6)
T2b	10 (4.7)
T2c	12 (5.6)
T3a	1 (0.5)
T3c	1 (0.5)
Capsular Invasion (%)	36 (17.0)
No. + perineural invasion (%)	104 (48.0)
No. high grade PIN (%)	55 (26.0)
Lymph node statement	
Median resected per case ± SD (range)	3.6 ± 3.3 (0–16)
Positive nodes	0

SD = standard deviation.

TABLE 3. SURGICAL MARGIN STATUS (215 PATIENTS)

	(-) SM	(+) SM
Overall rate (%)	201 (93.5)	14 (6.5)
No. clinical stage (cTNM) (%)		
T1c	149 (74.9)	11 (78.6)
T2	48 (24.1)	—
T3	2 (1.0)	3 (21.4)
No. specimen Gleason (%)		
5	2 (1.0)	—
6	94 (47.2)	4 (28.6)
3 + 4	83 (41.8)	5 (35.7)
4 + 3	10 (5.0)	3 (21.4)
≥8	10 (5.0)	2 (14.3)
No. preop PSA (ng/ml) (%)		
<2.5	21 (10.4)	1 (7.1)
2.6–4.0	41 (20.4)	2 (14.3)
4.1–10.0	123 (61.2)	11 (78.6)
10.1–20.0	12 (6.0)	—
>20	4 (2.0)	—
No. pathological stage (%)		
PT0	1 (0.5)	—
PT2a	37 (18.4)	—
PT2b	6 (3.0)	1 (7.1)
PT2c	136 (67.6)	8 (57.2)
PT3a	13 (6.5)	3 (21.5)
PT3b	7 (3.5)	1 (7.1)
PT4	1 (0.5)	1 (7.1)

SM = surgical margins.

runs deep from the symphysis pubis and attaches to the membranous urethra; a puboprostatic component, which blends with the anterior prostatic capsule; a pubovesical section, which is flimsy and travels to the anterior aspect of bladder in continuation with muscle fibers of the bladder wall, constituting the so-called detrusor apron¹³; and a curved, sickle-shaped extension that fuses with the arcus tendineus.

Puboperinealis muscular component. The puboperinealis is a paired muscle that originates from the pubis, flanks the prostatourethral junction, and terminates at the perineal body, the deep part of the external anal sphincter, and bulbospongiosus muscles. The striated sphincter is an omega-shaped structure that is deficient posteriorly; its contraction results in more of an anterior loop contraction rather than a true circumferential constriction of the urethra (Fig. 4).¹⁴ On the other hand, the muscle acts as a hammock that supports the urethra posteriorly and is responsible for the quick-stop phenomenon of urination in men.

When urinary continence and potency were prospectively assessed after laparoscopic radical prostatectomy in one series,²⁸ younger men were more likely to achieve urinary continence (1 pad or less daily) 1 year after the procedure. Younger men were also more likely to be potent and engaging in intercourse 1 year after bilateral nerve-sparing laparoscopic radical prostatectomy. When dissection is performed with bipolar cautery but not clips or monopolar cautery, Chien and colleagues²⁹ found that there was an earlier return of continence. Another study found that the most important prognostic factors for return of erectile function were preservation of the NVB, age of the patient, and sexual function before the operation.³⁰

TABLE 4. LOCATION OF +SM^a

Total locations	16 (14 patients)
Apical	4 (25)
Anterior	2 (13)
Bladder neck	1 (6)
Peripheral	1 (6)
Lateral	1 (6)
Posterolateral	3 (19)
Posterior	4 (25)

^aTwo patients presented two locations.

To date, there have been two prospective, nonrandomized studies that compare RP with RRP.^{32,32} Tewari and coworkers³² reported on 100 RRP performed by multiples surgeons and 200 contemporaneous RPs performed by a single surgeon at the same institution. The baseline characteristics were comparable between groups. The operative duration was not different (163 v 160 min). The blood loss was 910 and 150 mL for RRP and RP, respectively, and the transfusion rate was greater after RRP than RP (67% v none). There were four times as many complications after RRP than RP (20% v 5%), and the hospital stay was longer (approximately 4 v 1 d).

The most striking finding was that patients who underwent RP achieved continence much more quickly than after RRP, with 50% return of continence occurring at 44 v 160 days. In addition, patients had more rapid return of erection after RP compared with RRP (50% return at mean 180 v 440 d). Of the RP and RRP patients, 42% and 65%, respectively, used sildenafil.³²

Pathologic stage distribution for our series is similar to that of other contemporary series of RRP, with the majority of patients having organ-confined (pT₂) disease. Overall PSM rate of 6.5% compares favorably with that of rates in RRP published reports (12.8% to 19%^{33–35} of SM positivity). Menon and Tewari⁵ and Tewari and coworkers³² reported very low PSM rates (6% overall) with RP; however, in their series, apical margins were considered positive only if cancer was seen in the intraoperative distal biopsies.

Conclusions

Our technique of RRP has incorporated, over the last few years, many modifications based on an understanding of the precise anatomy and variations thereof. This novel alteration has contributed to making this procedure safer and has optimized outcomes for the patient.

TABLE 5. PSA RECURRENCE AFTER RRP IN 208 PATIENTS^a

Median PSA follow-up ± SD (range)	9 ± 5 (1–21)	
	No. patients (%)	No. PSA recurrence (%)
Overall PSA recurrence	194 (93)	14 (7)
No. pathological stage (%)		
pT2a	37 (19.7)	2 (28.6)
pT2b	7 (3.7)	—
pT2c	144 (76.6)	5 (71.4)

^aSeven patient's data lost during follow-up.

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Abbreviations Used

DVC = dorsal vein complex
HGPIN = high-grade prostatic intraepithelial neoplasia
NVB = neurovascular bundles
PNB = predominant neurovascular bundles
PNP = proximal neurovascular plate
PNI = perineural invasion
RP = radical prostatectomy
RRP = robot-assisted radical prostatectomy

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