Modifications of robotic-assisted laparoscopic radical prostatectomy can improve cancer control and minimize erectile dysfunction and incontinence.

Optimizing Cancer Control and Functional Outcomes Following Robotic Prostatectomy
José J. Correa, MD, and Julio M. Pow-Sang, MD

Background: Since robotic-assisted laparoscopic radical prostatectomy was introduced, different modifications in the technique have been described to improve cancer control and minimize the possibility of erectile dysfunction and incontinence.

Methods: We reviewed the recent English literature on specific topics including when to preserve the neurovascular bundle (NVB), and we describe techniques to diminish the rate of positive margins and to preserve continence and potency.

Results: Identifying predictor factors of local advanced disease helps in deciding when to preserve the NVB without compromising cancer control. Techniques to decrease the positive margins based on experience and modifications of the apical dissection are reviewed. Minimal disruption or reconstruction of the anatomic structures of the periprostatic tissues helps to maintain continence. Different degrees of NVB preservation can be performed based on the characteristics of the cancer. Cautery-free techniques and other modifications in the dissection to minimize the NVB injury are also discussed.

Conclusions: The understanding of the predictor factors of local advanced disease, together with modifications in the technique, helps to not only achieve cancer control but also improve quality of life after robotic-assisted laparoscopic radical prostatectomy.
ized disease is reported to reduce 10-year overall mortality, disease-specific mortality, and the risk of metastasis for patients in early stages of the disease.4

Margin status is one of the principal predictors of the recurrence of biochemical and local disease and the need for secondary cancer treatment. The positive margin rate in contemporary series has been reported in 11% to 38% of patients undergoing radical prostatectomy.5,6 Positive surgical margin rates are determined not only by cancer extent, but also by surgical technique and the surgeon’s experience. Studies have shown a reduction in the positive margin rate as a surgeon’s number of cases increases. Eastham et al7 studied the rate of positive surgical margins among surgeons, controlling for the severity of the disease. Surgeons with a high volume of cases had lower positive margin rates compared to low-volume surgeons. For RALRP, two retrospective series demonstrated a significant decrease in the positive margin rate as the learning curve matured.8,9

Two strategies diminish the percentage of positive margins. First, as the neurovascular bundles (NVBs) are anatomically located outside the capsule, preservation of these structures should not compromise margin status in patients with organ-confined disease, provided the capsule is not violated at the time of surgery. Second, the identification of patients at higher risk of extracapsular extension (ECE), which increases the risk of positive margins, would allow the selection of patients who will require unilateral or bilateral nerve excision to maximize cancer control.

Several investigators have developed nomograms that help to determine the risk of extraprostatic extension.10,11 Some studies use more information from the biopsy to provide guidance on when it is safe to preserve the NVBs, while others add the specific location of the positive biopsies. Most of these studies use information obtained by the sextant biopsy technique, while a more recent one uses 12 core biopsies.

In 2001, Graefen et al12 validated a previous retrospective analysis in 353 patients. The analysis included patients who underwent radical prostatectomy for clinically localized prostate cancer and excluded patients treated with hormonal therapy prior to the surgery and those without sextant biopsies. A total of 552 lobes were available for analysis. Preoperative variables were considered separately for each prostatic lobe. Nine tumor characteristics were measured: clinical stage, transrectal ultrasound, serum prostate-specific antigen (PSA), PSA

![Diagram](image-url)

Fig 1. — Likelihood of organ-confined prostate cancer for each lobe according to the different characteristics evaluated. The 4 bottom groups include the first retrospective study plus the prospective study population. The calculated positive predictive value (PPV) for the two most favorable risks groups is 86.6%. Adapted from Graefen M, Haese A, Pichlmeier U, et al. A validated strategy for side specific prediction of organ confined prostate cancer: a tool to select for nerve sparing radical prostatectomy. J Urol. 2001;165(3):857-863. Reprinted with permission by Elsevier.
density, number of positive biopsies, worst Gleason grade, number of biopsies with a Gleason score of 4/5, number of biopsies with predominantly high-grade cancer, and tumor length in the biopsy. At univariate analysis, the number of positive biopsies was the most useful single parameter, with a positive predictive value of 83% and a negative predictive value of 55%, followed by the length of tumor in the biopsy measured in millimeters. At multivariate analysis, the number of biopsies with high-grade cancer, the number of positive biopsies, and the serum PSA were independent for predicting organ-confined disease. The analysis resulted in four risks groups with different probability of organ-confined disease (Fig 1).

In 2003, Shah et al. developed an algorithm to define prospectively when to excise the NVB based on the results of the prostate biopsy. The goals of the study were to maximize the performance of nerve-sparing procedures and to decrease the percentage of positive surgical margins. Two groups of patients undergoing radical prostatectomy by the same surgeon were analyzed. In one group, including 272 patients, no criteria of NVB sparing or resection were used. In the second group, including 263 patients, criteria of NVB resection were used based on the results of the prostate biopsy and specifically based on the percentage of tumor in the biopsy, Gleason score, and presence of perineural invasion. A statistically significant decrease in the incidence of positive margins was found between the groups, with 14% of margins in the group where no specific criteria were used and 8% of margins in the group where the criteria were used. Also, more nerve-sparing surgeries were performed in the group in which the criteria were used (92% vs 85%). The criteria are lobe-specific and define that the NVB should be resected depending on the Gleason score, the percentage of cancer in the biopsy, and the presence of perineural invasion (Fig 2). The

<table>
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<tr>
<th>In Gleason 2-6 in the biopsy</th>
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<tr>
<td>• if the tumor volume is &gt; 50% and perineural invasion (PNI) is present</td>
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<th>In Gleason 7</th>
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<tr>
<td>• if &gt; 30% tumor volume or PNI</td>
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<th>In Gleason 8-10</th>
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<td>• if &gt; 10% tumor volume or PNI</td>
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sensitivity, specificity, positive predictive value, and negative predictive value were 18%, 93%, 28%, and 89%, respectively, with an accuracy of 84%. To explain how the percentage of tumor volume is measured, the authors cite another study that assessed the percentage of cancer in biopsy cores to predict extracapsular disease in T1–T2 disease. The formula used to calculate the percentage of tumor volume in the biopsy in this study was total length of invaded tissue on biopsies divided by the length of all biopsies minus the length of peri prostatic tissue.

Park et al. retrospectively reviewed 221 patients (442 sides) who underwent radical prostatectomy for clinically localized prostate cancer with NVB resection on the side of a positive biopsy and preservation on the side of a negative biopsy. The other variables measured were Gleason score and PSA level. The authors reported that 77% of patients had a moderate Gleason score defined as grade 5 or 6, 16% had a high Gleason score defined as grade 7 or above, and 7% had a low Gleason score of grade 4 or lower. The mean PSA was 8.24 (range, 0.5–48.9). The surgical specimens were reviewed for ECE and positive surgical margins in the area of the NVB, defined as the posterolateral area of the prostate. Of the 221 patients, 38% had ECE, and 20% had positive margins in the posterolateral area (NVB area), while 18% of the patients had ECE with negative margins with the potential risk of positive margins in case of preservation of the NVB. The authors concluded that sparing the NVB on the side with a positive biopsy significantly increases the risk of having a positive surgical margin. However, this study did not control for the number of cores involved by tumor or other variables that are significant when deciding on whether to excise the NVB.

Naya et al. also established criteria to determine extraprostatic extension by trying to define the location of the cancer as a predictor. The areas were defined as the neurovascular/posterolateral region, base (bladder neck area), apex, and the anterior, posterior, and lateral regions. Patients underwent non-nerve-sparing radical prostatectomy bilaterally or at least on one side. A total of 430 patients (720 sides) were evaluated according to the number of positive cores, location of the cores, Gleason score, length of cancer in the positive cores, and percentage of positive cores, as well as preoperative PSA, patient age, ethnicity, and clinical stage. They found that a higher number of positive cores, a higher biopsy Gleason score on a side, a positive core at the basal region, 50% or more tumor in the core, or a maximum length of 7 mm increased the risk of extraprostatic extension at the level of the NVB/posterolateral location. The strongest independent predictors of extraprostatic extension at the level of the NVB/posterolateral region on the multivariate analysis were tumor length 7 mm or greater and positive basal core.
Based on this, excluding any patient with 1 positive biopsy core with a maximum tumor length of 7 mm or greater, plus a positive basal core of any tumor length and grade, can decrease the risk of ECE by 10% at the NVP/posterolateral region. The same group validated their previous results in a follow-up report by Kamat et al.17 A single surgeon performed 270 consecutive radical prostatectomies using the criteria mentioned above; patients without a prostate biopsy core specimen with a tumor length of 7 mm or more and a positive basal biopsy core on one side of the prostate were eligible for nerve-sparing on that side. The incidence of extraprostatic extension in the final pathology was 33% for patients who met both criteria in the biopsy and 4.6% in patients who did not. The incidence of extraprostatic extension in patients with only a positive biopsy core with a maximum tumor length of at least 7 mm was 22%, and the incidence of patients with only a positive basal core of any grade or tumor length was 24%. Interestingly, the incidence of ipsilateral positive margins was 2.5% when the NVB was spared according to the criteria, and 11.8% positive margins were found when the NVB was resected according to the criteria. This model has a low positive predictive value (33%) but a high negative predictive value (95%), thus indicating that when the two variables are absent, the nerve-sparing will carry a low risk of having positive margins.

More recently, Tsuzuki et al18 reported a retrospective analysis that included 2,660 patients with 3,006 lobes (2,070 with organ-confined disease, 620 with ECE in the area of the NVB [posterolateral], and 316 with ECE in other regions of the gland). The study excluded patients with neoadjuvant hormonal treatment and also those with needle biopsies with multiple fragmented cores due to the inability to define the percentage of tumor. Variables included patient age, year of surgery, PSA, digital rectal examination, biopsy Gleason score, presence of perineural invasion, percent of side-specific biopsy cores with cancer, percent of each core involved with cancer, and the maximum percent of a core

involved with cancer. Variables statistically significant in the multivariate analysis specifically for ECE in the NVB area included PSA, biopsy Gleason score, digital rectal examination, average percent of biopsy core involved with tumor, and percent of side-specific positive cores with tumor. A model was generated using the preoperative variables that were statistically significant, and the variables were stratified into high risk or low risk. The probability of ECE in the NVB region was less than 10% in cases with 1 or none of the higher risk variables and more than 10% in cases of 1 or more of the higher risk variables (Table 1).

In 2004, Ohori et al19 included more information of the biopsy on a previous nomogram to increase accuracy in defining the probability of ECE. In the nomogram, a detailed and quantitative assessment of the biopsy results was performed to predict the likelihood of ECE on each side of the prostate. The study included 763 patients (1,526 lobes), all with 6 or more systematic transrectal ultrasound-guided biopsies, including biopsies from the apex, middle, and base. Besides the clinical variables previously studied — PSA, clinical stage, and Gleason sum score for each side — specific information on the biopsy was included: number of positive cores, percentage of positive cores from each lobe, maximum cancer length on each core, and percent of cancer in all cores from each side. The overall accuracy of the nomogram is about 80%. The nomogram is side-specific and, as previous studies have shown, it will help to define if the NVB should be resected or not. The authors recommend wider dissection around a specific lobe when the ECE exceeds 10% and wide resection of the NVB in the presence of a palpable mass if the chance of ECE exceeds 50% (Fig 3).

In 2008, Zorn et al20 conducted a study with side-specific NVB preservation based on preoperative variables. Patients were selected for side-specific NVB preservation using one of three techniques: interfascial, partial extrafascial, and wide extrafascial resection. The variables used to determine the type of resection were PSA, clinical stage, biopsy Gleason score, percentage of positive cores, and maximal core cancer percentage. The study compared 150 patients to a historic control group of 245 patients where no interfascial dissection was performed. The authors determined not only the positive surgical margin rate but also erectile function outcome. Most of these patients had at least 12 core biopsies.

Patients selected for interfascial or complete nerve-sparing dissection had a PSA ≤ 6, nonpalpable disease, and < 33% of ipsilateral cores positive for cancer. Those selected for partial extrafascial dissection had a small palpable nodule (cT2a) or a cT1c stage with either a PSA > 6, an ipsilateral Gleason score of 7, or moderate disease volume as defined by 33% to 66% of ipsilateral cores positive for cancer or > 33% maximal core involvement. Patients selected for wide extrafascial dissection had gross palpable disease (≥ cT2b) or any less of a clinical stage with either a Gleason score ≥ 8 or evidence of high disease volume defined as ≥ 66% of all ipsilateral biopsy cores positive for cancer.

Using these criteria, the investigators found a positive surgical rate of 12.6% in the group with the planned NVB preservation using the above criteria.

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<th>Study</th>
<th>Highest Risk Factors for Positive Margin if NVB Is Spared or Recommendation on When to Preserve the NVB</th>
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<tr>
<td>Graefen et al12</td>
<td>• &gt; 1 biopsy with Gleason 4/5 &lt;br&gt; • PSA ≥ 10</td>
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<tr>
<td>Shah et al13</td>
<td>• If Gleason 2–6: &gt; 50% of tumor in biopsy and perineural invasion (PNI) &lt;br&gt; • If Gleason 7: &gt; 30% of tumor in biopsy or PNI &lt;br&gt; • If Gleason 8–10: &gt; 10% of tumor in biopsy or PNI</td>
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<tr>
<td>Naya et al16</td>
<td>• 1 positive core with ≥ 7 mm involved by tumor and a positive core in the base of the prostate</td>
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<tr>
<td>Kamat et al17</td>
<td>• PSA ≥ 10 &lt;br&gt; • Gleason ≥ 7 &lt;br&gt; • Average percentage of core involved by tumor ≥ 20% &lt;br&gt; • Percentage of cores with tumor ≥ 33.3% &lt;br&gt; • Abnormal digital rectal examination</td>
</tr>
<tr>
<td>Ohorii et al19</td>
<td>Based on the result of the nomogram calculated % of possible ECE: &lt;br&gt; • Wider dissection around a specific lobe when the ECE exceeds 10% &lt;br&gt; • Wide resection of the NVB in the presence of a palpable mass if the chance of ECE exceeds 50%</td>
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<tr>
<td>Zorn et al20</td>
<td>Type of NVB preservation based on the clinical characteristics: &lt;br&gt; • Interfascial dissection if clinical stage T1c (nonpalpable disease), PSA ≤ 6, and &lt; 33% of ipsilateral cores positive for cancer &lt;br&gt; • Partial extrafascial dissection if small palpable nodule (cT2a) or cT1c stage with either a PSA &gt; 6, an ipsilateral Gleason of 7, or moderate disease volume as defined by 33% to 66% of ipsilateral cores positive for cancer or &lt; 33% maximal core involvement &lt;br&gt; • Wide extrafascial dissection if gross palpable disease (≥ cT2b) or any less of a clinical stage with either a Gleason score ≥ 8 or evidence of high disease volume defined as ≥ 66% of all ipsilateral biopsy cores positive for cancer</td>
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Table 2. — Summary of Selected Studies and Recommendations on Resecting or Sparing the Neurovascular Bundle (NVB)
compared to 20.4% in the group where no selective interfascial criteria was used. Also, the posterolateral location of positive surgical margins was significantly lower in the group where the selective interfascial preservation criteria was used (37% vs 70%). The post-operative potency, defined as the ability to achieve an erection sufficient for penetration with or without phosphodiesterase (PDE)-inhibitor medication 12 months after the surgery, was 80% in the group of bilateral interfascial preservation, 67% in the group of partial extrafascial nerve preservation, and 11% in the group with wide excision of the NVB. The authors concluded that preoperative planning of NVB preservation according to specific variables reduces the overall and posterolateral positive surgical margin rates with favorable early erectile function outcomes.

In summary, several investigators have attempted to determine when to preserve the NVB without compromising the risk of positive margins. Their aim has been to identify predictor factors that would define when the NVB could be safely spared in patients with locally advanced disease. All of these studies were retrospective and used transrectal ultrasound sextant biopsies except for the study by Zorn et al., in which most patients had at least 12 core biopsies. They included a definition of nerve-sparing that is described in more detail in the next section: maximal NVB-sparing or interfascial dissection, partial extrafascial dissection, and wide extrafascial dissection or no preservation (Table 2).

**Strategies for Cancer Control in RALRP Reducing the Positive Margins**

Several surgical techniques have been reported to decrease the positive margin rate at the time of RALRP. Ahlering et al reported on the first 140 cases of RALRP performed by their group. After reviewing the margin rate on the first 50 cases as well as the videos from those cases, they modified their technique in the following 51 to 140 cases. In the first set of cases, a significant percentage of positive margins was noted. Most of the positive margins were located at the apex. After a careful review of the technique, they noted problems during the ligation and division of the dorsal vein complex (DVC) in the first 40 cases. The modifications included the complete dissection of the fatty tissue around the puboprostatic ligaments and DVC, incision of the endopelvic fascia, dissection of the levator ani muscle fibers from the DVC in order to increase the length of the venous plexus, and finally use of a vascular stapler (Endo-GIA stapler, Ethicon Inc, Somerville, NJ) instead of the two figure-of-eight sutures used in the first set of cases. According to the authors, a 22F Foley catheter helped to protect the urethra because of the difficulty in stapling through it. With these modifications in the technique, the margin rate decreased from 36% in the initial 50 cases to 16.7% in the following 51 to 140 cases. Specifically, the T2 tumors decreased from 27.3% in the first 50 cases to 4.7% in the subsequent 51 to 140 cases. The same group recently reported on the next 141 to 250 cases, noting that the rate of positive margins was between 4.5% and 7.5%. They reported that 75% of those positive margins were focal and located in the apex in the pT2 and pT3 cancers. They continued dissecting the apex as described previously, but they now transect the urethra 3 to 6 mm distal to the prostatourethral junction. With this modification, they noted no statistically difference in continence but a decrease in the percentage of positive margins. The overall positive margins decreased further from 17.6% to 7.5%. The apical margins dropped from 5.3% to 2.8% for pT2 tumors and from 37% to 12% for pT3/4 tumors. The overall apical margin rate dropped from 13% to 5.5%.

**Preserving Potency**

In 2004, Ong et al used a canine model to evaluate the physiologic effects of different energy sources (bipolar, monopolar, and ultrasonic) used in the dissection of the NVB. The contralateral NVB was left undissected as a control. At 2 weeks following surgery, they found the use of energy sources in proximity to the prostate during dissection of the NVB was associated with a significantly decreased erectile response to cavernous nerve pressure. Ahlering et al described the dissection of the NVB without the use of bipolar cautery. The prostatic pedicle control was performed with 30-mm laparoscopic bulldog clamps. After dissection of the NVB and removal of the prostate, the clamps were removed and FloSeal (Baxter Healthcare Corp, Deerfield, IL) was applied and then covered with Gelfoam (Pfizer Inc, New York, NY). In case of bleeding, a figure-of-eight suture was placed for hemostasis. The technique was performed in 17 patients (27 vascular pedicles), with 4 cases requiring the suture to control bleeding. The average bleeding in the study was 91 cm³ (range, 75–150). The same group compared 3-month potency in patients undergoing the cautery-free technique vs dissection of the NVB using bipolar cautery, initially in 21 patients and later extended to 51 patients. Patients in these studies met three criteria: age < 66 years, a Sexual Health Inventory in Men (SHIM-5) score of 22 to 25, and either unilateral or bilateral NVB preservation. They compared this group of 51 patients in whom the cautery-free technique was performed with 36 patients in whom the use of bipolar energy was used for the dissection. Potency was defined as an erection adequate for vaginal penetration. At 3 months, the rate of potency was 47% in the cautery-free group and 8.3% in the group where bipolar energy was used. There is no unanimous nomenclature for the adjacent prostatic fascias. Performing anatomic dissections
in cadavers, Tewari et al\textsuperscript{26} noted the location of the NVB and suggested areas that could be injured during surgery. They described the NVB enclosed within layers of the periprostatic fascia. The inner layer (closest to the prostate) of the periprostatic fascia, is called the prostatic fascia and the outer layer is the lateral pelvic fascia. These fascial layers fuse posteriorly with the anterior layer of Denonvillier’s fascia to form a triangular space that contains the NVB. This space is wide at the base of the prostate and becomes narrow at the apex of the gland (Fig 4). Based on the location of the NVBs, the authors provided a description of the critical areas during the dissection in order to preserve the nerves intact.

- Avoid dissection lateral to the seminal vesicles and do not use cautery.
- Avoid excessive incision lateral to the bladder neck.
- For pedicle control, dissect to expose the blood supply and control the vessels with clips.
- Transect the bladder neck under vision (to avoid injury of the NVB at this level).
- Carefully place posterior stitches, mainly at the 5 and 7 o’clock locations.

Other studies have challenged the posterolateral anatomic location of the NVB by showing nerves also in the lateral to anterior aspect of the prostate. Kiyoshima et al\textsuperscript{27} described 79 specimens of radical prostatectomy where no nerve-sparing radical prostatectomy was performed. In 52% of patients, the nerves ran in the lateral and anterior aspect of the prostate, while in the other 48%, the nerves were located in the posterolateral region with a more defined nerve bundle. In the specimens where the NVB was located in the posterolateral region, the prostatic capsule and the lateral prostatic fascia adhered to each other in the lateral aspect of the gland. In the patients with nerves sparsely spread in the lateral and anterior aspect of the prostate, a space between the capsule and the lateral prostatic fascia was observed. However, it is not clear if the nerves located laterally or anteriorly have a role in erectile function.

Kaul et al\textsuperscript{28} introduced the concept of complete preservation of the prostatic fascia (Veil of Aphrodite) in order to provide maximal preservation of nerve fibers. Prior to this, NVB preservation was performed in an “intraprostatic fascia” fashion. In one of the first studies comparing the “classic” NVB preservation with the “complete” prostatic fascia (or Veil of Aphrodite) preservation, 97% of patients at 12 months in the Veil of Aphrodite preservation group had erections strong enough for sexual intercourse compared with 74% in the “classic” NVB preservation group. Only 1 patient had a positive margin at the apex, and no margins were found in the region of the Veil of Aphrodite. In this regard, not only is a dissection closer to the prostate performed, but a more anterior incision is achieved to include more nerves based on previous studies.\textsuperscript{27} The “superveil” modification of the technique was recently reported by the same group,\textsuperscript{29} sparing nerves in the posterolateral aspect as well as in the anterior aspect of the prostate between the 11 and 1 o’clock positions. These areas were resected in the previous description of their technique. They also preserved the puboprostatic ligaments and the dorsal venous plexus (Fig 5). With the modification at 6 to 18 months after the surgery, 94% of patients who attempted sexual inter-
course were successful, and the median SHIM-5 score was 18. Patients who underwent the superveil modification were able to achieve intercourse earlier when compared to patients who underwent a veil procedure. The procedure was performed in selected cases — patients with focal Gleason 6 disease who desired maximum nerve preservation. Although no data on positive margins were presented on the superveil study, no PSA recurrences were reported at 40 months of follow-up.

Regarding the different types of nerve preservation, Shikanov et al. compared the extrafascial vs the interfascial nerve-sparing techniques for robotic prostatectomy.
and compared outcomes of positive margins. The interfascial nerve-sparing technique is similar to the veil type of NVB preservation (ie, this type of dissection is closer to the prostate and preserves more nerves). The extrafascial NVB preservation is the classic nerve bundle preservation. Walsh et al.\(^3\) compared 110 patients who underwent bilateral extrafascial dissection of the NVB with 703 who underwent bilateral interfascial nerve-sparing. The criteria of nerve-sparing were similar to those in earlier studies, based on clinical characteristics of the prostate cancer and findings in the biopsy (Fig 6). Patients who underwent extrafascial dissection had a higher PSA, clinical and pathologic stage, and Gleason score. No difference in the positive margin rate was found. Quality of life was measured using the validated self-administered University of California Los Angeles Prostate Cancer Index (UCLA-PCI) questionnaire, with potency defined as answer number 4: “erection firm enough for intercourse.” The interfascial dissection group achieved a higher potency rate at 12 months compared with the extrafascial group, 64% vs 40%. There was no difference in the rate of positive margins between the groups.

**Preserving Continence in RALRP**

Postoperative urinary incontinence continues to be a significant complication for any type of surgical approach. Continence rates in reported series range from 76% to 98%. Incontinence rates following radical prostatectomy vary considerably between studies and appear to be dependent on the definition used. In general, physician-reported studies document a low incontinence rate compared to patient-reported questionnaires. Incontinence is considered more bothersome than impotence by some patients.\(^3\)\(^2\)\(^-\)\(^3\)\(^5\)

Different strategies to preserve continence and to recover continence earlier following surgery have been described. Most studies consider that a definitive evaluation of urinary function should extend to 12 months after surgery.\(^5\)\(^6\)

Rocco et al.\(^3\)\(^7\)\(^-\)\(^3\)\(^9\) reported that the striated sphincter, Denonvillier’s fascia, and the dorsal aspect of the prostate form the musculofascial plate — a structure that acts as a suspensory system for the prostatomembranous urethra. According to this theory, division of this structure during radical prostatectomy results in the loss of the posterior cranial insertion of the sphincter, the caudal displacement of the sphincteric complex, and a prolapse of the perineum. The reconstruction of the structure previous to the anastomosis of the bladder to the urethra will help in an early continence recovery. This first study was performed in open retropubic radical prostatectomies (Fig 7).

The same group published a similar study in laparoscopic cases.\(^3\)\(^9\) The authors compared the time to continence recovery after surgery in 250 patients in whom laparoscopic radical prostatectomy plus the musculofascial reconstruction was performed (group 1) to 50 patients in whom radical prostatectomy was performed with no musculofascial reconstruction (group 2). The definition for continence used was no use of pads or one pad per day. The incontinence definition was use of two or more pads in 24 hours. Continence was evaluated at 3 days after catheter removal with an interview and a 24-hour pad test. Continence was then evaluated at 30 days, 90 days, and every 3 months subsequently using the International Consultation on Incontinence Questionnaire (ICIQ) short form (Table 3).

Nguyen et al.\(^4\)\(^0\) described the posterior musculofascial plate reconstruction during robotic and laparoscopic prostatectomy. They compared 32 consecutive patients who underwent laparoscopic prostatectomy or RALRP (group 1) with 30 patients not having RALRP (historical controls, group 2). Continence was measured by patient self-reporting according to the number of pads used in 24 hours. Continence was defined as the use of no pads or one pad, moderate incontinence as the use of two pads, and severe incontinence as more than two pads. They also used intraoperative transrectal ultrasound to measure the membranous urethral length before and after the reconstruction. The continence rate at 3 days after surgery was statistically significant, with a 34% continence rate in group 1 vs 3% in group 2. At 6 weeks, the difference was 56% vs 17%. Also, the length of the urethra in the reconstructed group was 2 mm longer. They concluded that the technique leads to higher early continence rates and improved length of the urethra.

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<tr>
<th>Time of Evaluation</th>
<th>Group 1 (n = 250) (with musculofascial reconstruction) No. of Patients (% of continent patients)</th>
<th>Group 2 (n = 50) (control, no musculofascial reconstruction) No. of Patients (% of continent patients)</th>
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<tr>
<td>3 days</td>
<td>156 (62.4%)</td>
<td>7 (14%)</td>
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<td>30 days</td>
<td>18 (74%)</td>
<td>15 (30%)</td>
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<tr>
<td>90 days</td>
<td>213 (85.2%)</td>
<td>23 (46%)</td>
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<td>360 days (Group 1 = 200 Pts.)</td>
<td>188 (94%)</td>
<td>45 (90%)</td>
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Tewari et al\textsuperscript{41} reviewed the characteristics of patients who had immediate continence after catheter removal. These characteristics included minimal disruption of the puboprostatic ligaments, intact puboperinealis muscle, long urethral length, preserved bladder neck, watertight anastomosis, and a well-supported vesico-urethral junction. Using 10 cadavers, they applied an anatomic restoration technique of continence mechanism and preservation of the puboprostatic collar. Then they performed the technique to 50 patients who underwent RALRP. The technique included minimal distal incision of the endopelvic fascia, preservation of the puboperinealis and the puboprostatic ligaments, placement of a puboprostatic ligament-sparing dorsal venous suture, watertight anastomosis, and reattachment of the arcus tendineus to the lateral aspect of the bladder neck (Fig 8). In this anterior reconstruction, the authors reported a continence rate of 29\% during the first week, 62\% at 6 weeks, 88\% at 12 weeks, and 95\% at 16 weeks after catheter removal, thus shortening continence recovery time. In a second report,\textsuperscript{42} the same group described the concept of total reconstruction, which added to the previous description of anterior reconstruction a posterior reconstruction following the same principles that Rocco et al\textsuperscript{37-39} described. The goal of this addition was to restore the functional length of the urethral sphincter. In a study by the same group\textsuperscript{43} performing the total reconstruction, they measured the length of the urethral sphincter with transrectal magnetic resonance imaging (MRI) prior to the surgery. They categorized patients in one of two groups based on the length of the urethral sphincter in the MRI: length in group 1 was < 14 mm and length in group 2 was > 14 mm. Continence was defined as no pad use or a liner used for security reasons only. They also compared differences between anterior and total reconstruction. The continence rate at 6 months after surgery in group 1 was 81\% for anterior reconstruction and 90\% for anterior and posterior reconstruction. In group 2 the continence rate was 83\% for anterior reconstruction and 99\% for the total reconstruction. With the posterior reconstruction, the functional length of the sphincter is restored, which mostly benefits patients with short urethral sphincters on the preoperative MRI.

In a randomized trial that included 116 patients undergoing RALRP, Menon et al\textsuperscript{44} performed a posterior reconstruction similar to the Rocco technique in one group and added a suturing of the puboprostatic ligaments to the anterior pubovesical collar in the second

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\textbf{Fig 8.} — (A) Incision of endopelvic fascia (EPL) medial to white line. (B) Preserved collar of tissues around urethra after removal of prostate. This collar comprises the puboprostatic ligaments, endopelvic fascia (EPL), and arcus tendineus, which form the fascioligamentous component of the puboprostatic musculoligamentous complex. (C) Vesicourethral anastomosis with 3-0 sutures. (D) Final picture after anastomosis is suspended by three 3-0 sutures on either side. From Tewari AK, Bigelow K, Rao S, et al. Anatomic restoration technique of continence mechanism and preservation of puboprostatic collar: a novel modification to achieve early urinary continence in men undergoing robotic prostatectomy.\textit{Urology}. 2007; 69(4):726-731. Reprinted with permission by Elsevier.

AT = arcus tendineus, PPL = puboprostatic ligaments, PPN = puboperinealis muscle, DVC = dorsal vein complex, LA = levator ani.
group. The catheter was removed 7 days after the surgery if there was no leakage or if extravasation was minimal. Continence was defined as patients using no pads or 1 pad per day (30 g leak or less). A single-layer anastomosis was performed in 57 patients (group 1) and a double-layered anastomosis in 59 patients (group 2). No differences were encountered between the groups. The urinary continence at 1, 2, 7, and 30 days was 26%, 34%, 49%, and 51% in group 1 and 51%, 54%, 74%, and 80% in group 2 (no statistical difference). However, a difference in the percentage of the incidence of cystographic leaks was found, with 10% in group 1 and 3% in group 2.

Different strategies have been developed to help patients regain continence during the RALRP. Most of the techniques seek to diminish the amount of dissection at the level of the structures supporting the urethra and the posterior pelvic floor or to recreate these anatomical areas after removal of the prostate.

Conclusions

The goals of RALRP are to render the patient cancer-free, maintain continence and, in selected patients, preserve potency. Several authors have referred to these goals as the “trifecta.”4-17 Cancer characteristics are key variables to define which patients will benefit from NVB preservation without compromising cancer control. Different techniques have been developed to preserve the NVB and the anatomical structures responsible for continence.

References

39. Rocco F, Carmignani L, Acquati P, et al. Early continence recovery after open radical prostatectomy with restoration of the posterior aspect of...


