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The Case for Robot-Assisted Radical Prostatectomy

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Introduction

MANAGEMENT of clinically localized prostate cancer is one of the most controversial subjects in the field of urologic oncology. Because of the lack of randomized trials, it is difficult, if not impossible, to compare two modalities used for treating an identical patient. Therefore, we will approach this debate more as an intellectual exercise, focusing on key outcome parameters. This exercise is not meant to give comparative data.

Both laparoscopy and robotics are minimally invasive modalities. The goals of both are the same: To achieve oncologic control through negative margins and, in selected patients, to minimize damage to nervous tissue responsible for erections and urinary continence. Having said that, we enjoy performing robot-assisted prostatectomy and believe that the goals of prostatectomy are achievable using robotics in our hands. We present some technical, conceptual, and personal outcomes data to support our conclusions and provide objective data to clarify questions posed by the debate.

Management

Evaluation

To begin the process of choosing the best treatment option for the patient in the case presented, we evaluate the patient's life expectancy and quantify the extent and aggressiveness of his cancer.

Extent and aggressiveness of cancer. We use the following data points to risk stratify patients' cancer:

1. Prostate-specific antigen (PSA) level—greater or lower than 10 ng/mL.
2. Gleason score—primary Gleason grade 3 or more than 3.
3. Percent cancer in the biopsy—1% to 22%, 23% to 50%, or >50% in any core.
4. Percentage of positive cores—1% to 33% or >34% positive cores (>1/3 or 2/6 on the same side).
5. Unilateral or bilateral positive cores (surrogate for high volume or multifocality of the cancer).
6. Location of cancer in terms of apex or other area of the prostate.
7. Clinical stage—nonpalpable (T_{1c}), palpable (T_{2a} orT_{2b}), palpable at apex or suspected extracapsular extension (T_3)
8. Findings of 3T endorectal MRI in terms of cancer localization, volume, and status of capsule and periprostatic tissue.

Based on these variables, a patient is classified as having incidental, low-risk, moderate-risk, or high-risk cancers. These biopsy parameters are usually lower than what true histopathology reveals after evaluation of the entire histopathology of the radical prostatectomy (RP) specimen. Therefore, unless the biopsy sampling is thorough (12 or more cores), rebiopsy should be considered if initial findings suggest incidental cancer.

Patients with significant cancer are candidates for nerve-sparing robot-assisted surgery.

Life expectancy of the patient. Life expectancy and relevant comorbidities impact treatment choices of patients. Because no additional details are available in this hypothetical case, I will presume this patient is quite healthy. We use a nomogram to estimate life expectancy in these patients.[1] Based on his age and comorbidities, stage of cancer, Gleason score, and PSA level, his probability of surviving the next 10 years is 92%. If he chooses surgical excision, his probability of living is 97%, which is not much different than his natural life expectancy if he never had cancer. Therefore, I would recommend surgical excision for this patient.

Robot-assisted radical prostatectomy (RARP)

As with any type of surgical treatment, patients are trying to preserve their life expectancy, avoid urinary incontinence, reclaim erections, and achieve all this with minimal pain and the least impact on their body image, lifestyle, and ability to earn a living, and avoid complications, such as bleeding. Surgeons using robotics and laparoscopy have shown that they can achieve these goals in the setting of a minimally invasive approach. While long-term survival data are being accumulated, time tested surrogate oncologic outcome measures, such as margin positivity and early PSA recurrence data, are comparable.

Robot-assisted or laparoscopy. This choice is not easy. Robotics offers three-dimensional magnified vision, ease of op-

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Table 1. Predicting Individual Risk

Kattan nomograms	
Organ-confined disease	67%
Extracapsular penetration	30%
Seminal vesicle involvement	2%
Lymph node involvement	1%
Partin tables	
Organ-confined disease	80%
Extracapsular penetration	19%
Seminal vesicle invasion	1%
Lymph node invasion	0%

erating in a comfortable position, and using instruments that turn in all directions. These aspects of the robot provide me with a tool that is easy to use, less taxing on my muscles, enjoyable (in most cases) to work with, and precise in execution of nerve sparing, continence preservation, and oncologic control.

Robot-assisted surgery is, however, expensive and requires considerable consumables. Experienced surgeons can perform 3 to 5 robot-assisted procedures every day. This may help in offsetting some of the cost, but it still does not make robot-assisted surgery cheaper than a laparoscopic procedure. Hospitals and industry need to resolve or formulate strategies for cost effectiveness of this procedure. While cost is important, as surgeons, we are going to perform our procedures based on ease to our patients and us.

Algorithm for nerve sparing. Several factors are taken into account with respect to preservation of the neurovascular bundles. We estimate the risk of extracapsular extension, lymph node metastasis, and biochemical failure, based on nomograms and risk tables, to be low (Table 1). We believe that there is sufficient evidence that the disease is organ confined and that the patient is a good candidate for bilateral nerve-sparing using athermal RARP.

Foundations of our technique. Learning from our anatomic studies,[2–4] we appreciate the trizonal neural architecture. The trizonal neural architecture comprises the proximal neurovascular plate, the predominant neurovascular bundle, and accessory neural pathways.

Athermal principle of RARP. Based on our studies in cadavers that showed the close proximity of neurovascular tissue with the prostate and seminal vesicles, we undertook to evaluate the effect of thermal energy on tissue. Using a myocardial thermal needle electrode, we were able to show that both monopolar and bipolar cautery devices cause an increase in temperatures up to 1.5 cm from the area of dissection.[5] Based on this finding, we have routinely stopped using thermal energy when dissecting nerves and perform all dissection with scissors and clips.

Technique of RARP. The surgical approach was based on previously published techniques by Menon and associates.[6] The last author and a team in Innsbruck, Austria, made a few modifications. This included the exclusive use of scissors for the entire procedure (instead of a hook); appreciation and preservation of the proximal neurovascular plate (PNP) (neural trizonal anatomic concept)[3]; athermal dissection of seminal vesicles and neurovascular structures[7]; preservation of tissue texture because of absolute avoidance of thermal energy and coagulative necrosis; use of anatomic reconstruction of the pelvis after vesicourethral anastomosis[9];restricting the bladder neck dissection to midline, thus avoiding damage to the PNP; controlling the dorsal venous complex at the later stage of the procedure using a ligament sparing stitch[8]; and integration of specimen examination before the completion of surgery. In line with principles of anatomic RP, our technique included performance of obturator lymph node removal in all patients and more extensive dissection[10] in high-risk patients.[11]

Discussion

Recently, RARP has been introduced with much enthusiasm. This technique offers several advantages that could improve the outcomes based on three-dimensional visualization, tissue magnification, and very precise dissection. Several investigators have reported excellent results after RARP in terms of cancer control as well as functional outcomes (Table 2).

Competing goals

The three main goals to reach are:

1. Cancer control (negative surgical margins and PSA level <0.2 ng/mL).

There are few published RARP studies with long-term follow-up. The overall positive surgical margin (PSM) rate in robotic series with at least 15 patients ranges from 3% to 36%,[13–16] which is commensurate with the open and laparoscopic literature. By stage, positive margins ranged from 2.4% to 22% for pT_2 disease, and 13.8% to 67% for pT_3 disease. In the largest single-center experience, Menon and coworkers[13] reported an overall PSM rate of 13% in 2652 patients.

Table 2. Oncologic Outcomes

Author	*No.*	*pT_2 (%)*	*pT_3 (%)*	*Overall PSM rate (%)*	*PSM pT_2 (%)*	*PSM pT_3 (%)*
Menon[13]	2652	78	22	13	—	—
Patel[15]	500	78	20	9.4	2.5	68
Ahlering[14]	140	76	24	13.3	5.2	37.6
Tewari[17]	215	88	10.7	6.5	4.8	—

PSM = positive surgical margin.

Table 3. Sexual Function Outcomes

Author	No.	Follow-up (months)	UNS	BNS	Mean age	Intercourse %	PDE-5 inhibitors
Menon[13]	2652	12 48	25% (Veil)	33% (Veil)	57.4	70 (BNS) 100 (BNS)	50%
Chien[16]	56	12			58.9	69	+/−
Patel[15]	500	12		40%	63.2	78	+/−
Tewari[17]	215	12	—	85%	60	87	+/−

UNS = unilateral nerve sparing; BNS = bilateral nerve sparing; PDE-5 = phosphodiesterase type 5.

An important aspect of RARP is the reduction of iatrogenic positive margins in otherwise organ-confined disease. Patel and colleagues[15,18] noted a decline in PSMs from 13% in the first 100 cases to 8% in the subsequent 100.

Our results after 215 patients are shown on Table 2.

2. Sexual function outcomes. Published reports on erectile dysfunction (ED) after RP range from 40% to 85% at leading centers.[19,20] While an individual surgeon's experience and technique remain the dominant variables in the outcome, several other factors also could affect postoperative ED, including the patient's age,[20–23] preoperative sexual function,[23,24] and concomitant medical diseases.

ED after prostatectomy occurs because of injury to the neurovascular bundle (NVB) as a result of direct trauma during dissection, thermal injury from electrocautery, and neuropraxia from traction on the nerves.[25]

Whether there is a difference between return of erectile function after RP, laparoscopic RP, or RARP is still not clear, but it has been proposed that RARP may prevent damage to the NVB because dissection occurs in an antegrade fashion, reducing traction on the nerve; better vision allows more precise dissection, preventing inadvertent incision or incorporation into a suture or clip.

Our technique emphasized two concepts:

1. Avoidance of the use of any thermal energy during the dissection of the seminal vesicles, NVBs, and the apex.
2. The knowledge of the pelvic neural anatomy.

In the classical concept, the neuroanatomy for nerve-sparing pelvic surgery has been described in a limited area—i.e., only the posterolateral aspect of the prostate and the seminal vesicle.[26] Many urologists have imagined the preserved neural component to be a bundle-like structure. Recent studies, however, report the origin of the cavernous nerve is a distal branch of the pelvic splanchnic nerve. Also, these nerve fibers join the hypogastric nerve with a spray-like arrangement along the lateral wall of the rectum.[27] Because we approach the prostate in an antegrade fashion during RARP, we need to understand the anatomy around the proximal and posterior aspect of the prostate. From a practical standpoint, the relevant neural tissue that we encounter during RARP can be grouped into three broad zones: The PNP, the predominant neurovascular bundles (PNB), and the accessory distal neural pathways.[3]

Menon and coworkers[13] recently described and reported potency results for their technique of lateral prostatic fascia-sparing (veil of Aphrodite). Recovery of normal erections was defined as a Sexual Health Inventory for Men (SHIM) score higher than 21. Using these criteria, 70% and 100% of men with a preoperative SHIM score higher than 21 reported normal erections and intercourse at 12 and 48 months, respectively.

In our series, of 215 patients 182 patients (85%) underwent a bilateral nerve sparing using our trizonal-athermal technique, 24 patients (11%) underwent either an incremental nerve sparing, and another 9 patients (4%) underwent wide

Table 4. Urinary Function Outcomes

Author	No.	Age (years)	1 mo %	3 mo %	6 mo %	12 mo %	Continence definition
Patel[15]	500	63.2	—	89	95	—	No pads
Menon[13]	2652	57.4	50	90	—	95.2	No pads or single pad for security
Zorn[30]	300	59.4	23	47	68	90	No pads or occasional pad for security
Tewari[9]	304[a] 162[b]	62.84 61.24	— —	77 91	86 97	92 —	No pads or single pad for security

[a]Anterior reconstruction.
[b]Total reconstruction.

excision (Table 3). Of patients < 70 years of age who were pre-operatively potent (SHIM score > 22), and who had bilateral nerve sparing surgery, 87% (89/102) were potent at 1 year following the procedure.[17]

3. Urinary control outcomes. When considering radical treatment for patients with prostate cancer, continence outcome plays a key role in the decision-making process. Optimal preparation of the urethral stump followed by a watertight mucosa to mucosa anastomosis is fundamental for both continence and prevention of anastomotic strictures.[28] Postoperative continence rates have also shown to be improved by preservation of functional urethral length, younger age, preservation of the NVBs, and absence of an anastomotic stricture.[29]

Improved visualization with precise apical dissection helping to preserve the urethral sphincter and functional urethral length are means by which RARP can improve on the already impressive continence rates shown for RP and laparoscopic RP.

Menon and coworkers[13] reported a 95.2% continence rate at 12 months after lateral prostatic fascia-sparing RARP in 2652 patients.

Between January 1, 2005 and June 5, 2007 a cohort of 700 patients undergoing robotic radical prostatectomy were prospectively evaluated. Patients in 2005 (214) served as a control group; they received no additional methods to provide support to the vesicourethral junction; a standard anastomosis was made. Patients in 2006 (304) received an anterior reconstruction only, to provide additional vesico-urethral anastomotic support. Patients in 2007 (182) received the total reconstructive procedure, which included an anterior reconstruction and posterior reconstruction. The percentage of patients who had achieved continence in the control group were: 13%, 35%, 50%, 62%, and 82% at the 1-, 6-, 12-, 24- and 52-week follow-up, respectively. The percentage of patients who had achieved continence in the anterior reconstruction group were 27%, 59%, 77%, 86%, and 91%, respectively. The total reconstruction group had continence rates of 38%, 83%, 91%, and 97% at 1, 6, 12, and 24 weeks, respectively[9] (Table 4).

Conclusion

Based on our experience and data, we strongly recommend in this individual clinical scenario a RARP.

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Abbreviations Used

ED = erectile dysfunction
MR = magnetic resonance imaging
NVB = neurovascular bundle
PNP = proximal neurovascular plate
PSA = prostate-specific antigen
PSM = positive surgical margin
RARP = robot-assisted radical prostatectomy
RP = radical prostatectomy
SHIM = Sexual Health Inventory for Men