Continued improvement of perioperative, pathological and continence outcomes during 700 robot-assisted radical prostatectomies

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Background: *Several robot-assisted radical prostatectomy (RARP) series have reviewed the impact of the initial learning curve on perioperative outcomes. However, little is known about the impact of experience on urinary and sexual outcomes. Herein, we review the perioperative, pathological and functional outcomes of our initial 700 consecutive procedures with at least 1 year follow up.*

Methods: *From 2003-2006, 700 consecutive men underwent RARP at a single, academic institution. Perioperative data and pathologic outcomes were prospectively collected. Validated, UCLA-PCI-SF36v2 quality-of-life questionnaires were also obtained at 1, 3, 6 and 12 months following surgery. Outcomes between groups (cases 1-300, 301-500, and 501-700) were compared.*

Results: *Mean operative time (OT) and blood loss significantly decreased during the experience (286, 198, 190 min; $p < 0.001$; 266, 190, 169 ml; $p < 0.001$). Positive surgical margin (PSM) rate decreased in pT2 patients (15% versus 10% versus 7%; $p = 0.03$) despite operating on men with higher grade disease (biopsy GS ≥ 7 in 24%, 40%, 44%; $p < 0.001$). At 12 months postRARP, pad free continence rate was 81% when self reported and 62% when assessed by the UCLA-PCI-SF36v2 questionnaire in the initial group. Continence rates improved to 93% and 75%, respectively, for cases 501-700 ($p < 0.05$). Furthermore, significant improvement in continence rates between consecutive case groups was observed at all postoperative time points. Potency rate was 83% (bilateral nerve preservation) and 56% (unilateral nerve preservation) at 12 months when self reported and 63% and 37% respectively by the UCLA-PCI-SF36v2. No significant differences in sexual function were noted with increased experience.*

Conclusions: *A prolonged learning curve is observed for EBL, OT and pT2-PSM. In addition, to the best of our knowledge, this is first series demonstrating a continued improvement in urinary continence with increased RARP experience.*

Key Words: outcomes, laparoscopy, robotic surgery, radical prostatectomy, learning curve, continence

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Introduction

Open radical prostatectomy (ORP), the gold standard treatment for localized prostate cancer, has developed into a refined surgical procedure with excellent

outcomes.[1,2] Robot-assisted radical prostatectomy (RARP), first described in 2002, has rapidly gained acceptance. Similar pathological and short term oncological outcomes have been reported from high volume institutions.[3-5] Functional outcomes (continence and potency) are also comparable between open and robotic approaches.[5,6]

The concept of a learning curve refers to the diminishing amount of time it takes to perform a task as the task is repeated. Ahlering et al initially evaluated operative time (OT) as a surrogate for the learning curve reporting that 12 cases was necessary to achieve a 4 hour console time proficiency.[7] Other series have observed that 120 cases were required to achieve a 4 hour skin-to-skin proficiency.[8]

With such individual variation, most urologists believe that OT is not an accurate single metric of the surgeon's expertise. Instrument proficiency, procedure safety, and reduction of positive surgical margins (PSM) have also been evaluated as learning curve endpoints. Herrell and Smith have suggested that the time at which a surgeon overcomes the learning curve not only depends on the technical skills of the surgeon, but also upon attaining an internal perception of their expertise.[9] Such a goal was not achieved until > 250 RARP procedures in their report.

With regards to oncological outcomes, Vickers et al recently demonstrated in an ORP series, that as a surgeon's experience increases (> 250 cases), cancer control after radical prostatectomy improves, presumably because of improved surgical technique.[10,11] Similarly, results from our initial 300 RARPs have previously been reported, demonstrating a significant decline in overall and pT2-PSM rate.[12]

To date, no series has specifically examined the impact of continued surgical experience on functional urinary and sexual outcomes. As such, we sought to examine the perioperative and functional outcomes at our institution beyond the initial robotic experience.

Materials and methods

Patient selection

Between February 2003-June 2006, two surgeons at a single, academic institution performed 700 consecutive RARPs. No patients had prior radiation or neoadjuvant hormonal therapy. All clinical and pathological data was prospectively collected (IRB protocol-13732A).

Surgical technique

All patients underwent RARP using our previously described surgical technique.[12-14] Individuals with high risk disease features (≥ cT2b disease, biopsy GS ≥ 8 or PSA ≥ 10 ng/ml) had bilateral standard template pelvic lymph node dissection (PLND). Interfascial nerve preservation (NP) was achieved by sharp dissection and selective bipolar electrocautery of bleeding vessels. In general, potent men (SHIM > 20) with GS6 and low volume GS7 disease with PSA < 10 ng/ml were considered NP candidates. However, given the retrospective nature of this study, these were not absolute criteria and ultimately the decision to proceed with NP was made on a case-to-case decision.

Technical modifications with increasing experience

Throughout this series, several small technical modifications were incorporated into our surgical technique. Chronologically, these include the modified clipless, antegrade NP technique which was introduced early after our first 50 cases.[14] No additional changes in NP technique were made in this series. After approximately 300 cases, we began meticulously defatting the anterior prostatic surface to better expose the apex, bladder neck and endopelvic fascia. No changes in the anastamotic technique or use of posterior reconstruction were employed throughout this series.

Sexual function recovery protocol

Oral PDE5 inhibitors were introduced 2 weeks postoperatively for penile rehabilitation and all patients were instructed to use them at least three times a week for maintenance of cavernosal tissue integrity. Postoperative evaluation of potency did not consider the frequency or compliance with PDE5 inhibitor use.

Pathological analysis

All surgical specimens were weighed, external surfaces inked, and submitted for pathologic evaluation following a modified Stanford protocol.[15] Pathologic grade and stage, as well as margin status were recorded. PSM was defined as tumor cells at the inked specimen external border.

Follow up

Serum PSA was obtained at 3, 6, 12 months post RARP and biannually thereafter. Biochemical recurrence (BCR) was defined as a rising PSA > 0.1 ng/ml. Patients were prospectively followed using validated RAND-36 UCLA-Prostate-Cancer-Index questionnaire (UCLA-PCI-SF36v2).[16] These were completed at home prior to clinical visits. Those patients without preoperative surveys or incomplete follow up surveys were excluded from function analysis. Patients with preoperative impotence, defined as a SHIM ≤ 20 and men with non NP RARP were excluded from the functional analysis.

Urinary continence was assessed by both physician interview and UCLA-PCI-SF36v2 question 14 ("How many pads or adult diapers per day did you usually use to control leakage during the last 4 weeks?"). Only answers of "no pads" for question 14 were considered equivalent to urinary continence.

Sexual function was also assessed by both physician interview and UCLA-PCI-SF36v2 question 23 ("How would you describe the usual quality of your erections?"). Potency was respectively defined as an erection sufficient for regular sexual penetration with or without the use of PDE5 inhibitors and a response of "firm enough for intercourse."

Statistical analysis

All statistical analysis was performed using JMP7 software (SAS Institute; Cary, NC). Patient data was grouped chronologically (cases 1-300 (group1); 301-500 (group 2); 501-700 (group 3)) for statistical comparison. Reasons for choosing such groups were to evaluate the ongoing outcome improvements beyond our initial reported 300 cases.[12] Chi-squared and 2-tailed t-tests were used. A double sided p value < 0.05 was considered statistically significant.

Results

Patient characteristics, including medical comorbidities (specifically hypertension, coronary artery disease or diabetes) and preoperative IPSS were comparable between groups, Table 1. Only biopsy GS was significantly higher in later groups. In group 1, 24% of the cases were performed for biopsy GS ≥ 7, which increased to 44% in group 3 ($p < 0.001$). A trend toward increased core percentage involvement was noted with surgical experience ($p = 0.07$).

Perioperative data are also summarized in Table 1. Despite an increased percent of PLND (17%, 35%, 33%; $p < 0.001$), OT and EBL decreased significantly with increased experience ($p < 0.001$ for both). Overall complication rates were comparable among groups ($p = 0.82$).

At surgical pathology, Table 1, a significant increase in rate of extraprostatic disease (pT3) was observed in the later group ($p = 0.003$). No significant difference in pT3-PSM rate was observed ($p = 0.26$). However, a notable decrease in pT2-PSM rate was demonstrated with increased case volume, well beyond the initial 300 cases (15% versus 10% versus 7%; $p = 0.03$).

Continence outcomes from patient interview and validated questionnaires are summarized in Table 2. No patients were excluded due to preoperative incontinence. Mean age, BMI, and NP technique were comparable among respondents in all groups. Based on patient reported outcomes, 21%, 37%, 60% and 81% of men in group 1 compared to 35%, 51%, 75% and 93% for group 3, were continent at 1, 3, 6 and 12 months, respectively ($p < 0.05$ for all). To assess the accuracy of office reported continence, verification with UCLA-PCI-SF36v2 was performed for all time points. Response rates for groups 1, 2 and 3 continence questionnaires ranged between 65%-71%, 71%-76%, and 59%-70%, respectively. Mean preoperative urinary function domain score was comparable among the three groups (data not shown). Pad free rates were reported in 13%, 26%, 47% and 62% of men at 1, 3, 6 and 12 months, respectively, in group 1. Similar findings were again observed with increased RARP experience with outcomes in group 3 improved to 25%, 41%, 64% and 75%, respectively ($p < 0.05$ for all).

Sexual functional (SF) outcomes were also evaluated in a similar fashion, Table 2. Preoperative potency (SHIM ≥ 21), was observed in 248 (83%), 164 (82%), and 158 (79%) of men in groups 1, 2 and 3, respectively. Patients who underwent bilateral NP reported no significant difference in postoperative sexual function between consecutive groups. No significant difference in SF was noted at any time between patients who underwent bilateral NP when using UCLA-PCI-SF36v2 question 23. Similarly, no differences were observed with increased experience for men with unilateral NP.

Discussion

Since the development of RARP, several surgeons have published their initial RARP experience.[5,7,12,17,18] These reports have estimated the learning curve for efficiently and safely completing surgery with OT < 4 hours is between 10-30 cases. Other series have assessed the learning experience by surgeon comfort and confidence comparable to that with open RP. Such outcomes did not occur until > 250 RARP procedures.[9] Vickers et al have recently demonstrated that the biochemical recurrence learning curve was steep and did not begin to plateau until a surgeon had completed approximately 250 prior operations with 5 year recurrence rates of 17.9% and 10.7% for men treated by surgeons with 10 prior operations and 250 prior operations, respectively ($p < .001$).[10,11] To the best of our knowledge, no studies have specifically assessed the impact of continued RARP experience on continence and potency outcomes.

Unfortunately, the term "learning curve" remains primarily a theoretical concept. Despite the increasing number of "learning curve" publications that correlate results with surgeon experience, it is virtually impossible to compare accurately one published series to another

TABLE 1. **Perioperative and pathological data of stratified RARP series based on initial 700 consecutive cases.**

	Group 1 Cases 1-300	**Group 2 Cases 301-500**	**Group 3 Cases 501-700**	**p value**
Date range	Feb 2003-Aug 2005	Aug 2005-April 2006	April 2006-June 2006	-
Mean age (years)	59.5 (42-76)	59.5 (42-85)	60.0 (43-74)	0.71
Mean BMI (kg/m^2)	28.8 (18.1-50.6)	27.5 (17.9-46.6)	27.8 (18.3-42.9)	0.63
Mean IPSS score	7.8 (0-31)	8.1 (0-32)	8.0 (0-32	0.25
Mean PSA (ng/ml)	6.3 (0.6-32)	7.0 (0.5-30)	6.8 (0.8-52.5)	0.57
Clinical stage (%)				
T1c	226 (75)	151 (76)	156 (78)	0.77
T2a/b	74 (25)	49 (24)	44 (22)	
Biopsy Gleason (%)				
6	227 (76)	120 (60)	112 (56)	< 0.001
7	67 (22)	65 (33)	72 (36)	
8-10	6 (2)	15 (7)	16 (8)	
Percentage of biopsy cores involved with PCa				
< 50%	260 (87)	165 (82)	158 (79)	0.07
> 50%	40 (13)	35 (18)	42 (21)	
Mean operative time (min)	286 (143-540)	198 (121-330)	190 (94-400)	< 0.001
Mean EBL (ml)	266 (25-1500)	190 (25-2500)	169 (50-1200)	< 0.001
Pelvic lymph node dissection (%)	50 (17)	69 (35)	65 (33)	< 0.001
Nerve preservation technique (%)				
Bilateral	186 (62)	124 (62)	137 (69)	0.07
Unilateral	81 (27)	65 (33)	50 (25)	
None	33 (11)	11 (5)	13 (6)	
Mean pathological prostate weight (g)	51.6 (10-176)	53.2 (21-199)	55.9 (21-153)	0.18
Mean estimated percentage tumor volume (%)	16.8 (1-95)	21.5 (5-90)	22.1 (1-80)	0.11
Pathologic stage (%)				
pT2a	62 (21)	22 (11)	20 (10)	0.003
pT2b	190 (63)	133 (66)	135 (68)	
pT3a	40 (13)	30 (15)	35 (18)	
pT3b	8 (3)	15 (8)	10 (5)	
Positive surgical margin (%)				
Overall	19.3 (58/300)	19 (38/200)	16 (32/200)	0.26
pT2	14.7 (37/252)	10.3 (16/155)	7.1 (11/155)	0.03
pT3	43.8 (21/48)	48.9 (22/45)	47.7 (21/45)	0.88
Complications (%)				
Overall	27 (9%)	18 (9%)	15 (8%)	0.82
Myocardial infarction	2 (0.6)	1 (0.5)	1 (0.5)	
Thromboembolic event	2 (0.6)	2 (1)	1 (0.5)	
Hemorrhage	3 (1)	3 (1.5)	3 (1.5)	
Rectal injury	-	-	-	
Ureteral injury	-	1 (0.5)	1 (0.5)	
Lymphocele	2 (0.6)	3 (1.5)	3 (1.5)	
Anastamotic leak	4 (1.4)	2 (1)	2 (1)	
Bladder neck contracture	4 (1.4)	2 (1)	1 (0.5)	
Wound infection/hernia	6 (2)	4 (2)	3 (1.5)	
Femoral nerve palsy	4 (1.4)	-	-	
Mean follow up (mo)	34.5 (30-48)	26.3 (22-30)	20.9 (16-22)	< 0.001
Biochemical recurrence (%)	25 (8)	17 (8.5)	19 (9.5)	0.89

EBL = estimated blood loss; PLND = pelvic lymph node dissection

TABLE 2. **Comparison of continence and potency recovery rates following RARP with increasing surgical experience.**

	Cases 1-300	Cases 301-500	Cases 501-700	p-value
Continence (no pads, per patient)				
% continent				
1 month	21% (51/238)	29% (50/173)	35% (54/154)	0.011
3 months	37% (87/224)	45% (74/165)	51% (74/144)	0.025
6 months	60% (115/192)	67% (105/157)	75% (97/129)	0.017
12 months	81% (168/208)	85% (124/146)	93% (110/118)	0.009
Continence (no pads, per SF-36/UCLA PCI question 14)				
% continent				
1 month	13% (28/212)	13% (19/152)	25% (35/140)	0.004
3 months	26% (53/204)	30% (45/149)	41% (55/135)	0.015
6 months	47% (92/196)	51% (77/152)	64% (82/128)	0.009
12 months	62% (127/206)	65% (93/143)	75% (90/118)	0.039
Sexual potency (preoperative SHIM ≥ 21, postoperative patient clinic response)				
Bilateral NP				
1 month	36% (46/130)	38% (35/91)	39% (34/89)	0.86
3 months	58% (75/128)	65% (57/87)	65% (53/82)	0.52
6 months	63% (80/127)	63% (46/73)	68% (51/75)	0.74
12 months	83% (92/111)	80% (48/60)	85% (52/61)	0.75
Unilateral NP				
1 month	24% (12/49)	26% (9/34)	25% (9/36)	0.97
3 months	33% (15/45)	32% (8/25)	39% (12/31)	0.84
6 months	49% (23/47)	52% (14/27)	59% (17/29)	0.71
12 months	55% (24/44)	54% (15/28)	59% (16/27)	0.90
Sexual potency (preoperative SHIM ≥ 21, SF-36/UCLA PCI question 23 response)				
Bilateral NP				
1 month	26% (28/106)	25% (19/76)	28% (21/74)	0.89
3 months	41% (45/110)	43% (29/68)	44% (31/70)	0.90
6 months	47% (57/121)	51% (34/67)	54% (37/68)	0.62
12 months	61% (64/105)	63% (40/63)	65% (40/62)	0.88
Unilateral NP				
1 month	16% (7/43)	20% (7/35)	22% (8/37)	0.82
3 months	22% (9/41)	18% (5/28)	28% (9/32)	0.63
6 months	37% (16/43)	33% (7/21)	43% (12/28)	0.78
12 months	32% (12/38)	40% (9/23)	43% (12/28)	0.63

or set benchmark case numbers to define surgical expertise.[19] Aside from surgical volume, other factors such as individual talent, natural skill, experience of the operating room team and bedside assistant as well as the perioperative hospital environment are highly influential factors affecting patient outcome. Ideally, some quantifiable measure of competence and results would replace a case number. However, in the absence of such measures, numbers continue to serve as the surrogate. Focus during one's learning curve on complication rate, tumor margin status, postoperative continence and preservation of erectile function are as important, if not more, than OT and blood loss.

In the current series, as expected, despite an increasing percentage of patients undergoing PLND and bilateral NP, OT and EBL also continued to decrease after 300 cases. In our initial 300 series publication, we reported a significant decline in OT between the initial 100 cases and last 100 procedures with mean OT of 342 min and 217 min, respectively.[12] While OT did show a significant decline with further experience (cases 301-700), the difference between groups 2 and 3 (198 min versus 190 min) was clinically marginal suggesting a plateau effect during cases 301-500. A similar observation was also noted for EBL during the same period. Such perioperative outcomes can

be attributed to our standardized surgical technique, as well as increasing surgeon, bedside assistant and operating room support staff experience.

While our surgical approach has evolved throughout this series to improve surgical efficiency, the majority of these technical modifications were implemented very early in our experience (initial 100 cases). These include standardized port placement, assisted tissue retraction with an Endoholder device (Codman, Raynham, MA),[20] initial posterior seminal vesicle dissection[21] and use of the LapraTy-clip (Ethicon Endo-Surgery, Inc.; Cincinnati, OH) to optimize watertight suture tension for the vesicourethral anastamosis.[13] With these technical refinements continued in cases 301-700, complication rates have remained stable throughout the three study groups.

Ultimately, the main goal of RARP must be cancer control. Oncologic efficacy is best measured by disease specific survival; however, given the fact that RARP has only been regularly performed since 2002, information about long term follow up is unavailable. The surrogate to disease specific survival is the biochemical recurrence rate which is directly affected by PSM rate. Karakiewicz et al have previously demonstrated in a review of 5831 men undergoing RP, that PSM was associated with a 3.7-fold greater risk of prostate cancer progression.[22] The overall PSM rate of 18% in our RARP series compares favorably with 20% and 24% in select open and RARP series, respectively.[5,6] Similar findings were reported by Ficarra et al in a recent comprehensive review of RARP literature.[4] In the current series, a continued improvement in overall PSM rate was observed in successive groups. More important, pT2-PSM rates decreased with increasing case number (14.7% versus 10.3% versus 6.7%; $p = 0.03$). With now over 2400 procedures, the pT2-PSM in our last 200 cases is 5.3%. Multiple studies have also demonstrated a similar reduction in PSM rates with increasing surgical experience and improvements in robotic surgical technique.[7,17,23] Continued careful patient selection, especially for nerve preservation and refinement in surgical techniques may contribute even further to PSM reduction beyond that observed in this study.

Unfortunately, the pT3-PSM rate (range 43%-49%) in the current series demonstrated no improvement across groups. Clearly, the patients in groups 2 and 3 were at higher risk for extracapsular disease given their more aggressive biopsy Gleason score. As summarized in Table 1, pT3 disease was documented in 16% of men in group 1 compared to 23% of those in the later groups ($p = 0.03$). Nevertheless, our pT3-PSM rates compare with other contemporary RARP[4,6] and open series.[11] Perhaps the lack of intraoperative tactile sensation may play a role and improved robotic instrumentation may soon overcome this shortcoming. Proper patient selection and less aggressive interfascial NP may also improve PSM outcomes. Future implementation of validated nomograms, as described by Steuber et al[24] or radiographic assistance (ultrasound[25] or endorectal MRI) to help predict or identify extracapsular extension, may help in patient selection for nerve preservation. The union of real time optical coherence tomography and radiographic technology with the robotic platform (augmented reality), future immunofluorescent histochemical prostate tissue specific markers for identification of residual tissue along with technical advances with wider excisions during surgery may provide promise for further pT3 disease PSM reduction.

Throughout this experience however, significant improvements in pad free continence rates were noted at all time points postoperatively between groups, Table 2. Despite comparable patient characteristics (age, BMI, preoperative IPSS as well as baseline UCLA-PCI urinary function and bother scores), patient reported continence outcomes at 1, 3, 6 and 12 months were 21%, 37%, 60% and 81% for group 1 compared to 35%, 51%, 75% and 93% for group 3, respectively (all $p < 0.05$). Similar outcomes were also observed when continence was evaluated by question 14 on UCLA-PCI-SF36v2. Although much of this improvement may be attributed to better appreciation of pelvic floor anatomy and improved robotic skills, improved apical and bladder neck dissection are largely felt to have contributed to the continued improvement in continence over time. Specifically, defatting of the anterior prostate, avoidance of unnecessary dissection into the levator ani and rhabdosphincter as well as reduced cautery dissection of the bladder neck, have also likely contributed to this extended learning curve. Although, posterior[26] and anterior[27] reconstruction techniques have been recently described with potential to improve earlier return to continence, none of these restoration techniques were employed in this series.

With regards to potency, the previously described clipless, antegrade neurovascular bundle preservation technique[14] was implemented very early in our experience (after 50 cases). Aside from improvements in execution due to increasing experience, no additional modifications to NP have been implemented. However, it has become increasingly evident that incidental thermal and traction trauma can reduce, delay, or prevent full recovery of erectile function.[28] More recent NP methods proposed to improve potency outcomes include the use of an athermal technique with bulldog

clamps and suture ligation or Hemolock clip vascular control as well as preemptive local hypothermia.[29] The lack of continued improvement in potency across groups in this study may, in part, be due to our ability to surmount the learning curve during the first 300 cases with the current technique and subsequent resistance to adopt newer modifications. Nevertheless, 1 year potency rates following bilateral NP of 83% and 63% based on subjective (patient reported) and objective (questionnaire reported) methods, respectively, are comparable to other contemporary series.[4-6]

Our study has several limitations that reflect the retrospective, observational nature of our data. This retrospective analysis could not account for subtle differences in technique and patient selection between the two surgeons. Nevertheless, each group was equally distributed between the two surgeons and individual outcomes were comparable with regards to PSM and functional outcomes. Furthermore, the cutoffs we chose for patient groups were arbitrary. The rationale for selecting the group sizes was based on the hypothesis that functional outcomes continue to improve long after the traditional experience of 300 cases, which was previously reported.[12] Although the data for continued continence improvement is substantial, grouping the initial 300 cases together may have been a reason that potency outcomes did not continue to improve, especially because the NP technique remained constant throughout the series. As such, we may have surmounted our learning curve for nerve preservation within the first 300 cases. Ideally, the impact of case number could be assessed as a continuous, rather than a categorical, variable. With 700 cases being performed by two surgeons, it is difficult to provide a case number to define a continence learning curve. Unfortunately, it was not our goal to define a set case number after which optimal outcomes were achieved. Our goal was to evaluate whether functional outcomes continued to improve with greater experience. Finally, the current study should reinforce the notion that there is no single learning curve. Although certain aspects of RARP can be mastered quite early on (robot efficiency and safety), several outcomes, including urinary continence and pT2-PSM, continue to show improvement up to 700 cases. However, caution must be advised in applying these results to other surgeons.

Conclusion

Our data reaffirms that RARP is a safe and feasible method for the surgical management of prostate cancer. Nevertheless, a prolonged learning curve exists for EBL, OT, and pT2-PSM. Most important, the current series demonstrates, to the best of our knowledge, the first relationship of improved urinary continence with increasing RARP surgeon experience. A larger, multi institutional review of experienced RARP surgeons should be performed to further evaluate this relationship. □

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EDITORIAL COMMENT

The authors retrospectively review their single institution database of 700 robotic assisted radical prostatectomies (RARP). Cases were divided into three groups for analysis (initial 300, subsequent 200, final 200 cases). The usual suspects of learning curve studies predictably declined with experience (OR time from 4.8 to 3.2 hours; pT2 margin positivity from 15% to 7%).

More importantly, the authors examined how functional outcomes change with experience. Urinary continence was appropriately defined as "no pads." Their data suggests that urinary continence outcomes improved with experience at all time points (1, 3, 6, and 12 months). At 1 year, 81% and 62% of patients in the initial group were continent by self report and validated questionnaire, respectively. Comparable numbers improved to 93% and 75% for the most recent group, a statistically significant change.

Interestingly, the same was not true of sexual outcomes. Preoperatively potent men undergoing bilateral nerve sparing achieved erections sufficient for penetration 83% and 63% by self report and validated questionnaire at 1 year, respectively. These numbers remained approximately stable with time. It is quite possible that the authors became proficient at their nerve sparing technique relatively early in the series. Certainly these potency outcomes are excellent, and using strict definitions of potentcy there may be little room for improvement at this level.

I would warn aspiring robotic surgeons not to place too much emphasis on specific case numbers. As the authors point out, individual results may vary. Furthermore, these results are a sum of cases from two surgeons, so their single learning curves are difficult to extrapolate. The authors are to be congratulated for focusing on functional outcomes, and for eschewing absolute learning curve cutoff numbers. We are currently well beyond the dawn of robotic surgery, and the time to discuss decreasing operative time and EBL has passed. High volume centers should follow suit, and explore the reasons underlying incremental improvements in functional outcomes. What specific maneuvers account for improved urinary outcomes with time? How can we best educate trainees so that they can "hit the ground running" with good functional outcomes? The authors could only speculate that better apical and bladder neck dissections are responsible, but the true answers are unknown.

What I find most distressing is the implication that these results have for our system as a whole. Evidence is mounting that functional and oncological outcomes improve with significant case experience. If so, patients would fare better if surgical expertise is centralized to fewer high volume centers. The learning curve of the institutions, not only the surgeons, impacts outcomes; i.e. OR teams become more efficient, postoperative care streamlined and routine. Instead, economic and market forces have been driving robotic technology into small communities, decentralizing care. The long term impact of this model remains to be seen.

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