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Original Article

Can robot-assisted radical prostatectomy be taught to chief residents and fellows without affecting operative outcomes?

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ABSTRACT

Purpose: To determine whether robot-assisted radical prostatectomy (RARP) may be taught to chief residents and fellows without influencing operative outcomes.
Methods: Between August 2011 and June 2012, 388 patients underwent RARP by a single primary surgeon (DIL) at our institution. Our teaching algorithm divides RARP into five stages, and each trainee progresses through the stages in a sequential manner. Statistical analysis was conducted after grouping the cohort according to the surgeons operating the robotic console: attending only ($n = 91$), attending and fellow ($n = 152$), and attending and chief resident ($n = 145$). Approximately normal variables were compared utilizing one-way analysis of variance, and categorical variables were compared utilizing two-tailed χ^2 test; $P < 0.05$ was considered statistically significant.
Results: There was no difference in mean age ($P = 0.590$), body mass index ($P = 0.339$), preoperative SHIM (Sexual Health Inventory for Men) score ($P = 0.084$), preoperative AUASS (American Urologic Association Symptom Score) ($P = 0.086$), preoperative prostate-specific antigen ($P = 0.258$), clinical and pathological stage ($P = 0.766$ and $P = 0.699$, respectively), and preoperative and postoperative Gleason score ($P = 0.775$ and $P = 0.870$, respectively). Operative outcomes such as mean estimated blood loss ($P = 0.807$) and length of stay ($P = 0.494$) were similar. There was a difference in mean operative time ($P < 0.001$; attending only = 89.3 min, attending and fellow 125.4 min, and attending and chief resident 126.9 min). Functional outcomes at 3 months and 1 year postoperatively such as urinary continence rate ($P = 0.977$ and $P = 0.720$, respectively), and SHIM score ($P = 0.661$ and $P = 0.890$, respectively) were similar. The rate of positive surgical margins ($P = 0.058$) was similar.
Conclusions: Training chief residents and fellows to perform RARP may be associated with increased operative times, but does not compromise short-term functional and oncological outcomes.

1. Introduction

In the United States, prostate cancer is the second leading cause of cancer-related death in men and it affects one in seven men at some point in their lifetime.[1] Currently, robot-assisted radical prostatectomy (RARP) is the preferred approach for the surgical management of organ-confined prostate cancer.[2] In 2008, ~80% of RPs in the United States were performed robotically.[3] However, RARP is a technically challenging procedure associated with a significant learning curve. Herrell and Smith reported that an experienced open surgeon must perform at least 150 RARPs to achieve comparable outcomes to those obtained routinely with open RP.[4]

A major goal in academic urology is to train residents and fellows to become proficient urological surgeons. Operative experience is critical for trainees during the development of surgical skills and technical competency. Traditionally, a trainee learns surgery through a graduated operative experience under appropriate supervision by an attending surgeon. However, resident and fellow training has recently come under increased scrutiny. Healthcare reform and accreditation groups have increased their emphasis on quality control measures and outcome based metrics of care.[5] Also, patients have increased reluctance in having trainees involved in their care.[6]

Prior investigators have shown that a systematic and stepwise method to teaching RARP to residents and fellows is safe and

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effective.[7,8] However, it is unclear whether utilizing such an approach to teach trainees yields similar outcomes compared to those attained when an attending exclusively performs the procedure. The purpose of our investigation was twofold: to present our approach to teaching RARP to chief-residents and fellows; and to determine whether teaching RARP to trainees influences operative outcomes.

2. Methods

2.1. Study design

An Institutional-Review-Board-approved retrospective chart review was performed on 388 consecutive patients who underwent RARP for clinically localized prostate cancer between August 2011 and June 2012. A single primary surgeon (DIL) who had performed > 2300 RARPs prior to the start of the study performed all procedures with or without a trainee using the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA). Each operative day was structured such that the first RARP was exclusively performed by the attending. Subsequent cases were split between the attending and chief resident, and the attending and fellow. There were four chief residents, and one fellow included in the study. In all cases, the bedside assistant was a dedicated physician assistant. A surgical scheduler randomly scheduled all patients for surgical time slots. We compared patient characteristics and perioperative outcomes after dividing our cohort according to the surgeons operating the robotic console: attending only, attending and chief resident, and attending and fellow. Baseline urinary function was assessed preoperatively using the AUASS (American Urologic Association Symptom Score). Urinary continence, defined as using 0 ppd (pads per day), was assessed postoperatively. Sexual function, assessed using the SHIM (Sexual Health Inventory for Men) questionnaire, was assessed pre- and postoperatively.

2.2. Chief-resident and fellow training

We did not implement a formal and standardized robotic educational protocol for our trainees prior to initiating RARP training at our institution. The chief residents and fellows had the opportunity to gain robotic experience through practicing on a robotic simulator at a dry laboratory, assisting at the bedside for various robotic procedures as junior residents, and operating on the robotic console on various robotic procedures as senior residents. Our approach to teaching our technique for RARP was modular, graded, and divided the procedure into five parts[9]:

Stage 1: port placement, docking of robotic arms, dropping the bladder, dissecting endopelvic fascia, and stapling the dorsal vein complex;
Stage 2: dissecting the bladder neck[10];
Stage 3: dissecting the seminal vesicles;
Stage 4: anastomosis;
Stage 5: dissecting the pedicles.

There was no difference in our approach to teaching RARP to chief residents and fellows. Each trainee began at Stage 1, and was allowed to sequentially progress to the next stage once he or she demonstrated technical proficiency as subjectively determined by the attending. After mastering each stage stepwise, the trainee advanced to performing groups of segmental steps. While the trainee was operating on the console, the primary surgeon critiqued the trainee's approach and technique. The attending took over the robotic console when the trainee was struggling for a prolonged period of time. While the primary surgeons were operating on the console, they highlighted salient aspects of their approach to the trainee. Chief-resident and fellow operative experience was supplemented with a weekly lecture series that reviewed relevant recorded video of RARP performed by the attending and trainees.

2.3. Statistical analysis

Statistical analysis was conducted using Minitab version 16 (Minitab Inc., State College, PA, USA). Approximately normal variables were compared utilizing one-way analysis of variance test, and categorical variables were compared utilizing two-tailed χ^2 test; $P < 0.05$ was considered statistically significant.

3. Results

Patient characteristics and perioperative outcomes were compared after dividing our cohort according to the surgeons operating the robotic console: attending only ($n = 91$), attending and chief resident ($n = 145$), and attending and fellow ($n = 152$). Among the three groups, there was no significant difference in mean age ($P = 0.590$), body mass index ($P = 0.339$), preoperative SHIM score ($P = 0.084$), preoperative AUASS ($P = 0.086$), and preoperative prostate specific antigen ($P = 0.258$) (Table 1). There was no significant difference among the three groups in clinical stage ($P = 0.766$), pathological stage ($P = 0.699$), preoperative ($P = 0.775$) and postoperative ($P = 0.870$) Gleason scores (Table 2). With regards to operative outcomes, there was no significant difference in mean estimated blood loss ($P = 0.807$) and length of stay ($P = 0.494$). Procedures involving trainees, however, had significantly longer mean operative times ($P < 0.001$; attending only = 89.3 min, attending and chief resident = 126.9 min, and attending and fellow = 125.4 min). At 3 months and 1 year postoperatively, there was no difference in urinary continence rate ($P = 0.977$ and $P = 0.720$, respectively) and SHIM score ($P = 0.661$ and $P = 0.890$, respectively). There was no statistically significant difference in the rate of positive surgical margins although this value approached significance ($P = 0.058$) (Table 3).

4. Discussion

The influence of trainee involvement during surgery on operative outcomes has been relatively unexplored in the urological literature. Furthermore, there have only been a few prior studies examining resident involvement on RARP outcomes. Although it is reasonable to assume that resident and fellow involvement may potentially be associated with worse operative outcomes, only a few studies have suggested this presumption to be the case. A study by Kern et al.[11] examined whether trainee involvement during open and minimally invasive partial nephrectomies was associated with increased complication rates in 1251 patients using the ACS NSQIP (American College of Surgeons National Safety and Quality Improvement Program) database. The investigators noted that resident and fellow involvement was associated with an increased rate of overall, nonserious, and serious morbidity; overall and superficial surgical site infections; bleeding; and sepsis. Furthermore, resident and fellow involvement was associated with increased operative times.[11] Also utilizing the ACS NSQIP database, Liu et al. found resident involvement to be an independent predictor of major complications in both partial ($n = 2902$) and radical ($n = 5459$) nephrectomy. However, the authors cautioned that their finding was likely confounded by the possibility that procedures involving residents may reflect more complex and higher risk tumors, as they were more likely to be performed at tertiary care centers.[12] Studies using the ACS NSQIP database are limited as they

Table 1
Patient characteristics.

	Attending	Attending and chief resident	Attending and fellow	*P*
Mean age ± SD (y)	58.8 ± 7.6	59.8 ± 7.2	59.6 ± 7.4	0.59
Mean BMI ± SD (kg/m^2)	27.5 ± 3.8	27.6 ± 5.2	28.3 ± 4.4	0.339
Mean preop SHIM ± SD (score)	20.1 ± 6.6	18.6 ± 8.9	17.6 ± 8.0	0.084
Mean preop AUASS ± SD (score)	7.3 ± 6.6	8.1 ± 11.4	5.9 ± 5.2	0.086
Mean preop PSA ± SD (ng/mL)	5.3 ± 3.4	6.1 ± 5.7	6.6 ± 6.7	0.258

AUASS, American Urologic Association Symptom Score; BMI, body mass index; preop, preoperative; PSA, prostate-specific antigen; SD, standard deviation; SHIM, Sexual Health Inventory for Men.

Table 2
Staging and Gleason characteristics.

	Attending	Attending and chief resident	Attending and fellow	*P*
Clinical stage				0.766
T1	84	131	136	
T2	7	14	16	
Pathological stage				0.699
T2	72	110	113	
T3	19	35	39	
Preop gleason				0.775
6	51	80	85	
7	30	48	48	
8	9	11	17	
9	1	5	2	
10	0	1	0	
Postop gleason				0.87
6	31	43	54	
7	54	93	87	
8	5	7	7	
9	1	2	4	

Postop, postoperative; Preop, preoperative.

do not provide any insight as to the extent of resident involvement in each case. Also, this database only tracks patient outcomes for 30 days following the index procedure, and thus does not capture long-term outcomes.

Numerous studies have suggested that trainee involvement does not compromise urological surgical outcomes. Bedaiwy et al. compared outcomes of robot-assisted sacrocolpopexy before ($n = 20$) and after ($n = 21$) the involvement of urology residents, and found no difference in operative times, blood loss, and intraoperative complications. In all cases involving a trainee, the urology resident performed at least 50% of the robotic portion of the procedure. Although the authors noted that both groups demonstrated significant correction of all points on vaginal examination at 24 weeks, there was no comparison of the primary outcome variable between the two groups.[13] Herrick and Yap showed that it is feasible to safely train residents in laser prostate surgery in the private practice setting without adversely affecting surgical outcomes. When comparing cases with ($n = 42$) and without ($n = 37$) resident involvement, the authors found no difference in postvoid residual urine volume, change in international prostate symptom score, change in quality of life score, and reoperation rate in patients with at least 6 months follow-up. Cases involving residents, however, were associated with longer operative times.[14] These studies, however, were limited by their small cohorts.

In the largest of such analyses, Matulewicz et al.[5] used the ACS NSQIP database to examine the influence of resident involvement on 40,001 patients who underwent urological surgery. After adjusting for confounders using propensity scores, the authors noted that operative times were longer in cases with resident involvement compared to those without resident involvement. However, there was no difference in the rate of overall, medical, and surgical complications between the two cohorts. Furthermore, on multivariate analysis, resident involvement was associated with decreased odds of overall complications, medical complications, and reoperations. Matulewicz et al.[5] concluded that resident involvement is not detrimental to operative outcomes and may actually be protective in some situations. The investigators reasoned that having another physician during an operation allows for the implementation of a check-balance system.[5] This study, however, was limited because the authors did not stratify the results by the specific urological procedure performed, and simply included all cases in which urology was the primary surgical service. Also, as previously mentioned, the ACS NSQIP database does not offer insight on any long-term outcomes of surgery.

Our approach to teaching RARP is based on the "modular teaching" method first introduced by Grantcharov and Reznick.[15] Briefly, this scheme involves subdividing a procedure into smaller modules, and teaching the trainee to master each module in order of increasing difficulty under appropriate supervision. This approach has been shown to be successful in transferring technically challenging surgical skills to trainees.[16] After dividing laparoscopic RP into 12 segments, Stoltzenburg et al.[17] taught two residents to perform the procedure with a similar rate of complications to those of the teacher in <50 cases. We found the modular teaching method to be particularly effective in our experience. It emphasizes maximal skill acquisition through repetition by requiring the trainee to master each stage of RARP to the highest standard. Also, it stresses patient safety by providing the attending a means to promptly intervene when the trainee is failing to progress. In addition to the most technically challenging portions of

Table 3
Perioperative outcomes.

	Attending	Attending and chief resident	Attending and fellow	*P*
Mean EBL ± SD (mL)	104.4 ± 68.1	100.7 ± 45.7	104.1 ± 48.0	0.807
Mean LOS ± SD (d)	1.0 ± 0	1.0 ± 0.3	1.0 ± 0.4	0.494
Mean OT ± SD (min)	89.3 ± 18.2	125.43 ± 22.3	126.9 ± 28.7	<0.001
Continence rate at 3 mo (%)	44.7%	44.5%	43.4%	0.977
Continence rate at 1 y (%)	80.1%	75.8%	76.7%	0.72
Mean SHIM score at 3mo ± SD	8.7 ± 7.6	7.6 ± 7.3	7.5 ± 8.4	0.661
Mean SHIM score at 1 y ± SD	14 ± 8.9	13.3 ± 9.3	13.1 ± 9.1	0.89
Mean PSM (%)	9.0%	15.90%	20.40%	0.058

EBL, estimated blood loss; LOS, length of stay; OT, operating time; PSM, SD, standard deviation; SHIM.

the case (i.e., bladder neck dissection, nerve sparing, or prostatic apex dissection), a case may be much more difficult due to patient factors (i.e., previous transurethral resection of prostate or obesity) and may prompt an earlier attending intervention. Lastly, as there is no pre-established number of times a trainee must complete each stage, each trainee progresses through the stages according to his or her specific skill set. We believe that our teaching algorithm adequately prepares trainees to perform RARP upon graduation.

Similar to prior reports, our study found that trainee involvement was not associated with an increase in the complication rate,[5,13,14] but was associated with longer operative times.[5,11,14] We used estimated blood loss and length of hospital stay as surrogates for complications because our rates of intraoperative and postoperative complications were too small for a meaningful statistical comparison. With regards to functional outcomes, there was no difference in urinary continence rate and SHIM score at 3 months and 1 year postoperatively among the three groups. Due to our short-term follow up of 1 year, we used the rate of positive surgical margins to assess our oncological outcomes. Although there was no statistically significant difference in the rate of positive surgical margins among the three groups, it is important to note that the difference did approach significance. With longer follow up, we will be able to more accurately assess oncological outcomes by comparing the biochemical recurrence rate among the three groups.

Our study had several limitations, in addition to the deficiencies inherent to a retrospective design. As the attending always exclusively performed the first case of the day due to operative room availability, our results may have been subject to the potentially confounding effect of surgeon fatigue. Bagrodia et al [18] showed that operative times, intraoperative complications, and oncological and functional outcomes were similar regardless of order of RARP. However, the authors only compared outcomes between the first and second RARP cases of each day, and so the implications of surgeon fatigue on five consecutive RARPs (our typical operative day) is still unclear. Also, we utilized a subjective grading scale to determine when a trainee was ready to progress to the next stage. Utilizing an objective grading scale to help assess when a trainee is ready to progress to the next stage could help standardize our teaching technique although we feel there is an unmeasurable but uniquely valuable benefit to the subjective evaluation. Developing a teaching algorithm that has been validated at multiple institutions and allows trainees to effectively learn RARP without compromising patient outcomes will be necessary. Lastly, similar to prior reports evaluating the influence of trainee involvement on perioperative outcomes,[5,11–14] we did not record a detailed description of the trainee's role in each procedure. Although all of our trainees operated on the console in accordance with our training approach, specific information on which stage a trainee performed may potentially offer more insight on a trainee's effect on functional and oncological outcomes.

In conclusion, a major goal of academic urology is to train proficient urologists. Subdividing RARP into five stages and having trainees master each stage in a stepwise fashion is an effective way to teach RARP. Training chief residents and fellows to perform RARP may be associated with increased operative times, but may not compromise oncological and functional outcomes. Longer follow-up will allow for a more accurate means for comparing oncological outcomes.

Conflicts of interest

All authors have no conflicts of interest or financial ties to disclose.

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