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Resident Involvement and Experience Do Not Affect Peri-Operative Complications Following Robotic Prostatectomy

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Abstract

Purpose—Most urologic training programs use robotic prostatectomy (RP) as an introduction to teach residents appropriate robotic technique. However, concerns may exist regarding differences in RP outcomes with resident involvement. Our objective was therefore to evaluate whether resident involvement affects complications, operative time, or length of stay following RP.

Methods—Using the National Surgical Quality Improvement Program database (2005 – 2011), we identified patients who underwent RP, stratified them by resident presence or absence during surgery, and compared hospital length of stay (LOS), operative time, and postoperative complications using bivariable and multivariable analyses. A secondary analysis comparing outcomes of interest across postgraduate year (PGY) levels was also performed.

Results—5,087 patients who underwent RPs were identified, in which residents participated in 56%, during the study period. After controlling for potential confounders, resident present and absent groups were similar in 30-day mortality (0.0% vs. 0.2%, $p = 0.08$), serious morbidity (1.8% vs. 2.1%, $p = 0.33$), and overall morbidity (5.1% vs. 5.4%, $p = 0.70$). While resident involvement did not affect LOS, operative time was longer when residents were present (median: 208 vs. 183 minutes, $p < 0.001$). Similar findings were noted when assessing individual PGY levels.

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Conclusions—Regardless of PGY level, resident involvement in RPs appears safe and does not appear to affect postoperative complications or length of stay. While resident involvement in RPs does result in longer operative times, this is necessary for the learning process.

Keywords

residents; surgical training; robotics; prostatectomy; complications

INTRODUCTION

Intraoperative resident participation is integral to any surgical training program. With recent technological advancements and an emphasis on minimally invasive procedures, numerous surgical fields now train their residents in robotic procedures [1–3]. In Urology, many programs utilize robotic prostatectomy (RP) to familiarize residents with appropriate robotic technique [4].

Concurrent with these changes in surgical training is a shift towards patient-centered, high-quality care in the U.S. [5–8]. This emphasis is evident in the National Surgical Quality Improvement Program (NSQIP), a quality care initiative sponsored by the American College of Surgeons which tracks provider characteristics and patient outcomes. NSQIP is a nationally validated, risk-adjusted, outcomes-based program with the primary goal of improving surgical care quality. Databases like NSQIP have inspired a reevaluation of surgical training that builds on the subject of resident inexperience as a potential contributor to adverse patient outcomes [9]. A clearer understanding of the relationship between intraoperative resident involvement and patient outcomes will continue to direct surgical training towards higher quality care [10]. Several surgical fields have used NSQIP data to analyze the effects of resident involvement on postoperative outcomes [9–20]; however, to our knowledge, this relationship following robotic surgery has not yet been explored across institutions in the urological literature. We chose to analyze outcomes following RP because of its early importance in urologic robotic training. This study's objective is therefore to evaluate whether resident involvement and postgraduate year level affect complications, operative time, or length of stay following RP using a national, prospective database.

METHODS

Data Collection

As a quality care initiative, NSQIP prospectively collects patient data on 135 variables, including preoperative risk factors, perioperative variables, and 30-day postoperative complications and mortality on a sample of surgeries at participating institutions [21]. NSQIP data have been validated as accurate, and its methods have been shown to be reliable for the measurement and improvement of surgical care quality [22–25]. All NSQIP data are collected and recorded by formally trained clinical reviewers using standardized methods at every site. Audits are performed periodically across participating institutions to ensure inter-rater reliability [11, 21].

Using the NSQIP 2005 – 2011 Participant Use File, we identified 8,424 patients undergoing RP between January 2005 and December 2011 using CPT code 55866. While this code may also reflect laparoscopic prostatectomy, the use of this modality is quite low (<1%) as demonstrated by other national samples [26]. As some variable definitions changed throughout the study period, data were carefully merged by cross-validating variables to ensure consistent definitions. Cases were excluded if important baseline characteristics or outcomes were not collected (2,703 patients). Additionally, cases were excluded if data on resident and/or attending involvement were missing or mismatched (634 patients) (e.g. the variable for attending listed attending only, but PGY year listed a resident). Excluded cases were analyzed to ensure baseline characteristics and outcomes were not appreciably different from included cases. Resident participation was defined as having a resident scrubbed during the RP. Additionally, for subgroup analysis, residents were classified by postgraduate year (PGY) of training such that PGY-1 through PGY-5 represented their years individually, while PGY-6 and above (including fellows) were grouped as PGY-6+.

Variables

Thirty-day postoperative complications were classified into 7 major categories, based on prior literature [9, 27]. These categories included: (1) any infectious complications (organ space surgical site infection [SSI], septic shock, pneumonia, superficial SSI, urinary tract infection, deep SSI), (2) cardiopulmonary complications (cardiac arrest requiring cardiopulmonary resuscitation, myocardial infarction, ventilator dependence > 48 hours, pneumonia, pulmonary embolism, unplanned intubation), (3) wound complications (dehiscence, organ space SSI, superficial SSI, deep incisional SSI), (4) neurologic/renal complications (coma > 24 hours, stroke/cerebrovascular accident with neurologic deficit, peripheral nerve injury, progressive renal insufficiency, urinary tract infection), (5) septic complications (septic shock, sepsis), (6) vascular complications (deep venous thrombosis or thrombophlebitis), and (7) bleeding requiring transfusion.

Additionally, the category of serious morbidity was included in the analysis and was defined as having any of the following: wound dehiscence, organ space SSI, coma > 24 hours, stroke/cerebrovascular accident with neurologic deficit, cardiac arrest requiring cardiopulmonary resuscitation, myocardial infarction, pulmonary embolism, ventilator dependence > 48 hours, progressive renal insufficiency, sepsis or septic shock [9, 28]. Furthermore, overall morbidity was defined as experiencing any of the aforementioned complication categories. Operative time was defined as the time between incision and closure.

Data Analysis

Baseline characteristics of the cohort were stratified by resident involvement. These included age, body mass index (BMI), American Society of Anesthesiologists (ASA) classification, functional status, prior surgery within 30 days, and other risk factors (including diabetes, hypertension, smoking history, steroid use, and dialysis). Bivariable analysis for continuous variables was performed using simple linear regression, one-way ANOVA or two-sample t test for normal distributions and Spearman's correlation, Kruskal-Wallis test or Wilcoxon Rank-Sum test for non-normal distributions. Categorical variables were compared using Pearson's Chi-square or Fisher's exact test. Multiple linear regression was used to compare hospital length of stay (LOS) and operative time between groups. For dichotomous outcomes, we fit a logistic regression model to estimate the odds ratios of postoperative complications between groups. Each multivariable model was adjusted for potential confounders that were independently predictive of its specific outcome with the threshold of a p-value < 0.10. We repeated the analyses (with the same covariates for each outcome) stratified by PGY levels comparing outcomes to the resident absent group. All reported p-values are two-sided with p < 0.05 deemed statistically significant. Statistical analyses were performed using STATA, version 12 (College Station, TX).

RESULTS

Sample Characteristics

From 2005 to 2011, 8,424 patients underwent RP with 5,087 remaining after exclusion for missing and/or mismatched data. Of note, a sub-analysis compared excluded cases to those included. No differences in baseline characteristics were noted except for dialysis use, whose absolute difference was quite small (0.1% in included vs. 0.5% in excluded cases). The included patients were stratified by resident participation into resident present (n=2,841) or absent (n=2,246). BMI and ASA classifications were unspecified in 34 cases and 10 cases, respectively, with data complete on all remaining variables in Table 1. Of patients undergoing RP, overall mean age was 61.7 years (SD = 7.3) and mean BMI was 28.8 (SD = 5.0) (Table 1). Approximately 10% of patients had diabetes, 50% had hypertension, and 10% were current smokers. Among cases with a resident compared to attendings alone, there were lower percentages of patients with diabetes (8.4% vs. 12.7%), hypertension (49.3% vs. 53.3%), and current smokers (11.2% vs. 15.0%) (p < 0.01). Age, BMI, ASA classification, functional status, prior surgery within 30 days, steroid use, and dialysis were each similar regardless of resident involvement (Table 1).

Postoperative Outcomes

Of the 5,087 patients included in the study, 1.9% experienced serious morbidity, while 5.2% experienced in-hospital 30-day morbidity. Concerning the major complication categories, rates ranged from 0.6% for vascular complications to 2.8% for infectious complications. Overall median (IQR) values for LOS and operative time were 1 (1 – 2) days and 198 (163 – 243) minutes, respectively. 30-day mortality was less than 0.1% for the entire sample. When comparing included and excluded patients, no significant differences were noted other than bleeding requiring transfusion being more common among those excluded (2% vs. 1%).

Unadjusted Differences in Outcomes by Resident Presence

Prior to adjusting for covariates, outcomes of interest were stratified by resident presence or absence and compared. No statistically significant differences were observed among any complication category, including 30-day mortality (0.0% vs. 0.2%, p = 0.08), serious morbidity (1.8% vs. 2.1%, p = 0.33), or overall morbidity (5.1% vs. 5.4%, p = 0.69). Hospital LOS was also not significantly different between the two groups (p = 0.96). Operative times were statistically different between the two groups, with resident involvement resulting in longer surgical times [median (IQR): 208 (174 – 250) vs. 183 (153 – 230) minutes, $p < 0.001$] (Table 2).

Outcomes after Adjusting for Potential Confounders in Patient Characteristics

After adjusting for appropriate covariates, no difference in 30-day mortality was noted between patients with a resident present or absent (0.0% vs. 0.2%, p = 0.08). Serious morbidity did not differ significantly between these groups (1.8% vs. 2.1%, p = 0.33), and thirty-day postoperative complications, defined by the category of overall morbidity, were also comparable (5.1% vs. 5.4%, p = 0.70). All remaining complication categories were largely similar between the two groups.

When assessing LOS, the difference between groups with and without residents remained non-significant after adjusting for potential confounders (p = 0.78). Operative times were clinically and statistically different with resident involvement resulting in longer surgical times (median: 208 vs. 183 minutes, $p < 0.001$).

Differences by PGY Level

After assessing differences between resident presence and absence, we explored complication differences among surgeries including different PGY level residents compared to surgeries without resident involvement. No differences in serious morbidity or overall morbidity were observed between any PGY subgroup and the resident absent group. Concerning hospital LOS, a statistically significant decrease was observed in the PGY-4 subgroup (p = 0.01); however, the absolute difference was small (0.25 days) and of questionable clinical importance. Lastly, although operative time was similar in the PGY-1 subgroup, all other PGY subgroups demonstrated significantly longer operative times than did the resident absent group (Table 3).

DISCUSSION

The use of robot-assisted laparoscopic surgery and its inclusion in resident training programs has grown exponentially over the past decade [2]. Moving forward, the use of this technology will be dictated by the pursuit of patient-centered, high-quality care [5]. As such, assessing the relationship between resident participation and patient outcomes is essential in achieving this goal. Matulewicz et al recently explored this general relationship for the collective body of urologic procedures from 2005-2011 in NSQIP and found no associated increases in overall or surgical complications [20]. Our study also presents a nationwide evaluation of resident involvement and perioperative outcomes; however, it focuses specifically on RPs alone. Like Matulewicz et al, our analysis demonstrated that intraoperative participation of residents in RPs resulted in slightly longer operative time but similar postoperative outcomes compared to attendings alone. Serious morbidity, overall morbidity and all other complication categories were not statistically different between the two groups. This is reassuring and supports that resident involvement in urologic robotic procedures is safe. These findings are further corroborated by the robust nature of NSQIP data in which regular auditing helps ensure data reliability and independent reviewers allow for objectivity in data capture. Additionally, our PGY subgroup analysis showed no difference in complications for any PGY level compared to the resident absent group. This is also reassuring, suggesting that the current system appropriately involves urologic residents throughout their training without increasing patient complications.

One concern regarding intraoperative resident involvement involves the length of surgery. Consistent with numerous prior studies (9, 10, 29), we found that operative time was longer for cases with a resident present. Explanations for this finding include residents' reduced efficiency compared to attendings and the need for dedicated teaching time during cases. When assessing operative time differences by PGY level, we found that operative time in the PGY-1 subgroup did not differ from attendings alone, whereas higher level residents were associated with longer operative times. This can be explained in that lower-level residents often participate in fewer portions of the case due to inexperience than do upper-level residents.

Despite the strengths of a large, national, prospectively ascertained dataset coupled with multivariable regression to minimize confounding, our study has several limitations. First, the detailed extent of resident involvement remains largely unknown. While some residents may simply assist, others may perform key portions of the case. While we expect that upper-level residents are more extensively involved, the limitations of data granularity with respect to this question preclude us from confirming this assumption. Another limitation is the non-specific CPT code of minimally invasive prostatectomy, which includes both pure laparoscopic and robotic procedures. While we may have included laparoscopic prostatectomy in our sample, the number is likely very low (<1%), given the predominant use of robotics in the United States (26). Additionally, surgical complications and deaths are reported within a limited 30-day period; therefore, our analysis does not capture late morbidity with potential underreporting of complication rates. However, the majority of complications following RP occur within the first 30 days, and this is unlikely to affect our conclusions (30). Furthermore, there exists no data on functional outcomes specific to RP, including continence and potency or pathologic outcomes.

Other limitations are those inherent to cohort studies. Our study population was not randomized, leaving it vulnerable to unmeasured confounders, especially those related to the medical centers providing RPs (e.g., academic vs. non-academic institutions), which may have biased results [10]. Lastly, in the PGY subgroup analysis, the power declines significantly as the comparative sample sizes decrease, which may limit its conclusions.

CONCLUSIONS

Robotic surgery has become integral in healthcare delivery, particularly for the surgical treatment of prostate cancer [26]. Therefore, resident training in the appropriate use of these new tools and techniques is essential. In this context, steps must be taken to ensure that the quality of patient care is not adversely affected by resident training programs. Our study assessed whether resident involvement in a common urologic robotic procedure (i.e., RP) adversely affected postoperative outcomes. Our results revealed no difference in 30-day mortality, serious morbidity or overall morbidity with resident involvement in RP. These findings support the safety of the current system of urologic residency training in robotic surgery, which does not appear to worsen morbidity or mortality rates. As such, resident involvement in RPs should be supported and encouraged as a teaching tool for robotic technique. While slightly longer operative times are noted for resident involvement, this is a wellknown phenomenon that is unavoidable and necessary, given the time needed by residents to learn techniques and refine skills.

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Table 1

Baseline characteristics of RP cases stratified by resident involvement

	Resident Present	Resident Absent	
Patient Characteristic	**n = 2,841**	**n = 2,246**	**p-value**
Age, years, mean (SD)	61.8 (7.2)	61.7 (7.3)	0.50
BMI classification, mean (SD)	28.8 (4.6)	28.7 (5.5)	0.49
ASA classification, n (%)			0.20
1. No disturbance	90 (3.2)	89 (4.0)	
2. Mild disturbance	1,854 (65.4)	1,424 (63.5)	
3. Severe disturbance	874 (30.8)	709 (31.6)	
4. Life threatening	17 (0.6)	20 (0.89)	
Functional health status, n (%)			0.08
Independent	2,832 (99.7)	2,244 (99.9)	
Partially dependent	9 (0.3)	2 (0.1)	
Prior surgery within 30 days, n (%)	15 (0.5)	6 (0.3)	0.15
Diabetes, n (%)	239 (8.4)	271 (12.7)	<0.01
Hypertension, n (%)	1,400 (49.3)	1,197 (53.3)	<0.01
Current smoker, n (%)	305 (10.7)	331 (14.7)	<0.01
Steroid use, n (%)	26 (0.9)	16 (0.7)	0.43
Dialysis, n (%)	4 (0.1)	2 (0.1)	0.59
Resident Characteristic			
PGY of residents, n (%)			
PGY-1	45 (1.6)	---	
PGY-2	271 (9.5)	---	
PGY-3	287 (10.1)	---	
PGY-4	567 (20.0)	---	
PGY-5	821 (28.9)	---	
PGY-6+	850 (29.9)	---	

Table 2

Comparison of outcomes of patients undergoing RP with and without resident involvement

	Resident Present	Resident Absent	p-value (unadjusted)	p-value (adjusted)	Adjusted OR (95% CI)
	n = 2,841	**n = 2,246**			
Outcome					
Hospital LOS (days), median (IQR)	1 (1-2)	1 (1-2)	0.96	0.78[a]	----
Operative time (minutes), median (IQR),	208 (174-250)	183 (153-230)	**<0.001**	**<0.001**[b]	----
30-day mortality, n (%)	0 (0.0)	4 (0.2)	0.08	0.08[c]	0.15 (0.00 − 1.20)[c]
Infectious complications, n (%)	83 (2.9)	61 (2.7)	0.66	0.62[d]	1.09 (0.78 − 1.53)[d]
Cardiopulmonary complications, n (%)	22 (0.8)	28 (1.3)	0.09	0.14[e]	0.65 (0.37 − 1.15)[e]
Wound complications, n (%)	27 (1.0)	21 (0.9)	0.96	0.93[f]	1.03 (0.58 − 1.83)[f]
Neurologic and renal complications, n (%)	68 (2.4)	50 (2.2)	0.69	0.59[g]	1.11 (0.76 − 1.61) [g]
Septic complications, n (%)	25 (0.9)	13 (0.6)	0.22	0.16[h]	1.63 (0.83 − 3.21)[h]
Vascular complications, n (%)	13 (0.5)	16 (0.7)	0.23	0.22[i]	0.63 (0.30 − 1.31)[i]
Bleeding requiring transfusion, n (%)	27 (1.0)	21 (0.9)	0.96	0.91[i]	1.03 (0.58 − 1.84)[i]
Deep SSI, n (%)	0 (0.0)	1 (0.04)	0.44	----	----
Organ Space SSI, n (%)	9 (0.3)	7 (0.3)	0.97	0.93[j]	0.95 (0.35 − 2.59)[j]
Deep + Organ Space SSI, n (%)	9 (0.3)	8 (0.4)	0.81	0.86[k]	0.92 (0.35 − 2.42)[k]
Serious morbidity, n (%)	50 (1.8)	48 (2.1)	0.33	0.34[l]	0.82 (0.55 − 1.23)[l]
Overall morbidity, n (%)	146 (5.1)	121 (5.4)	0.69	0.70[m]	0.95 (0.74 − 1.22)[m]

[a] adjusted for age, ASA classification, prior surgery within 30 days, diabetes, hypertension and smoking status;

[b] adjusted for age, BMI, ASA classification, prior surgery within 30 days, diabetes, hypertension and smoking status;

[c] no adjustments made;

[d] adjusted for age, BMI, prior surgery within 30 days, diabetes and hypertension;

[e] adjusted for age, BMI, ASA classification, prior surgery within 30 days, hypertension and smoking status;

[f] adjusted for age, BMI, functional status and hypertension;

[g] adjusted for BMI, prior surgery within 30 days, hypertension and smoking status;

[h] adjusted for age, diabetes and hypertension;

[i] adjusted for age and ASA classification;

[j] adjusted for functional status;

[k] adjusted for functional status and diabetes;

[l] adjusted for age, BMI, ASA classification, prior surgery within 30 days, diabetes and hypertension;

[m] adjusted for age, BMI, ASA classification, prior surgery within 30 days, hypertension and smoking status

Table 3

Comparison of outcomes of patients undergoing RP with residents stratified by PGY level, each compared to those without resident involvement

	Resident Absent	**PGY-1**	**p**	**PGY-2**	**p**	**PGY-3**	**p**	**PGY-4**	**p**	**PGY-5**	**p**	**PGY-6+**	**p**
Outcome	**n = 2,246**	**n = 45**		**n = 271**		**n = 287**		**n = 567**		**n = 821**		**n = 850**	
Hospital LOS, days, median (IQR)[a]	1 (1-2)	2 (1-2)	0.23	1 (1-2)	0.74	1 (1-2)	0.13	1 (1-2)	**0.01**	1 (1-2)	0.95	1 (1-2)	0.08
Operative time, min, median (IQR)[b]	183 (153-230)	192 (171-237)	0.63	218 (179-262)	**<0.001**	203 (170-263)	**<0.001**	208 (168-247)	**<0.001**	211 (178-255)	**<0.001**	203 (171-237)	**<0.001**
Serious morbidity, n (%)[c]	48 (2.1)	1 (2.2)	0.96	4 (1.5)	0.41	4 (1.4)	0.44	10 (1.8)	0.62	29 (2.3)	0.77	12 (1.4)	0.23
Overall morbidity, n (%)[d]	121 (5.4)	3 (6.7)	0.83	12 (4.4)	0.40	18 (6.3)	0.45	29 (5.1)	0.83	39 (4.8)	0.59	45 (5.3)	0.92

[a] adjusted for age, ASA classification, prior surgery within 30 days, diabetes, hypertension and smoking status;

[b] adjusted for age, BMI, ASA classification, prior surgery within 30 days, diabetes, hypertension and smoking status;

[c] adjusted for age, BMI, ASA classification, prior surgery within 30 days, diabetes and hypertension;

[d] adjusted for age, BMI, ASA classification, prior surgery within 30 days, hypertension and smoking status