Achieving proficiency with robot-assisted radical prostatectomy: Laparoscopic-trained versus robotics-trained surgeons

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Cite as: *Can Urol Assoc J* 2013;7(11-12):e711-5. http://dx.doi.org/10.5489/cuaj.360
Published online November 8, 2013.

Abstract

Background: Initiating a robotics program is complex, in regards to achieving favourable outcomes, effectively utilizing an expensive surgical tool, and granting console privileges to surgeons. We report the implementation of a community-based robotics program among minimally-invasive surgery (MIS) urologists with and without formal robotics training.

Methods: From August 2008 to December 2010 at Kaiser Permanente Southern California, 2 groups of urologists performing robot-assisted radical prostatectomy (RARP) were followed since the time of robot acquisition at a single institution. The robotics group included 4 surgeons with formal robotics training and the laparoscopic group with another 4 surgeons who were robot-naïve, but skilled in laparoscopy. The laparoscopic group underwent an initial 7-day mentorship period. Surgical proficiency was measured by various operative and pathological outcome variables. Data were evaluated using comparative statistics and multivariate analysis.

Results: A total of 420 and 549 RARPs were performed by the robotics and laparoscopic groups, respectively. Operative times were longer in the laparoscopic group ($p = 0.002$), but estimated blood loss was similar. The robotics group had a significantly better overall positive surgical margin rate of 19.9% compared to the laparoscopic group (27.8%) ($p = 0.005$). Both groups showed improvements in operative and pathological parameters as they accrued experience, and achieved similar results towards the end of the study.

Conclusions: Robot-naïve laparoscopic surgeons may achieve similar outcomes to robotic surgeons relatively early after a graduated mentorship period. This study may apply to a community-based practice in which multiple urologists with varied training backgrounds are granted robot privileges.

Introduction

Over the past decade, RARP has become the most widely used surgical modality for prostate cancer in the United States.[1,2] Other regions worldwide have adopted the procedure at increasing rates.[3] The growth of robotic technology has led to hundreds of new programs at academic and community centres, operated by urologists with varying levels of robotics experience. As a technically challenging procedure without standard credentialing guidelines however, important implications may arise. These include patient safety, surgical outcomes, hospital efficiency, and productivity. Our goal was to provide insight into this matter by reporting our experience integrating a RARP program at a large community practice, comprised of urologists skilled in minimally-invasive surgery (MIS), with and without robotics training.

Methods

From August 2008 to December 2010, surgical performance and outcome data involving 2 groups of urologists performing RARP were prospectively collected at Kaiser Permanente Southern California at a single institution after receiving institutional review board approval. The ***robotics group*** comprised of 4 surgeons with formal robotics training who logged at least 100 RARPs during their fellowships. The ***laparoscopic group*** had no previous robotics training, but had proficiency in laparoscopy. Among the 4 surgeons in this group, 3 had fellowship experience in laparoscopic radical prostatectomy (LRP) and 1 had performed at least 25 LRPs as the primary surgeon during residency.[4,5] All surgeons performing RARP at our institution were included.

The laparoscopic group underwent an initial 7-day mentorship period, which has been previously described.[6] The first 2 days involved assisting a preceptor, who was a member of the robotics group. The last 5 days comprised of performing RARP as the console surgeon with the preceptor as the assistant. After the mentorship period, the bedside assistant consisted of a surgeon from either the robotics or laparoscopic group.

All RARPs were performed for localized disease and in a standardized fashion via a 6-port transperitoneal approach using a da Vinci 4S and 4Si Surgical System (Intuitive Surgical, Sunnyvale, CA). Bilateral nerve sparing was used, unless gross disease was encountered. A pelvic lymphadenectomy was also performed at the discretion of the primary surgeon.

All patients who underwent RARP during the study period were enrolled. We recorded patient demographics and clinical factors, including age, body mass index (BMI), American Society of Anesthesiology (ASA) score, preoperative prostate-specific antigen (PSA) level, biopsy Gleason sum, and clinical stage.

Surgical proficiency was evaluated by both intra-operative and pathological data. Intra-operative data included total operating time, actual prostatectomy time, and estimated blood loss (EBL). ***Total operating time*** was the elapsed time from initial incision to port closure and ***actual prostatectomy time*** was the elapsed time from the start of RARP after docking the robot arms to completion of the vesicourethral anastomosis. Pathological outcomes included positive surgical margin rate (PSMR), positive surgical margin (PSM) location, final Gleason sum, and pathologic stage according to the 2002 TNM staging system. A PSM was defined as tumour seen at the inked prostate margin. Patients without a documented margin status in the pathology report were excluded.

Utilizing PSMR as a surrogate endpoint for proficiency in RARP, the surgeon groups were compared after each set of 50 cases. Basic comparative statistics were employed. Multivariate adjusted testing was also used to account for differences attributed to PSA, final Gleason sum, pathological stage, and BMI. A p value of less than 0.05 was considered statistically significant.

Results

A total of 969 consecutive RARPs were performed during the study period, 420 and 549 by the robotics and laparoscopic groups, respectively. After the initial 7-day mentorship period, none of the surgeons in the laparoscopic group needed further mentorship.

There were no significant differences in patient demographics, including mean age, BMI, and ASA score (Table 1). Most patients had a final Gleason sum of 6 (44.7%) or

Table 1. Patient age, BMI and ASA score, final Gleason sum, and pathologic stage of patients in the laparoscopic and robotics groups

	Laparoscopic group	Robotics group	Combined	*p* value
No. patients	549	420	969	
Age (years)				
Mean (SD)	59.8 (7.35)	59.5 (6.90)	59.7 (7.16)	0.4257
Range	41 – 78	22 – 76	22 – 78	
BMI (kg/m²)				
Mean (SD)	28.1 (4.18)	28.5 (4.28)	28.3 (4.23)	0.3295
ASA score				
Missing	2	8	10	0.4393
1	13 (2.4%)	10 (2.4%)	23 (2.4%)	
2	397 (72.6%)	284 (68.9%)	681 (71%)	
3	137 (25%)	118 (28.6%)	255 (26.6%)	
PSA (ng/mL)				
Mean (SD)	6.4 (4.08)	7.1 (5.49)	6.7 (4.75)	0.1316
Range	0.2 – 46.9	0.7 – 50.8	0.2 – 50.8	
Final Gleason sum				
Missing	4	4	8	0.2265
6	251 (46.1%)	179 (43%)	430 (44.7%)	
7	270 (49.6%)	208 (50%)	478 (49.7%)	
8	16 (2.9%)	23 (5.5%)	39 (4.1%)	
9	6 (1.1%)	6 (1.4%)	12 (1.2%)	
10	2 (0.4%)	0 (0%)	2 (0.2 %)	
Pathologic stage				
Missing	3	3	6	0.9468
T2	425 (77.8%)	325 (77.9%)	750 (77.9%)	
T3	121 (22.2%)	92 (22.1%)	213 (22.1%)	

BMI: body mass index; ASA: American Society of Anesthesiology; PSA: prostate-specific antigen.

7 (49.7%) and were pathologic stage T2 (77.9%), with no overall differences in the groups.

There was no difference in EBL between the robotics and laparoscopic groups, with a mean of 129.7 and 128.6 mL, respectively (Table 2). Operative times were longer in the laparoscopic group, with a difference of 11.9 minutes (p = 0.0016) and 13.4 minutes (p = 0.0003) for actual and total prostatectomy times, respectively.

The laparoscopic group reported a higher overall PSMR of 27.8% versus 19.9% in the robotics group (p = 0.0046) (Table 3). The difference was more pronounced in patients with pT2 disease. The PSMRs for both groups initially trended downwards with increasing RARP cases performed (Fig. 1). It appeared to plateau at 200 cases for the robotics group and at 300 cases for the laparoscopic group. We tallied the odds ratio for each set of 50 cases comparing PSMRs (Table 4). Although there were no significant differences in PSMRs between the groups, there was a trend towards equivalency after 250 cases. The results were similar in the multivariate analysis, adjusting for PSA, Gleason sum, pathological stage, and BMI.

Most PSMs were located at the apex (41%), followed by the posterior (33%) region of the prostate. The robotics group achieved a lower PSMR (36%) at the apex when compared to the laparoscopic group (43%) (p = 0.04). Although not statistically significant, the PSMRs were notably higher PSMR at 7% versus 2% at the anterior prostate for the laparoscopic group. Conversely, the robotics group obtained a higher PSMR along the posterior prostate (39% vs. 30%). PSMRs were comparable between the 2 groups at the base and lateral aspects of the gland. In total, 7 patients (2 from the robotics group and 5 from the laparoscopic group) had unreported margin data and were therefore excluded from the analysis.

Discussion

Despite the ubiquity of robotic programs today, there is no formal uniform credentialing process to guide hospital programs in granting robotic privileges. A major consideration includes the growing healthcare climate of monitoring quality and utilization indicators, the results of which may be tied to financial reimbursement. It may therefore be in the best interest of the hospital to grant privileges only to a few high-volume surgeons, and to avoid "diluting" the experience over many surgeons. It would also be more economical to ensure the efficient and productive use of the robot, as it is an expensive surgery in comparison to traditional prostatectomy.

Another major consideration, but competing interest, of the hospital is to ensure the hiring and preservation of their physician roster. More lenient granting policies likely allow for easier recruitment, especially for the newly trained urologic surgeon. Determining the optimal solution to this debated issue is evidently complex.

The current literature regarding surgeon learning curves for robotic surgery generally consists of a small cohort of prominent academic urologists in the field. Ahlering and colleagues reported the successful transfer of open surgical skills to RARP within only 9 to 12 cases.[7] In contrast, Herrell and Smith reported the experience of an open surgeon reaching acceptable proficiency after 150 cases and attaining confidence after 250 cases.[8] Menon and colleagues reported that a gradual learning curve leading to shorter operative times exists after the first 18 patients, and 180 cases are required to attain proficiency.[9] Jaffe and colleagues confirmed these findings and further noted abrupt breakpoints in the learning curves after the first 12 and 189 cases.[10]

Our study reflects a larger group of surgeons in a community-based practice setting. The learning curve of the laparoscopic group was a reflection of a mentorship-driven model. This study may therefore be of particular interest to hospital boards in the midst of allocating console privileges to surgeons with varying degrees of MIS experience.

Intra-operative and pathological outcomes were used as surrogate measures for proficiency. Operative times and EBL were surprisingly similar between the groups. Although statistically significant, actual and total prostatectomy times were only slightly longer for the laparoscopic group. The difference was likely more pronounced earlier on, and

Table 2. Estimated blood loss and operative times of patients in the laparoscopic and robotics groups

	Laparoscopic group	Robotics group	Combined	p value
Estimated blood loss (mL)				
Mean (SD)	128.6 (120.08)	129.7 (158.73)	129.1 (138.05)	0.8162
Range	5 – 1400	5 – 2200	5 – 2200	
Actual prostatectomy time (min)				
Mean (SD)	114.3 (38.95)	100.9 (34.18)	108.6 (37.53)	0.0003
Range	43 – 262	46 – 308	43 – 308	
Total operative time (min)				
Mean (SD)	211.3 (55.83)	199.4 (52.33)	206.2 (54.66)	0.0016
Range	108 – 464	61 – 551	61 – 551	

SD: standard deviation.

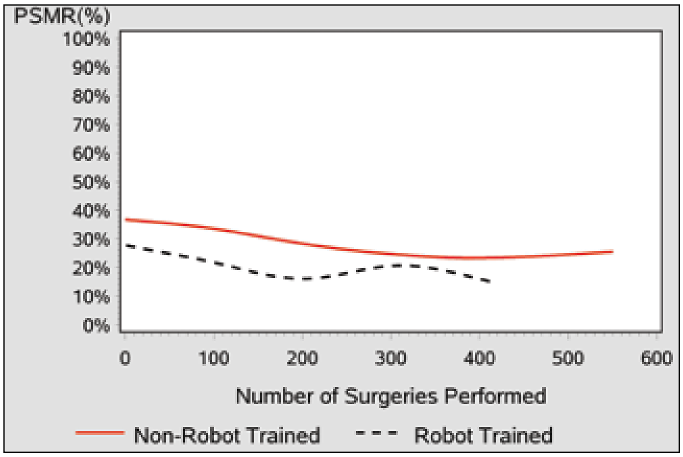

Fig. 1. Positive surgical margin rates (PSMR) of the laparoscopic versus robotics group.

Table 4. Bivariate and multivariate analysis comparison of positive surgical margin rates between laparoscopic and robotics groups over each set of 50 cases

	Bivariate analysis		Multivariate analysis*	
No. cases per group	OR	95% CI	OR	95% CI
1-50	0.61	0.23-1.5	0.57	0.23 – 1.4
51-100	0.64	0.27-1.5	0.50	0.20 – 1.2
101-150	0.52	0.21-1.3	0.58	0.22 – 1.5
151-200	0.41	0.15-1.1	0.45	0.13 – 1.6
201-250	0.32	0.11-0.99	0.22	0.050 – 0.98
251-300	0.87	0.35-2.2	0.86	0.32 – 2.3
301-350	0.83	0.34-2.0	0.97	0.33 – 2.9
351-400	1.13	0.40-3.2	1.7	0.18 – 16

*Adjusted for prostate-specific antigen, Gleason score, pathologic stage, and body mass index. OR: odds ratio; CI: confidence interval.

improved over time with experience. These results illustrate that surgeons without formal robotics training may become adept at using the console relatively early on.

With respect to pathological outcomes, margin status was used to assess proficiency. For the robotics group, there was a gradual but notable improvement during the initial 200 RARP cases. They achieved a PSMR of 19.9%, which is comparable to the reported PSMRs of 2% to 59% in the literature.[11-13] The laparoscopic group had a similar improvement, however, over the first 300 RARP cases. Unlike the findings previously cited by Jaffe and colleagues, there were no sudden breakpoints in the learning curve in either group.[10]

When evaluating cases with PSMs, overall rates were higher for pT3 compared to pT2 tumors, as would be expected simply based on tumour extent. When comparing margin rates between groups, PSMRs were significantly higher in the laparoscopic group for pT2 tumours. This is likely attributed to differences in surgical technique and progress along the learning curve. We anticipated a higher PSMR earlier on while learning RARP, due to technical challenges experienced in performing a meticulous dissection.

With respect to PSM location, the laparoscopic group had a higher rate at the prostatic apex. All other margin location rates were similar between groups. The apical dissection is regarded as one of the most challenging steps in any prostatectomy, since visualization can be poor, the tissue planes can be ill-defined, and a fine balance is required to preserve the urinary sphincter. It is consequently the most common site for iatrogenic positive margins.[12,13] The difference between the groups in this study likely reflects additional skills acquired in a robotics fellowship. Conversely though, a larger PSMR difference would perhaps have been obtained if the laparoscopic group had no prior MIS experience. The dissection steps and magnified tissue planes in LRP are at least similar to RARP, in comparison to the open approach.

All surgeons in the study had prior MIS training. Most residency programs in North America currently incorporate MIS training to a large degree, facilitating the learning process. In Europe, laparoscopic radical prostatectomy (LRP) gained popularity in the early 2000s and new robotics programs developed shortly afterwards, fueling the trend towards an MIS approach.[14] Presumably, a significant proportion of European urologists learning RARP had prior LRP experience, similar to surgeons in this study. The development of RARP in Canada will likely take a similar course. It has been less rapid likely due to high costs and the debate as to the benefits of robotic surgery.[15]

There were several potential limitations in this study. First, our proficiency assessment was limited to the intra-operative variables stated above, as well as PSMRs. Other measures of proficiency may include perioperative complication rates, functional, and oncologic outcomes. Evaluating all potential measures of proficiency, such as complications, was beyond the scope of this study. A longer follow-up may include these data and provide a more accurate assessment.

Another limitation in the study is that the data were analyzed as a cohort of surgeons in each group, rather than comparing surgeons on an individual level. This was done to illustrate potential differences between robotics-proficient and robotics-naïve surgeons in a community group practice, as several single-surgeon series have already been reported in the literature.

In addition, RARP as a single procedure was used to measure general robotic surgical proficiency, as it was consequently the only robotic procedure carried out in the initial 2 years of the program. It may be valuable to assess proficiency in other robotic surgeries, such as partial nephrectomy or pyeloplasty.

In a stepwise, mentor-led fashion, this study showed that the robot-naïve surgeon group can achieve similar results of formally-trained robotic surgeons relatively early on. The learning process is reflective of the recent recommendations from the Society of Urologic Robotic Surgeons in regards to preceptorship.[6]

Table 3. Surgical margin details of prostatectomy specimens from the laparoscopic and robotics groups

	Laparoscopic group	Robotics group	Combined	*p* value
Margins				
Missing	5	2	7	0.0046
Negative	393 (72%)	335 (80%)	728 (76%)	
Positive	151 (28%)	83 (20%)	234 (24%)	
Positive margin pathologic stage				
T2	85/424 (20%)	44/325 (14%)	129/749 (17%)	0.02
T3	66/120 (55%)	39/93 (42%)	105/213 (49%)	0.07
Positive margin location on specimen				
Apex	85 (43%)	34 (36%)	119 (41%)	0.04
Base/bladder neck	23 (12%)	11 (12%)	34 (12%)	0.73
Lateral	16 (8%)	10 (11%)	26 (9%)	0.69
Anterior	13 (7%)	2 (2%)	15 (5%)	0.07
Posterior	60 (30%)	36 (39%)	96 (33%)	0.49

Conclusion

Surgeons with primarily laparoscopic surgical experience, trained in a stepwise fashion by a preceptor, can approximate their surgical results to robotics-trained surgeons, in regards to operative times, estimated blood loss, and PSMRs. The findings of this study may provide insight to hospitals when determining credentialing privileges in robotic surgery programs.

Acknowledgements: We would like to acknowledge the dedicated robotics team at the Kaiser Permanente West Los Angeles Medical Center: Kirk Tamaddon, Sivaporn Bassett, Judee Azuro, Bernardo Duran, Vaughan Belzonie, and Melvin Lamothe; as well as Dianne Taylor for reviewing this manuscript from the Department of Research and Evaluation.

Competing interests: Dr. Kim, Dr. Chang, Dr. Kaswick, Dr. Derboghossians, Dr. Jung, Dr. Slezak, Dr. Wuerstle, Dr. Williams, and Dr. Chien all declare no competing financial or personal interests.

This paper has been peer-reviewed.

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