J Robotic Surg (2016) 10:129–134
DOI 10.1007/s11701-016-0582-z

ORIGINAL ARTICLE

The role of the assistant during robot-assisted partial nephrectomy: does experience matter?

Aaron M. Potretzke[1] · Brent A. Knight[1] · John A. Brockman[1] · Joel Vetter[1] · Robert S. Figenshau[1] · Sam B. Bhayani[1] · Brian M. Benway[2]

Received: 30 December 2015 / Accepted: 19 March 2016 / Published online: 2 April 2016

Abstract The objective of this study was to evaluate surgical outcomes with respect to the experience level of the bedside assistant during robot-assisted partial nephrectomy. A retrospective review was conducted of a prospectively maintained database of 414 consecutive robot-assisted laparoscopic partial nephrectomies performed by experienced robotic surgeons at our institution from April 2011 to September 2014. A senior-level assistant was defined as a resident in his or her post-graduate year (PGY) 4 or 5, or a fellow. Junior-level assistants were considered to be PGY-2, PGY-3, or a nurse first assistant. Multivariate analyses were performed using linear, Poisson, and logistic regression models. There were 115 junior-level cases and 299 senior-level cases. On univariate analysis, the experience level of the assistant had no impact on operative time (168 for junior level vs. 163 min for senior level, $p = 0.656$). Likewise, there were no differences between the junior- and senior-level groups with regard to warm ischemia time (21.3 vs. 20.9 min, $p = 0.843$), negative margin status (111/115 (96.5 %) vs. 280/299 (93.6 %), $p = 0.340$), or postoperative complications (17/115 (14.8 %) vs. 35/299 (11.7 %), $p = 0.408$). After multivariate analysis, operative time was associated with increased body mass index and tumor size (both $p < 0.001$), but not with resident experience level ($p = 0.051$). Estimated blood loss and postoperative complications were also not associated with the PGY of the assistant ($p = 0.488$ and $p = 0.916$, respectively). Despite common concern, the PGY status of a physician trainee serving as the bedside assistant does not appear to influence the outcomes of robot-assisted partial nephrectomy at a high-volume center.

Keywords Nephrectomy · Partial nephrectomy · Robotics · Postoperative complications · Neoplasm

Introduction

The incidence of kidney cancer continues to rise in the US, in large part attributed to early and enhanced detection of incidental masses with cross-sectional abdominal imaging [1–3]. Partial nephrectomy (PN) offers comparable oncologic control [4] and improved renal function [5] when compared to radical nephrectomy. It is recommended as standard therapy for stage T1a and many T1b renal tumors [6]. Accordingly, the utilization of robot-assisted partial nephrectomy (RAPN) is also increasing [7, 8]. RAPN affords an operation with less blood loss, shorter length of stay, more rapid convalescence, and improved cosmesis when compared to open PN [9]. Furthermore, urologists may favor RAPN over laparoscopic partial nephrectomy (LPN) as it offers more favorable renal function recovery, shorter length of stay (LOS), and shorter warm ischemia time (WIT) [10]. It also provides relative technical advantages [11] and a shorter learning curve [12] when compared to LPN.

Robotic surgery affords the surgeon the advantages of enhanced visualization and dexterity. The sacrifice for these advantages is being physically separated from the patient. The surgeon relinquishes some control of skilled,

✉ Aaron M. Potretzke
potretzkea@wudosis.wustl.edu

[1] Division of Urologic Surgery, Washington University School of Medicine, 4960 Children's Place, Campus Box 8242, St. Louis, MO 63110, USA

[2] Urology Academic Practice, Cedars-Sinai Medical Center, Los Angeles, CA, USA

precise maneuvers to the bedside assistant. Trepidation exists amongst some robotic surgeons regarding the relative acumen and experience of their bedside assistant; many of these concerns are based on early robotic experience and are descriptive only [13–18]. We sought to formally examine the significance of the post-graduate year (PGY) of the bedside assistant on surgical outcomes in RAPN at an academic center.

Patients and methods

Study population

After Institutional Review Board approval, we performed a retrospective review of a prospectively maintained database of 414 consecutive RAPN performed by four experienced robotic surgeons at our institution from April 2011 to September 2014. Exclusion criteria included any incomplete or unclear documentation of the level of the assistant. Data collected included: age, gender, body mass index (BMI), American Society of Anesthesiologists score, Charlson comorbidity index (CCI), tumor size, nephrometry score, surgical approach, laterality, operative time, use of off-clamp technique, WIT, estimated blood loss (EBL), need for renal pelvis repair, LOS, complications, positive surgical margins, and pathology. A senior-level assistant was defined as a resident in his or her PGY-4 or -5, or a fellow. Junior-level assistants were considered to be PGY-2, PGY-3, or a nurse first assistant at the bedside. The nurse first assistant had participated in <20 robotic cases. Physician assistants (PAs) are not employed for assistance at the bedside at our institution. In cases where a senior- and junior-level resident were both noted assistants, the junior resident was considered the bedside assistant. In such circumstances, it is our practice that the more senior assistant is unscrubbed and performs portions of the case at the console.

Statistical analysis

Univariate analyses were performed using Wilcoxon rank-sum test for numerical variables and Chi-square test of independence for categorical metrics. Multivariate analyses were performed to assess for a relationship between the level of experience of the assistant and the following outcomes: operative time, EBL, WIT, LOS, presence of a postoperative complication, and surgical margin status. The multivariate models controlled for the following variables: BMI, age, surgeon, gender, pathologic tumor size, nephrometry score, off-clamp status, CCI, need for pelvicaliceal repair, and approach (retro- vs. transperitoneal). Models for LOS, margin status, and complications additionally controlled for EBL and operative time. Linear regression, Poisson, and logistic regression models were used for continuous, counting, and binomial data, respectively. All statistical analysis was performed in R version 3.2.0.

Results

The total number of patients meeting inclusion criteria was 414. Junior-level assistants were present in 115 cases, and senior-level assistants in 299. See Table 1 for patient and surgical characteristics. After univariate analysis, patient and tumor characteristics were similar except for BMI which was greater in the senior assistant group (31.5 vs. 29.9 kg/m^2, $p = 0.031$). In regard to surgical parameters, the percentage of off-clamp procedures was greater in the senior assistant group (98/299 (32.8 %) vs. 23/115 (20.0 %), $p = 0.011$).

Based on univariate analysis, LOS was shorter for the senior assistant group (2.23 vs. 2.38 days, $p = 0.048$) however, this relationship did not persist after multivariate analysis. No differences in outcomes were witnessed between the junior and senior assistant groups, including for operative time, EBL, WIT, LOS, presence of a postoperative complication, and surgical margin status (Table 1).

Based on multivariate analysis, postoperative complications were not associated with resident experience level ($p = 0.916$). They were, however, associated with CCI >3 and performing the procedure off clamp ($p = 0.023$ and $p = 0.047$, respectively). Operative time was 9.3 min longer and trended toward significance in the junior-level group ($p = 0.051$). Tumor size and BMI were both associated with increased operative time ($p < 0.001$). EBL was not associated with resident experience level ($p = 0.488$) but was associated with tumor size ($p < 0.001$) and nephrometry score ($p = 0.040$). The results of this multivariate analysis can be found in Table 2.

A sub-group multivariate analysis was performed which excluded off-clamp procedures. In the on-clamp cohort of RAPNs ($N = 325$), there was no difference between cases done with junior- or senior-level assistance in terms of operative time, EBL, WIT, LOS, complications, or positive margin status ($p = 0.14$, 0.50, 0.35, 0.86, 0.53, and 0.87, respectively).

Discussion

The surgeon–patient relationship is unique and deeply valued. With the advent of robotic surgery, tactile feedback is forfeited for the benefits of superior visualization and precision of surgical maneuvers. The bedside assistant is,

Table 1 Patient and surgical characteristics in robot-assisted partial nephrectomy cases for which there was a junior- or senior-level bedside assistant

	Junior ($N = 115$)	Senior ($N = 299$)	p value
Age, years (mean ± SD)	57.5 ± 12.4	57.5 ± 11.4	0.929
Female (%)	44.3	41.1	0.579
BMI, kg/m^2 (mean ± SD)	29.9 ± 6.7	31.5 ± 7.2	**0.031**
ASA (%)			
1 or 2	58.3	53.5	0.440
3 or 4	42.6	46.5	
Clinical tumor size, cm (mean ± SD)	2.86 ± 1.21	3.08 ± 1.50	0.315
Pathologic tumor size, cm (mean ± SD)	2.55 ± 1.04	2.80 ± 1.41	0.237
Nephrometry score	7.67 ± 2.03	7.88 ± 1.80	0.475
Right sided (%)	53.0	52.2	0.873
Retroperitoneal approach (%)	20.0	29.1	0.061
Operative time, minutes (mean ± SD)	168 ± 62.9	163 ± 49.9	0.656
EBL, mL (mean ± SD)	179.3 ± 264.0	208.5 ± 279.9	0.685
WIT, min (mean ± SD)[a]	21.3 ± 11.7	20.9 ± 9.5	0.843
Off-clamp RAPN (%)	20.0	32.8	**0.011**
Renal pelvis repair (%)	53.0	59.9	0.573
LOS, days (mean ± SD)	2.38 ± 1.08	2.23 ± 1.24	**0.048**
Postoperative complication (%)	14.8	11.7	0.408
Malignant histology (%)	82.6	83.9	0.742
Positive surgical margin (%)	3.5	6.4	0.340

SD standard deviation; *BMI* body mass index; *EBL* estimated blood loss; *WIT* warm ischemia time; *LOS* length of stay; *ASA* American Society of Anesthesiologists score; *RAPN* robotic-assisted partial nephrectomy. Bolded values have $p < 0.05$

[a] Excludes off-clamp procedures: junior $N = 91$, senior $N = 199$

Table 2 Multivariate analysis of patient and surgical characteristics with perioperative outcomes in robot-assisted partial nephrectomy

Outcome	Multivariate association with senior- vs. junior-level assistant[a]	
	Estimated effect[b]	p value
Operative time, minutes	−9.31	0.051
Natural log EBL	0.08	0.488
Natural log WIT	−0.05	0.350
	OR	p value
Length of stay, days	1.02	0.837
Postoperative complication	0.96	0.916
Positive margin	2.47	0.332

EBL estimated blood loss; *WIT* warm ischemia time; *OR* odds ratio

[a] Multivariate analyses included the following covariates: body mass index, age, surgeon, gender, pathologic tumor size, nephrometry score, off-clamp status, Charlson comorbidity index, need for pelvicaliceal repair, and approach (retro- vs. transperitoneal)

[b] Estimated effect represents the change in the dependent variable based on the level of experience of the assistant. With a senior-level assistant, the operative time decreased by 9.31 min, the EBL increased by 8 %, and the WIT decreased by 5 %

therefore, relied upon heavily. The level of experience of the assista

nt can be a source of anxiety for the surgeon. In the present study, we found the outcomes were similar between cases performed with either a junior- or senior-level assistant. There were no differences between the assistant levels for operative time, EBL, WIT, LOS, presence of a postoperative complication, or surgical margin status. Operative time did trend toward being shorter in cases with senior-level assistants ($p = 0.051$).

After univariate analysis, there was a difference in LOS between senior- and junior-level assistants (2.23 ± 1.24 vs. 2.38 ± 1.24 days, $p = 0.048$). However, the results of multivariate analysis did not corroborate this relationship. It is likely that this small, but statistical, difference can be attributed to surgeon-specific practices; after controlling for surgeon, the difference was nullified. A similar explanation may apply to the univariate discrepancy in off-clamp procedures (98/299 (32.8 %) vs. 23/115 (20.0 %) for senior vs. junior assistants, $p = 0.011$). This is substantiated by the fact that surgeon 1 had a senior-level assistant 153/218 (70.2 %) of the time, compared to surgeon 2 with 120/152 (78.9 %). It is known within our institution that surgeon 2 performs off-clamp RAPN more often, per his preference. An unintended bias may be present regarding the assignment of senior-level assistants more often to surgeon 2, as there was no randomization of residents to each surgeon's case.

Few previous authors have objectively examined the significance of the bedside assistant's experience. Sgarbura et al. assessed the experience of bedside assistants in thoracic, digestive, and gynecologic robotic surgery [18]. The authors found that those assistants with formal training had improved efficiency for simple tasks such as placing instruments. More complicated tasks (e.g., application of stapler, and deployment of endobag), however, were preselected for assistants with ≥150 cases of laparoscopic experience [18]. In 2014, McMillan et al. queried the National Surgical Quality Improvement Program (NSQIP) database of 5087 robotic-assisted radical prostatectomies, performed with or without the assistance of a resident [19]. There were no differences in operative time or complications between the groups. Although when stratified by PGY status, those cases with a PGY >1 did have longer operative times. Importantly, in the absence of resident assistance, the level of training of the assistant was not defined.

Kern et al. compared resident and fellow involvement in minimally invasive versus open PN [20]. Although unable to qualify whether cases were done robotically or laparoscopically, the authors found higher complications rates in those performed with resident assistance compared to "attending alone." Further, they found that the presence of a PGY ≥6 was associated with greater postoperative morbidity. Lastly, Ruhotina et al. reviewed the NSQIP database of urologic minimally invasive operations including 573/786 (72.9 %) PNs with resident involvement [21]. There was no difference in complications for any of the procedures. Due to the nature of the database, no distinction could be made between robotic and laparoscopic procedures. The authors also acknowledged the need for studies assessing WIT, EBL, and positive surgical margins. Such data are presented for the first time in the present manuscript. Furthermore, the present cohort is homogenous in regard to the small number of surgeons from a single institution.

The diffusion and practice of new surgical technology are a concern as they pertain to appropriate, standardized training and credentialing [22]. Although most of this focus relates to the surgeon, the rest of the operative team, and particularly the bedside assistant, need to be comfortable performing delicate tasks. At present, there is no specific certification required for an assistant with a critical and highly technical role in RAPN. Thiel et al. constructed a structured bedside assistant training program for robotic prostatectomy [23]. In the study, the participants viewed the course as being very beneficial, although no objective evidence of improvement in the assistant's skill or the patient's outcomes is available. At our institution, no dedicated training is required for bedside assistance during robotic operations. However, junior-level residents are required to attend a session each year with the da Vinci representative and experienced, robotically trained faculty. Along with training for console-specific techniques, topics such as docking the robot and manual clutching of the robotic arms are discussed. Residents are able to practice operating the robot using virtual trainers to simulate surgical techniques. All residents are encouraged to use the robotic trainer that is available in the simulation center as their time allows. In addition, the responsibilities during a robotic case are typically assigned in graduated fashion. As such, residents experience a predictable number of robotic cases in each of their post-graduate years. Future study may address the objective changes in accuracy and speed of bedside assistants performing surgical maneuvers in an ex vivo model.

The findings detailed herein do not intend to diminish the vitality of the role of the bedside assistant nor undermine the importance of the assistant's competence. As previous authors have noted, the assistant's performance is critical to the safe and successful performance of a robotic operation [23]. Sur et al. found that if the assistant amasses mistakes, surgical efficacy and outcomes depreciate, leading to undo morbidity and open conversion [24]. Other authors have noted that relative inexperience of a bedside assistant can relate to untoward intraoperative complications such as aortic punctures and difficulties with lost needles [25, 26]. As a result of such reports and the implicit apprehension a surgeon might have in delegating surgical acts, some robotic surgeons have looked toward minimizing the role of the assistant. Techniques such as employing the robotic fourth arm, ultrasonic TilePro software (Intuitive Surgical, Sunnyvale, CA) [15], and barbed suture for renorrhaphy [27] have been suggested. The TilePro system allows the console surgeon to remain at the console and independently manipulate the intracorporeal ultrasonic probe while viewing the live image. Likewise, barbed

suture has been utilized by some due to its increased efficiency, which may in part be due to the reduced number of maneuvers designated to the bedside assistant [e.g., cutting suture, applying Hem-o-lok clips (Teleflex Incorporated, Morrisville, NC)].

Our study presents limitations inherent to a retrospective study. Although not quantifiable, the difference in BMI may represent an unconscious selection bias, whereby a surgeon arranged for a more senior assistant. This is not, however, common practice at our institution as assignments are made by the chief resident, not by staff urologists. Further, the experience is from a single institution with a high-volume robotic practice. Dedicated robotic operating room staff (nurses and surgical technicians) are present for robotic cases. Therefore, the results may not be translatable to every practice type. Finally, the experience of surgical technicians and PAs, who are employed for bedside assistance in other practice types, was not evaluated in the present study. Residents and/or fellows assist during the vast majority of robotic procedures at our institution (<20 cases were performed with the assistance of a nurse first assistant). Certainly some well-experienced PAs, nurse practitioners, and surgical technicians may be far more facile with bedside maneuvers and the progression of a case, so as to provide an advantage in terms of operative time and other surgical outcomes. Future studies may compare the surgical outcomes of those surgeries assisted by residents and fellows versus PAs and technicians, based on the number of cases experienced. Finally, we endorse the education of novice bedside assistants, both physicians and non-physicians, before performing any robotic surgery.

Conclusions

Robotic technology may confer relative technical advantages to the surgeon during RAPN. In exchange, the surgeon must rely heavily upon the bedside assistant to perform skilled operative maneuvers. There is common concern about the impact of the assistant's level of experience. However, at a large academic center, PGY level is not associated with any quantifiable difference in surgical outcomes.

Compliance with ethical standards

Conflict of interest Aaron M. Potretzke, Brent A. Knight, John A. Brockman, Joel Vetter, Robert S. Figenshau, Sam B. Bhayani, Brian M. Benway declare that they have no conflict of interest.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent section For this type of study formal consent is not required.

This article does not contain any studies with animals performed by any of the authors.

References

1. Chow WH, Dong LM, Devesa SS (2010) Epidemiology and risk factors for kidney cancer. Nature Rev Urol 7(5):245–257. doi:10.1038/nrurol.2010.46
2. Hollingsworth JM, Miller DC, Daignault S, Hollenbeck BK (2006) Rising incidence of small renal masses: a need to reassess treatment effect. J Natl Cancer Inst 98(18):1331–1334. doi:10.1093/jnci/djj362
3. Hock LM, Lynch J, Balaji KC (2002) Increasing incidence of all stages of kidney cancer in the last 2 decades in the United States: an analysis of surveillance, epidemiology and end results program data. J Urol 167(1):57–60
4. Kim SP, Murad MH, Thompson RH, Boorjian SA, Weight CJ, Han LC, Erwin PJ, Costello BA, Chow GK, Leibovich BC (2012) Comparative effectiveness for survival and renal function of partial and radical nephrectomy for localized renal tumors: a systematic review and meta-analysis. J Urol. doi:10.1016/j.juro.2012.10.026
5. Scosyrev E, Messing EM, Sylvester R, Campbell S, Van Poppel H (2014) Renal function after nephron-sparing surgery versus radical nephrectomy: results from EORTC randomized trial 30904. Eur Urol 65(2):372–377. doi:10.1016/j.eururo.2013.06.044
6. Campbell SC, Novick AC, Belldegrun A, Blute ML, Chow GK, Derweesh IH, Faraday MM, Kaouk JH, Leveillee RJ, Matin SF, Russo P, Uzzo RG, Practice Guidelines Committee of the American Urological A (2009) Guideline for management of the clinical T1 renal mass. J Urol 182(4):1271–1279. doi:10.1016/j.juro.2009.07.004
7. Patel HD, Mullins JK, Pierorazio PM, Jayram G, Cohen JE, Matlaga BR, Allaf ME (2013) Trends in renal surgery: robotic technology is associated with increased use of partial nephrectomy. J Urol 189(4):1229–1235. doi:10.1016/j.juro.2012.10.024
8. Bjurlin MA, Walter D, Taksler GB, Huang WC, Wysock JS, Sivarajan G, Loeb S, Taneja SS, Makarov DV (2013) National trends in the utilization of partial nephrectomy before and after the establishment of AUA guidelines for the management of renal masses. Urology 82(6):1283–1289. doi:10.1016/j.urology.2013.07.068
9. Tanagho YS, Bhayani SB, Figenshau RS (2012) Robot-assisted partial nephrectomy in contemporary practice. Front Oncol 2:213. doi:10.3389/fonc.2012.00213
10. Choi JE, You JH, Kim DK, Rha KH, Lee SH (2015) Comparison of perioperative outcomes between robotic and laparoscopic partial nephrectomy: a systematic review and meta-analysis. Eur Urol. doi:10.1016/j.eururo.2014.12.028
11. Pierorazio PM, Patel HD, Feng T, Yohannan J, Hyams ES, Allaf ME (2011) Robotic-assisted versus traditional laparoscopic partial nephrectomy: comparison of outcomes and evaluation of learning curve. Urology 78(4):813–819. doi:10.1016/j.urology.2011.04.065
12. Hanzly M, Fredrick A, Creighton T, Attwood K, Mehedint D, Kauffman E, Kim HL, Schwaab T (2014) Learning curves for robotic-assisted and laparoscopic partial nephrectomy. J Endourol. doi:10.1089/end.2014.0303
13. Drasin T, Dutson E, Gracia C (2004) Use of a robotic system as surgical first assistant in advanced laparoscopic surgery. J Am Coll Surg 199(3):368–373. doi:10.1016/j.jamcollsurg.2004.05.257

14. Lee DI, Eichel L, Skarecky DW, Ahlering TE (2004) Robotic laparoscopic radical prostatectomy with a single assistant. Urology 63(6):1172–1175. doi:10.1016/j.urology.2004.01.043
15. Rogers CG, Laungani R, Bhandari A, Krane LS, Eun D, Patel MN, Boris R, Shrivastava A, Menon M (2009) Maximizing console surgeon independence during robot-assisted renal surgery by using the fourth arm and TilePro. J Endourol 23(1):115–121. doi:10.1089/end.2008.0416
16. Mandhani A, Tewari AK, Berryhill R Jr (2007) Athermal robotic technique of radical prostatectomy: an assistant's perspective. Arch Esp Urol 60(4):375–382
17. Kumar R, Hemal AK (2006) The 'scrubbed surgeon' in robotic surgery. World J Urol 24(2):144–147. doi:10.1007/s00345-006-0068-0
18. Sgarbura O, Vasilescu C (2010) The decisive role of the patient-side surgeon in robotic surgery. Surg Endosc 24(12):3149–3155. doi:10.1007/s00464-010-1108-9
19. McMillan DT, Viera AJ, Matthews J, Raynor MC, Woods ME, Pruthi RS, Wallen EM, Nielsen ME, Smith AB (2014) Resident involvement and experience do not affect perioperative complications following robotic prostatectomy. World J Urol. doi:10.1007/s00345-014-1356-8
20. Kern SQ, Lustik MB, McMann LP, Thibault GP, Sterbis JR (2014) Comparison of outcomes after minimally invasive versus open partial nephrectomy with respect to trainee involvement utilizing the American College of Surgeons National Surgical Quality Improvement Program. J Endourol 28(1):40–47. doi:10.1089/end.2013.0051
21. Ruhotina N, Dagenais J, Gandaglia G, Sood A, Abdollah F, Chang SL, Leow JJ, Olugbade K, Rai A, Sammon JD, Schmid M, Varda B, Zorn KC, Menon M, Kibel AS, Trinh QD (2014) The impact of resident involvement in minimally-invasive urologic oncology procedures. Can Urol Assoc J 8(9–10):334–340. doi:10.5489/cuaj.2170
22. Parsons JK, Messer K, Palazzi K, Stroup SP, Chang D (2014) Diffusion of surgical innovations, patient safety, and minimally invasive radical prostatectomy. JAMA Surg 149(8):845–851. doi:10.1001/jamasurg.2014.31
23. Thiel DD, Lannen A, Richie E, Dove J, Gajarawala NM, Igel TC (2013) Simulation-based training for bedside assistants can benefit experienced robotic prostatectomy teams. J Endourol 27(2):230–237. doi:10.1089/end.2012.0382
24. Sur RL, Wagner AA, Albala DM, Su LM (2008) Critical role of the assistant in laparoscopic and robot-assisted radical prostatectomy. J Endourol 22(4):587–589. doi:10.1089/end.2007.9837 **(discussion 589–590)**
25. DA Omar MA, Karim OMA (2012) Lost needle: a dilemma in robotic-assisted laparoscopic surgery. J Robot Surg 6:73–75
26. Gibson B, Abaza R (2011) Robotic repair of access-related aortic injuries: unexpected complication of robot-assisted prostatectomy. J Endourol 25(2):235–238. doi:10.1089/end.2010.0367
27. Sammon J, Petros F, Sukumar S, Bhandari A, Kaul S, Menon M, Rogers C (2011) Barbed suture for renorrhaphy during robot-assisted partial nephrectomy. J Endourol 25(3):529–533. doi:10.1089/end.2010.0455