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ORIGINAL ARTICLE

Prostate Disease

Resident involvement in the prostatic urethral lift: implementing innovative technology in an academic setting

Ridwan Alam, Matthew J Rabinowitz, Taylor P Kohn, Vanessa N Peña, James L Liu, Yasin Bhanji, Amin S Herati

Adoption of the prostatic urethral lift (PUL) as a treatment for benign prostatic hyperplasia highlights the importance of training residents with novel technology without compromising patient care. This study examines the effect of resident involvement during PUL on patient and procedural outcomes. Retrospective chart review was conducted on all consecutive PUL cases performed by a single academic urologist between October 2017 and November 2019. Trainees in post-graduate year (PGY) 1–3 are considered junior residents, while those in PGY 4–6 are senior residents. The International Prostate Symptom Score (IPSS) and quality of life (QOL) scores were used to measure outcomes. Simple and mixed-effects linear regression models were used to compare differences. There were 110 patients with a median age of 66.4 years. Residents were involved in 73 cases (66.4%), and senior residents were involved in 31 of those cases. Resident involvement was not associated with adverse perioperative outcomes with respect to the number of implants fired, the percentage of implants successfully placed, or the postoperative catheterization rate. After adjustment for confounding factors, junior residents were associated with significantly longer case length compared to the attending alone (+12.6 min, $P = 0.003$) but senior residents were not (+2.4 min, $P = 0.59$). IPSS and QOL scores were not significantly affected by resident involvement ($P = 0.12$ and $P = 0.21$, respectively). The presence of surgeons-in-training, particularly those in the early stages, prolongs PUL case length but does not appear to have an adverse impact on patient outcomes.

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INTRODUCTION

The field of urology is perhaps particularly unique in its demand for trainees to demonstrate proficiency in endoscopic, laparoscopic, robotic, microscopic, and open surgical techniques. The explosion of new surgical innovations, particularly in the past two decades, requires urologists to be very comfortable with this wide set of skills. Multiple studies have examined the effect that laparoscopic and robotic technology has had on resident training, but few have looked at one of the basic cornerstones of urology, the cystoscope.[1–4]

Indeed, the surgical treatment of benign prostatic hyperplasia (BPH) is highly dependent on proficiency with cystoscopy and its associated maneuvers. Since the advent of the resectoscope in 1926, the transurethral resection of the prostate (TURP) has become the mainstay for surgical management of BPH.[5] Guidelines from both the American Urological Association and European Association of Urology list TURP as the gold standard procedure nearly 100 years after its introduction.[6,7] However, this procedure is not without its risks or limitations, including bleeding, retrograde ejaculation, and the need for general anesthesia. As such, there has been a push to innovate new techniques to manage this condition which affects approximately 15 million American men.[8]

The UroLift is one such innovation that has gained attention after receiving approval from the Food and Drug Administration (FDA) in 2013. While long-term data examining the durability of the prostatic urethral lift (PUL) is still maturing, the short-term data offer significant promise.[9,10] As such, it stands to provide a potentially less invasive and less morbid alternative to the TURP. However, PUL implants need to be placed with the correct orientation and under appropriate tissue tension to optimize patient outcomes. Improper implant placement can result in longer operative time, added expense, and potentially diminished functional outcomes. Thus, the purpose of our study was to determine the impact that resident training has on the implementation and outcomes of a new surgical technique, the PUL, in an academic medical center.

PATIENTS AND METHODS

We performed a retrospective chart review of all consecutive PUL cases performed by a single academic urologic attending (ASH) between October 2017 and November 2019. All PULs were performed using the UroLift device (NeoTract, Inc., Pleasanton, CA, USA). In cases of patients with an obstructive median lobe, the technique previously described by Rukstalis *et al.*[11] was utilized. All patients completed the International Prostate Symptom Score (IPSS) before surgery and at

Department of Urology, The James Buchanan Brady Urological Institute, Johns Hopkins University School of Medicine, Baltimore, MD 21287, USA.
Correspondence: Dr. AS Herati (aherati1@jhmi.edu)
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every follow-up visit after surgery. Unsuccessful implants were defined as pull-throughs, which signified a lack of capsular tab deployment, or implants that traversed the bladder neck and extended into the bladder requiring implant removal due to the risk of calcification. Follow-up data were collected through the time of administrative censoring in January 2020. This study was approved by the Johns Hopkins University Institutional Review Board (IRB00257636, Baltimore, MD, USA), and consent from all patients was received.

Urology residency training length at the Johns Hopkins University School of Medicine is 6 years, with graduated responsibilities each year. Our program consists of 4.5 years of clinical training specific to urology; the remaining time comprises half a year dedicated to general surgery as a post-graduate year (PGY) 1 and one year dedicated to urologic research as a PGY 4. Trainees in PGY 1–3 are considered junior residents while those in PGY 4–6 are senior residents.

Cases in which residents were present and were not present (*i.e.*, attending alone) were compared using comparative statistics. The presence of a resident during a case was the product of scheduling and resident availability; as this is a retrospective study, there was no prior randomization or prospective assignment of residents to cases. Univariable and multivariable linear regression modeling was used to study associations between resident involvement and operative time. The mixed-effects linear regression model was used to examine the effect of resident presence on patient outcomes to account for the non-random association between preoperative and postoperative IPSS and quality of life (QOL). This model also accounts for missing data with respect to postoperative scores, which is assumed to be randomly distributed among patients. A subset analysis was performed by distinguishing the residents as either junior-level or senior-level based on their year of training. All analyses were conducted using Stata, version 15 (StataCorp LLC, College Station, TX, USA). Statistical significance was set at $P = 0.05$.

RESULTS

A total of 110 patients were included in the study. The median age of patients was 66.4 years with a median IPSS of 19.8 points and QOL of 4.1 points. There were 23 patients (20.9%) with an obstructive median lobe, with a median intravesical protrusion distance of 0.8 cm. Residents were involved in 73 cases (66.4%), of which senior residents were involved in 31. When stratified by resident involvement, there were no statistically significant differences in baseline patient demographics across most variables (**Table 1**). The only significant difference was in the proportion of patients who were on medical therapy prior to surgery (89.0% in the resident group *vs* 100% in the attending alone group, $P = 0.04$).

The presence of residents was found to have a minimal effect on most perioperative outcomes. The number of implants fired was not significantly different based on resident involvement (5.4 implants with residents *vs* 5.2 implants without residents, $P = 0.60$). Approximately 98.0% of fired implants were successfully placed when a resident was present, compared to 95.9% when a resident was not present, but this difference was not statistically significant ($P = 0.19$). The proportion of patients requiring a catheter after surgery did not differ between the two groups (27.4% with residents *vs* 18.9% without residents, $P = 0.33$). When these outcomes were compared between junior residents and senior residents, no significant differences were noted (**Supplementary Table 1**).

However, residents were associated with a longer operative time when compared to the attending alone (29.3 min *vs* 21.4 min, $P = 0.03$). Univariable linear regression demonstrated that junior residents trended toward longer operative time when compared to senior residents (+8.1 min, $P = 0.05$). Furthermore, junior residents were associated with a significant increase in operative time compared to the attending alone (+11.4 min, $P = 0.005$). On the other hand, senior residents posted operative time that were comparable in length to the attending alone (+3.3 min in cases with the senior resident, $P = 0.44$; **Table 2**).

After controlling for potential confounders, cases with the junior resident were still found to take the longest time (**Figure 1**). Multivariable regression demonstrated that the junior resident not only took significantly longer time than the attending alone (+12.6 min, $P = 0.003$) but also the senior resident (+10.2 min, $P = 0.02$). There remained no significant difference in operative time between the senior resident and attending alone (+2.4 min in cases with the senior resident, $P = 0.59$; **Table 2**).

The median follow-up time was 1.9 months, but there was considerable variability among patients with an interquartile range (IQR) of 0–7.6 months. Excluding the 32 patients (29.1%) who followed up, the median follow-up time increases to 5.1 (IQR: 1.7–7.9) months. Of the 110 patients in the study, 78 (70.9%) attended the first follow-up appointment at a median 1.5 (IQR: 1.4–1.8) months; 48 (43.6%) attended two follow-up appointments, with the second appointment at a median 7.7 (IQR: 5.1–8.9) months. There were no significant

Table 1: Baseline demographic factors of all patients, including stratification by resident involvement

Characteristics	*All patients (n=110)*	*Resident present (n=73)*	*No resident present (n=37)*	*P*
Age (year), median (IQR)	66.4 (60.4–73.7)	65.7 (59.0–71.9)	68.8 (64.3–76.3)	0.06
African-American, *n* (%)	19 (17.2)	13 (17.8)	6 (16.2)	0.83
Comorbidities, *n* (%)				
Chronic kidney disease	14 (12.7)	12 (16.4)	2 (5.4)	0.10
Chronic obstructive pulmonary disease	10 (9.1)	9 (12.3)	1 (2.7)	0.10
Diabetes mellitus	19 (17.2)	15 (20.5)	4 (10.8)	0.20
Hypertension	58 (52.7)	41 (56.2)	17 (45.9)	0.31
Myocardial infarction	3 (2.7)	2 (2.7)	1 (2.7)	0.99
Stroke	5 (4.5)	4 (5.5)	1 (2.7)	0.51
On medical therapy, *n* (%)	102 (92.7)	65 (89.0)	37 (100.0)	0.04
Obstructive median lobe present, *n* (%)	23 (20.9)	17 (23.3)	6 (16.2)	0.39
Intravesical protrusion distance (cm), median (IQR)	0.8 (0.6–1.1)	0.9 (0.6–1.5)	0.7 (0.5–0.9)	0.27
Preoperative IPSS, median (IQR)	20 (13–24)	21 (13–25)	20 (15–23)	0.76
Preoperative QOL, median (IQR)	4 (3–5)	4 (3–5)	4 (3–5)	0.98

IPSS: International Prostate Symptom Score; IQR: interquartile range; QOL: quality of life differences in the proportion of patients who followed up or in the follow-up time when the patients were sorted by resident involvement.

The preoperative IPSS was 19.9 points and 19.7 points for patients treated with resident involvement and without resident involvement, respectively ($P = 0.93$; **Figure 2a**). On unadjusted analysis, there was no difference in IPSS scores or at the first follow-up visit ($P = 0.53$); at the second follow-up visit, patients treated by residents scored 4.8 points lower than those treated by the attending alone (5.8 points *vs* 10.6 points, $P = 0.04$). When adjusting for potential confounders, mixed-effects linear regression analysis demonstrated that there was no difference in IPSS scores between men treated with and without resident involvement ($P = 0.12$).

The preoperative QOL was 4.1 points for both groups ($P > 0.999$; **Figure 2b**). Similarly, there were no significant differences in QOL scores at the first ($P = 0.69$) or second ($P = 0.43$) follow-up appointment on unadjusted analysis. The adjusted analysis demonstrated that there was no statistically significant difference in QOL scores between the two groups ($P = 0.21$).

Using the Clavien-Dindo classification system, this study cohort demonstrated only two complications (1.8%).[12] Both complications were urinary tract infections requiring antibiotic treatment, resulting in Grade II complications. Both patients underwent the procedure in the presence of a resident.

DISCUSSION

The boundaries of urology continue to be pushed as the field devises new ways to improve outcomes, reduce morbidity, and enhance the patient experience. Introduction of the PUL is one such example, especially for patients who would otherwise not be candidates for standard therapy. As the adoption of PUL grows, there will be a need for current trainees to demonstrate proficiency in this technique. In this study, we evaluated the impact of resident involvement during PUL cases on perioperative and patient outcomes.

Importantly, cases with resident involvement are not associated with inferior outcomes when compared to cases performed by the attending surgeon alone. There is a wealth of data spanning multiple surgical specialties which show that resident involvement does not have a negative impact on patient outcomes when controlled for factors such as baseline patient comorbidities and case complexity.[3,13–16] On the contrary, some data suggest that residents are associated with a protective effect due to the presence of a second opinion in

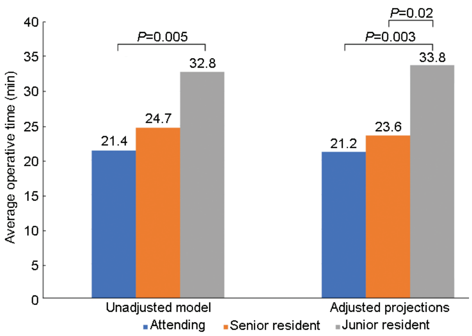

Figure 1: Average operative time stratified by level of experience (attending, senior resident, junior resident). The unadjusted model on the left reflects the reported time from the raw data. The adjusted model on the right shows the projected time based on any given patient with the median values for each potentially confounding variable (*i.e.*, 66.4 years of age, not African-American, 1 comorbidity, on medical therapy, and without an obstructive median lobe). Only statistically significant relationships are noted with brackets pointing to the two comparison groups.

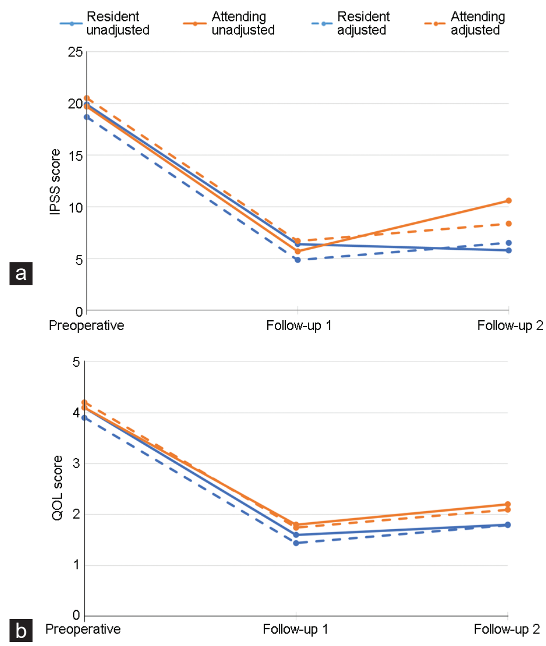

Figure 2: (**a**) IPSS scores and (**b**) QOL scores prior to intervention with PUL and at two postoperative follow-up visits. Solid lines represent the unadjusted model, which reflect the scores from the raw data. Dashed lines represent the adjusted model with projected scores based on any given patient with the median values for each potentially confounding variable (*i.e.*, 66.4 years of age, not African-American, 1 comorbidity, on medical therapy, without an obstructive median lobe, and with 1.5 months at the first follow-up visit [follow-up 1] and 7.7 months at the second follow-up visit [follow-up 2]). IPSS: International Prostate Symptom Score; QOL: quality of life; PUL: prostatic urethral lift

Table 2: Univariable and multivariable linear regression analyses of patient and case characteristics on the outcome of operative time

Characteristics	*Univariable analysis*		*Multivariable analysis*	
	Coefficient (min)	*P*	*Coefficient (min)*	*P*
Experience				
Attending	Reference		Reference	
Senior resident	3.3 (−5.2–11.7)	0.44	2.4 (−6.4–11.0)	0.59
Junior resident	11.4 (3.6–19.3)	0.005	12.6 (4.2–20.9)	0.003
Age (per year)	−0.5 (−0.8–−0.2)	0.003	−0.4 (−0.7–0)	0.03
African-American	2.4 (−6.7–11.5)	0.60	1.9 (−7.0–10.7)	0.67
Comorbidities (per comorbidity)	−2.0 (−5.5–1.5)	0.26	−2.1 (−5.7–1.5)	0.25
On medical therapy	7.7 (−5.4–20.8)	0.25	9.0 (−4.1–22.2)	0.18
Obstructive median lobe present	6.4 (−2.0–14.7)	0.13	2.1 (−6.4–10.5)	0.62

The coefficient represents the additional operative time the perioperative period.[3,16] In cases where both attendings and residents may be adapting to new technology, the second opinion could theoretically prove to be even more significant. While this was not demonstrated in the present study, it is reassuring that no undue harm was imposed upon the patient by having resident involvement.

In concordance with previous literature, the results from this study demonstrate that residents are associated with an increase in case length.[3,14] Perhaps this is not surprising, as the presence of residents in the operating room usually implies the added responsibility of teaching along with the act of performing surgery. The hope with surgical training is that as residents advance to more senior roles within the program, increased proficiency accompanies the increased knowledge. Indeed, this study demonstrates the strength of the graduated responsibility system inherent in the residency framework, as senior residents in this study were found to be significantly quicker than junior residents without compromising outcomes. Furthermore, senior residents demonstrated performance statistics that were very similar to the attending surgeon. This supports a recent survey of chief residents and recent residency graduates that showed 91% of respondents felt comfortable performing cystoscopy in an unsupervised setting.[17] Accompanying cystoscopic procedures, such as transurethral resection of bladder tumor and TURP, were also associated with a high rate of confidence at 100% and 89%, respectively. By comparison, respondents demonstrated little confidence in robotic techniques, ranging from 5% for a robotic retroperitoneal lymphadenectomy to 34% for a robotic radical nephrectomy. The cumulation of these data suggests that innovative technology based on the principles of cystoscopy is more likely to be welcomed with ease due to a higher level of familiarity and comfort. There are, of course, exceptions, as in the case of holmium laser enucleation of the prostate – a procedure which has repeatedly demonstrated stellar outcomes but has had very little uptake in the United States due to its notorious difficulty.[18,19] To this end, the PUL potentially strikes a delicate balance by introducing revolutionary technology with a promising upside while also not straying too far from surgical concepts universally learned during residency.

Finally, the results from this study demonstrate that patients derive benefit from PUL. While not the focus of this study, patients demonstrated an improvement in IPSS and QOL scores that were comparable to, if not better than, those described in the literature.[9–11] Although patients demonstrated a slight increase in IPSS and QOL scores between the first and second postoperative visits, this difference was not statistically significant. Notably, however, this does follow the trend seen in previous studies. Nevertheless, it is reassuring that the trend in IPSS and QOL were similar for both residents and attendings; in fact, unadjusted analysis demonstrated that residents may be associated with slightly improved outcomes.

There are several limitations which should be noted. Durability could not be assessed due to the limited length of follow-up. As a newer technology, however, this is not unexpected and continued surveillance of these patients into the future will allow for assessment of long-term outcomes. Perhaps more importantly, approximately 30% of patients did not attend the postoperative visit, which is routinely scheduled 1–2 months after surgery. As such, the results could suggest an element of selection bias, as those who are satisfied with the results may be less inclined to follow-up than those who experience unchanged or worsening outcomes. This is suggested by the slightly worse IPSS and QOL scores for those who attended a second follow-up visit. Finally, the level of resident involvement could not be assessed with granularity. However, it is the practice of the attending surgeon to allow junior residents to place one implant; in certain cases, senior residents have been allowed to place most, if not all, of the implants under attending supervision. This suggests that junior residents are associated with a much longer operative time per implant placed than senior residents, who managed to post shorter overall case times despite performing a greater proportion of the surgery.

CONCLUSIONS

Programs with a surgical residency carry the unique task of educating the next generation of surgeons while concurrently delivering excellent and uncompromised care to current patients. The present study is the first to examine PUL in an academic setting and shows that residents are not associated with adverse patient outcomes. Increased experience, as in the case of a senior resident or attending, is associated with significantly shorter operative time when compared to less experienced trainees (*i.e.*, junior residents). The findings of this study should alleviate any concerns about trainee involvement in the application of this innovative technology.

AUTHOR CONTRIBUTIONS

RA was involved in the conception, design, acquisition, analysis, interpretation, drafting, and revision of the manuscript. MJR was involved in the acquisition, analysis, interpretation, and revision of the manuscript. TPK, VNP, JLL, and YB were involved in the analysis, interpretation, and revision of the manuscript. ASH was involved in the conception, acquisition, revision, administrative support, and supervision of the manuscript. All authors read and approved the final manuscript.

COMPETING INTERESTS

All authors declare no competing interests.

Supplementary Information is linked to the online version of the paper on the *Asian Journal of Andrology* website.

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Supplementary Table 1: Perioperative outcomes stratified by level of resident experience

Characteristics	*Senior resident (n=31)*	*Junior resident (n=42)*	*P*
Total implants fired, *n* (s.d.)	5.4 (1.7)	5.4 (1.4)	0.99
Percentage of implants successfully placed, percentage (s.d.)	97.1 (8.3)	98.7 (4.2)	0.31
Required postoperative catheter, *n* (%)	7 (22.6)	13 (31.0)	0.43

s.d.: standard deviation