The impact of training on the perioperative and intermediate functional outcomes after holmium laser enucleation of the prostate

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Introduction: *To systemically measure the impact of trainees' participation on the perioperative and functional outcomes after holmium laser enucleation of the prostate (HoLEP).*

Materials and methods: *Benign prostatic hyperplasia patients who underwent HoLEP at our department between January 2007 and January 2013 were classified based on trainee's level. Perioperative outcomes and complications were collected. Functional outcomes were assessed using the Sexual Health Inventory for Men (SHIM), International Prostate Symptom Score (IPSS), and International Continence Society–Short Form (ICSmaleSF) questionnaires. Voiding and incontinence domains of ICSmaleSF were assessed separately. Patients were divided into group 1 if no trainee participated in the operation, group 2 if a senior trainee performed the operation, and group 3 if a junior trainee participated in the operation. The patient's baseline characteristics, complications, and perioperative outcomes were compared.*

Results: *There were no differences in the baseline characteristics. There were significant differences in overall operative and enucleation time ($p = 0.0186$, $p = 0.0047$, respectively) with shorter times noticed with more experienced operators. There were no differences in resected tissue weight, hemoglobin change, and transfusion rates. Postoperatively, all patients had a similar length of stay and catheterization. Complications (graded by Clavien grading system) were not different. All patients were followed up at regular intervals starting at 6 weeks, 3 months , 6 months, 1 year, and every year after that and there were no differences in flow rates or post void residual volumes at any time point. There were no differences in SHIM, IPSS, and ICSmale voiding scale among the groups. However, ICSmale continence scale was significantly different where the highest score seen in group 2.*

Conclusion: *Trainee participation in HoLEP in a controlled training environment does not compromise the safety of the procedure.*

Key Words: benign prostatic hyperplasia holmium laser enucleation of the prostate, holmium, residency, training

Introduction

Holmium laser enucleation of the prostate (HoLEP) is considered one of the most effective and definitive surgical treatment options for benign prostatic hyperplasia (BPH).[1] It has been demonstrated to provide symptomatic and urodynamic outcomes similar to open prostatectomy but without all of the associated morbidities and risks.[2-4] HoLEP has been labeled and considered the new gold standard treatment for enlarged prostates.[5,6] Supporting evidence has been documented in a wide array of patient populations where good results were attained in different ages and different sizes of prostates.[7,8]

Nearly two decades after HoLEP' s first description, the pace at which HoLEP has been adopted into clinical practice in the United States does not correlate with the favorable results associated with this procedure; less than 10% of American urologists perform HoLEP.[9]

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Many authors believe that the main reason behind the slow integration of HoLEP is its steep learning curve and the need to develop unique endoscopic skills to perform it, as HoLEP is procedurally unlike any other.[10] It mandates a combination of knowledge about laser tissue interaction, a unique dissection technique using endoscopic instruments, and tissue morcellation. Hence, HoLEP has been perceived by the urologic community as a difficult procedure to master since the beginning.

Postgraduate residency is not only the cornerstone for good surgical training but is also essential for the dissemination of new techniques and technology. It can rarely be totally supplanted by shorter hands-on courses, especially for complex or challenging operations due to limited exposure and opportunity for mastery. Residency is longer where the trainee adopts skills at earlier stages with higher exposure, repetition, and in a controlled environment that mutually protects patient safety and ensures good outcomes. Surgical education has changed dramatically in the United States since the implementation of new duty hour rules by the American Council of Graduate Medical Education in 2011.[11] Moreover, trainees have to learn in an atmosphere that poses further restrictions with the implementation of new outcomes-based health care rules and frequent utilization of certifying bodies by the teaching hospitals that put surgical training under scrutiny. However, if there is going to be a transformation in clinical practice, we believe that residency is the arena to champion such a change.

Many series have described the initial learning curve of HoLEP in a self-taught situation or fellowship training programs.[12-16] However, none have looked into the impact of residency training on the outcomes of this procedure. The aim of this study was to measure the impact of residency training and trainee participation on the perioperative and intermediate functional outcomes after HoLEP based on an independent third-party assessment.

Materials and methods

Patients and procedures

This study was approved by the Mayo Clinic Institutional Review Board. All BPH patients who underwent HoLEP at our institution between January 2007 and January 2013 were included in the study. Patients with prostate cancer, previous prostatic intervention, or concomitant urethral stricture were excluded. All cases were performed or supervised by the senior author who is an endourology fellowship trained urologist who has performed more than 1,000 HoLEP procedures and his technique did not change during the study period.[8] Cases were classified into three groups based on the presence or absence of a trainee and the level of the trainee: group 1, if no trainee participated in the procedure; group 2 if a senior resident (PGY 4 and 5) performed the procedure; and group 3 if a junior resident (PGY 1, 2, or 3) participated in the procedure.

Preoperative evaluation included routine history and physical examination, prostate-specific antigen (PSA), uroflowmetry, post void residual (PVR) urine volume, cystoscopy, transrectal ultrasound prostate volume measurement, and urodynamic evaluation, if clinically indicated. Baseline urinary and sexual function was measured by the International Prostate Symptoms Score (IPSS) and Sexual Health Inventory for Men (SHIM) questionnaires.

Operative variables included operative time, which was defined as anesthesia time. Enucleation time, defined as the time from initial laser incision at bladder neck until delivery of the last lateral lobe in the bladder and morcellation time defined as total time needed to complete morcellation of the enucleated adenoma. Bleeding was assessed with hemoglobin change, defined as the difference between the preoperative and postoperative hemoglobin, and need for blood transfusion. All complications were reported according to the Clavien-Dindo grading system.[17]

Postoperatively, all patients were followed up at regular intervals starting at 6 weeks, 3 months, 6 months and 1 year and every year after that. At each visit, patients were assessed with uroflowmetry and PVR. At the end of the study period, all patients received a comprehensive questionnaire through an independent third-party center. The survey included IPSS, SHIM and International Continence Society–Short Form (ICSmaleSF) questionnaires. The ICSmaleSF questionnaire has two domains: 1) continence scale (ICSmaleIS), which assesses storage symptoms (urgency, urge incontinence, stress incontinence, overflow incontinence, and nocturnal enuresis) and 2) voiding scale (ICSmaleVS), which assesses voiding symptoms (hesitancy, straining, stream, intermittency, and incomplete emptying) in addition to three separate questions for nocturia, frequency, and quality of life. The ICSmaleSF was used since it has the advantage of categorizing the urinary symptoms and assigning them to a specific domain, as well as providing a composite score.[18] Only patients who responded to this survey were included in the study.

Resident training program

Our institution is a tertiary training center with a dedicated residency training program. We follow a mentorship training model. The trainees typically have a gradually increasing operative role based on

their progress. Furthermore, chief residents have the autonomy to schedule their own cases under the supervision of the staff throughout the last year. Once starting their own practice, graduates were advised to have a proctor during the first few cases in their new institutions.

Training of HoLEP at our institution is systematic, modulated, and based on the satisfactory demonstration of each step of the procedure. HoLEP training usually follows the following pattern: observation and learning common pitfalls, cystoscopy and instrumentation setup, safe morcellation, initial resection at bladder neck at 5 and 7 o'clock position, apical dissection, anterior dissection, division of the anterior commissure, mucosal bridge resection, and finally, release of remaining attachments. Residents may perform a more difficult step if the case is straightforward and if they have demonstrated sufficient mastery of the preceding steps of the procedure based on the discretion of the supervising surgeon.

Data analysis

After retrospectively identifying all applicable patients, we collected and analyzed data on all perioperative outcomes and complications. Categorical variables are summarized as number of patients and percentages, and continuous variables are summarized as mean (SD). Differences among the three groups based on the presence of trainees were analyzed. Stata software (StataCorp LP) was used for statistical analysis. P less than .05 was considered statistically significant.

Results

A total of 157 patients who underwent HoLEP for BPH during the study period met the inclusion criteria and responded to the survey. There were 51 patients (32.5%) in group 1, 31 (19.8%) in group 2, and 75 (47.8%) in group 3. Analysis of preoperative and baseline characteristics showed no significant differences in patient age, American Society of Anesthesia score,

TABLE 1. **Patients' preoperative baseline characteristics**

	Group 1[a] (No trainees) (n = 51)	**Group 2[a] (Sr trainees) (n = 31)**	**Group 3[a] (Jr trainees) (n = 75)**	**p value**
Age, years	72 (6.6)	73 (7.8)	72 (6.6)	.79
ASA score	2 (0.5)	2 (0.6)	2 (0.5)	.97
BMI, kg/m^2	26.0 (3.5)	26.6 (4.3)	27.0 (4.2)	.69
No. of patients with preoperative retention	17 (33.3)	12 (38.7)	22 (29.3)	.95
No. of patients with preoperative incontinence	6 (12.5)	4 (15.4)	13 (18.6)	.67
IPSS score	21.5 (6.6)	19.5 (5.8)	19.0 (7.5)	.67
Bother score	4.3 (4.3)	4.0 (1.2)	4.0 (1.2)	.63
SHIM score	16.8 (7.7)	9.0 (10.6)	12.5 (9.3)	.23
Prostate volume, mL[b]	122.2 (183.8)	80.6 (137.1)	107.9 (63.3)	.09
Preoperative PSA, ng/mL	6.9 (7.7)	5.5 (4.4)	6.3 (7.4)	.77
Voided volume (mL)[c]	150.7 (92.7)	210.6 (151.5)	192.5 (118.5)	.10
Q_{max} (mL/sec)[c]	8.74 (5.33)	10.79 (7.10)	9.23 (6.40)	.52
Q_{avg} (mL/sec)[c]	4.9 (2.6)	5.9 (3.6)	4.2 (2.1)	.15
PVR (mL)[c]	274 (316.5)	247 (257.3)	290 (284.5)	.71

Sr = senior; Jr = junior; ASA = American Society of Anesthesiologists; BMI = body mass index; IPSS = International Prostate Symptom Score; SHIM = Sexual Health Inventory for Men; PSA = prostate-specific antigen; Q_{max} = maximum flow rate; Q_{avg} = average flow rate PVR = post void residual urine volume

[a]values are mean (SD) or no. of patients (%)

[b]as measured on transrectal ultrasound using the ellipsoid formula

[c]excluding those patients who were unable to void preoperatively

TABLE 2. **Perioperative outcomes**

	Group[a]			
	1 (No trainee) (n = 51)	**2 (Sr trainees) (n = 31)**	**3 (Jr trainees) (n = 75)**	**p value**
Operating room time, min	133.9 (54.4)	143.3 (51.4)	155.3 (42.6)	.02
Operative time, min	98.9 (54.3)	108.3 (49.0)	121.3 (44.9)	.02
Enucleation time, min	50.9 (23.9)	61.8 (21.6)	65.4 (125.8)	.005
Morcellation time, min	23.9 (38.1)	21.2 (31.8)	20.7 (20.7)	.55
Estimated blood loss, mL	57.4 (35.2)	66.6 (60.2)	61.1 (47.7)	.98
Hemoglobin change, g/dL	1.9 (1.3)	1.8 (0.8)	1.8 (0.9)	.97
Blood transfusion	2 (4)	0 (0)	1 (1.4)	.59
Resected tissue weight, g	67.1 (59.7)	46.6 (35.4)	62.5 (150.7)	.28
Hospitalization, d	1.3 (0.8)	1.1 (0.3)	1.2 (0.5)	.52
Catheterization, d	2.5 (2.3)	2.2 (2.0)	2.7 (2.8)	.78

Sr = senior; Jr = junior
[a]values are mean (SD) or no. of patients (%)

body mass index, preoperative urinary retention rate and incontinence rate, IPSS score, and SHIM score among the groups, Table 1. On preoperative evaluation, there were no statistical differences in prostate volume, preoperative PSA, voided volume, maximum flow rate, average flow, or PVR.

Operative time and enucleation time correlated with the experience level of the operator, Table 2. Mean (SD) operative time increased significantly as the presence of less-experienced trainees increased: 98.9 (54.3), 108.3 (49.1), and 121.3 (44.9) minutes for groups 1, 2, and 3, respectively (p = .02). Mean enucleation time was also significantly longer with less-experienced trainees; for the three groups, the times were 50.9 (23.9), 61.8 (21.6), and 65.4 (125.8) minutes, respectively (p = .005). Other perioperative outcomes, such as hemoglobin change or incidence of blood transfusion, were not different among the groups. Postoperatively, trainee involvement did not result in longer catheterization or hospital stay, Table 2.

Neither the rate nor the severity of complications increased when trainees participated in the operation, Table 3. There were five grade III complications in group 1, one in group 2, and two in group 3. No grade IV complications occurred in any group. With regard to uroflowmetry results, there were no differences identified other than the voided volume at 6 weeks, which was significantly lower for the two groups with trainees (p = .03). However, no other significant differences in voided volume, maximum flow rate, average flow rate, or PVR were seen among the groups at the 2 time points.

Neither the SHIM score nor urinary outcomes were different among the groups when assessed by the IPSS. However, when the urinary functional outcomes were assessed using the ICSmaleSF, the ICSmaleIS was marginally significantly different (p = .046) where group 2 had a score of 4.8 (3.4), group 1 had a score of 2.9 (2.8), and group 3 had a score of 3.8 (3.9). There was no difference in ICSmaleVS and overall ICS scores, Table 4.

TABLE 3. **Complications**

	Groups			
	1 (No trainee) (n = 51)	**2 (Sr trainee) (n = 31)**	**3 (Jr trainee) (n = 75)**	**p value**
Complication				.30
Grade I	3	4	9	
Grade II	2	0	6	
Grade III	5	1	2	
Grade IV	0	0	0	

Sr = senior
Jr = junior

TABLE 4. **Postoperative functional outcomes**

	Group[a]			
	1 (No trainee) (n = 51)	**2 (Sr trainees) (n = 31)**	**3 (Jr trainees) (n = 75)**	**p value**
SHIM	11.1 (8.8)	7.6 (7.6)	8.9 (8.3)	.24
IPSS	4.8 (4.4)	7.3 (6.9)	6.1 (5.4)	.20
IPSS Bother	1.2 (1.4)	1.3 (1.6)	1.5 (1.4)	.14
ICSmaleVS	2.5 (3.2)	2.9 (3.6)	3.6 (3.9)	.24
ICSmaleIS	2.9 (2.9)	4.8 (3.4)	3.8 (3.9)	.046

Sr = senior; Jr = junior; SHIM = Sexual Health Inventory for Men; IPSS = International Prostate Symptom Score; ICSmaleVS = International Continence Society–voiding scale; ICSmaleIS = International Continence Society–continence scale
[a]values are mean (SD)

Discussion

The learning curve of HoLEP has been described to range from 10 to 50 cases.[13,15] This wide range of variation is believed to depend on the method at which the procedure was adopted and whether the surgeon was trained in a mentored fellowship environment or was self-taught.[10] There is general consensus that HoLEP is a difficult procedure that has a steep learning curve. Lee et al[9] found that lack of previous training was one of the most common reasons that made surgeons refrain from doing certain BPH surgical procedures and that high-volume surgeons were more likely to perform HoLEP. This led several authors to suggest new technical modifications to facilitate or at least shorten this learning curve.[19] In one such attempt to help make the learning curve less steep, a simulator was designed and utilized in different training scenarios, but the applicability and validity of this simulator has yet to be determined.[20]

So far, little is known regarding the methodology or safety associated with the integration of HoLEP in a residency program. The objective of this study was to measure the impact of resident involvement on the perioperative and functional outcomes and complications after HoLEP, and to see if residents were likely to achieve acceptable outcomes based on their level of training as seen through patient self-assessment through a third-party survey center.

Our findings confirmed that trainee participation, regardless of the training level, did not result in increased morbidity or less favorable outcomes. Expectedly, trainee involvement resulted in prolongation of enucleation time and thus operative time but not morcellation time. The latter was mainly dependent on the efficiency of the morcellator rather than the technique and thus did not change when a trainee was involved. The prolongation in operative time was 10 and 30 minutes longer in junior and senior residents' hands, respectively. This difference did not result in increased complication rates, such as anesthesia, thromboembolic, or urinary tract infection rates as has been suggested by previous reports[21,22] that found a correlation between operative time and some of the abovementioned complications. The longer time did not translate into a larger decrease in hemoglobin counts or need for further transfusion.

We believe that the additional time is essential for training and demonstrates relatively no increased risks for patients. This may highlight one of the benefits of HoLEP where more intraoperative time can be spent teaching without fear of fluid overload, transurethral syndrome, or bleeding that may be concerning in transurethral resection of prostate. Postoperatively, patients had a comparable recovery time, duration of hospitalization, and Foley catheterization. Trainee participation did not result in higher overall complications. However, we noticed insignificant trends of less major and more minor complications associated with trainee's participation. Postoperative functional evaluation did not demonstrate an objective difference among the groups as evidenced by the uroflowmetry parameters.

Questionnaires evaluating postoperative urinary symptoms showed an overall concordance in patients' opinions regarding symptoms and satisfaction with outcomes. When ICSmaleIS was analyzed, there were more irritative symptoms in group 2 but not in group 3. This was used in order to analyze the overall urinary symptoms and differentiate between the storage and

voiding components. This domain was highest for senior trainees, and this finding may reflect higher chances for incontinence in this group. However, this did not affect patient overall satisfaction. Finally, the fact that senior resident's participation may result in higher risk of complication compared to junior trainees is well observed in previous reports.[23] This was partially explained by the fact that senior trainees and fellows are more likely to perform larger and more complicated parts of the procedure.

Performing HoLEP during the early stages of the learning curve has been examined by many authors,[12-16] and its safety was established. However, all of these authors were experienced endourologists who had considerable endoscopic experience by the time they performed HoLEP. Thus, the question of whether training a resident who does not have previous endourological skills affects outcomes remains unanswered. This question arises in a dynamically changing academic atmosphere that is influenced by the shift in practice measurement metrics and unprecedented degrees of concern regarding patient safety. Our answer is coming through a stringent method of data collection through a third-party survey center without intervention from investigators.

The safety of resident involvement in urology has been confirmed using large databases, such as the American College of Surgeons National Surgical Quality Improvement Program.[24] However, the impact of performing specific procedures has not been individually addressed. The current study represents the largest available report in urology training, and it supports that resident participation could be protective since those patients had less complications, as they were performed under careful mentorship and guidance. El-Hakim et al examined the outcome of the first 27 HoLEP cases performed by a single surgeon and found that it was safe to perform this procedure if mentored by an experienced surgeon.[15] This study was limited by a single trainee and small number of cases. In our study, the trainees performed 25-35 procedures during each rotation with gradual increase in autonomy and had the chance to maintain their skills throughout their last year of training. In another study, Herrick and Ya examined the result of resident training of holmium laser ablation of the prostate in a private practice setting and found similar outcomes with regard to operative time and safety.[25] However, holmium laser ablation is technically very different from HoLEP, and these results cannot be extrapolated. Moreover, the level of trainee was not examined. To provide clarity, we sought to analyze our data based on the level of the trainees, since this may affect the outcome, and we divided those trainees based on assigned responsibilities over the course of their training.

Despite the fact that our data were prospectively collected, this study is limited by its retrospective nature of the analysis and the fact that we did not collect the SHIM and IPSS preoperatively using a third party as we did postoperatively. Moreover, this study is specific to our residency program setting and these results may not be directly applicable to all other programs. Despite these limitations, our results demonstrate several important results. Firstly, residents will be able to perform the procedure with acceptable outcomes by the time they finish their training. Secondly, HoLEP training did not affect the perioperative outcomes or complication rates. Lastly, increase in operative times did not result in increased complications. Our study demonstrated that incorporating HoLEP in training programs does not compromise patient safety. With adequate non-interrupted training, graduating young urologists can adopt this procedure as a surgical treatment for BPH in their practice while avoiding a steep learning curve. □

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