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Catheter Removal on the Same Day of Holmium Laser Enucleation of the Prostate: Outcomes of a Pilot Study

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OBJECTIVE	To determine if same day catheter removal is feasible in a select population after holmium laser enucleation of the prostate (HoLEP).
METHODS	We performed an analysis of patients undergoing HoLEP at our institution who underwent same-day catheter removal after HoLEP. All HoLEPs were performed with Moses 2.0 Optimized for BPH. Patients were dismissed from postoperative recovery unit to the clinic for catheter removal and voiding trial.
RESULTS	To date, 30 patients have undergone same day catheter removal. Median age is 68.6 years (interquartile range [IQR] 61.8-73.3) and preoperative prostate volume 81 mL (IQR 53-114.8). Median enucleation time was 39.5 minutes (IQR 30.5-53), morcellation time was 5 minutes (IQR 4-12 minutes), and enucleated specimen weight was 52.5 g (IQR 33-81). Twenty-seven (90%) patients successfully voided on the same day without requiring catheter replacement. All patients were catheter free by POD1. For patients who successfully passed their voiding trial, the median time from the end of the procedure to hospital discharge was 2.6 hours (IQR [2.1-2.9]) and from the end of the HoLEP to catheter removal was 4.9 hours (IQR [3.5-6.0]).
CONCLUSION	We present for the first time that same day catheter removal is a feasible option in a select population of patients undergoing HoLEP. With more study, this has the potential for transforming the management of BPH, especially larger glands. UROLOGY 146: 225–229, 2020. © 2020 Elsevier Inc.

Holmium laser enucleation of the prostate (HoLEP) is a highly effective, minimally invasive surgical procedure for benign prostatic hyperplasia (BPH). HoLEP is a size independent procedure,¹ but has had the strongest impact in the management of large (>80 g) prostates² by preventing the need for more invasive therapies such as open or robotic simple prostatectomy. Compared to the “gold standard” transurethral resection of prostate (TURP), HoLEP has a lower hospital stay, transfusion rate, retreatment rate and equivalent if not superior postoperative outcomes.³

Surgical BPH treatments are often associated with inpatient hospital stays. TURP, photovaporization of the prostate (PVP) and HoLEP are all traditionally associated

with at least overnight hospital stays.^{3,4} Newer technologies, such as bipolar TURP and 180W PVP, have allowed those procedures to be more conducive to same day discharge. In an attempt to reduce morbidity of BPH treatment, new therapies have emerged, such as convective water thermal therapy and prostatic urethral lift,⁵ with the goal of same day procedure discharge, minimal morbidity and reduced duration of indwelling catheter time.

In light of goals to reduce morbidity of HoLEP, investigators have explored ways for HoLEP to be performed as an outpatient procedure. Multiple series have demonstrated HoLEP can be done as outpatient procedure in selected patient populations.⁶⁻¹¹ Since these publications, improvements in laser technology have resulted in increased energy delivery to tissue, with a resultant clinical in hemostasis over conventional holmium laser during HoLEP.¹² Furthermore, modifying the procedure by moving away from less blunt scope dissection (ie, peeling) to more laser and bubble dissection (noncontact lasering) has also contributed to less bleeding. We sought to determine if these technical and technological advancements would allow for successful same day catheter removal after HoLEP.

Financial Disclosures

TL – Paid consultant Boston Scientific and Lumenis

MER – Paid consultant Boston Scientific and Lumenis

AEK – Paid consultant Boston Scientific and Lumenis.

Funding Support: None.

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Submitted: May 7, 2020, accepted (with revisions): September 29, 2020

METHODS

After obtaining Institutional Review Board approval, we performed a retrospective review of patients undergoing HoLEP who underwent same day catheter removal at our institution by 3 surgeons from November 2019 to March 2020. Patients were offered same day catheter removal, as a potential option, being aware our standard practice was to dismiss patients on the same day of surgery and to remove the catheter as an outpatient on postoperative day 1 (POD1). Patients who were not offered same day catheter removal were those with prostate volumes >250 mL on preoperative imaging study (all were required to have imaging to be considered). Additionally, the patient could not actively be taking therapeutic doses of anticoagulation. Furthermore, only the first 2 cases of the day were candidates for same day catheter removal due to time limitations within the clinic.

Per our standard practice, patients underwent general anesthesia with a supraglottic airway to avoid neuromuscular paralysis. Narcotics were limited to induction only and not administered during the remainder of the case or in the recovery area. All HoLEPs were performed in standard technique utilizing high-power laser technology, specifically the 550 μ m D/F/L fiber with Moses 2.0 Optimized for BPH (Lumenis Ltd, Yokneam, Israel). Technique for HoLEP and utilizing Moses technology is standard among the 3 surgeons with either a bi- or trilobar enucleation depending on presence of a median lobe using a bottom up technique,¹² with the exception of laser settings of 2 J and 40 Hz or 2J and 60 Hz being used.

Postoperatively, 3 L of normal saline was run as continuous bladder irrigation at the maximum rate allowed per the tubing, and the catheter was clamped to assess for hematuria. The decision to continue irrigation vs discharge for catheter removal was made by one of the surgeons on the team. Overall this was a judgment call but essentially there needed to be an absence of clots

and the urine needed to flow freely in the catheter tubing. A maximum of 9 L of catheter irrigation were allowed to be run before the patient was no longer a candidate for same day catheter removal. No opioids and no anticholinergics were given after induction. Patients were typically dismissed from the postoperative care unit (POCU) to the clinic for catheter removal, voiding trial and postvoid residual check. Voiding trial was performed by retrofilling the catheter with 300-500 mL of saline or until the patient felt the subjective urge to urinate. The volume voided, color of urine and postvoid residual were assessed to ensure there was no concern for hematuria or possible clot retention. Postvoid residual of less than half the voided volume was considered adequate for passing. Patients were asked to stay within 30 miles of our facility on POD0, but were not required to come to clinic on POD1. All patients were contacted within 7 days of catheter removal for telephone follow-up. A diagram of our process for same day catheter removal can be found in Figure 1.

There was no external funding for this study. Data were obtained and statistically analyzed using JMP Pro 14 (SAS Institute, Cary, NC). Descriptive statistics were performed of preoperative, operative, and postoperative outcomes. Median with interquartile ranges (IQR) are presented for continuous statistics and total number with percentage are presented for nominal statistics.

RESULTS

A total of 30 patients were included in our cohort. Median age was 68.6 years (IQR 61.8-73.3) and BMI was 28.5 (IQR 25.5-33.2). Median prostate volume was 81 mL (IQR 53-114.8) with a total range of 37-235 mL. There were 9 patients (30%) who were in urinary retention requiring a urinary catheterization

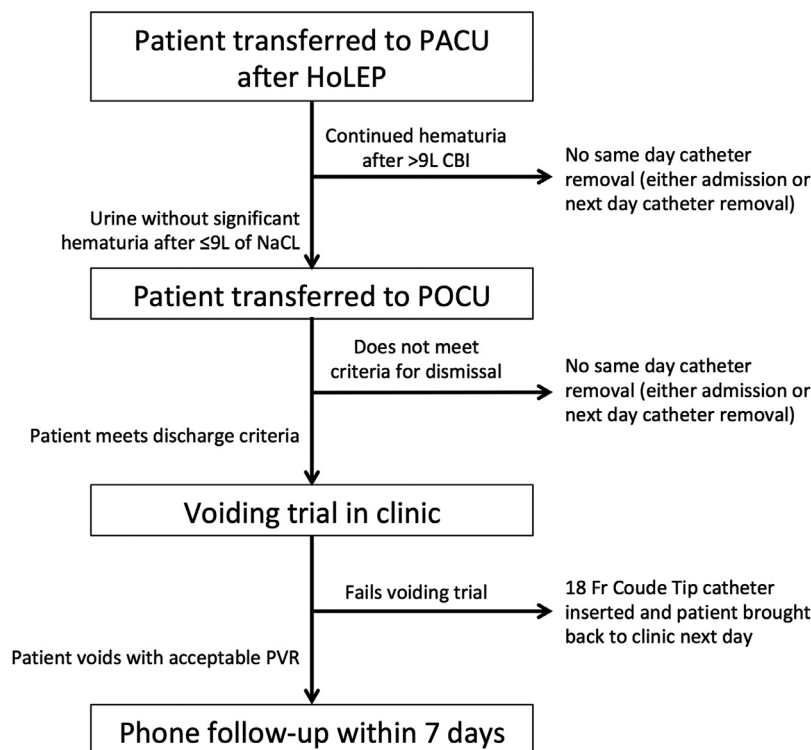


Figure 1. Same day catheter removal process.

Table 1. Preoperative patient data

n = 30	Median or Total	IQR or Percent
Age	68.6	61.7-73.3
BMI	28.5	25.5-33.2
Prostate volume	81	53-115
Retention	n = 8	27%
Prior therapy	n = 4	13%
Antiplatelet/anticoagulation	n = 6	20%
Peak urine flow (n = 8)	6.4 mL/s	5.1-8.5
Postvoid residual	82 mL	30-132
AUA symptom score	18	13-29
Quality of life	4	3.5-5.5

(indwelling or intermittent) prior to surgery. Of the 21 patients who were not in urinary retention, 16 were on medication therapy: 11 (52%) on an alpha-1 antagonist only and 6 (29%) were on combination alpha-1 antagonist and 5-alpha reductase inhibitor. Four (13%) patients had previously undergone a prior procedure to treat BPH, 2 prostatic urethral lifts, 1 PVP and 1 TURP. There were 6 patients (20%) on anticoagulation preoperatively, and 1 patient was on therapeutic anticoagulation at the time of the procedure. This patient had his catheter inadvertently removed in the postanesthesia care unit (PACU) after his continuous bladder irrigation had been shut off and voided successfully, so he was included in the results of the study. No patients underwent preoperative urodynamic studies, since that is not our standard practice if the patient shows a compromised uroflowmetry and is endoscopically obstructed on cystoscopy even after prior surgical intervention. Table 1 has other preoperative data for our cohort. Of note, subjective and objective voiding parameters are provided only for those patients who were not in urinary retention prior to surgery.

ASA score was I-II in 17 patients (57%) and 28 (93%) patients underwent anesthesia with a supraglottic airway without neuromuscular paralysis. Median enucleation time was 39.5 minutes (IQR 30.5-53), morcellation time 5 minutes (IQR 4-12), and enucleated specimen weight was 52.5 g (33-81). Median time from the end of the procedure to hospital discharge was 2.6 hours (IQR [2.1-2.9]).

Same day voiding trial was successful in 27 (90%) of patients, after catheter removal. Median time from end of the procedure to catheter removal was 4.9 hours (IQR 3.5-6.0). Of the 3 patients who required catheter replacement, 2 patients failed voiding trial immediately after catheter removal. The third patient passed his clinic voiding trial, and after 2 subsequent successful voids went to the emergency department in urinary retention. All 3 had 18-Fr coude catheters placed without need for cystoscopy or use of guidewire and underwent successful catheter removal on POD1. None of these patients had undergone a prior BPH surgical therapy.

There were no known 90-day complications or surgical reinterventions. There were 16 patients with available follow-up. Median time to follow-up was 16 weeks (IQR 13-28.5), and 9 patients had virtual follow-up only due to the Covid-19 pandemic. Median AUA (American Urological Association) symptom score was 5 (IQR 2-5), quality of life 1 (IQR 0-2). In 7 patients with in person follow-up, postvoid residual was 16 mL (IQR 8-37) and PSA was 0.7 ng/dl (IQR 0.36-1). Eight patients (50%) experienced postoperative dysuria that resolved, with the longest duration in 1 patient being 4 weeks. Six (37.5%) experienced transient stress urinary incontinence, with 1 patient

experiencing mild incontinence at 13 weeks postoperatively. No patients required medical therapy for BPH or LUTS at time of follow-up.

DISCUSSION

Our cohort highlights that same day catheter removal is feasible in select patients after HoLEP. We demonstrate 90% success of same day catheter removal, and 100% success in removal catheters by POD1. Overall, 3 patients required catheter replacement after same day catheter removal, 2 after an immediate failed voiding trial and one 10 hours after catheter removal. Of the patients who required catheter replacement, there were no obvious differences between these groups. All patients were catheter free by POD1. Patients had a significant improvement in voiding symptoms without lasting dysuria/incontinence.

Although patients with very large glands (>250 mL on preoperative imaging) were excluded from this approach, our cohort's prostate volume is similar to other outpatient HoLEP series,^{6,7,11} with a wide range of 37-235 mL. The successful application of same day catheter removal for prostates <250 g is encouraging as HoLEP by nature is size independent^{1,2} and would apply to the vast majority of patients undergoing HoLEP. The rate of passage of voiding trial on the same day as surgery is also similar to recent HoLEP studies,^{11,12} demonstrating there is no added risk to patient of catheter reinsertion compared to the standard approach.

Recently, there has been an effort to reassess perioperative HoLEP care and reduce stays postoperatively. Technical progress and new laser technology have reduced morbidity and hospital stay associated with HoLEP.^{12,13} Multiple studies have demonstrated feasibility of HoLEP as an outpatient case,⁷⁻¹⁰ including 2 recent studies.^{6,11} This series builds off the previous work by removing the catheter on the same day as the procedure, HoLEP can be transitioned to a true single day encounter for the patient. Our cohort did not experience significant dysuria, incontinence, or postoperative complications.

There is limited literature regarding same day catheter removal with TURP and PVP,^{14,15} and by removing the catheter the same day we can offer HoLEP with a single day encounter as well. Although patients required around 2 additional hours in the facility after postprocedure discharge from the hospital, the practice of same day catheter removal saved patients many more potential hours of catheterization and a return trip to the clinic. Our clinic is attached to our hospital, and patients often had a meal in between hospital dismissal and their appointment for clinic voiding trial. The timing of catheter removal is often dictated by clinic scheduling restraints, and not necessarily reflective of actual time needed.

Same day catheter removal brings several benefits to patients. The first is the reduction in time of indwelling catheterization. At our institution, we utilize a 22-Fr 3-way catheter for continuous bladder irrigation and for effective hematuria drainage. The size of this catheter,

even for men managed with indwelling catheter preoperatively, increases discomfort after this procedure. Additionally, less indwelling catheter time should theoretically decrease rate of postoperative urinary tract infections. Patients also ambulate less with a catheter in place,^{16,17} which has the potential to increase the risk for postoperative deep venous thrombosis. Catheter dysfunction is also a postoperative issue, causing for patient concern and unintended emergency room visits for clogging and/or poor drainage. With same day catheter removal, patients are able to pass small clots per urethra that could otherwise obstruct a catheter. Anecdotally from postoperative calls within the first week of surgery, patients whose catheter removal was performed the same day rarely passed urinary clots beyond POD1. They also did not experience prolonged dysuria/incontinence or postoperative complication or reintervention.

In order to facilitate same day catheter removal, we provide a few suggestions from lessons we have learned to date. It is important to have an effective plan in place for patients to undergo a successful voiding trial. At our institution, PACU/POCU do not have time, ability or experience to carry out effective voiding trials. We initially found that patients were not ambulated or retrofilled before voiding trial, and this was leading to false failures. These patients then went to clinic and passed. The PACU/POCU's inability to perform successful voiding trials led to a change in our protocol for same day catheter removal in HoLEP patients to undergo catheter removal in our office, which is in the same physical location as our operating room. Additionally, we hypothesize neuromuscular paralysis required for endotracheal intubation may have a negative effect on postoperative ability to generate a detrusor contraction. We opted for all patients to undergo supraglottic airway without paralysis, but two patients did undergo intubation without the knowledge of the operating surgeon. Of these patients, 1 of 2 patients did not void; however, this sample is not large enough to draw a conclusion. Likewise, we minimized narcotic and anticholinergic use in these patients to avoid the cognitive and detrusor effects that these medications can cause.

This is the first study demonstrating same day catheter removal is possible and successful after HoLEP. Although it is a single center, there are 3 surgeons included, which increases generalizability. All surgeons are fellowship-trained in HoLEP and each perform >100 cases annually. All cases were done with Moses 2.0 Optimized for BPH, which is technology that may not be available to all providers at this time. Limitations of this study include retrospective review and low sample size. The patients who were permitted to undergo same day catheter removal were limited by gland size, anticoagulation, and medical fitness for an outpatient procedure. The method outlined for our same day catheter is also dependent on the OR and clinic to be in close proximity. Patients could be safely driven by their accompanying adult to a clinic for catheter removal if it was not attached to the operating location; however, we found that having the patient walk

from the OR to the clinic was the best way to initiate normal bladder function after the HoLEP procedure. A larger series or multi-institutional series would provide power to assess for different factors for failure of the same day voiding trials such as prior treatment, mode of anesthesia and other potential factors. However, despite these limitations, this study is the first to demonstrate the feasibility and high success rate of same day catheter removal after HoLEP.

CONCLUSION

Same day catheter removal after HoLEP is feasible and safe in selected patients, making the procedure truly minimally invasive for the patients. Notably, this approach does not worsen postoperative outcomes. Newer laser technology likely has a significant impact on the success in these patients due to reduced rates of hematuria. A prospective trial will be helpful to affirm the safety and success of the same day catheter removal outpatient HoLEP approach.

References

1. Humphreys Mitchell R, Miller Nicole L, Handa Shelly E, Terry C, Munch Larry C, Lingeman James E. Holmium laser enucleation of the prostate—outcomes independent of prostate size? *J Urol.* 2008;180:2431–2435.
2. Krambeck AE, Handa SE, Lingeman JE. Holmium laser enucleation of the prostate for prostates larger than 175 grams. *J Endourol.* 2009;24:433–437.
3. Cornu J-N, Ahyai S, Bachmann A, et al. A systematic review and meta-analysis of functional outcomes and complications following transurethral procedures for lower urinary tract symptoms resulting from benign prostatic obstruction: an update. *Eur Urol.* 2015;67:1066–1096.
4. Anderson BB, Heiman J, Large T, Lingeman J, Krambeck A. Trends and perioperative outcomes across major benign prostatic hyperplasia procedures from the ACS-NSQIP 2011–2015. *J Endourol.* 2018;33:62–68.
5. Magistro G, Chapple CR, Elhilali M, et al. Emerging minimally invasive treatment options for male lower urinary tract symptoms. *Eur Urol.* 2017;72:986–997.
6. Abdul-Muhsin H, Critchlow W, Navaratnam A, et al. Feasibility of holmium laser enucleation of the prostate as a 1-day surgery. *World J Urol.* 2020;38:1017–1025.
7. Comat V, Marquette T, Sutter W, et al. Day-case holmium laser enucleation of the prostate: prospective evaluation of 90 consecutive cases. *J Endourol.* 2017;31:1056–1061.
8. Gabbay G, Bernhard JC, Renard O, et al. Holmium laser enucleation of the prostate as a day case surgery: prospective evaluation of the first 30 patients. *Prog Urol.* 2015;25:34–39.
9. Larner TR, Agarwal D, Costello AJ. Day-case holmium laser enucleation of the prostate for gland volumes of <60 mL: early experience. *BJU Int.* 2003;91:61–64.
10. Lee SM, Gordon K, McMillan R, Crystal F, Acher P. Day-case holmium laser enucleation of the prostate: feasibility, safety and predictive factors. *Ann R Coll Surg Engl.* 2018;100:475–479.
11. Lwin AA, Zeng J, Evans P, et al. Holmium laser enucleation of the prostate is safe and feasible as a same day surgery. *Urology.* 2020;138:119–124.
12. Large T, Nottingham C, Stoughton C, Williams Jr. J, Krambeck A. Comparative study of holmium laser enucleation of the prostate with MOSES Enabled Pulsed Laser Modulation. *Urology.* 2020;136:196–201.

13. Dusing MW, Krambeck AE, Terry C, et al. Holmium laser enucleation of the prostate: efficiency gained by experience and operative technique. *J Urol*. 2010;184:635–640.
14. Khan A. Day care monopolar transurethral resection of prostate: is it feasible? *Urol Ann*. 2014;6:334–339.
15. Zorn KC, Liberman D. GreenLight 180W XPS photovaporization of the prostate: how I do it. *Can J Urol*. 2011;18:5918–5926.
16. Agarwal DK, Viers BR, Rivera ME, et al. Physical activity monitors can be successfully implemented to assess perioperative activity in urologic surgery. *Mhealth*. 2018;4:43.
17. Gold PA, Garbarino LJ, Anis HK, et al. The effect of bladder catheterization on ambulation and venous thromboembolism following total knee arthroplasty: an institutional analysis. *J Arthroplast*. 2020;35:S197–S200.