

Same-day trial of void and discharge following standard vs. MOSES™ holmium laser enucleation of the prostate: A single-center experience

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Cite as: Noureldin Y, Gupta A, Hodhod A, et al. Same-day trial of void and discharge following standard vs. MOSES™ holmium laser enucleation of the prostate: A single-center experience. *Can Urol Assoc J* 2022 August 30; Epub ahead of print. <http://dx.doi.org/10.5489/cuaj.7983>
Published online August 30, 2022

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ABSTRACT

Introduction: We aimed to compare perioperative and postoperative outcomes and to assess the safety and feasibility of same-day trial of void (TOV) in patients who underwent standard holmium laser enucleation of the prostate (HoLEP) vs. MOSES™ HoLEP (MoLEP).

Methods: We conducted a retrospective review of prospectively collected data of patients that underwent HoLEP (100 W) or MoLEP (120 W) with same-day catheter removal three hours postoperatively at our institution from August 2018 to September 2021. Patient demographics, intraoperative parameters, and postoperative outcomes were analyzed. Data were compared as means with standard deviation and medians with interquartile range (IQR) or numbers and percentages. Continuous and categorical variables were assessed using the Mann-Whitney U test and Chi-squared test, respectively. Predictors of shorter enucleation time and failed same-day TOV were investigated.

Results: Of the 90 patients included, 28 underwent HoLEP while 62 had MoLEP. There was no significant difference between the groups in terms of the successful TOV (23 [82%] vs. 58 [93.5%], $p=0.1$) and readmission rate (3 [10.7%] vs. 1 [1.6%], $p=0.08$); however, the MoLEP group had a significantly shorter mean enucleation time ($p<0.001$), mean hemostasis time ($p<0.001$), mean morcellation time ($p=0.003$), and lower mean energy used ($p<0.001$). On the logistic regression model, MoLEP (odds ratio [OR] 0.03, 95% confidence interval [CI] 0.007–0.19, $p<0.001$), lower preoperative prostate-specific antigen (PSA) test (OR 1.25, 95% CI 1.01–

1.55, $p=0.03$), and smaller prostate size (OR 1.06, 95% CI 1.02–1.09, $p<0.001$) were independent predictors of shorter enucleation time. History of preoperative retention was the only significant factor associated with a failed same-day TOV ($p=0.04$). There was no different difference in intraoperative or postoperative complication rates or postoperative functional outcomes between the two technologies.

Conclusions: Same-day TOV and discharge are feasible following standard HoLEP and MoLEP, with comparable outcomes; however, the use of MOSES technology offered better enucleation efficiency with excellent hemostatic potential. Preoperative retention was the only predictor for failed same-day TOV.

INTRODUCTION

Lower urinary tract symptoms (LUTS) caused by benign prostatic hyperplasia (BPH) significantly impact patients' quality of life. A wide range of laser technologies have been developed for the surgical treatment of BPH. Holmium laser enucleation of the prostate (HoLEP) is an effective minimally-invasive technique for treating BPH, with treatment outcomes that are comparable to open prostatectomy (OP) and transurethral resection of the prostate (TURP)^{1–3}. HoLEP is particularly effective for treating patients with large prostates⁴.

MOSES™ technology has further revolutionized the HoLEP procedure with modulated pulsed energy transmission, which displaces fluid between the laser fiber tip and the target tissue⁵. HoLEP performed using MOSES™ technology (MoLEP) has been shown to provide faster hemostasis than HoLEP performed using a standard 100-W holmium laser⁵. However, other clinical outcomes such as quality of life (QoL) score, post-void residual volume (PVR), incontinence, and complication rates have been shown to be comparable between holmium laser types thus far⁵.

The clinical success of minimally invasive BPH treatments has prompted a paradigm shift towards same-day discharge for HoLEP patients. Several studies have demonstrated that HoLEP and MoLEP are safe and effective as ambulatory procedures, with indwelling catheter removal on postoperative day 1 (POD1)^{1,4,6,7}. Furthermore, pilot studies have demonstrated that same-day trial of void (TOV) was successful in (90%) of patients undergoing MoLEP⁸.

Our objective was to compare the feasibility, safety, and success of same-day TOV between standard HoLEP and MoLEP and to assess factors associated with failed same-day TOV and shorter enucleation time. We hypothesized that the improved hemostasis provided by MOSES™ would yield reduced rates of hematuria, clot retention, and readmission compared to standard HoLEP.

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METHODS

After obtaining Research Ethics Board approval, we performed a retrospective review of a prospectively collected database of patients who underwent HoLEP at our institution between August 2018 and September 2021. From August 2018 to December 2020, we used a 100-W holmium:YAG laser (*VersaPulse PowerSuite™, Lumenis, Yokneam, Israel*). Afterward, a 120-W MOSES™ (*Lumenis, Yokneam, Israel*) was utilized from December 2020 to September 2021. A 550-µm laser fibre and 28-F continuous flow resectoscope (*Karl Storz SE & Co. KG, Tuttlingen, Germany*) were used for both techniques. The primary laser settings for enucleation were 2 J and 40 Hz with 2 J and 20 Hz on the secondary laser foot-pedal for hemostasis.

Laser enucleation of the prostate was performed in patients with LUTS secondary to BPH with a prostate volume >80 cc that were candidates for surgical treatment. Our study did not include patients with prostate size < 80cc because they undergo GreenLight™ or Holmium Xpeeda™ laser prostatectomy at our institution.

Patients with preoperative factors such as an unfit medical condition (e.g., cognitive disorder, anticoagulant therapy, and uncontrolled cardiovascular disease) were excluded from early discharge. Patients residing beyond city limits and those without a caregiver were also excluded. Patients were not excluded based on PVR, the presence of an indwelling catheter, or any other subjective criteria. Participants were counselled regarding their ability to decline discharge without a catheter at any point if they felt uncomfortable.

Patients that met predetermined discharge criteria after assessment by the operating surgeon were offered the option of same-day catheter removal 3 hours postoperatively, with the knowledge that our standard practice was to remove the catheter on postoperative day 1 (POD 1) in an outpatient

All patients that met the criteria for same-day TOV were offered same-day catheter removal.

We reviewed all pertinent variables related to the feasibility of same-day catheter removal prior to discharge. Preoperative evaluation included general patient demographics, a complete medical history, physical examination (including a digital rectal exam), anticoagulant and antiplatelet medication use, history of urinary retention, and prior prostate procedures. Symptom assessment with the International Prostate Symptom Score (IPSS) and QoL questionnaires were completed. All patients underwent basic laboratory workup, prostate-specific antigen (PSA) testing, uroflowmetry, a PVR bladder scan, and a transrectal ultrasound for prostate volume estimation.

If medically feasible, participants were instructed to temporarily hold their anticoagulant and antiplatelet medications prior to surgery for 3 and 7 days, respectively. Patients weren't offered the same-day TOV if it wasn't suitable to withhold anticoagulant or antiplatelet therapy. Intraoperative parameters, postoperative outcomes, and disposition and readmission data were collected and analyzed. Surgical parameters such as enucleation time, morcellation time, laser energy, resected weight, intraoperative complications, and the need for blood transfusion were

recorded. Hemostasis time was calculated from the end of enucleation to the beginning of morcellation. The time required to achieve hemostasis after morcellation was added to the calculation, as needed. Early postoperative complications included clot retention and a failed TOV.

Surgical technique

All HoLEP procedures were performed under general anesthesia by a single surgeon (H.E), who is a HoLEP expert with (>500 cases), using the top-down technique described in a previous publication⁹.

Postoperative care

All patients had a three-way Foley catheter (22 F, with 75 ml of sterile water in the balloon) inserted postoperatively in the operating room and were kept on mild traction with continuous bladder irrigation (CBI). All cases were postoperatively transferred to the Post Anesthesia Care Unit (PACU) for observation. CBI continued for 2 hours and was then stopped for an additional hour to evaluate the degree of hematuria.

Routine blood testing was conducted in the PACU which included a complete blood count and basic metabolic profile. Voiding trials were performed 3 hours postoperatively after being assessed by the urologist for suitability for discharge. The TOV was performed by filling the catheter with 300-500 mL of saline or until the patient felt the urge to urinate. The volume voided, urine colour, and PVR were assessed to ensure there was no concern for hematuria or possible clot retention.

Predetermined discharge criteria included: if the patient was deemed medically fit, had a caregiver; was not on anticoagulant or antiplatelet medications and met PACU discharge criteria¹⁰. Using the modified Post Anaesthetic Discharge Scoring System, patients with a minimum score of 9 were considered ready for discharge. A score of ≥ 2 was required for vital signs, pain and surgical bleeding criteria, whereas a minimum score of 1 was required for all other criteria.

Prior to discharge, patients were also required to have acceptable laboratory results, hematuria scores (without CBI or the presence of clots)¹, to tolerate diet, and were ambulating independently. A TOV was considered successful if there was no concern for hematuria or possible clot retention, the patient had a PVR <300 and if the residual volume was less than half the voided volume.

Patients were followed-up according to our standard postoperative schedule at 1, 3, and 6 months. Additional clinical visits were required based on clinical evaluation. Follow-up visits involved clinical examination, IPSS, QoL assessment, flowmetry, a bladder scan for PVR, and cystoscopy, if indicated. The PSA blood test was conducted at 3 months.

Statistical analyses

Data were compared as means with standard deviation and medians with interquartile range (IQR) or numbers and percentages. Continuous and categorical variables were assessed using the Mann-Whitney U Test and the Chi-Square test, respectively. Logistic regression analyses were used to identify predictors of shorter enucleation time and failed TOV. All two-tailed p-values were considered significant if less than 0.05.

RESULTS

All patients that fulfilled the preoperative criteria for a 3-hour TOV and same-day discharge also met the postoperative criteria for TOV and discharge at 3 hours postoperatively. A total of 210 patients underwent HoLEP during the study period; 90 individuals had a same-day TOV and were included in this study, and 120 patients were excluded from the same-day TOV (6 patients with postoperative hematuria, 17 on blood thinners, 5 with dementia, 13 without a caregiver, and 79 residing beyond city limits).

Of the 90 patients included in our study, 28 underwent HoLEP and 62 had MoLEP. The mean age was 71.5 ± 7 versus 71.4 ± 7 years and the mean prostate volume was 115.6 ± 38.5 versus 109.5 ± 30.8 cc in the HoLEP and MoLEP groups, respectively (Table 1). Other baseline demographics in terms of the indication for HoLEP, the mean prostate enucleated weight, mean preoperative PSA (ng/ml), median preoperative IPSS median preoperative QoL, mean preoperative maximum flow rate [Qmax (mL/sec)], and mean preoperative PVR (cc) were comparable between both groups (p-values >0.05) (Table 1).

No intraoperative complications were recorded in either group. During the postoperative follow-up period, 85 of the 90 patients (94.4%) showed up to their 1-month appointment [25/28 (89.3%) vs. 60/62 (96.8%)], 78 (86.7%) to their 3-month visit [22/28 (78.5%) vs. 56/62 (90.3%)], and 66 (73.3%) to their 6-month appointment [19/28 (67.8%) vs. 47/62 (75.8%)] in the HoLEP and MoLEP groups, respectively.

None of the patients in our study required postoperative blood transfusion. There was no significant difference in the postoperative outcomes between the two groups in terms of successful TOV and readmission rate.

Three patients (10.7%) in the standard HoLEP cohort required hospital readmission compared to one patient (1.6%) in the MOSESTM group (p=0.08). All four cases of hospital readmission occurred during the first month and were due to hematuria with clot evacuation that was managed using a 3-way catheter (Clavien I) (Table 2).

On unadjusted analyses, the MoLEP group had a significantly shorter mean enucleation time (p<0.001), mean hemostasis time (p<0.001), mean morcellation time (p=0.003) and lower mean energy used (p<0.001) (Table 1). This resulted in a significant difference in the mean decrease in Hemoglobin (g/L) in MoLEP group compared to the HoLEP group (p<0.001) (Table 2). Moreover, the two groups were comparable in terms of the improvement in all functional outcomes (IPSS, QoL, Qmax, and PVR) at 1, 3 and 6 months postoperative (Table 2).

Factors affecting failed same-day TOV were studied and history of preoperative retention was the only significant factor ($p=0.04$). Logistic regression analyses revealed that MoLEP (OR: 0.03, 95% CI: 0.007-0.19; $p<0.001$), lower preoperative PSA (OR: 1.25, 95%CI: 1.01-1.55; $p=0.03$) and smaller prostate size (OR: 1.06, 95% CI: 1.02-1.09; $p<0.001$) were independent predictors of enucleation time (Table 3).

DISCUSSION

The American Urological Association guidelines recognize HoLEP as a safe procedure for managing benign prostatic obstruction (BPO)¹¹. In recent years, there has been a shift for endourologic interventions for urolithiasis and BPO to be performed as outpatient procedures, potentially reducing costs for the healthcare system, and decreasing patients' morbidity¹². Same-day TOV following standard HoLEP or MoLEP may provide potential advantages to patients, including lessening the discomfort associated with indwelling catheterization and improved ambulation, which may prevent thromboembolism. Furthermore, same-day TOV may reduce catheter-associated infections and catheter dysfunction due to clot retention from small clots, which could be more easily passed in the absence of an indwelling catheter⁸.

In the current study, we compared same-day TOV for standard HoLEP versus MoLEP.

Furthermore, intraoperative performance was assessed by enucleation and hemostasis times, and postoperative functional outcomes were compared. Earlier studies demonstrated the feasibility and safety of outpatient HoLEP. However, patients were discharged home with an indwelling urethral catheter that was later removed at home or in an outpatient setting^{1,3,6,7,13}.

Larner and colleagues studied the feasibility of performing HoLEP as a day-case procedure in 38 patients with a prostate size $<40\text{cc}^3$. Another study with 90 consecutive HoLEP cases as a day-case surgery reported an 83% success rate for discharge home within 12 hours⁶. Similarly, Abdul-Muhsin and colleagues included 47 patients for same-day discharge following HoLEP and reported a success rate of approximately 60% with the same-day discharge and a readmission rate of 18 percent¹. Two other studies reported the safety of HoLEP as an outpatient procedure^{7,13}. However, all patients in the above-mentioned articles were discharged home with an indwelling catheter that was removed either the following day or within one week of the procedure^{1,3,6,7,13}. In the HoLEP group of the present study, same-day TOV and discharge was higher (82%) and the readmission rate was lower (10.7%) than those in the aforementioned studies.

Moreover, Abdul-Mohsin et al. did not find any significant predictors for same-day discharge following HoLEP on multivariable analysis¹. In contrast, Lee and colleagues found that small size prostate ($\leq 40\text{ g}$) was an independent predictor for successful day-case HoLEP⁷. Furthermore, Lwin et al. reported that preoperative retention and large prostate size were associated with failed same-day TOV following HoLEP¹³. In our study, only preoperative retention was associated with a failed same-day TOV. However, our study included both HoLEP and MoLEP cases, rather than only HoLEP as with the above-mentioned studies^{1,7,13}.

A recent meta-analysis conducted by Salciccia et al. that included 9 studies of HoLEP as an outpatient procedure (<12 hours) demonstrated the reliability and safety of the procedure. However, the authors reported significant differences in outcomes depending on the type of procedure, prostate volume, and discharge protocol¹⁴.

The introduction of MOSES™ technology integrated into the new novel holmium laser platform from Lumenis (*Yokneam, Israel*) potentially offers better delivery of laser energy with improved efficiency¹⁵. That is why it is hypothesized that MOSES™ technology offers better enucleation and hemostasis during MoLEP. Slade and co-investigator's study of 114 patients reported a success rate of 87.7% for same-day TOV in individuals that underwent MoLEP¹⁶. Moreover, none of the variables including age, body mass index, prostate size, the presence of a preoperative indwelling urethral catheter, history of prior BPH surgery, preoperative α -blocker or 5-alpha reductase inhibitor, preoperative anticoagulation or antiplatelet therapy, preoperative IPSS, intraoperative morcellation time, and amount of energy used were predictors for failed same-day TOV¹⁶. This is fairly consistent with our findings as preoperative retention was the only variable associated with failed same-day TOV on univariate analysis; hence, we were unable to perform multivariable analyses for the predictors of failed same-day TOV.

Agarwal et al. reported that among 30 men that underwent MoLEP, same-day TOV and discharge was feasible in 90% of patients with a median time of approximately 5 hours from MoLEP to catheter removal⁸. In our MoLEP group, successful TOV was higher (93.5%) despite the larger prostate size (109 cc) and higher enucleated prostate weight (78.5 g) compared with 81 cc and 52 g, respectively. In addition, we performed the TOV 3 hours postoperatively in our study.

We considered a TOV successful if there was no concern for hematuria or possible clot retention, the patient had a PVR <300 and if the residual volume was less than half the voided volume. This is similar to Agarwal et al., who described a PVR of less than half of the voided volume as adequate for passing⁸. Since HoLEP and MoLEP are size-independent procedures, we did not exclude patients based on an upper limit for prostate size. Some authors considered a prostate size of 250 cc as an upper limit for same-day TOV⁸.

The findings of Assmus and colleagues further support this concept. They reported a success rate of 84% for planned same-day discharge following MoLEP among 45 patients with a mean prostate volume of 229.9 cc (175–535 cc)⁴. However, Agarwal and colleagues excluded patients with prostate glands >250 cc⁸.

Other studies that compared the two techniques reported MoLEP's superiority in terms of the intraoperative enucleation efficiency and hemostasis which resulted in shorter operative time. However, both modalities were comparable in terms of the functional outcomes and same-day discharge^{5,17-20}.

Kavoussi et al. conducted the first double-blind randomized controlled trial comparing the two techniques in 60 patients. They reported significantly a shorter operative time (101 vs. 126 min), enucleation time (68 vs. 80 min) and hemostasis time (18 vs. 29 min), and a

significantly lower drop in Hematocrit (−6.4 vs. −9.0) in the MoLEP group compared to the HoLEP group¹⁷. This was similar to our findings where MoLEP was associated with significantly shorter enucleation time and hemostasis time and a significantly lower drop in Hemoglobin. Furthermore, Kavoussi and colleagues had comparable results in terms of the functional outcomes which coincide with our findings¹⁷. However, their study differs from the current study as they discharged patients with an indwelling urethral catheter which was removed within one week postoperatively. Their follow-up period was limited to 6 weeks compared to 6 months in our study¹⁷.

Our findings are consistent with the results of another randomized controlled study where 27 patients underwent HoLEP on one prostate lobe while MoLEP was performed on the other lobe. The authors reported shorter enucleation time (21 vs. 36.7 min) and higher enucleation efficiency (1.75 vs. 1.05 g/min) with MoLEP compared to HoLEP¹⁸. The improved hemostasis translated into a shorter operative time^{5,17}. Another study found that the operative and ablation times were comparable for HoLEP and MoLEP, while ablation efficiency was superior for MoLEP²⁰.

In another study by Nottingham and co-investigators, MoLEP offered shorter hemostasis time (8.7 vs. 10.6 ± 6 minutes) compared to HoLEP and same-day TOV and discharge were achieved in 69.4% of patients in the MoLEP group¹⁹. This is similar to our findings in terms of the hemostatic efficiency of MoLEP. In addition, the TOV was performed on the same day of surgery and MoLEP was performed as an outpatient procedure. However, same-day TOV and discharge was not offered to HoLEP patients and the success of same-day TOV for MoLEP (69.4%) was much lower than that in our MoLEP group (93.5%). These results are further supported by a recent meta-analysis which found that MoLEP had better intraoperative performance resulting in shorter enucleation time, hemostasis time, and overall operative times compared to HoLEP. In addition, MoLEP provided early TOV and discharge²¹.

We believe that MoLEP's shorter morcellation time is mainly attributed to enhanced visibility due to better hemostasis. Despite the additional features of MOSES™ technology, standard HoLEP had comparable outcomes to MoLEP in terms of successful same-day TOV. This may be attributed to the excellent tissue debulking capabilities of HoLEP. Further studies comparing same-day TOV for other forms of anatomical endoscopic enucleation of the prostate are warranted. MOSES™ laser technology may have a meaningful impact on enucleation time and drop in hemoglobin due to its clear incision and enhanced hemostasis throughout the procedure.

Our study has some limitations, including its retrospective nature and that it is a single-center experience. Nevertheless, it is a retrospective analysis of prospectively collected data. Another limitation is the lack of a total operative time calculation. However, the significantly shorter enucleation time, morcellation time, and hemostasis time may be considered surrogates for shorter operative time. Moreover, postoperative hemoglobin levels were measured in the recovery unit and were used to document intraoperative blood loss. In our experience,

hemoglobin levels in the immediate postoperative period may not reflect the actual values. Hemoglobin levels may be affected by various factors, including the volume of intravenous fluids administered and fluid absorption. Furthermore, we could not study the predictors of readmission due to the low number of hospital readmissions among our patients. Finally, it is not our standard practice to perform a urodynamic study (UDS) prior to HoLEP. None of the patients in our cohort required clean intermittent catheterization (CIC) or re-catheterization during the follow-up period. Additional studies with larger sample sizes and more extended follow-up periods are warranted.

CONCLUSIONS

Same-day TOV and discharge are feasible following standard HoLEP and MoLEP with comparable outcomes. However, the use of MOSES™ technology offered better enucleation efficiency with excellent hemostatic potential. Preoperative retention was the only predictor for failed same-day TOV.

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Figures and Tables

Table 1. Baseline demographics and intraoperative parameters for both groups				
Variable		HoLEP (28 patients)	MoLEP (62 patients)	p
Mean age, yrs		71.5±7	71.4±7	0.9
Indication for HoLEP	Urine retention	6	12	0.7
	LUTS/hematuria	22	50	
Mean prostate volume, cc		115.6±38.5	109.5±30.8	0.4
Mean prostate enucleation weight, g		82.3±41.2	78.5±29.1	0.6
Mean enucleation time, min		63.4±17.8	47±12.5	<0.001
Mean hemostasis time, min		7.1±2.6	3±1.1	<0.001
Mean morcellation time, min		14.1±7	10.2±5	0.003
Mean enucleation efficiency, g/min		1.3±0.4	1.7±0.6	0.001
Mean energy, KJ		116.7 ±37.6	84.9±26.9	<0.001
Mean preoperative PSA, ng/mL		5.2±3.5	5.5±3.1	0.6
Median preoperative IPSS		24 (22–28)	25 (22–28)	0.9
Median preoperative QoL		5 (4–6)	5 (4–5.3)	0.5
Mean preoperative Qmax, mL/sec		9±3	8.3±3	0.3
Mean preoperative PVR, cc		219±146.8	243.3±143.4	0.4

Tests performed: Student t-test /two-tailed Fisher's exact test/Mann-Whitney U test.

HoLEP: holmium laser enucleation of the prostate; IPSS: International Prostate Symptom Score; MoLEP: MOSES™ HoLEP; PSA: prostate-specific antigen; PVR: postvoid residual; TOV: trial of void; Qmax: maximum flow rate; QoL: quality of life.

Table 2. Postoperative outcomes for both groups				
		HoLEP (28 patients)	MoLEP (62 patients)	p
Successful TOV (3 hours post-HoLEP)		23 (82%)	58 (93.5%)	0.1
Readmission		3 (10.7%)	1 (1.6%)	0.08
Mean decrease in hemoglobin, g/L		14.7±5	10.7±4.5	<0.001
Mean postoperative PSA, ng/mL		0.7±1	0.6±0.4	0.5
Mean percentage reduction in PSA		85±16	87±7	0.4
Median IPSS	1 month	10 (4.75–13)	8 (6–11)	0.6
	3 months	6.5 (4–8)	4 (2–6)	0.07
	6 months	4 (3–5)	3 (1.5–4)	0.1

Median QoL	1 month	2 (1–4)	2(1–3)	0.9
	3 months	1 (0–3)	1 (0–2)	0.2
	6 months	1 (0–1)	1 (0–1)	0.9
Mean Qmax, mL/sec	1 month	22.7±5.6	22.3±6.5	0.7
	3 months	22.6±7.7	24.7±7.4	0.2
	6 months	23.1±7.3	22.1±5.9	0.4
Mean PVR, cc	1 month	42.3 ±26.9	52.8±47.2	0.2
	3 months	45±41	40±39	0.5
	6 months	37.5±20.4	28±20	0.2

Tests performed: Student t-test/two-tailed Fisher's exact test/Mann-Whitney U test.

HoLEP: holmium laser enucleation of the prostate; IPSS: International Prostate Symptom Score; MoLEP: MOSES™ HoLEP; PSA: prostate-specific antigen; PVR: postvoid residual; TOV: trial of void; Qmax: maximum flow rate; QoL: quality of life.

Table 3. Multivariable analyses of factors affecting enucleation time		
Variables	OR (95% CI)	p
MoLEP	0.04 (0.01-0.19)	<0.001
Age at time of surgery, yrs	0.99 (0.94-1.04)	0.78
Preoperative PSA, ng/mL	1.26 (1.01-1.55)	0.03
Prostate volume, cc	1.06 (1.03-1.09)	<0.001

CI: confidence interval; MoLEP: MOSES™ holmium laser enucleation of the prostate; OR: odds ratio; PSA: prostate-specific antigen.