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Comparison of Predictive Factors for Postoperative Incontinence of Holmium Laser Enucleation of the Prostate by the Surgeons' Experience During Learning Curve

Katsumi Shigemura, Kazushi Tanaka, Fukashi Yamamichi, Koji Chiba, Masato Fujisawa

Division of Urology, Department of Organ Therapeutics, Faculty of Medicine, Kobe University Graduate School of Medicine, Kobe, Japan

Purpose: To detect predictive factors for postoperative incontinence following holmium laser enucleation of the prostate (HoLEP) according to surgeon experience (beginner or experienced) and preoperative clinical data.
Methods: Of 224 patients, a total of 203 with available data on incontinence were investigated. The potential predictive factors for post-HoLEP incontinence included clinical factors, such as patient age, and preoperative urodynamic study results, including detrusor overactivity (DO). We also classified the surgeons performing the procedure according to their HoLEP experience: beginner (< 21 cases) and experienced (≥ 21 cases).
Results: Our statistical data showed DO was a significant predictive factor at the super-short period (the next day of catheter removal: odds ratio [OR], 3.375; P = 0.000). Additionally, patient age, surgeon mentorship (inverse correlation), and prostate volume were significant predictive factors at the 1-month interval after HoLEP (OR, 1.072; P = 0.004; OR, 0.251; P = 0.002; and OR, 1.008; P = 0.049, respectively). With regards to surgeon experience, DO and preoperative International Prostate Symptom Score (inverse) at the super-short period, and patient age and mentorship (inverse correlation) at the 1-month interval after HoLEP (OR, 3.952; P = 0.002; OR, 1.084; P = 0.015; and OR,1.084; P = 0.015; OR, 0.358; P = 0.003, respectively) were significant predictive factors for beginners, and first desire to void (FDV) at 1 month after HoLEP (OR, 1.009; P = 0.012) was a significant predictive factor for experienced surgeons in multivariate analysis.
Conclusions: Preoperative DO, IPSS, patient age, and surgeon mentorship were significant predictive factors of postoperative patient incontinence for beginner surgeons, while FDV was a significant predictive factors for experienced surgeons. These findings should be taken into account by surgeons performing HoLEP to maximize the patient's quality of life with regards to urinary continence.

Keywords: Urinary Incontinence; Holmium-YAG Lasers; Transurethral Resection of Prostate; Learning curve; Urodynamics

• **Conflict of Interest:** No potential conflict of interest relevant to this article was reported.

INTRODUCTION

Holmium laser enucleation of the prostate (HoLEP) is performed, more routinely than before, for the surgical management of benign prostate hyperplasia (BPH) as it is becoming a substitute for transurethral resection of the prostate (TURP), especially in specific groups of patients with enlarged prostates [1]. HoLEP is considered a more accessible technique, but does involve a particularly steep learning curve in comparison with other surgical modalities for BPH [2]. Even though HoLEP is now widespread and offers good patient outcomes for lower urinary tract symptoms (LUTS), with less blood loss during surgery and minimal

Corresponding author: Katsumi Shigemura http://orcid.org/0000-0002-5695-2794
Department of Urology, Kobe University Graduate School of Medicine, 7-5-1 Kusunoki-Cho, Chuo-Ku, Kobe 650-0017, Japan
E-mail: yutoshunta@hotmail.co.jp / Tel: +81-78-382-6155 / Fax: +81-78-382-6169
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influence on the prostate capsule compared to TURP and other modalities [3], postoperative urinary incontinence remains a representative complication of HoLEP and can have a negative influence on the patient's quality of life (QoL) [4]. This adverse event is of particular concern in the cases encountered by surgeons during the learning curve. Montorsi et al. [5] reported that urinary incontinence was more frequent after HoLEP than after other modalities, including TURP. Several studies have since sought to identify predictive factors for post-HoLEP incontinence [6]; however, most of these studies have chosen subjective evaluations. For instance, they have considered symptom scores, such as the International Prostate Symptom Score (IPSS), or surgery-related factors, such as surgical time and surgeon experience or enucleation efficiency, as potential predictive factors. More importantly, this type of study has usually been conducted within a high-volume center by experienced surgeons and, as such, information on patient outcomes associated with surgeon experience, particularly for beginner surgeons, is generally lacking.

Regarding the influence of surgeon experience on post-HoLEP incontinence in patients, Kim et al. [7] concluded that the surgeon's skills with the HoLEP procedure might plateau after approximately 25 cases. The overall occurrence of postoperative incontinence has been reported to be approximately 16.2% [4]. Kwon et al. [8] later showed that involuntary detrusor contractions in urodynamic studies (UDS) were significantly improved after surgical management with HoLEP.

In this study, we evaluated potential predictive factors for postoperative incontinence following HoLEP, focusing on surgeon experience (beginner or experienced) in combination with preoperative UDS data.

MATERIALS AND METHODS

Patients and Surgeons

Of all the procedures performed (n=224) at Kobe University Hospital from 2006 to 2014, a total of 203 patients, for whom data on urinary incontinence was available, were included in this study. Urinary incontinence was defined as involuntary leakage of urine, in accordance with the recommendations of the International Continence Society [9], that required the use of pads. Incontinence was evaluated at the super-short period (the day after catheter removal), and at 1 and 3 months after HoLEP. We defined a mentor (mentorship) as a surgeon who had experience with 50 or more cases of HoLEP and included only one mentor in this study. This is a retrospective study and all study-related procedures were performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Urodynamic Examination

Urodynamic examination, including free uroflowmetry, filling cystometry, and pressure flow studies was performed before HoLEP [10]. We obtained informed consent by way of patient signatures for UDS. Briefly, 5-Fr feeding tubes were inserted transurethrally for bladder filling and for measuring intravesical pressure during cystometry, and an 8-Fr tube was inserted into the rectum to measure rectal pressure. The parameters investigated included maximum cystometric capacity, bladder volume at the time of the first involuntary detrusor contraction, detrusor pressure at the time of the highest involuntary detrusor contraction, and bladder compliance. The primary outcome parameters derived from the UDS results were: maximal voiding pressure (MVP), compliance, detrusor overactivity (DO), Schafer classification, volume of first desire to void (FDV), maximum cystometric capacity (MCC), and residual volume (RV) [10,11].

Holmium Laser Enucleation of the Prostate

Patients who underwent HoLEP with full UDS data were enrolled in this study. Patients with LUTS owing to BPH and who were also suspected of having prostate cancer underwent prostate biopsies first, and only patients without cancer were recommended for HoLEP. The surgical procedures carried out were as those described previously [12]. The laser setting was 72–100 W (1.8–2.5 J and 30–40 Hz). The HoLEP equipment included a high power 100-W Ho:YAG laser (VersaPulse Select; Lumenis Inc., Yokneam, Israel), a 550-μm fiber (SlimLine 550; Lumenis Inc.), a modified 26-Fr Storz continuous-flow resectoscope with a working element for stabilizing the laser fiber, a Storz rigid nephroscope, and a tissue morcellator (VersaCut system; Lumenis Inc.). Catheter indwelling time after HoLEP was 1–3 days as a rule. We herein refer to mentorship as the surgery with help by mentor as mentioned above [13].

Predictive Factors for Postoperative Incontinence

We investigated the predictive factors for postoperative incontinence following HoLEP, including potential factors, such as patient age, preoperative IPSS/QoL, the surgeon's experience (beginners: 20 cases or less; experienced: 21 cases or more), the presence of a mentor at the surgery (mentorship), and prostate size, as well as UDS factors, including MVP, compliance, DO,

Schafer classification, FDV, MCC, and RV.

Statistical Analyses

For statistical analyses, univariate and multivariate tests were performed using StatView 5.0 software (Abacus Concepts Inc., Berkley, CA, USA). Forward stepwise logistic regression analysis was conducted to determine the association between various parameters and postoperative urinary incontinence status. Statistical significance was established at the level of $P < 0.05$.

Table 1. Patients' characteristics (n = 203)

Characteristic	Value
Age (yr), median (range)	71 (34–90)
Prostate volume (mL)	76.1 ± 41.1
Resected prostate weight (g)	52.9 ± 35.3
Surgical time (min)	172 ± 63.4
Enucleation time (min)	113 ± 45.3
Morcellation time (min)	29.6 ± 28.4
Surgeons, n (%)	
Performed by experienced	84 (41.4)
Performed by beginners	119 (58.6)
Prostate cancer, n (%)	16 (7.88)

Values are presented as mean ± standard deviation unless otherwise indicated.

RESULTS

Patient and Surgeons

Patient characteristics are shown in Table 1. Briefly, the median patient age was 71 years (range, 34–90 years). Resected prostate weight was 52.9 ± 35.3 g (Table 1). Prostate cancer was detected in 16 cases (7.88%). We included 11 surgeons in this study and 10 beginner surgeons performed 119 cases indicated for HoLEP. The number of patients with incontinence at the super-short period, and at 1 and 3, and 6 months after HoLEP for cases treated by beginner surgeons was 47 (39.5%), 35 (29.4%), 20 (16.8%), and 6 (5.04%) (data not shown), respectively, and for cases treated by experienced surgeons was 33 (39.3%), 32 (38.1%), 11 (13.1%), and 4 (4.76%) (data not shown), respectively.

Predictive Factors for Post-HoLEP Incontinence

We investigated the predictive factors for urinary incontinence

Table 2. Predictive factors for incontinence at the next day of catheter removal after HoLEP in all surgeons

Variable	Univariate			Multivariate		
	Odds ratio	95% CI	P-value	Odds ratio	95% CI	P-value
Age	1.038	0.997–1.080	0.067			
Preoperative IPSS	0.987	0.944–1.031	0.551			
Quality of life	0.992	0.687–1.434	0.968			
Operation time	1.007	1.003–1.012	0.002*	0.999	0.988–1.011	0.894
Enucleation time	1.010	1.003–1.017	0.003*	1.009	0.995–1.023	0.216
Morcellation time	1.008	0.997–1.018	0.141			
Mentorship	0.697	0.367–1.323	0.270			
Resected prostate weight	1.009	1.001–1.017	0.036*	0.997	0.972–1.022	0.815
Prostate volume	1.007	1.000–1.014	0.049*	1.006	0.986–1.027	0.546
MVP	1.007	1.000–1.014	0.067			
Compliance	0.990	0.980–1.000	0.056			
Detrusor overactivity	3.336	1.826–6.095	< 0.000*	3.375	1.790–6.363	0.000*
Schafer	1.171	0.921–1.490	0.198			
First desire to void	0.998	0.994–1.002	0.419			
MCC	0.998	0.996–1.001	0.136			
Residual volume	1.000	0.997–1.002	0.899			

HoLEP, holmium laser enucleation of the prostate; CI, confidence interval; IPSS, International Prostate Symptom Score; MVP, maximum voiding pressure; MCC, maximum cystometric capacity.
*$P < 0.05$, statistical significance.

Table 3. Predictive factors for incontinence at 1 month after HoLEP in all surgeons

Variable	Univariate			Multivariate		
	Odds ratio	95% CI	P-value	Odds ratio	95% CI	P-value
Age	1.086	1.036–1.137	0.001*	1.072	1.023–1.124	0.004*
Preoperative IPSS	0.975	0.932–1.021	0.281			
Quality of life	0.749	0.517–1.086	0.127			
Operation time	1.005	1.000–1.009	0.055			
Enucleation time	1.006	1.000–1.013	0.062			
Morcellation time	1.005	0.995–1.016	0.292			
Mentorship	0.225	0.095–0.534	0.001*	0.251	0.104–0.609	0.002*
Resected prostate weight	1.008	1.000–1.016	0.057			
Prostate volume	1.008	1.001–1.015	0.024*	1.008	1.000–1.015	0.049*
MVP	1.003	0.995–1.010	0.503			
Compliance	0.994	0.985–1.004	0.237			
Detrusor overactivity	1.055	0.582–1.910	0.861			
Schafer	1.027	0.809–1.303	0.829			
First desire to void	1.003	0.999–1.008	0.107			
MCC	1.001	0.998–1.003	0.637			
Residual volume	1.001	0.999–1.004	0.316			

HoLEP, holmium laser enucleation of the prostate; CI, confidence interval; IPSS, International Prostate Symptom Score; MVP, maximum voiding pressure; MCC, maximum cystometric capacity.
*$P < 0.05$, statistical significance.

Table 4. Predictive factors for incontinence at 3 months after HoLEP in all surgeons

Variable	Univariate			Multivariate		
	Odds ratio	95% CI	P-value	Odds ratio	95% CI	P-value
Age	1.053	0.996–1.114	0.071			
Preoperative IPSS	1.007	0.951–1.067	0.802			
Quality of life	0.943	0.594–1.497	0.803			
Operation time	1.003	0.997–1.009	0.291			
Enucleation time	1.001	0.992–1.010	0.849			
Morcellation time	1.004	0.991–1.016	0.581			
Mentorship	0.509	0.184–1.406	0.192			
Resected prostate weight	1.006	0.996–1.016	0.230			
Prostate volume	1.006	0.998–1.015	0.143			
MVP	0.996	0.986–1.006	0.407			
Compliance	0.997	0.984–1.010	0.681			
Detrusor overactivity	1.328	0.601–2.932	0.483			
Schafer	0.852	0.633–1.147	0.290			
First desire to void	1.005	1.000–1.010	0.047	1.004	0.992–1.016	0.516
MCC	1.001	0.998–1.004	0.496			
Residual volume	1.001	0.998–1.004	0.393			

HoLEP, holmium laser enucleation of the prostate; CI, confidence interval; IPSS, International Prostate Symptom Score; MVP, maximum voiding pressure; MCC, maximum cystometric capacity.

Table 5. Predictive factors for incontinence at the next day of catheter removal after HoLEP in beginner surgeons

Variable	Univariate			Multivariate		
	Odds ratio	95% CI	P-value	Odds ratio	95% CI	P-value
Age	1.021	0.971–1.073	0.422			
Preoperative IPSS	0.933	0.879–0.990	0.022*	0.892	0.828–0.962	0.003*
Quality of life	1.113	0.707–1.752	0.643			
Operation time	1.003	0.998–1.009	0.257			
Enucleation time	1.003	0.994–1.012	0.490			
Morcellation time	1.003	0.991–1.016	0.585			
Mentorship	0.642	0.305–1.350	0.243			
Resected prostate weight	1.006	0.995–1.018	0.273			
Prostate volume	1.005	0.994–1.015	0.396			
MVP	1.009	1.000–1.019	0.055			
Compliance	0.991	0.979–1.002	0.118			
Detrusor overactivity	3.561	1.568–8.089	0.002*	7.069	2.235–22.358	0.001*
Schafer	1.291	0.922–1.807	0.137			
First desire to void	0.994	0.988–1.000	0.044	0.992	0.980–1.004	0.189
MCC	0.996	0.992–0.999	0.019	1.000	0.993–1.007	0.961
Residual volume	0.999	0.995–1.003	0.504			

HoLEP, holmium laser enucleation of the prostate; CI, confidence interval; IPSS, International Prostate Symptom Score; MVP, maximum voiding pressure; MCC, maximum cystometric capacity.
*P < 0.05, statistical significance.

Table 6. Predictive factors for incontinence at 1 month after HoLEP in beginner surgeons

Variable	Univariate			Multivariate		
	Odds ratio	95% CI	P-value	Odds ratio	95% CI	P-value
Age	1.099	1.028–1.174	0.005*	1.084	1.016–1.157	0.015*
Preoperative IPSS	0.961	0.900–1.026	0.234			
Quality of life	0.818	0.515–1.299	0.395			
Operation time	1.004	0.998–1.011	0.169			
Enucleation time	1.007	0.997–1.016	0.172			
Morcellation time	1.001	0.988–1.014	0.855			
Mentorship	0.304	0.127–0.730	0.008*	0.358	0.145–0.883	0.026*
Resected prostate weight	1.004	0.992–1.016	0.520			
Prostate volume	1.001	0.990–1.013	0.838			
MVP	0.999	0.989–1.009	0.880			
Compliance	0.995	0.984–1.007	0.404			
Detrusor overactivity	1.203	0.531–2.727	0.658			
Schafer	0.974	0.700–1.356	0.878			
First desire to void	1.000	0.994–1.006	0.926			
MCC	0.998	0.995–1.002	0.337			
Residual volume	1.000	0.996–1.005	0.852			

HoLEP, holmium laser enucleation of the prostate; CI, confidence interval; IPSS, International Prostate Symptom Score; MVP, maximum voiding pressure; MCC, maximum cystometric capacity.
*P < 0.05, statistical significance.

Table 7. Predictive factors for incontinence at 3 months after HoLEP in beginner surgeons

Variable	Univariate			Multivariate		
	Odds ratio	95% CI	P-value	Odds ratio	95% CI	P-value
Age	1.064	0.989–1.144	0.099			
Preoperative IPSS	0.906	0.828–0.991	0.031*	0.911	0.834–0.996	0.040*
Quality of life	1.081	0.620–1.884	0.784			
Operation time	1.008	1.000–1.015	0.046	1.005	0.994–1.016	0.375
Enucleation time	1.01	0.998–1.021	0.097			
Morcellation time	1.004	0.990–1.019	0.539			
Mentorship	0.573	0.210–1.559	0.276			
Resected prostate weight	1.005	0.991–1.019	0.499			
Prostate volume	1.002	0.988–1.016	0.767			
MVP	1.001	0.989–1.013	0.859			
Compliance	1.000	0.989–1.011	0.981			
Detrusor overactivity	1.071	0.401–2.862	0.891			
Schafer	1.090	0.736–1.614	0.668			
First desire to void	1.003	0.996–1.009	0.433			
MCC	1.002	0.998–1.006	0.454			
Residual volume	1.003	0.998–1.008	0.220			

HoLEP, holmium laser enucleation of the prostate; CI, confidence interval; IPSS, International Prostate Symptom Score; MVP, maximum voiding pressure; MCC, maximum cystometric capacity.
*P < 0.05, statistical significance.

Table 8. Predictive factors for incontinence at the next day of catheter removal after HoLEP in experienced surgeons

Variable	Univariate			Multivariate		
	Odds ratio	95% CI	P-value	Odds ratio	95% CI	P-value
Age	1.067	0.999–1.139	0.053			
Preoperative IPSS	0.995	0.925–1.072	0.905			
Quality of life	0.775	0.405–1.484	0.442			
Operation time	1.016	1.007–1.025	0.001*	1.004	0.987–1.022	0.625
Enucleation time	1.023	1.011–1.036	0.000*	1.017	0.994–1.041	0.152
Morcellation time	1.017	0.999–1.036	0.071			
Mentorship	0.6	0.425–1.024	0.979			
Resected prostate weight	1.011	0.999–1.023	0.062			
Prostate volume	1.009	1.000–1.019	0.060			
MVP	1.003	0.991–1.015	0.612			
Compliance	0.988	0.968–1.008	0.242			
Detrusor overactivity	3.208	1.288–7.992	0.012*	2.624	0.964–7.138	0.059
Schafer	1.052	0.743–1.487	0.776			
First desire to void	1.004	0.997–1.010	0.236			
MCC	1	0.997–1.004	0.773			
Residual volume	1	0.998–1.003	0.747			

HoLEP, holmium laser enucleation of the prostate; CI, confidence interval; IPSS, International Prostate Symptom Score; MVP, maximum voiding pressure; MCC, maximum cystometric capacity.
*P < 0.05, statistical significance.

Table 9. Predictive factors for incontinence at 1 month after HoLEP in experienced surgeons

Variable	Univariate			Multivariate		
	Odds ratio	95% CI	P-value	Odds ratio	95% CI	P-value
Age	0.990	0.930–1.053	0.741			
Preoperative IPSS	1.017	0.948–1.092	0.632			
Quality of life	1.173	0.623–2.210	0.621			
Operation time	1.000	0.993–1.008	0.926			
Enucleation time	1.004	0.994–1.014	0.416			
Morcellation time	0.992	0.972–1.013	0.465			
Mentorship	0.733	0.468–1.149	0.979			
Resected prostate weight	0.995	0.984–1.007	0.454			
Prostate volume	0.997	0.987–1.007	0.528			
MVP	1.006	0.994–1.019	0.320			
Compliance	1.005	0.987–1.023	0.578			
Detrusor overactivity	1.705	0.692–4.204	0.246			
Schafer	1.098	0.771–1.562	0.605			
First desire to void	1.009	1.002–1.017	0.012*			
MCC	1.002	0.999–1.005	0.243			
Residual volume	1.000	0.997–1.003	0.877			

HoLEP, holmium laser enucleation of the prostate; CI, confidence interval; IPSS, International Prostate Symptom Score; MVP, maximum voiding pressure; MCC, maximum cystometric capacity.
*P < 0.05, statistical significance.

Table 10. Predictive factors for incontinence at 3 months after HoLEP in experienced surgeons

Variable	Univariate			Multivariate		
	Odds ratio	95% CI	P-value	Odds ratio	95% CI	P-value
Age	0.956	0.873–1.048	0.335			
Preoperative IPSS	0.977	0.881–1.083	0.658			
Quality of life	1.261	0.485–3.280	0.634			
Operation time	0.990	0.977–1.003	0.123			
Enucleation time	0.984	0.966–1.003	0.096			
Morcellation time	0.994	0.965–1.025	0.709			
Mentorship	0.167	0.088–0.316	0.981			
Resected prostate weight	0.991	0.971–1.011	0.372			
Prostate volume	0.994	0.977–1.010	0.451			
MVP	0.988	0.969–1.007	0.216			
Compliance	1.003	0.979–1.027	0.795			
Detrusor overactivity	0.968	0.269–3.482	0.960			
Schafer	0.718	0.427–1.208	0.212			
First desire to void	0.995	0.985–1.005	0.343			
MCC	0.995	0.989–1.002	0.166			
Residual volume	0.996	0.990–1.003	0.300			

HoLEP, holmium laser enucleation of the prostate; CI, confidence interval; IPSS, International Prostate Symptom Score; MVP, maximum voiding pressure; MCC, maximum cystometric capacity.

for the super-short period, and at 1 and 3 months after HoLEP. Our statistical data are shown in Tables 2–10. Briefly, in the investigation of all surgeons, preoperative DO was a significant predictive factor at the super-short period after HoLEP (odds ratio [OR], 3.336; P=0.000). Even though the following variables had comparatively lower OR patient age and prostate volume were significant predictive factors at the 1-month interval after HoLEP (OR, 1.072; P=0.004 and OR, 1.008; P=0.049, respectively). Importantly, in the multivariate analyses, mentorship during surgery was an inverse significant predictive factor at the 1-month interval (OR, 0.251; P=0.002) in all patient categories.

In the classification of surgeon experience, briefly, DO and preoperative IPSS (inverse) at the super-short period after HoLEP, and patient age and mentorship (inverse correlation) at the 1 month (OR, 0.892; P=0.003; OR, 7.069; P=0.001 and OR, 1.084; P=0.015; OR, 0.358; P=0.026, respectively) and preoperative IPSS (inverse) (OR, 0.911; P=0.040) at the 3 months for beginner surgeons, were identified as significant predictive factors in multivariate analyses, and FDV at the 1-month interval after HoLEP (OR, 1.009; P=0.012) performed by experienced surgeons, was identified as a significant predictive factor in univariate analyses. These results suggest that preoperative DO is significantly correlated with incontinence at the super-short period after HoLEP considering the high OR value; for experienced surgeons, DO tended to be a predictive factor with a high OR (2.624) although this finding was not statistically significant. Importantly, mentorship significantly contributed to patient outcome with regards to continence at 1 month following HoLEP (Tables 2–10). However, no significant predictive factors were identified in either experienced surgeon category at 3-month interval after HoLEP in experienced surgeons.

DISCUSSION

Post-HoLEP incontinence has been issued as the main adverse event [14]; however, it should be prevented because patients are generally able to maintain continence preoperatively. Lerner et al. [6] stated that the risk factors for post-HoLEP stress incontinence include the number of days between cases for surgeons. On the other hand, there is a study describing a learning curve that the postoperative transient urinary incontinence rate was higher in initial cases (No. 1–50) than in the other groups (No. 51–100 and No. 101–190) [15]. Therefore, we investigated the predictive factors for post-HoLEP incontinence from the super-short period to 3 months after surgery, with a particular focus on the surgeon's level of experience. There are some arguments regarding the clinical validity of investigating the super-short period after HoLEP [16,17]; however, we believe incontinence may damage patient QoL even during the period immediately following the procedure, and, as such, we chose to include this timeframe in our examination.

In general, post-HoLEP incontinence may be due to an imbalance between the bladder's storage functions, following release of the bladder outlet obstruction, and sphincter function after HoLEP [18]. Several studies have addressed the damage to the sphincter as a risk factor for post-HoLEP incontinence, and surgical time and the surgeon's skill level can affect the risk of the sphincter damage [19]. Shah et al. [20] found, in their 280-case study, that the surgeon's experience was a significant factor for post-HoLEP incontinence, because inexperienced surgeons tended to be disoriented, and may inadvertently cause sphincter damage, or may encounter delays when dealing with the membrane at the prostate apex such that tension in the membrane would damage or affect the nearby sphincter. As to the strategies for decreasing post-HoLEP incontinence, Jeong et al. [21] stated that surgeons needed to have experience with at least 25 cases to optimize their technique, even though the learning curve for HoLEP is steep compared to other modalities, such as TURP. In addition, the presence of a mentor (mentorship) at the surgery tended to decrease surgical complications and offer better patient outcomes when compared with surgeries where no mentor was present [22]. Related to this issue, our data showed that in particular DO and mentorship (inverse correlation) were significant predictors for post-HoLEP incontinence for beginner surgeons. Moreover, FDV was a significant predictive factor for experienced surgeons, suggesting, taken together, that mentorship contributes to the prevention of post-HoLEP incontinence and the education system works well for this purpose.

Bruschini et al. [23] stated that preoperative DO or urethral sphincter insufficiency was a significant factor in urinary incontinence following surgery for BPH. Our UDS and post-HoLEP incontinence data also showed that DO was a significant factor in the super-short period after HoLEP (the next day of catheter removal) and this finding is emphasized for non-experienced surgeons.

Our data also showed that patient age was a significant predictive factor for incontinence at the 1-month interval for beginner surgeons. However, Lerner et al. [6] stated that they

found no significant differences in patient age between those with and without incontinence at 3 months following HoLEP. Elmansy et al. [18] reported that diabetes mellitus, but not patient age, was significantly associated with a higher incidence of incontinence. This difference could be attributed to the variation in sample sizes: n=66 (Lerner et al. [6]) and n=954 (Elmansy et al. [18]) vs. n=203 in our study, as well as, the number of surgeons included. To our knowledge, there are no reports that have investigated the predictive factors for post-HoLEP incontinence, as classified according to the surgeons' level of experience. Our data showed that the significant predictive factors identified for post-HoLEP in each surgeon category (based on experience) are informative, even for surgeons with a variety of experience. However, we identified no significant predictive factors in the investigation at 3 months after HoLEP in experienced surgeons; therefore, a longer period of observation is necessary as well.

A number of study limitations also remain to be addressed. First, this is a retrospective audit of patient outcomes from a single-center study. Second, several UDS parameters, including urethral length and maximum urethral closure pressure, were not assessed. Third, we did not investigate severity or type, as well as, the continuation of incontinence, with objective tests, such as the pad test or bladder diary and did not include a definitive training program for the surgeons involved in the study. Fourth, we have no available data regarding what a mentor may have pointed out in detail during the surgery, or rather, what factors may render the surgical outcome different before and after 21 HoLEP cases for beginner surgeons. However, these data are from retrospective studies conducted in teaching hospitals, implying that this study could potentially be undertaken in all institutions where HoLEP is performed. As such, the above stated limitations should be overcome in future prospective studies.

In conclusion, we found that predictive factors for post-HoLEP incontinence had variations in their time course. Especially preoperative DO at the super-short period and patient age, surgeon mentorship, and prostate volume at 1 month after HoLEP, were the representative significant predictive factors identified during our 3-month follow-up duration. Additionally, preoperative DO and surgeon mentorship were representative significant factors for beginner surgeons, while only FDV age was a significant factor for experienced surgeons. These findings should be taken into account by surgeons, in particular beginners, to maximize the patient's QoL with regards to urinary continence.

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