Comparison of Postoperative Stress Urinary Incontinence between Anteroposterior Dissection and Modified Gilling Method in Holmium Laser Enucleation of the Prostate

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Purpose: Few studies have evaluated the usefulness of anteroposterior dissection holmium laser enucleation of the prostate (HoLEP). Thus, this study investigated the incidence of stress urinary incontinence (SUI) after HoLEP and the usefulness of anteroposterior dissection HoLEP in preventing postoperative SUI.

Materials and Methods: In total, 288 patients who underwent HoLEP performed by a single experienced surgeon between May 2014 and September 2021 were enrolled. Furthermore, 134 patients underwent retrograde dissection using the modified Gilling method (surgery 1) and 154 patients underwent anteroposterior dissection HoLEP (surgery 2). The risk factors for SUI, as well as the rates of SUI improvement for the two surgical procedures, were evaluated.

Results: Postoperative SUI was observed in 58 (20.1%) of 288 patients, of whom, 48 (82.8%) recovered continence within 6 months. SUI incidence 1 month after HoLEP was 29.9% (40/134 patients) for surgery 1 and 11.7% (18/154 patients) for surgery 2; a statistically significant difference was observed between the two groups (odds ratio [OR], 0.311; 95% confidence interval [CI], 0.168–0.575; $p < 0.001$). In addition, surgery 2 was significantly associated with early recovery from SUI compared with surgery 1 (stratified hazard ratio, 0.782; 95% CI, 0.615–0.995; $p < 0.001$). The multivariable analysis demonstrated that only surgical procedure (OR, 0.350; 95%CI, 0.168–0.732; $p = 0.005$) was an independent predictor of SUI.

Conclusion: We reaffirmed that anteroposterior dissection HoLEP is a useful procedure for reducing the risk of postoperative SUI and early recovery of urinary continence.

Keywords: benign prostatic hyperplasia; enucleation; holmium laser; risk factors; urinary incontinence

INTRODUCTION

Transurethral resection of the prostate (TURP) is the gold standard for the endoscopic management of benign prostatic hyperplasia (BPH). Despite its effectiveness, TURP is associated with many adverse effects and limitations; thus, several alternative minimally invasive and effective surgical techniques have been reported recently. Holmium laser enucleation of the prostate (HoLEP), initially reported by Gilling et al in 1998, is an established surgical procedure for BPH.[1] Previous studies and reviews have shown HoLEP to be a safe and effective procedure. It is associated with lower morbidity, less bleeding, shorter catheterization time, shorter hospitalization duration, size-independence, and lower reoperation rate owing to BPH recurrence compared with TURP.[2,3] However, postoperative transient stress urinary incontinence (SUI) is a bothersome complication of this procedure. The SUI rate in the first 3 months after HoLEP ranges from 8.1% to 22.1%.[4,5] Although most patients spontaneously recover continence within 3-6 months, it is important to improve surgical procedures to promote early recovery of urinary continence or prevent urinary incontinence altogether. Improved surgical techniques, i.e., modified HoLEP have been reported to reduce the incidence of postoperative urinary incontinence.[6,7] Endo et al. reported that anteroposterior dissection HoLEP significantly reduced postoperative SUI.[6] However, no studies have yet reevaluated its usefulness or evaluated risk factors for postoperative urinary incontinence, including modified HoLEP.

This study examined risk factors for SUI after HoLEP, including two modified HoLEP, modified Gilling's method and anteroposterior dissection HoLEP, performed by a single surgeon, as well as the utility of anteroposterior dissection HoLEP for preventing postoperative SUI.

MATERIALS AND METHODS

Study population

The study was conducted in accordance with the guidelines of the 1964 Declaration of Helsinki and its later amendments and was approved by the ethics committee of Tokyo Medical University (no. T2022-0085). This retrospective study was performed using data from medical records of all patients undergoing HoLEP at the Tokyo Medical University Hachioji Medical Center between May 2014 and May 2020 and at the Tokyo Medical University Hospital between June 2020 and September 2021.

All HoLEP surgeries were performed by a single ex-

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Table 1. Baseline patients' characteristics, symptom score, and urinary function by surgical procedure.

Variable	Surgery 1 (N=134) Mean ± SD or N (%)	Surgery 1 (N=134) Median, (Q1-Q3)	Surgery 2 (N=154) Mean ± SD or N (%)	Surgery 2 (N=154) Median, (Q1-Q3)	*P*-value
Preoperative data					
Age (years)	71.7 ± 7.1	69 (62-82)	72.6 ± 6.5	69 (65-74)	0.263†
BMI (Kg/m^2)	23.1 ± 3.4	24.1 (22.5-24.1)	23.6 ± 3.0	24.5 (23.0-28.5)	0.179†
Serum PSA (ng/mL)	9.76 ± 10.22	5.2 (1.4-7.2)	7.28 ± 8.13	4.9 (3.9-6.7)	0.025†
Total prostate volume (mL)	95.6 ± 47.3	93.3 (66.5-125.5)	64.8 ± 29.8	55.1 (36.6-71.5)	< 0.001†
Transitional zone volume (mL)	36.4 ± 20.5	27.0 (19.0-43.3)	38.0 ± 23.2	29.9 (19.3-40.5)	0.749†
history of acute urinary retention (N, %)	72 (53.7%)	-	72 (46.8%)	-	0.237§
Subjective symptoms					
IPSS total	19.0 ± 7.4	21 (17-30)	18.0 ± 8.4	22 (16-29)	0.441†
IPSS-QOL	4.9 ± 1.1	5 (4-6)	4.5 ± 1.5	5 (4-6)	0.591‡
Urodynamic study					
Qmax (mL/s)	7.5 ± 3.5	4.7 (3.9-9.3)	8.6 ± 4.4	7.6 (5.1-11.1)	0.080‡
Mean flow rate (mL/s)	4.4 ± 1.9	2.4 (1.8-4.6)	3.8 ± 1.8	2.7 (2.2-4.7)	0.070‡
Voided volume (mL)	160 ± 97	118 (68-150)	158 ± 94	138 (75-209)	0.892†
Postvoid residual (mL)	112 ± 81	168 (77-274)	150 ± 113	134 (91-213)	0.018‡

Surgery 1: retrograde dissection based on modified Gilling's method, Surgery 2: anteroposterior dissection HoLEP.
†Student's *t* test
‡Mann-Whitney *U* test
§Chi-squared test
Abbreviations: BMI, body mass index; IPSS, International Prostate Symptom Score; QOL, quality of life; Qmax, maximum flow rate; SD, Standard deviation; Q1-Q3, Interquartile range

perienced surgeon (T.S.) with more than 400 cases of HoLEP surgical experience at the commencement of this study. HoLEP was recommended for patients with prostate volume ≥ 30 ml, moderate and severe lower urinary tract symptoms with International Prostate Symptom Score (IPSS) ≥ 8, maximum flow rate (Qmax) ≦ 5 ml/s, postvoid residual (PVR) ≥ 100 ml, or urinary retention despite medical therapy.
Patients with a preoperative or postoperative histopathological diagnosis of prostate cancer and a possibility of treatment intervention for prostate cancer, or patients with dementia or other difficulties in answering the IPSS/QOL questionnaire were excluded from the study.
In total, 296 patients underwent HoLEP during the study period. Eight patients were excluded owing to lost follow-up. Ultimately, 288 patients were included in this study.

Surgical procedures

For enucleation, a Holmium YAG (Ho:YAG) laser generator (Versapulse®, Lumenis Inc., Santa Clara, CA, USA) was set to 78–100 W (2.6 J × 30 Hz to 2.5 J × 40 Hz), and a reusable 550-micron laser fiber (SlimLineTM 550, Lumenis Inc. Yokneam, Israel) was inserted through a modified continuous-flow 26 Fr endoscope. Enucleated adenomas were collected using a tissue morcellator (VersaCut®, Lumenis) inserted through a rigid indirect nephroscope.
Enucleation procedures for surgery 1 (modified Gilling's method) and surgery 2 (anteroposterior dissection HoLEP) are summarized in Figure 1. In brief, these HoLEP procedures generally employed a "three-lobe" technique, and the enucleation of the median lobe was the same in both surgical procedures.

Surgery 1

From May 2014 to December 2016, 134 patients underwent retrograde dissection based on modified Gilling's method.[8] However, because of the anatomy of the prostatic apex and urethral sphincter,[9,10] dissection and enucleation were performed to preserve the urethral mucosa between the 11-o'clock and 1-o'clock positions of the prostate roof, approximately 1 cm proximal to the level of the verumontanum herein (designated surgery 1).

Surgery 2

For the 154 cases from January 2017 to September 2021, the anteroposterior dissection HoLEP method reported by Endo et al. was performed to preserve not only the prostate roof mucosa, but also the mucosa of the side of the verumontanum as much as possible (designated surgery 2).[6] In both groups, the urethral catheter was generally removed 2 days after surgery, and pelvic floor muscle training was performed systematically.

Table 2. Patients' perioperative data by surgical procedure.

Variable	Surgery 1 (N=134) Mean ± SD	Surgery 1 (N=134) Median, IQR	Surgery 2 (N=154) Mean ± SD	Surgery 2 (N=154) Median, IQR	*P*-value
Operation time (min)	120.3 ± 49.1	112.0 (80.0-148.0)	115.0 ± 44.7	99.0 (78.0-137.0)	0.345†
Enucleation time (min)	75.0 ± 40.5	64.0 (40.0-101.0)	72.2 ± 39.3	58.0 (39.0-75.0)	0.551†
Morcellation time (min)	19.6 ± 14.7	16.0 (7.5-25.5)	12.6 ± 11.6	10.0 (6.5-18.0)	< 0.001‡
Enucleated prostate weight (g)	46.0 ± 30.3	42.0 (25.5-67.0)	36.0 ± 23.9	28.7 (14.9-46.5)	< 0.001†
Laser energy used (kJ)	158.7 ± 70.1	139.5 (111.1-139.5)	131.3 ± 53.8	122.6 (92.0-159.2)	< 0.001†
Hemoglobin loss (g/dL)	1.3 ± 1.0	1.5 (1.0-1.9)	1.2 ± 1.4	1.3 (1.0-1.8)	0.251†
Length of stay (day)	5.4 ± 1.7	5.0 (5.0-5.0)	5.6 ± 1.9	5.0 (5.0-5.0)	0.338†

Surgery 1: retrograde dissection based on modified Gilling's method, Surgery 2: anteroposterior dissection HoLEP.
†Student's *t* test
‡Mann-Whitney *U* test
Abbreviations: SD, Standard deviation; IQR, Interquartile range

Table3. Univariate and multivariate logistic regression analysis for predicting postoperative stress urinary incontinence.

Variable	Univariate analysis Odds ratio (95% CI)	*P*-value	Multivariate analysis Odds ratio (95% CI)	*P*-value
Baseline characteristic				
Age (years)	1.035 (0.991 – 1.081)	0.12	1.047 (0.994 – 1.103)	0.084
BMI (Kg/m^2)	1.003 (0.916 – 1.099)	0.947	0.989 (0.893 – 1.095)	0.831
Prostate volume (mL)	1.009 (1.003 – 1.016)	0.007	0.996 (0.982 – 1.011)	0.634
History of urinary retention	0.858 (0.459 – 1.605)	0.633	0.530 (0.263 –1.067)	0.075
Perioperative data				
Surgery 2 vs Surgery 1	0.344 (0.177 – 0.668)	< 0.001	0.350 (0.168 – 0.732)	0.005 a
Operation time (min)	1.005 (0.999 – 1.011)	0.122	0.996 (0.983 – 1.008)	0.521
Enucleated prostate weight (g)	1.012 (1.002 – 1.022)	< 0.001	1.011 (0.991 – 1.032)	0.287
Laser energy used (kJ)	1.009 (1.004 – 1.014)	< 0.001	1.009 (1.000 – 1.017)	0.052

a Significant *P*-value < 0.05.
Abbreviations: BMI, body mass index.
Surgery 1: retrograde dissection based on modified Gilling's method, Surgery 2: anteroposterior dissection HoLEP.

Demographic and outcome data

Preoperative demographic data included the patient's age, body mass index, IPSS, IPSS-quality of life (QOL) questionnaires, Qmax, PVR, serum prostate-specific antigen (PSA) level, prostate volume, and presence of urinary retention. Perioperative variables, including operation time, enucleated prostate weight, changes in serum hemoglobin concentration, and laser energy used,

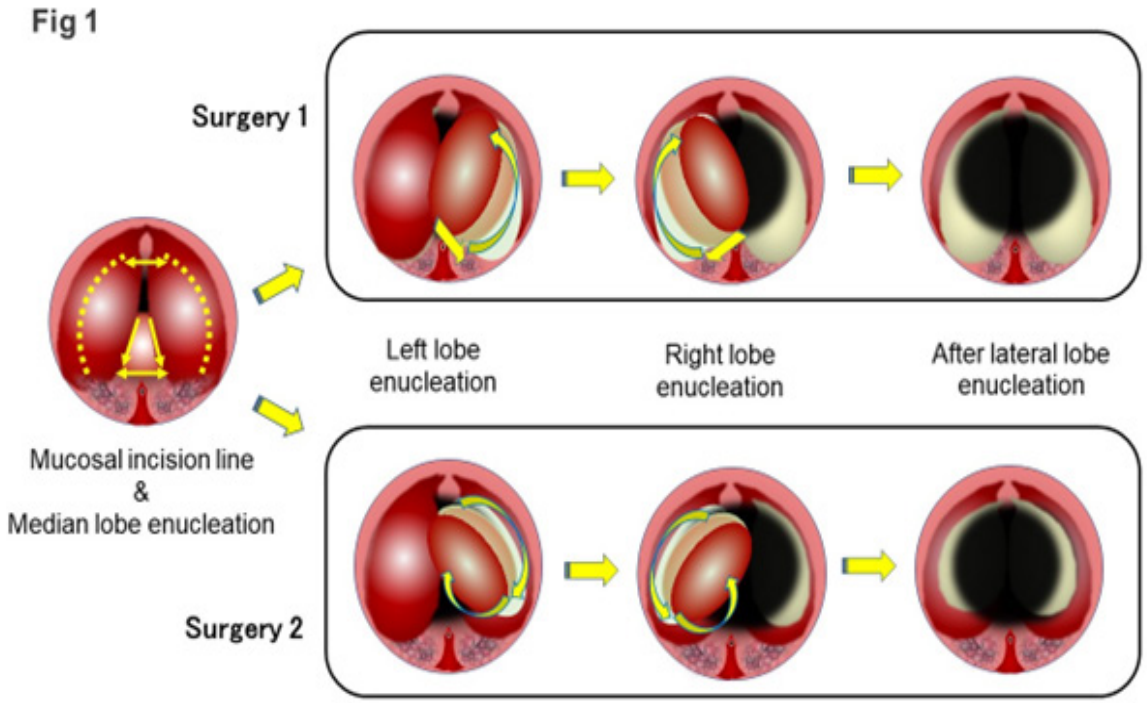

Figure 1: Procedures for surgery 1 and 2 (three-lobe technique)
Enucleation of the median lobe (Common to both procedures)
A transverse incision was made at the proximal site of the verumontanum between the 5-o'clock and 7-o'clock positions throughout the depth of the capsule, and two vertical incisions were made at the 5-o'clock (between the left lateral lobe and the median lobe) and 7-o'clock (between the right lateral lobe and the median lobe) positions proximally at the bladder neck in the case of the three-lobe technique or only on one side in the case of the two-lobe technique. The posterior plane of the median lobe was detached from the capsule using a retrograde approach, and the median lobe was enucleated.
Surgery 1
To avoid injuries to the sphincter and mucosal defect around the 12-o'clock position, a transverse mucosal incision was made between the 11 o'clock and 1 o'clock positions on the prostatic roof approximately 1 cm proximal to just above the verumontanum, and longitudinal incisions were made from the bladder neck to this incision line. An apex side mucosal incision was then made between the 1 o'clock and 5-o'clock positions and between the 11-o'clock and 7 o'clock positions according to the shape of the adenoma. Subsequently, enucleation was performed according to the procedure described by Gilling et al.
Surgery 2
The incision on the prostate roof and enucleation of the median lobe were the same as those in surgery 1. The lateral lobe was dissected from the surgical capsule at the 12-o'clock position (middle of the adenoma), retracting the adenoma downward. This separation layer was then extended anteroposterior and downward towards the 6-o'clock apical adenoma. At this point, the endoscope is switched from the reverse hand to the forward hand, and the weight of the adenoma and the endoscope is used to efficiently detach the adenoma. When the separated area from the upper side reaches the lower edge of the adenoma, the apical urethral mucosa between the 12 o'clock and 5 o'clock positions tears off naturally from the capsule without damaging the ring formed by the sphincter muscle, and the remaining apical belt-shaped urethral mucosa is completely separated from the adenoma and can then be cut off without sphincteric damage. This procedure is called "anteroposterior dissection HoLEP."
Generally, both surgical procedures were performed using the three-lobe technique; however, if enlargement of the middle lobe was not observed, the two-lobe technique was used. Enucleated tissue was then removed using a morcellator.
HoLEP, Holmium laser enucleation of the prostate

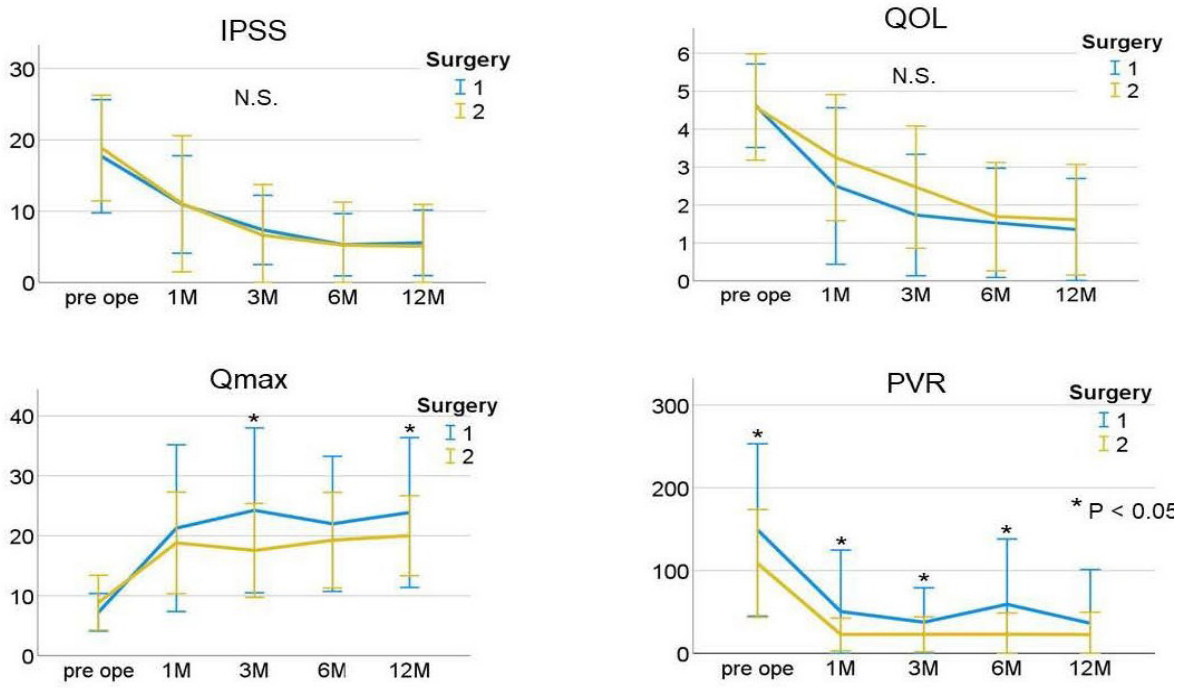

Figure 2: Mean change (standard error) in symptoms and voiding parameters from baseline at each visit in surgery 1 and 2 with respect to (a) IPSS; (b) QOL score; (c) Qmax (mL/s); (d) PVR (mL). There were significant differences in Qmax at 1, 3, and 12 months, and in PVR at 1, 3, and 6 months after HoLEP between the two groups. IPSS = International Prostate Symptom Score; PVR = Postvoid residual; Qmax = Maximum flow rate; QOL = Quality of life

were also investigated. Postoperative evaluations were systematically performed at 1, 3, 6, and 12 months. At each follow-up point, IPSS and IPSS-QOL questionnaires, as well as flow measurements with PVR, were performed. Urinary incontinence was defined as requiring the use of pads, based on the recommendations of the International Continence Society, and more than one pad needed for urinary control.[11] The patients with or without urinary incontinence and the type of incontinence were recorded at each visit. We included patients with SUI and mixed urinary incontinence and excluded those with urge urinary incontinence alone.

Statistical analysis

For group comparisons of continuous variables, Student's t-test or the Mann-Whitney U test was performed depending on the results of the Kolmogorov–Smirnov test. The chi-squared test was used to examine categorical variables. To evaluate the risk of SUI between groups after the adjustment for confounding variables, a multivariable logistic regression was conducted. A survival analysis was applied, setting the day of surgery as the origin, to examine the duration required for SUI recovery. In addition to the Kaplan-Meier method and log-rank test, a univariate Cox regression analysis was used to estimate the hazard ratio. Statistical significance was set at $p < 0.05$. Further details are provided in the appendix. Analyses were computed using SPSS® version 28 (IBM Corp., Armonk, NY, USA).

RESULTS

Patient baseline characteristics and the urinary condition are summarized in Table 1. There were significant differences in the preoperative PSA level, total prostate volume, and PVR between the surgery 1 and 2 groups.

Table 2 shows perioperative data. There were significant differences in morcellation time and laser energy used between the two groups.

Changes in urinary conditions after HoLEP are shown in Figure 2. IPSS and QOL scores significantly decreased 1 month after HoLEP in both groups. In addition, Qmax improved and PVR decreased in both surgery groups. However, there were significant differences in Qmax at 1, 3, and 12 months and in PVR at 1, 3, and 6 months after HoLEP between the two groups.

Postoperative SUI was observed in 58 (20.1%) patients. The incidence of SUI at 1 month after HoLEP was 29.9% (40/134 patients) for surgery 1 and 11.7% (18/154 patients) for surgery 2; a statistically significant difference was observed between the two groups ($p < 0.001$) (**Figure 3a**).

Of the 58 patients with urinary incontinence, 36 (62.1%) recovered continence within 3 months, 12 (20.7%) recovered continence at 3–6 months, and 10 (17.2 %) recovered continence after 6 months.

Surgery 2 was significantly associated with early recovery from SUI compared to surgery 1 (stratified hazard ratio, 0.782; 95%CI, 0.615–0.995; $p < 0.001$) (**Figure 3b**).

On univariate analysis, prostate volume, surgical procedure, enucleated prostate weight, and laser energy used were risk factors for postoperative SUI; only surgical procedure remained an independent risk factor on the multivariable analysis (OR, 0.350; 95%CI, 0.168–0.732; $p = 0.005$) (**Table 3**).

DISCUSSION

The efficacy and minimal invasiveness of HoLEP have been confirmed in randomized clinical trials; however, the technique is cumbersome, difficult for surgeons

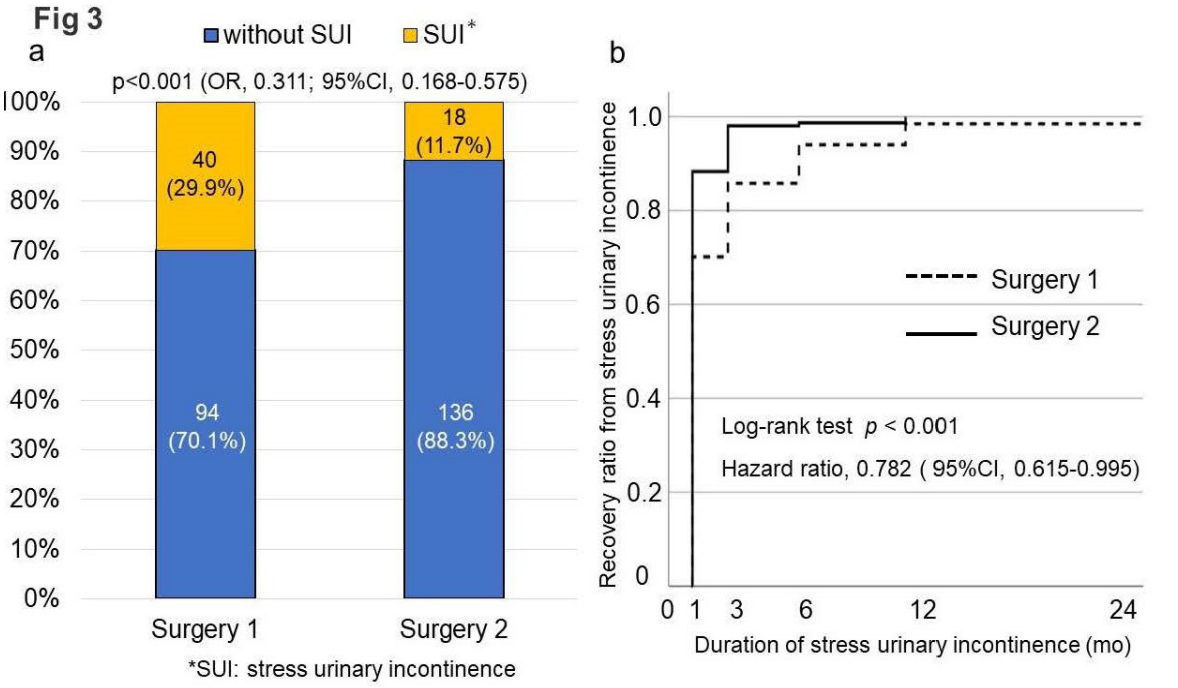

Figure. 3 Comparison of recovery rate of SUI depending on its duration in surgery 1 and 2. 3a SUI rates were 29.9% (40/134) for surgery 1 and 11.7% (18/154) for surgery 2, with a statistically significant difference between the two groups (odds ratio [OR], 0.311; 95% confidence interval [CI], 0.168–0.575; p < 0.001). 3b Recovery ratio of stress urinary incontinence depending on its duration. The beginning was the date of surgery, the confirmation of urinary continence started at the 1st month, and the end time was the 24th month. The recovery ratio of stress urinary incontinence depended on this duration. In surgery 1, SUI lasted for < 6 months in 32 (23.9%) patients and for > 6 months in 8 (6.0%) patients. For surgery 2, SUI lasted for < 6 and > 6 months in 16 (10.4%) and 2 (1.3%) patients, respectively.

to learn, and may lead to postoperative complications during the surgeon's process of technical acquisition. In addition, even experienced surgeons often encounter several postoperative complications. Postoperative SUI after HoLEP is transient and usually resolves within 3–6 months. However, some patients have reported long-term urinary incontinence. A higher incontinence rate is reported to be associated with procedures performed by surgeons with less experience and is thought to be associated with the difficulty of learning the procedure.[12-14] Age, prostate volume, BMI, weight of the surgical enucleation, inappropriate enucleation, preoperative urinary drainage, and longer operation time may affect the incidence of SUI after HoLEP.[14-17] In addition, excessive laser irradiation at the prostate apex may also induce thermal injury to the urethral sphincter and anterior fibromuscular stroma, thereby increasing the incidence of SUI.[18-19] Since the first report by Gilling,[1] several modified HoLEP techniques have been reported to reduce the risk of postoperative SUI.[6,7] Endo et al. reported that anteroposterior dissection HoLEP, in which dissection is performed from the bladder neck to the apex, decreased the rate of postoperative SUI from 25.2% to 2.7%.[6] They hypothesized that their technique reproduced an open simple prostatectomy procedure that may reduce the rate of postoperative SUI because it does not stretch the internal layer of the external urethral sphincter. They also stated that this procedure is technically simple, and surgeons can learn it quickly. We also consider that this technique is easy to learn not only for surgeons familiar with the Gilling method but also for HoLEP novices, because traction is applied by the weight of the endoscope and adenoma, making it easy to enucleate the lateral lobes. However, if identification of the dissected layer is difficult, it is recommended to lower the pulse rate and carefully locate the dissected layer while tractioning the upper margin of the adenoma downward.

According to a review of the urethral sphincter by Walz et al., "the inner muscular layer of the urethral sphincter surrounds the urethra, which is composed of smooth muscle fibers and elastic tissue and is subdivided into an outer circumferential and an inner longitudinal-oriented layer".[20] At the apex of the prostate, the adenoma protrudes distally and compresses the muscle fibers of the urethral sphincter distally, whereas near the verumontanum and urethral crest, the sphincter muscle is fused and attached to the smooth fibers of the urethra.[21,22] The external urethral sphincter and the layer of the urethral smooth muscle are contiguous, which is thought to allow for the maintenance of high urethral retention pressure. If the mucosa is incised close to the verumontanum, and the lateral lobes are enucleated, the continuity between the external urethral sphincter and urethral smooth muscle is severed, and SUI may be prolonged. Therefore, we consider that anteroposterior dissection HoLEP not only reduces the excessive load on the sphincter during lateral lobe enucleation, but also preserves more of the mucosa on the outer side of the verumontanum, thereby reducing the destruction of the connection between the urethral sphincter and urethral smooth muscle.

In this study, we compared two different HoLEP procedures (modified Gilling's method and anteroposterior dissection). SUI was observed within 1 month after HoLEP in 58 patients (20.1%). However, 48 (82.8%) of the 58 patients recovered continence within 6 months. Patients who underwent anteroposterior dissection

HoLEP showed significantly earlier recovery from SUI than those who underwent HoLEP using the modified Gilling's method. The multivariable analysis demonstrated that anteroposterior dissection HoLEP was an independent predictor of early continence recovery. Therefore, we believe that anteroposterior dissection HoLEP is a useful procedure for reducing the risk of postoperative SUI and early recovery of continence.

However, compared to the modified Gilling's method, anteroposterior dissection HoLEP tended to have lower postoperative QOL, lower Qmax, and higher PVR, despite a lower postoperative SUI complication rate. This may be because the modified Gilling's method had a higher proportion of patients with preoperative urinary retention, higher patient satisfaction with the postoperative catheter-free status, and better Qmax.

In particular, anteroposterior dissection HoLEP preserved more of the mucosa outside the seminal vesicle, resulting in lower Qmax and higher PVR compared to the modified Gilling's method. However, we believe that these differences are acceptable for both patients and clinicians because there was no significant difference in postoperative IPSS between the two surgery groups.

Our study had several limitations. First, it was retrospectively conducted at two academic hospitals where a single surgeon performed HoLEP at different periods. Therefore, the number of cases in each hospital was relatively small, and there were significant differences in several variables at baseline between the two groups. This might be due to the regional characteristics related to the locations of the hospitals. Second, the modified Gilling's method was performed from May 2014 to May 2020, while anteroposterior dissection HoLEP was performed later from June 2020 to September 2021. Therefore, it is plausible that increased HoLEP experience decreased the postoperative SUI rate in anteroposterior dissection HoLEP, although this series of HoLEP was performed by a single experienced surgeon who had performed more than 400 cases of HoLEP prior to the study period. It is thought that there was little effect of the surgeon's experience between the two surgery groups.

The preoperative prostate volume and intraoperative laser energy used were greater in the modified Gilling's method group than in the anteroposterior dissection HoLEP group, which could also have contributed to the better outcome of anteroposterior dissection HoLEP. Despite these limitations, we believe that anteroposterior resection of HoLEP is a useful method for reducing the risk of postoperative SUI and for early recovery of urinary continence.

CONCLUSIONS

In the present study, we found that surgical technique was an independent risk factor for postoperative SUI after HoLEP. Anteroposterior dissection HoLEP has a low complication rate of postoperative SUI, and even when SUI is a complication, continence is restored early, reaffirming that anteroposterior dissection HoLEP is a useful technique. Although this technique can be easily learned by urologists who have mastered conventional HoLEP and may shorten the learning process for HoLEP novices, further comparative studies are needed to clarify the effect of this technique on the HoLEP learning process.

SUMMARY

We evaluated risk factors for postoperative stress urinary incontinence (SUI) after holmium laser enucleation of the prostate (HoLEP), and only the technique was an independent risk factor. Anteroposterior dissection HoLEP reduced postoperative SUI rates.

CONFLICT OF INTEREST

There is no potential conflict of interest to declare.

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