European Review for Medical and Pharmacological Sciences 2024; 28: 2396-2402

Comparison of urinary incontinence following three different prostate apex disconnection techniques in transurethral thulium laser prostatectomy

X.-B. MENG[1], Y. LI[2], Z.-H. GAO[1], C.-J. WANG[1], Y.-M. GU[1]

[1]Department of Urology, Peking University First Hospital - MiYun Hospital, Beijing, China
[2]Department of Urology, The Third Hospital of Hebei Medical University, Shijiazhuang, China

Xuebing Meng and Yue Li contributed equally to this study

Abstract. – OBJECTIVE: This study investigates the incidence of urinary incontinence following transurethral thulium laser prostatectomy with three different prostate apex disconnection techniques: semi-separation, pre-separation, and post-separation. The findings aim to provide references for clinical treatment.

PATIENTS AND METHODS: A retrospective analysis was conducted on 74 patients treated with transurethral thulium laser prostatectomy for prostatic hyperplasia from April 2022 to March 2023. Complete clinical and follow-up data were available for 52 patients. Clinical and follow-up data were collected for these patients. A comparison was made of urinary incontinence following the three different types of prostate apex disconnection in transurethral thulium laser prostatectomy.

RESULTS: In this study, the immediate postoperative urinary incontinence rate for transurethral thulium laser prostatectomy was 9.62% (5/52), the short-term incontinence rate was 11.54% (5/52), and the long-term incontinence rate was 9.62% (5/52). The immediate postoperative incontinence rates for semi-separation, pre-separation, and post-separation were 8.33% (1/12), 8.33% (2/24), and 12.5% (2/16), respectively. The short-term incontinence rates for semi-separation, pre-separation, and post-separation were 8.33% (1/12), 8.33% (2/24), and 18.75% (3/16), respectively. The long-term incontinence rates for semi-separation, pre-separation, and post-separation were 8.33% (1/12), 8.33% (2/24), and 12.5% (2/16), respectively.

CONCLUSIONS: The incidence of urinary incontinence following transurethral thulium laser prostatectomy was lower with semi-separation and pre-separation compared to post-separation.

Key Words:
Prostatectomy, Prostatic apex, Urinary incontinence, TURP.

Introduction

Benign Prostatic Hyperplasia (BPH) is a leading cause of Lower Urinary Tract Symptoms (LUTS) in the aging male population, with prevalence correlating positively with advancing age[1,2]. Surgical intervention is often deemed the most effective modality for managing BPH[3]. In the realm of surgical options, Transurethral Resection of the Prostate (TURP) has been traditionally regarded as the "gold standard" for BPH treatment over several decades[4]. However, Transurethral Thulium laser Resection of the Prostate (THLRP) has recently gained increasing traction and wider application in the clinical setting[5-7]. Postoperative complications associated with these procedures can significantly impact patient quality of life[4,8,9].

Urinary incontinence stands out as one of the most challenging sequelae following prostatectomy, attributed to postoperative anatomical and functional alterations[10]. The incidence of immediate postoperative urinary incontinence has been reported to range between 8.5% and 42.7%[11], while long-term incontinence rates vary from 4% to 69%[4,12,13]. Despite most patients regaining urinary control within a fortnight postoperatively through pelvic floor muscle exercises, the complication of early incontinence post-procedure can elicit apprehensions about the surgical outcome and increase the psychological burden, particularly among less experienced surgeons[14]. Hence, the implementation of techniques aimed at minimizing early urinary incontinence is of paramount importance.

In this study, by comparing the urinary control outcomes following pre-separation and semi-separation *vs.* post-separation prostatectomy, we aim to provide clinical practitioners with therapeutic references for reducing postoperative urinary incontinence.

Corresponding Author: Yaming Gu; MD; e-mail: gymmiyun@126.com

Patients and Methods

A total of 74 patients with BPH underwent TURP at the Urology Department of Peking University First Hospital-Miyun Hospital, between April 2022 and March 2023. Among these, 52 patients had complete baseline and follow-up data. The TURP procedure was performed using one of three techniques for prostate apex disconnection: semi-separation (n=12), pre-separation (n=24), and post-separation (n=16). Clinical and follow-up data were collected, including baseline demographics, preoperative residual urine volume, prostate specific antigen (PSA) levels, prostate mass, and nocturia frequency. The primary follow-up outcome was postoperative urinary incontinence.

Inclusion criteria were: 1) age 45-85 years; 2) radiological diagnosis of BPH; 3) complete baseline and follow-up data.

Exclusion criteria included: 1) history of prostate cancer or postoperative pathology indicative of prostate cancer; 2) coagulation disorders; 3) cardiopulmonary dysfunction.

This study was conducted in accordance with the principles of the Declaration of Helsinki (2013 revision) and was approved by the Ethics Committee of Peking University First Hospital-Miyun Hospital. Informed consent for this retrospective analysis was waived.

Surgical Technique

After successful anesthesia, the patient is positioned for lithotomy, followed by routine disinfection and draping. The thulium laser is set to an energy of 60W, 1.5J. A 25°F26 urethrocystoscope (Hawk, Hangzhou, China) is inserted through the urethra to observe the bilateral lobes, middle lobe, anterior lobe proliferation, ureteric orifices, and the interior of the bladder. The thulium laser fiber creates an inverted U-shaped standard groove at the level of the verumontanum, deepening to the prostate surgical capsule. Resection of the lateral lobes is performed using a combination of sharp (laser) and blunt (sheath levering) dissection at the 5 and 7 o'clock positions along the urethra. The dissection extends to the 1 and 11 o'clock positions (mucosal bridge), separating the lateral lobes towards the bladder neck. The mucosal bridge near the gland side is severed with the laser. After opening the bladder neck, the gland body is pushed into the bladder cavity. Residual glandular tissue and nodules within the prostatic fossa are repaired, and complete hemostasis of the surgical site is achieved. A morcellator is used to fragment and evacuate prostate tissue. Before withdrawing the scope, normal urine spraying from both ureteric orifices is observed, the prostate apex is fully open, displaying a "door-like" change, with smooth abdominal pressure micturition and no leakage after removal of abdominal pressure. A triple-lumen catheter (Bard, NJ, USA) is placed for continuous bladder irrigation.

Pre-separation: laser circumferential disconnection is performed at 0.5-1 cm within the prostatic urethral mucosa. Semi-separation: at 5 and 7 o'clock positions, dissection is carried out to reveal the surgical capsule, then bluntly or sharply extended laterally to near the 1 and 11 o'clock mucosal positions before disconnection. Post-separation: the 12 o'clock mucosa and glandular tissue are treated after entering the bladder.

Follow-Up

Patients had their catheters removed one week postoperatively. Postoperative urinary incontinence was assessed through telephone follow-up. Immediate incontinence was defined as using 0-1 urinary pad per day within 1-2 weeks postoperatively[15]. Short-term incontinence was defined as the need to use urinary pads within 1 month postoperatively[16]. Long-term incontinence was defined as the need to use urinary pads 6 months postoperatively[17].

Statistical Analysis

Data were analyzed using SPSS 22.0 (IBM Corp., Armonk, NY, USA). Quantitative variables included age, preoperative residual urine volume, PSA levels, prostate mass, and nocturia frequency. Qualitative variables included gender, diabetes, hypertension, and hyperlipidemia. Normally distributed data were expressed as mean ± standard deviation, and skewed data as median (range). Continuous variables following a normal distribution were analyzed using the *t*-test, and those not following a normal distribution with the Mann-Whitney U test. Categorical variables were analyzed using Fisher's exact test. Statistical significance values were set at $p<0.05$.

Results

Urinary Incontinence Post Transurethral Thulium Laser Prostatectomy

Baseline patient data are presented in Table I. In this study, the incidence of immediate urinary

incontinence post transurethral thulium laser prostatectomy was 9.62% (5/52), the short-term incontinence rate was 11.54% (6/52), and the long-term incontinence rate was 11.54% (6/52).

Comparison of Urinary Incontinence in Semi-separation vs. Post-separation Following Transurethral Thulium Laser Prostatectomy

Clinical data for patients in the semi-separation and post-separation groups are shown in Table II. The incidence of immediate urinary incontinence post-prostatectomy in the semi-separation group was 8.33% (1/12), compared to 12.5% (2/16) in the post-separation group, with no significant statistical difference between the two groups (p=0.72). The short-term incontinence rate was 8.33% (1/12) in the semi-separation group and 18.75% (3/16) in the post-separation group, again showing no significant statistical difference (p=0.61). The long-term incontinence rate was 8.33% (1/12) in the semi-separation group *vs.* 18.75% (3/16) in the post-separation group, with no significant statistical difference noted (p=0.61). There was no significant statistical difference in postoperative urinary

Table I. Basic characteristics of the patients.

Variable	Mean (SD) or n/N
Patients	52
Mean age (years)	67.31±7.32
BMI (kg/m^2)	23.62±2098
Hypertension, n (%)	
Yes	15 (28.85%)
No	37 (71.15%)
Diabetes mellitus, n (%)	
Yes	2 (3.85%)
No	50 (96.15%)
CHD, n (%)	
Yes	6 (11.54%)
No	46 (88.46%)
Prostate mass (g)	67.46±29.57
Nocturia (second)	4.68±1.42
Preoperative residual urine (mL)	133.37±130.07
Maximum flow rate (ml/s)	9.21±7.30
PSA (ng/mL)	5.95±4.84
Surgical Procedures, n (%)	
Pre-separation	12 (23.08%)
Post-separation	16 (30.77%)
Semi-separation	24 (46.15%)
Immediate incontinence, n (%)	5 (9.62%)
Short-term urinary incontinence, n (%)	6 (11.54%)
Chronic urinary incontinence, n (%)	6 (11.54%)

BMI: body mass index; PSA: prostate specific antigen; CHD: coronary heart disease.

Table II. Comparison of urinary incontinence after post-separation *vs.* pre-separation prostate aponeurotomy.

Variable	Post-separation group	Pre-separation group	*p*-value
Patients, n (%)	16	12	
Mean age (years)	67.88±7.05	68.64±6.44	0.79
BMI (kg/m^2)	24.35±3.44	23.63±3.21	0.61
Hypertension, n (%)			0.69
Yes	4 (25%)	4 (33.33%)	
No	12 (75%)	8 (76.67%)	
Diabetes mellitus, n (%)			
Yes	1 (6.25%)	0 (0%)	0.38
No	15 (93.75%)	12 (100%)	
CHD, n (%)			0.24
Yes	3 (18.75%)	0 (0%)	
No	13 (81.25%)	12 (100%)	
Prostate mass (g)	98.45±74.43	70.76±31.51	0.71
Nocturia (second)	4.36±0.93	5.11±1.29	0.18
Preoperative residual urine (mL)	187.17±105.49	162±147.62	0.75
Maximum flow rate (ml/s)	10.9±5.25	7.23±3.98	0.09
PSA (ng/mL)	5.95±5.48	5.78±4.26	0.94
Immediate incontinence, n (%)			0.72
Yes	2 (12.5%)	1 (8.33%)	
No	14 (87.5%)	11 (91.67%)	
Short-term urinary incontinence, n (%)			0.61
Yes	3 (18.75%)	1 (8.33%)	
No	13 (81.25%)	11 (91.67%)	
Chronic urinary incontinence, n (%)			0.61
Yes	3 (18.75%)	1 (8.33%)	
No	13 (81.25%)	11 (91.67%)	

BMI: body mass index; PSA: prostate specific antigen; CHD: coronary heart disease.

incontinence between the two groups; however, the incidence of incontinence was higher in the post-separation group.

Comparison of Urinary Incontinence in Pre-separation vs Post-separation Following Transurethral Thulium Laser Prostatectomy

Clinical data for patients in the pre-separation and post-separation groups are detailed in Table III. The incidence of immediate urinary incontinence in the pre-separation group was 8.33% (2/24), compared to 12.5% (2/16) in the post-separation group, with no significant statistical difference between the groups (p=0.67). The short-term incontinence rate was 8.33% (2/24) in the pre-separation group and 18.75% (3/16) in the post-separation group, also showing no significant statistical difference (p=0.37). The long-term incontinence rate was 8.33% (2/24) in the pre-separation group *vs.* 18.75% (3/16) in the post-separation group, with no significant statistical difference (p=0.37). There was no significant statistical difference in postoperative urinary incontinence between the two groups; however, the incidence of incontinence was higher in the post-separation group.

Discussion

BPH is a common cause of male LUTS. The prevalence of this condition increases with age, reaching up to 90% in males aged 70 years and above[18]. Currently, surgery remains a crucial treatment modality for BPH, particularly for patients with moderate to severe LUTS, significantly affecting their quality of life[19]. This study primarily explores the differences in postoperative urinary incontinence following transurethral thulium laser prostatectomy with three different prostate apex disconnection techniques. Different approaches to handling the prostate apex have varying impacts on the urethral sphincter. We hypothesize that post-separation of the prostate apex may result in repeated traction and consequent damage to the urethral sphincter. Our findings suggest lower rates of postoperative urinary incontinence with semi-separation and pre-separation techniques compared to post-separation.

Previous studies have mainly focused on exploring preoperative risk factors for postoperative urinary incontinence in prostatectomy, thereby providing references for clinical practitioners to reduce this complication. Studies by Lai et al[20] identified

Table III. Comparison of urinary incontinence after post-separation *vs*. semi-separation prostate aponeurotomy.

Variable	Post-separation group	Semi-separation group	*p*-value
Patients, n (%)	16	24	
Mean age (years)	67.88±7.05	66.33±7.59	0.54
BMI (kg/m^2)	24.35±3.44	23.12±2.31	0.2
Hypertension, n (%)			0.77
Yes	4 (25%)	7 (29.17%)	
No	12 (75%)	17 (70.83%)	
Diabetes mellitus, n (%)			0.77
Yes	1 (6.25%)	1 (4.17%)	
No	15 (93.75%)	23 (95.83%)	
CHD, n (%)			0.67
Yes	3 (18.75%)	3 (12.5%)	
No	13 (81.25%)	21 (87.5%)	
Prostate mass (g)	75.8±31.12	60.27±24.90	0.12
Nocturia (second)	4.36±0.93	4.78±1.60	0.45
Preoperative residual urine (mL)	187.17±105.49	131.28±177.14	0.52
Maximum flow rate (ml/s)	10.9±5.25	9.21±10.12	0.63
PSA (ng/mL)	5.95±5.48	6.02±4.59	0.97
Immediate incontinence, n (%)			0.67
Yes	2 (12.5%)	2 (8.33%)	
No	14 (87.5%)	22 (91.67%)	
Short-term urinary incontinence, n (%)			0.37
Yes	3 (18.75%)	2 (8.33%)	
No	13 (81.25%)	22 (91.67%)	
Chronic urinary incontinence, n (%)			0.37
Yes	3 (18.75%)	2 (8.33%)	
No	13 (81.25%)	22 (91.67%)	

BMI: body mass index; PSA: prostate specific antigen; CHD: coronary heart disease.

obesity and overactive bladder as risk factors affecting post-prostatectomy incontinence. Research by Xu et al[21] demonstrated the significant impact of age and prostate volume on postoperative urinary incontinence. While preoperative risk factors offer predictive insights for clinicians, factors like patient obesity, age, and prostate volume are not readily modifiable, thus providing limited assistance in enhancing postoperative urinary control.

However, our study, by comparing the outcomes of semi-, pre-, and post-separation techniques in transurethral prostatectomy, offers actionable insights for surgical decision-making that can directly and effectively improve postoperative urinary control. We observed a notable reduction in immediate postoperative urinary incontinence with semi-separation and pre-separation techniques compared to post-separation, suggesting that these approaches may result in better postoperative urinary control. Studies by Dalela et al[22] on robot-assisted laparoscopic prostatectomy (transperitoneal approach) reported higher immediate postoperative incontinence rates compared to the Retzius-sparing (posterior) approach, which aligns with our findings on the efficacy of semi-separation. Similarly, research by Sood et al[23] found improved urinary control postoperatively with semi-separation of the prostate apex, consistent with our study's conclusions. Early disconnection of the prostate apex involves laser circumferential disconnection at a distance of 0.5 cm-1 cm from the prostatic urethral mucosa and sphincter, thereby avoiding repeated traction on the urethral sphincter during subsequent prostate dissection, which could lead to sphincter damage. This study is based on surgeries performed by experienced clinicians; however, there is a potential risk for beginners using semi-separation or pre-separation techniques to inaccurately identify anatomical landmarks, potentially causing damage to the urethral sphincter.

Anatomical understanding and control of the prostate apex is a critical step in prostate surgery, especially in terms of maintaining urinary continence. Early disconnection of the prostate apex may facilitate more precise control of the surgical area, reducing potential damage to the urethral sphincter and surrounding structures during the operation. Protecting the urethral sphincter and maximizing the preservation of urethral length during surgery are key factors in maintaining postoperative urinary control. Early disconnection of the prostate apex could potentially better safeguard these structures, thereby lowering the risk of postoperative urinary incontinence. While the choice of surgical technique can reduce the incidence of incontinence, its occurrence is still inevitable. Postoperative pelvic floor muscle training and electrical stimulation remain essential for improving urinary incontinence[24-27].

Limitations

This study has certain limitations. Firstly, the small sample size may not adequately reflect the differences in urinary control outcomes post-prostatectomy using the three different disconnection methods. Additionally, as the study was conducted in a single center, the lack of multicenter data could limit the generalizability of the results. The retrospective nature of this study meant that some variable data were missing and could not be included.

Conclusions

The incidence of urinary incontinence post-transurethral thulium laser prostatectomy is lower with early and pre-separation of the prostate apex compared to post-separation. Early and pre-separation of the prostate apex can better protect the urethral sphincter, thereby reducing the occurrence of urinary incontinence.

Funding

None.

Ethics Approval

The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Ethics Committee of Peking University First Hospital-Miyun Hospital (No.: 2023-017-001).

Informed Consent

Informed consent for this retrospective analysis was waived.

Availability of Data and Materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflict of Interest

None declared.

Authors' Contributions

Conception and design: Xuebing Meng, Yue Li. Administrative support: Xuebing Meng, Yue Li, Yaming Gu. Provision of study materials or patients: Xuebing Meng, Yue Li, Yaming Gu, Zihui Gao. Collection and assembly of data: Xuebing Meng, Yue Li, Yaming Gu. Data analysis and interpretation: Xuebing Meng, Yue Li. Manuscript writing: All authors Final approval of manuscript: All authors.

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