Does preoperative bladder compliance affect long-term functional outcomes after laser prostatectomy?

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Abstract

Introduction: We assessed the effects of preoperative bladder compliance on the long-term functional outcomes, especially focused on postoperative storage symptom changes, after laser prostatectomy. Materials and Methods: From January 2008 to March 2014, 1608 men who underwent laser prostatectomy, including holmium laser enucleation or photo-vaporization of the prostate, were included in the analysis. We divided patients into 3 groups according to bladder compliance on a baseline urodynamic study: < 12.5; 12.5–25.0; [?]25 mL/cm H2O. A multivariable analysis was performed to determine the impact of bladder compliance on long-term functional outcomes after laser prostatectomy. Results: Bladder compliance was less than 12.5 ml/cm H2O in 50 (3.1%), 12.5-25 ml/cm H2O in 232 (14.4%) patients. As bladder compliance decreased, the baseline International Prostate Symptom (I-PSS) total score and storage sub-score were increased; the voiding sub-score remain unchanged. At postoperative 36 months, improvements in the I-PSS total score and storage sub-score were significantly higher in < 12.5 mL/cm H2O group compared to other groups, although those were equivalent at postoperative 1 and 12 months. On the multivariable analysis, decreased bladder compliance < 12.5 mL/cm H2O was significantly associated with superior improvement in storage sub-score at postoperative 36 months, although it was not associated with voiding sub-score. Conclusion: In patients with preoperative bladder compliance < 12.5 mL/cm H2O, storage symptoms could be further improved at 36 months after laser prostatectomy compared to others. Thus, laser prostatectomy could be a considerable treatment option for patients with severely decreased bladder compliance

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Running Head: Bladder compliance and laser prostatectomy

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Abstract

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Materials and Methods: From January 2008 to March 2014, 1608 men who underwent laser prostatectomy, including holmium laser enucleation or photo-vaporization of the prostate, were included in the analysis. We divided patients into 3 groups according to bladder compliance on a baseline urodynamic study: < 12.5; 12.5–25.0; [?]25 mL/cm H_2O. A multivariable analysis was performed to determine the impact of bladder compliance on long-term functional outcomes after laser prostatectomy.

Results: Bladder compliance was less than 12.5 ml/cm H_2O in 50 (3.1%), 12.5-25 ml/cm H_2O in 232 (14.4%) patients. As bladder compliance decreased, the baseline International Prostate Symptom (I-PSS) total score and storage sub-score were increased; the voiding sub-score remain unchanged. At postoperative 36 months, improvements in the I-PSS total score and storage sub-score were significantly higher in < 12.5 mL/cm H_2O group compared to other groups, although those were equivalent at postoperative 1 and 12 months. On the multivariable analysis, decreased bladder compliance < 12.5 mL/cm H_2O was significantly associated with superior improvement in storage sub-score at postoperative 36 months, although it was not associated with voiding sub-score.

Conclusion: In patients with preoperative bladder compliance < 12.5 mL/cm H_2O, storage symptoms could be further improved at 36 months after laser prostatectomy compared to others. Thus, laser prostatectomy could be a considerable treatment option for patients with severely decreased bladder compliance

Keywords : Compliance; Laser; Prostatic hyperplasia; Prostatectomy; Urinary bladder

WHAT'S KNOWN?

Accurate prediction of surgical outcomes and proper patient selection are considered as one of the most important steps for BPH surgery. However, despite these advancements in the preoperative patient evaluation and selection, there were still concerns about the remaining storage symptoms after surgical treatment for BPH

WHAT'S NEW?

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Introduction

Lower urinary tract symptoms (LUTS) due to benign prostate hyperplasia (BPH) rapidly increase as men age[1, 2]. In the United States, over 100,000 patients with BPH annually undergo surgical treatment to alleviate LUTS[3] despite advancements in medical treatment and widespread usage of medications[4]. Although conventional transurethral prostatectomy (TURP) has remained the cornerstone of surgical treatment for BPH, laser enucleation or vaporization are regarded as alternative treatment options although prostate volume and patient condition need to be considered for selecting treatment methods[5].

However, even after surgical treatment, a considerable proportion of patients with BPH still continues medical treatment due to the remaining LUTS [6]. In this regard, accurate prediction of surgical outcomes and proper patient selection are considered as one of the most important steps for BPH surgery. Consequently, numerous studies have evaluated the predictors for better functional outcomes after laser prostatectomy in BPH patients[7, 8]. However, despite these advancements in the preoperative patient evaluation and selection, there were still concerns about the remaining storage symptoms after surgical treatment for BPH [9]. In addition, storage symptoms did not improve as much as voiding symptoms after surgical treatment for BPH[10], and some studies have reported that storage symptoms did not improve as much after laser prostatectomy than conventional TURP[11, 12].

In this regard, several studies have evaluated the impacts of conditions related to storage symptoms on the functional outcomes after BPH surgery[13]. However, currently, there is no reliable method for predicting changes in postoperative storage symptoms after laser surgery. In this current clinical situation, a urodynamic study (UDS) could be a viable option for predicting remained storage symptoms after laser surgery although current guidelines only recommend a urodynamic study (UDS) in selected situations [5, 14]. In addition to detrusor overactivity, bladder compliance is a well-known parameter derived from UDS and reported to be related to storage function of the bladder[15]. However, the impact of bladder compliance on the changes in the functional outcomes after laser prostatectomy have been barely studied. Thus, we assessed the effects of bladder compliance on the long-term functional outcomes after laser prostatectomy in patients with BPH, with a focus on storage symptoms.

Material and Methods

Patient cohort

From January 2008 to March 2014, a total of 1985 patients with BPH who underwent laser prostatectomy at two university hospitals were initially included. Among these patients, PVP was performed in 836 patients, and HoLEP was performed in 1149 patients. After excluding 377 patients with incomplete data about bladder compliance prior to surgery, 1608 patients were finally included in the analysis. Medical records of these patients were retrospectively reviewed using database of Boramae Medical Center from 2018 to 2020. Data were fully anonymized before accessed them. This study was approved and the consent was waived by the Institutional Review Board of Boramae Medical Center. In addition, all methods were performed in accordance with relevant guidelines and regulations by including statement in the methods section to this effect.

Surgical procedures

Surgical treatment was performed in patients with LUTS that did not sufficiently improved after medical treatments or patients who wanted to be surgically treated, after sufficient consideration regarding patient, clinical characteristics and clinicians' preference. In general, three urologic surgeons who were experts on laser prostatectomy performed these surgeries. Two experts performed HoLEP and one expert performed PVP. The detailed surgical procedures have been previously reported.

Preoperative and postoperative patient evaluation

In these patients, validated Korean version of International Prostate Symptom Score (I-PSS) questionnaires were acquired preoperatively[16]. Prostate volume measurement using trans-rectal ultrasonography, serum prostate specific antigen (PSA) level examination, and uroflowmetry with post-voided residual urine were also performed prior to surgery. In addition, UDS was routinely performed before the surgery. At postoperative 1, 6, 12, 24, 36, 48, and 60 months, I-PSS questionnaires and uroflowmetry with post-void residual urine were evaluated. Serum PSA level and prostate volume were measured at postoperative 6 months.

Definitions

Bladder compliance was calculated using parameters derived from UDS by normalizing the bladder volume change to the change in detrusor pressure during that change in bladder volume[15]. In the current study, we divided bladder compliance into 3 groups as follows: $<$ 12.5 mL/cmH_2O; 12.5–25.0 mL/cmH_2O; [?]25 mL/cmH_2O)[17-19]. In this study, the functional outcomes measured at postoperative 1, 12, and 36 months were defined as short-term, mid-term, and long-term functional outcomes, respectively. At 1, 12, and 36 months after surgery, 1029 (64.0%), 513 (31.9%), and 357 (22.2%) patients were followed-up, respectively. Detailed follow-up data was presented in Supplementary table. The variables associated with long-term functional outcomes were analyzed and demonstrated.

Statistical analysis

Patient characteristics were presented and compared according to bladder compliance using the mean +- standard deviation (SD) for continuous variables and a frequency table for categorical variables. Preoperative and postoperative data of I-PSS questionnaires and uroflowmetry with post-voided residual urine were presented and compared according to bladder compliance. In addition, the changes in these parameters were demonstrated and compared. The percent changes in PSA level and prostate volume were also calculated and demonstrated according to bladder compliance. A multivariable linear regression analysis was performed to determine the impacts of bladder compliance on long-term functional changes after adjusting other variables, including age, body mass index, prostate volume, surgical methods, and I-PSS related variables. For multivariable analysis, a backward elimination method was used for analysis. The impact of bladder compliance in the HoLEP and PVP groups was separately assessed using multivariable analysis for the differences in the effects of bladder compliance on functional outcomes according to surgical methods. In addition, to confirm the results of the current study after considering the effects of time, repeat measured analysis of variance (ANOVA) was performed. All statistical comparisons were performed using IBM SPSS Statistics, Version 21 (IBM SPSS, Armonk, NY, USA). A p value of less than 0.05 was considered statistically significant.

Results

Among 1608 patients, bladder compliance was $<$ 12.5 mL/cm H_2O in 50 patients (3.1%), and 12.5-25 mL/cm H_2O in 232 patients (14.4%) (Table 1). Bladder compliance decreased as age increased (72.9 vs. 68.9 vs. 68.4 years, p$<$0.001) and body mass index decreased (22.9 vs. 23.6 vs. 24.1 kg/m^2, p=0.002). The I-PSS total score (22.3 vs. 19.5 vs 19.0, p=0.018), storage sub-score (9.0 vs. 8.2 vs. 7.5, p=0.002), and quality of life (QoL) index (4.7 vs. 4.2 vs 4.1, p=0.001) increased as bladder compliance decreased, although the voiding sub-score was equivalent regardless of bladder compliance. PVP was more frequently performed in patients with decreased bladder compliance compared to HoLEP. At postoperative 6 months, the percent decrease in PSA (p=0.854) and prostate volume (p=0.755) were similar regardless of bladder compliance (supplementary table 1).

At postoperative 1, 12, and 36 months, I-PSS total, storage sub-score, and QoL index, respectively, were equivalent according to bladder compliance, although the preoperative values were significantly different (Supplementary table 2). In addition, the peak flow rate also showed no difference at postoperative 1, 12, and 36 months according to bladder compliance. However, BVE was significantly higher in men with bladder compliance $>$25 mL/cmH_2O than decreased bladder compliance at postoperative 36 months, although there was no difference in BVE at postoperative 1 and 12 months. The 5-year serial follow-up data was

demonstrated in Supplementary table 3. Decreases in I-PSS total score were significantly higher in patients with bladder compliance < 12.5 mL/cm H_2O at postoperative 36 months (-14.3 vs. -8.5 vs. -7.4, p=0.019) (Table 2). Although decreases in voiding sub-score were equivalent regardless of bladder compliance, decreases in storage sub-score (-5.5 vs. -3.1 vs. -2.3, p=0.006) and QoL index (-2.8 vs. -2.1 vs. -1.7, p=0.031) at postoperative 36 months were significantly higher in patients with bladder compliance < 12.5 mL/cm H_2O than in the other groups. However, there was no difference in total I-PSS score, voiding sub-score, and storage sub-score decreases according to bladder compliance at postoperative 1 and 12 months. Changes in the objective parameters, including peak flow rate and BVE, were equivalent during the postoperative follow-up duration of 36 months, except for the changes in BVE at postoperative 1 month.

On the multivariable analysis, bladder compliance < 12.5 mL/cmH_2O (B=4.201, p=0.042), in addition to prostate volume, preoperative I-PSS total score, and surgical methods, was significantly associated with decreases in total I-PSS score at postoperative 36 months (Table 3). However, bladder compliance was not significantly associated with changes in voiding sub-score although bladder compliance < 12.5 mL/cmH_2O (B=2.040, p=0.017) was significantly associated with storage sub-score after adjusting other variables. On

additional analysis, bladder compliance, regardless of the surgical methods, was associated with decreases in storage score, although statistical significance was not achieved in patients who underwent HoLEP (Table 4)

On the repeat measured ANOVA analysis, patients with bladder compliance < 12.5 mL/cmH_2O showed significantly superior improvements in I-PSS storage score (vs. >25 mL/cmH_2O; difference: -1.4, p=0.002, vs. 12.5-25 mL/cmH_2O; difference: -1.3, p=0.023) and total score (vs. >25 mL/cmH_2O; difference: -4.2, p=0.027, vs. 12.5-25 mL/cmH_2O; difference: -4.9, p=0.026) compared to the other groups, although I-PSS voiding score was equivalent regardless of bladder compliance (Supplementary table 4).

Discussion

A considerable proportion of patients with BPH ultimately undergo surgical treatment for BPH and, recently, laser prostatectomy has been increasingly selected [1, 2, 20]. However, even though surgical treatment for BPH has been performed, a recent study reported that about a half of patients with BPH are still treated with medication due to the persistent LUTS[6]. In this regard, current clinical guidelines recommend a number of preoperative examinations [21]. However, even though these examinations are performed, it is not easy to accurately predict the postoperative symptomatic improvement, and some novel parameters for predicting improvements in postoperative storage symptoms after laser surgery are needed due to the impairment of storage symptoms after laser prostatectomy as mentioned above. To the best of our knowledge, this is the first study to report the prevalence of decreased bladder compliance in patients with BPH who underwent laser prostatectomy and to evaluate the impact of bladder compliance on functional outcomes after laser prostatectomy.

In the previous study, the bladder compliance has been reported to decrease as men age [22], which is consistent with the findings of the current study. In that study, about 1 out of 5 patients showed decreased bladder compliance regardless of its severity, and about 1 out of 33 patients showed bladder compliance < 12.5 mL/cmH_2O among patients with BPH who opted for laser surgery. In these men with bladder compliance <12.5 mL/cmH_2O, preoperative subjective symptoms, especially storage symptoms, were impaired compared to men with bladder compliance > 25 mL/cmH_2O. which is in accordance with previous study. These relations thought to be came from increased detrusor overactivity in men with poor bladder compliance[23]. Although decreased compliance could be related with the neurogenic bladder, in the current study, the prevalence of neurological or cerebrovascular diseases was not associated with bladder compliance, which might be due to the exclusion of patients with moderate to severe neurogenic bladders who were generally regarded as not optimal candidates for BPH surgery. In addition, in this study, bladder compliance was negatively associated with prostate volume or bladder outlet obstruction, in accordance with a previous study [24, 25]. A previous study also suggested that BPH-induced decreased bladder compliance could be due to collagen deposition in the bladder smooth muscle fiber[26].

The findings of the study suggest that as preoperative bladder compliance decreased, more improvements in storage symptom could be expected at long-term follow-up. However, interestingly, storage symptom was similarly improved regardless of the degree of bladder compliance at the short-term or mid-term follow-up, i.e., at 1 and 12 months postoperatively. Relief from of BPH seemed to be helpful for improving storage symptoms induced by decreased bladder compliance, although a few years are needed to realize these improvements, which was consistent with a previous study[27]. This could also be supported by another previous study demonstrating that restoration of bladder compliance was not significantly observed at 6 months after surgery [28]. These findings might be related to the elimination of collagen deposition in the bladder smooth muscle fiber after resolving bladder outlet obstruction; however, this hypothesis needs to be validated in a future study. In addition, based on the results of the current study, clinicians could be more interested in the laser surgery for BPH in men with severe storage symptoms and decreased bladder compliance. However, because storage symptom was similarly improved regardless of the bladder compliance until 1 year, the clinicians should be careful for offering laser surgery in these patients with decreased bladder compliance by expecting immediate improvement in storage symptoms. In other words, clinicians should not avoid laser surgery in men with severe lower urinary symptoms because of the low bladder compliance, because storage symptoms might be alleviated with the time. One concern was that the effects of bladder compliance on functional outcomes might be not equivalent according to surgical methods. Based on the current study, HoLEP seemed to be superior compared to PVP regarding long-term voiding and storage symptom improvements, which might come from large removal of the prostate. However, the differences in storage sub-score outcomes according to surgical methods seemed to be minimized compared to voiding sub-score. In other words, compared to voiding sub-score, impacts of laser prostatectomy on long-term storage functional outcomes according to bladder compliance seemed to be similar regardless of surgical methods.

In addition, based on this study, bladder compliance < 12.5 mL/cmH_2O was thought to be a reliable and reasonable cut-off value for predicting long-term functional outcomes after laser prostatectomy. This was because bladder compliance with 12.5–25 mL/cmH_2O showed similar improvements for subjective symptoms compared to the bladder compliance [?] 25 mL/cmH_2O. Although several cut-off values for bladder compliance have been suggested[17, 18], none of these cut-off values have been validated in patients with BPH who underwent laser prostatectomy. Furthermore, the results of the current study need to be validated in a future study with a larger number of patients and longer follow-up duration.

There were several limitations in the current study in addition to its retrospective design. Due to the long study period, the selection of the surgical methods may have changed, and this may affect the results of the current study. In addition, a relatively high drop-out rate through the long-term follow-up after surgery may have inadvertently created a selection bias. However, the results of the current study could be useful for clinicians to properly predict and explain surgical outcomes, especially in men with decreased bladder compliance.

Conclusions

In patients with preoperative bladder compliance < 12.5 mL/cm H_2O, storage symptoms could be further improved at 36 months after laser prostatectomy compared to others. Thus, laser prostatectomy could be a considerable treatment option for patients with severely decreased bladder compliance. In addition, bladder compliance < 12.5 mL/cmH_2O seemed to be a reliable cut-off value for predicting superior improvements in long-term storage symptoms after laser prostatectomy.

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Supporting information captions

Supplementary table 1. Perioperative PSA and prostate volume change according to bladder compliance

Supplementary table 2. Serial follow-up data of subjective and objective parameters after laser prostatectomy

Supplementary table 3. 5-year serial follow-up data of subjective and objective parameters after laser prostatectomy

Supplementary table 4. The impacts of long-term functional changes using repeat measures ANOVA

* Some of the data is available as supporting information

* Data are available from the Bormae Medical Center Institutional Data Access / Ethics Committee for researchers who meet the criteria for access to confidential data.

* Contact details for the Boramae Medical Center IRB are as follows: http://www.e-brmirb.co.kr/

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`Tables.docx` available at https://authorea.com/users/435348/articles/538441-does-preoperative-bladder-compliance-affect-long-term-functional-outcomes-after-laser-prostatectomy