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Original Article - Voiding Dysfunction

Changes in Bladder Wall Thickness and Detrusor Wall Thickness After Surgical Treatment of Benign Prostatic Enlargement in Patients With Lower Urinary Tract Symptoms: A Preliminary Report

Hakmin Lee, Minsoo Choo, Myong Kim, Sung Yong Cho, Seung Bae Lee, Hyeon Jeong, Hwancheoul Son

Department of Urology, SMG-SNU Boramae Medical Center, Seoul, Korea

Purpose: The purpose of the present study was to evaluate the perioperative changes in bladder wall thickness and detrusor wall thickness after transurethral prostatectomy.

Materials and Methods: Fifty-one men who were treated for benign prostatic hyperplasia/lower urinary tract symptoms with transurethral prostatectomy were prospectively analyzed from May 2012 to July 2013. Prostate size, detrusor wall thickness, and bladder wall thickness were assessed by transrectal and transabdominal ultrasonography perioperatively. All postoperative evaluations were performed 1 month after the surgery.

Results: The patients' mean age was 69.0 years, the mean prostate-specific antigen concentration was 8.1 ng/mL, and the mean prostate volume was 63.2 mL. The mean bladder wall thickness was 5.1 mm (standard deviation [SD], ±1.6), 5.1 mm (SD, ±1.6), and 5.0 mm (SD, ±1.4) preoperatively and 4.5 mm (SD, ±1.5), 4.5 mm (SD, ±1.3), and 4.6 mm (SD, ±1.2) postoperatively in the anterior wall, dome, and trigone, respectively (p=0.178, p=0.086, and p=0.339, respectively). The mean detrusor wall thickness was 0.9 mm (SD, ±0.4) preoperatively and 0.7 mm (SD, ±0.3) postoperatively (p=0.001). A subgroup analysis stratifying patients into a large prostate group (weight, ≥45 g) and a high Abrams-Griffiths number group (>30) showed a significant decrease in detrusor wall thickness (p=0.002, p=0.018).

Conclusions: There was a decrease in detrusor wall thickness after transurethral prostatectomy. The large prostate group and the high Abrams-Griffiths number group showed a significant decrease in detrusor wall thickness after surgery.

Keywords: *Lower urinary tract symptoms; Prostate; Urinary bladder*

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Corresponding Author:
Hwancheoul Son
Department of Urology, SMG-SNU Boramae Medical Center, 20 Boramae-ro 5-gil, Dongjak-gu, Seoul 156-707, Korea
TEL: +82-2-870-2391
FAX: +82-2-870-3863
E-mail: volley@snu.ac.kr

INTRODUCTION

Benign prostatic hyperplasia (BPH) and lower urinary tract symptoms (LUTS) have become very common among middle-aged men in Korea. The overall prevalence of BPH/LUTS is approximately 40% among men aged >65 years [1]. However, the relationship between benign prostatic enlargement, LUTS, and bladder outlet obstruction (BOO) is unknown. Therefore, there has been much effort to understand this conundrum in the past decade. The gold standard diagnostic tool for BOO traditionally has been the pressure-flow study (PFS), but it is an invasive, expensive, and time-consuming procedure [2]. Moreover, the increasing number of PFSs is not clinically favorable [3].

Bladder wall thickness (BWT) and detrusor wall thickness (DWT) assessments have been shown to be promising substitutes for PFSs to diagnose BOO [4-8]. They are noninvasive, easy to perform, and less time-consuming than PFSs. Another strong point is that measurement of BWT and DWT can be performed in combination with trans-rectal prostate ultrasonography. Commercially available instruments can already measure BWT and automatically estimate bladder weight by use of transabdominal ultrasonography [9].

Studies have shown that the relief of obstruction by surgery reduces secondary bladder hypertrophy caused by BOO [10,11]. However, the change in BWT and DWT after surgery for BPH has been poorly investigated thus far. Accordingly, the present study aimed to evaluate the perioperative changes in these parameters and to investigate whether changes in these parameters differ depending on patients' baseline characteristics.

MATERIALS AND METHODS

Between May 2012 and July 2013, 56 patients were surgically treated for LUTS/BPH. Patients with a history of neurologic disease, urologic surgery, urinary stones, urethral stricture, or any malignancy in the pelvic cavity were excluded. One patient who had prostate cancer after the surgery was excluded from the study. Thus, a total of 51 men were analyzed for this study. This study was designed as a prospective observation study, and had been reviewed and approved by the Institutional Review Board of SMG-SNU Boramae Medical Center. Data were collected during the preoperative assessment and postoperative follow-up examination. The preoperative workup included trans-rectal prostate ultrasonography, free uroflowmetry, and assessment of the International Prostate Symptom Score (IPSS). BWT and DWT were simultaneously assessed with transrectal ultrasonography (7.5 MHz, SA-8000, Medison, Seoul, Korea).

The surgery was performed by 2 experienced urologists. All patients were treated by transurethral prostatectomy. At the postoperative follow-up examination 1 month after the surgery, transabdominal and transrectal ultrasounds were performed. DWT was assessed after uroflowmetry in the suprapubic area (Fig. 1). BWT was checked at 3 locations (i.e., the anterior wall, dome, and trigone) by transrectal prostate sonography after uroflowmetry. All these sonographic examinations were performed by a single experienced radiologist during the postmicturition state after uroflowmetry [12].

Subgroup analysis was performed by stratifying the patients according to prostate size, response after surgery, and the Abrams-Griffiths (AG) number. The response after surgery was determined to be good when the change in IPSS was >4. The paired samples t-test and Wilcoxon signed-rank test were used to analyze the differences after the surgery. A p-value ≤ 0.05 was considered significant. All statistical analyses were performed by using IBM SPSS ver. 19.0 (IBM Co., Armonk, NY, USA).

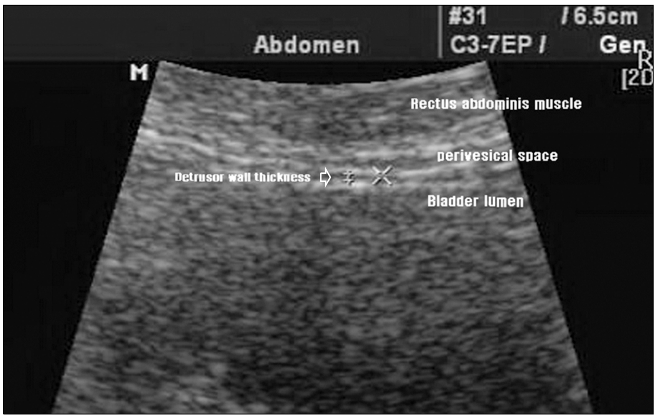

FIG. 1. Measurement of detrusor wall thickness.

RESULTS

The baseline characteristics of the study subjects are presented in Table 1. The mean prostate volume was 63.2 mL. The mean preoperative and postoperative IPSSs were 24.5 and 18.5, respectively. Changes in the parameters after surgery are shown in Table 2. IPSS and DWT significantly

TABLE 1. Patient demographics (n=51)

Variable	Mean±SD (range)
Age (y)	69.0±7.6 (49.0–83.0)
Body mass index (kg/m^2)	16.4±3.8 (9.2–24.5)
PSA (ng/dL)	7.4±9.3 (0.1–41.4)
Preoperative IPSS	24.6±10.2 (3.0–41.0)
Preoperative Qmax (mL/s)	7.7±4.3 (1.3–19.0)
Preoperative BWT (mm)	
Anterior	5.1±1.6 (2.5–10.8)
Dome	5.1±1.6 (2.6–10.8)
Posterior	5.0±1.4 (2.6–9.6)
Preoperative DWT (mm)	0.9±4.0 (0.3–2.1)

SD, standard deviation; PSA, prostate-specific antigen; IPSS, International Prostate Symptom Score; Qmax, maximal flow rate; BWT, bladder wall thickness; DWT, detrusor wall thickness.

TABLE 2. Changes in parameters after surgery

Variable	Preoperative	Postoperative	p-value
IPSS	24.6±10.2	18.5±10.4	0.003
DWT (mm)	0.9±0.4	0.7±0.3	0.001
BWT (mm)			
Anterior	5.1±1.6	4.5±1.5	0.178
Dome	5.1±1.6	4.5±1.3	0.086
Trigone	5.0±1.4	4.6±1.2	0.339
Qmax (mL/s)	7.7	9.4	0.085

Values are presented as mean±standard deviation.
IPSS, International Prostate Symptom Score; DWT, detrusor wall thickness; BWT, bladder wall thickness; Qmax, maximal flow rate.

decreased after the surgery, but no significant change in DWT or the maximal urinary flow rate (Qmax) was noted.

A subgroup analysis was performed by stratifying patients according to prostate size, response after surgery, and the AG number from their preoperative PFS (Table 3). DWT significantly decreased after surgery in the high AG number group (≥30). The subgroup analysis of prostate size revealed that there was a significant decrease in DWT in the large prostate group (≥45 g). In the small prostate group, the decrease in BWT was significant. Good responders after surgery showed significant Qmax improvement compared with that of the nonresponder group, whereas both BWT and DWT decreased in the nonresponder group.

DISCUSSION

In the past decade, a number of studies have shown the effectiveness of various diagnostic parameters such as BWT and DWT, but there are still several limitations associated with their clinical use as diagnostic tools because normative data, a standardized procedure, and unified bladder filling are still lacking. Nevertheless, many studies have found a relevant relationship between BOO and these parameters [3,5-8,13].

In their review, Mirone et al. [14] described "bladder wall hypertrophy as first line anatomic change after BOO." Oelke et al. [5] assessed DWT in patients with BOO and found a positive correlation between the degree of BOO and DWT. DWT was 1.33, 1.62, 2.4, and >3 mm in the unobstructed, equivocal, obstructed, and severely obstructed groups, respectively. Oelke et al. [7] also reported DWT to be a sensitive parameter for predicting BOO compared with other parameters such as Qmax and postvoid residual urine (PVR). DWT≥2 mm showed a high positive predictive value of 94%. Kessler et al. [6] assessed 102 patients with LUTS and found that DWT was significantly higher in the obstructed group than in the unobstructed and equivocal groups. DWT>2.9 mm showed a strong predictive value of BOO (positive predictive value, 100%; specificity, 100%; and sensitivity, 43%).

Several studies have shown that bladder hypertrophy was reversible after the resolution of BOO. Nielsen et al. [15] reported a 6-fold increase in bladder weight, a 3-fold increase in the muscle cell number, and an 8-fold increase in collagen content after the creation of BOO and a partial reversal after recovery in an animal study. Kojima et al. [16] analyzed the estimated bladder weight before and after surgical treatment of BPH (open prostatectomy and transurethral prostatectomy), and bladder hypertrophy was markedly reduced after the surgery. The mean estimated bladder weight was 52.9 g preoperatively and 31.6 g after 3 months, and that of the control group was 26.5 g [16-18].

Based on previous studies, the present study showed that DWT decreased after surgery for BPH (p=0.001). In addition, the change in DWT after surgery was associated

TABLE 3. Subgroup analysis

Variable	Prostate size≥45 (n=31)			Prostate size<45 (n=20)			Change of IPSS≥4 (n=24)			Change of IPSS<4 (n=20)			AG number≥30 (n=18)			AG number<30 (n=18)		
	Preoperative	Postoperative	p-value	Preoperative	Postoperative	p-value	Preoperative	Postoperative	p-value	Preoperative	Postoperative	p-value	Preoperative	Postoperative	p-value	Preoperative	Postoperative	p-value
DWT (mm)	0.97±0.46	0.74±0.32	0.001	0.75±0.26	0.66±0.23	0.232	0.91±0.50	0.75±0.38	0.056	0.84±0.29	0.66±0.19	0.022	0.944±0.43	0.749±0.38	0.018	0.87±0.35	0.70±0.17	0.059
BWT (mm)																		
Anterior	5.42±1.70	4.92±1.62	0.194	4.74±1.36	3.97±0.93	0.011	4.88±1.31	4.56±1.46	0.203	5.23±1.50	4.13±0.96	0.006	4.92±1.66	4.72±1.66	0.461	5.52±2.15	4.64±1.29	0.177
Dome	5.40±1.71	4.92±1.53	0.262	4.76±1.42	3.94±0.69	0.014	4.88±1.42	4.57±1.34	0.287	5.26±1.42	4.09±0.79	0.002	5.04±1.26	4.61±1.58	0.222	5.35±2.16	4.61±1.23	0.286
Posterior	5.27±1.45	4.96±1.36	0.345	4.66±1.15	4.11±0.70	0.036	4.84±1.29	4.60±1.20	0.335	5.13±1.13	4.31±0.76	0.009	4.94±1.09	4.82±1.54	0.653	5.16±1.76	4.66±0.96	0.355
Qmax (mL/s)	7.67±4.54	9.82±7.47	0.245	7.80±3.91	8.87±5.37	0.575	7.24±3.93	12.35±7.64	0.002	9.05±4.36	8.26±3.71	0.438	8.84±3.45	12.74±7.85	0.122	8.51±4.60	7.12±4.21	0.286

Values are presented as mean±standard deviation.
IPSS, International Prostate Symptom Score; AG number, Abrams-Griffiths number; DWT, detrusor wall thickness; BWT, bladder wall thickness; Qmax, maximal flow rate.

with the preoperative prostate size and AG number (Table 3). In a subgroup analysis of the AG number, both groups showed a decrease in BWT and DWT, but the decrease in DWT was significant only in the high AG number group. DWT is related to smooth muscle hypertrophy, which can result from BOO. This finding suggests that DWT can be a more sensitive indicator of BOO than BWT. This result corroborates findings from other studies that showed a decrease in bladder weight after the resolution of BOO [10].

There was a significant decrease in BWT and DWT in the nonresponder group (change of IPSS $<$ 4). Although IPSS is a good representative of subjective symptoms of patients, it is difficult to establish a direct relationship between IPSS and BOO. Changes in BWT and DWT are considered associated with resolving BOO and not with symptoms. Therefore, the significant changes in BWT and DWT in the nonresponder group could have resulted from nonconformity between subjective symptoms and structural alteration or the small number of samples.

However, compared with that measured in other studies, the DWT measured in the present study is relatively small. The mean DWT was 0.944, ranging from 0.901 to 1.37 even in the high AG number group. Unavoidable measurement error and personal error are known issues when measuring DWT. Considering that the approximate range of DWT is 1–2 mm, the impact of these errors can be more profound. Moreover, DWT is not uniform; it can vary depending on the site examiners choose to measure. To reduce these errors, ultrasonographic examination in the present study was performed by a single radiologist in a consistent manner. The discrepancy between the present study and previous studies might stem from racial differences; more research is needed in the future to bridge this gap.

The present study had several limitations. First, the study sample size was relatively small, which might have affected the robustness of our results. A follow-up study with a larger sample size and longer follow-up period is needed to confirm our outcomes. Second, the bladder filling rate was not controlled in the present study. To avoid unnecessary invasive procedures, we assessed BWT and DWT during the postmicturition state. The bladder filling rate affects BWT and DWT and thus might have affected the results of the present study. To control this factor, an invasive procedure such as catheterization is needed. However, it is contradictory that measuring DWT, a noninvasive predictor of BOO, requires catheterization. Moreover, using a catheter to control the bladder filling rate is impractical for clinical use.

Finally, there is a possibility of bias because of the differences in PVR between the groups with high and low AG number. The mean PVR was 75.2 mL and 31.1 mL for the high and low AG number groups, respectively. Considering the negative correlation between DWT and the bladder filling rate, DWT could have been underestimated in the high AG number group because of the high PVR. Because the underestimation of DWT leads to underestimation of the change in DWT in the high AG number group, the direction of bias does not weaken our results.

CONCLUSIONS

DWT significantly decreased after transurethral resection of BPH, and patients in the large prostate and high AG number group showed a significant decrease in DWT after surgery in this preliminary study.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

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