Establishment of the Novel Cystoscopic Classification for Bladder Trabeculation of Neurogenic Bladder

Jae Hyun Jung, Sung Yong Cho, Changwon Yoo, and Seung-June Oh

OBJECTIVE To establish a cystoscopic grading system for trabeculation of neurogenic bladders.

MATERIALS AND METHODS A total of 140 neurogenic bladder patients who had undergone both fluoroscopic urodynamic study and cystoscopic examination were retrospectively reviewed. Cystoscopic images were categorized into 4 grades according to the formation of the muscle bundle layer and height-to-width ratio of the muscle bundle: 0 (none), 1 (mild), 2 (moderate), and 3 (severe). Test-retest reliability and interobserver reliability were assessed. Cystoscopic grade of the trabeculated bladder was correlated with urodynamic results and the fluoroscopic grades of trabeculation.

RESULTS The test-retest reliability showed almost perfect agreement with all levels of Cronbach alpha ranging from 0.925 to 0.970. The intraclass correlation coefficient was 0.986, indicative of an almost perfect level of interobserver reliability. The grading system showed clinical significance by correlation with urodynamic parameters (Q_{max}, P value = .016; postvoid residual, P value <.001; bladder outlet obstruction index, P value = .002). Cystoscopic grades correlated moderately well with fluoroscopic grades, showing comparable clinical significance with fluoroscopic grades.

CONCLUSION Our results showed that this novel cystoscopic classification of bladder trabeculation was highly reliable. UROLOGY 84: 515–519, 2014. © 2014 Elsevier Inc.

Patients with bladder dysfunction often show trabeculated bladder structures comprising an irregular contour with thick walls and hypertrophied muscle bundles.[1,2] This bladder trabeculation reflects dysfunction of the detrusor muscle.[3-5] The clinical correlation of trabeculated bladder with urodynamic parameters was investigated in patients with lower urinary tract dysfunction.[6-8]

Differences in clinical parameters according to the severity of trabeculated bladders were evident.[2,9] Khoury et al[3] reported that the severity of bladder trabeculation in patients with neurogenic bladder could be a marker of bladder outlet resistance. Groutz et al[10] found that in patients who had refractory detrusor overactivity without any alarming signs, diagnostic cystourethroscopy facilitated the identification of silent signs, such as bladder trabeculation and timely diagnosis. However, neither study used objective criteria of bladder trabeculation. The former study classified the condition into 2 grades, whereas the latter study classified it into 3 subjective grades. El Din et al[11] reported cystoscopic grades based on representative images of each grade. However, neither study established the reliability of the grades of bladder trabeculation by using appropriate validation processes.

We previously established a system for the fluoroscopic grading system of bladder trabeculation and have proven its validity and reliability.[1] Because cystoscopic examinations are widely used in daily clinical practice and allow for direct inspection of the intraluminal bladder, it is necessary to establish an objective cystoscopic classification system for the trabeculated bladder. The present study was undertaken to establish a cystoscopic classification system and to indicate the clinical significance of trabeculation graded by the cystoscopic classification according to urodynamic parameters in patients with neurogenic bladder.

MATERIALS AND METHODS

Subjects and Cystoscopic Examination

This study was approved by the Institutional Review Board of Seoul National University Hospital (approval no. H1305-636-492). A total of 411 patients were enrolled in this study, all of whom had neurogenic bladders and had undergone a fluoroscopic urodynamic study with cystoscopic examination within the previous 6 months to assess voiding dysfunction in our institute between September 2005 and December 2012. The medical records were retrospectively reviewed, and all

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From the Department of Urology, Seoul National University Hospital, Seoul, South Korea; the Department of Urology, SMG-SNU Boramae Medical Center, Seoul, South Korea; and the Department of Biostatistics, Florida International University, Miami, FL

Reprint requests: Seung-June Oh, M.D., Department of Urology, Seoul National University Hospital, 101 Daehak-no, Jongno-gu, Seoul 110-744, South Korea. E-mail: sjo@snu.ac.kr

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Table 1. Cystoscopic grading system of bladder trabeculation

Variables	Cystoscopic grades			
	0 (none)	1 (mild)	2 (moderate)	3 (severe)
Criteria A: formation of muscle bundle layer	No	One layer	Two layers (<50% of the image)	Two layers (>50% of the image) or more layers
Criteria B: ratio of "height" to "width"	N/A	N/A	"height" <"width"	"height" >"width"
Typical images				

"Height" indicates the height of muscle bundle, measured from the deepest portion of the mucosa, and "width" indicates the width between the muscle bundles described previously.

cystoscopic and fluoroscopic images were collected by 1 investigator (J.H.J.) from the cystoscopic and urodynamic databases. The exclusion criteria were cases with anatomic changes (eg, vesicoureteral reflux, urethral leak, or diverticulum), cases with previous urologic surgery or with urethral stricture, and cases with unclear cystoscopic images due to aspects such as turbid urine and bleeding. The investigators (S.-J.O., S.Y.C., and J.H.J.) read all images and randomly selected 140 cases: 40 from cystoscopic grade 0 (none), 40 from cystoscopic grade 1 (mild), 30 from cystoscopic grade 2 (moderate), and 30 from cystoscopic grade 3 (severe).

In all patients, history-taking and physical examination were performed to identify underlying disease. The fluoroscopic urodynamic study and cystourethroscopy were performed sequentially. The study was performed in the same manner described previously[1] as recommended by the International Continence Society.[12] The urodynamic study was performed using the same protocol (UD-2000, Medical Measurement System, Enschede, the Netherlands) as described in a previous study.[1] In brief, with a dual-lumen catheter of 6F (Medtronic, Skovlunde, Denmark) and a rectal balloon catheter (Medical Measurement System), patients were positioned supine on a fluoroscopy table (Sonialvision 100 model ZS100I; Shimadzu, Kyoto, Japan) and evaluation of bladder appearance was performed during the filling and emptying phases.

Cystoscopic examination was performed in the dorsal lithotomy position. Cystourethroscopy using a 30° telescopic lens was performed using endoscopy (Karl Storz Endoscope, Tuttlingen, Germany) and was used to evaluate the whole urethra from the meatal opening to the bladder neck, to check any structural abnormalities. Then, 70° cystoscopy was used to evaluate the bladder. Whole bladder inspection by cystoscopy was performed to identify orifices, mucosal abnormalities (eg, trabeculation), and other anatomic changes. The urinary bladder was typically filled with normal saline with natural gravity until 70%-80% of the maximal voided volume is reached, which was determined by a 3-day voiding diary. Therefore, the bladder trabeculation is assumed to be assessed in approximately 70%-80% of maximal voided volume. Cystoscopic findings were recorded using a digital recorder (Telecam SL II; Karl Storz Endoscope), and still images were taken from midline trigone and various directions (ie, 7-, 9-, 11-, 5-, 3-, 1-, and 12-o' clock) of the urinary bladder. Then, still images were taken from the dome and posterior wall area carefully to cover whole area.

Establishing New Cystoscopic Classification

To assess the severity of trabeculation, we distinguished between 4 grades: 0 (none), 1 (mild), 2 (moderate), and 3 (severe). We classified bladder trabeculation according to 2 criteria—namely, formation of muscle bundles and depth of mucosal layer (Table 1). Criteria A were as follows: if no formation of muscle bundle was detected by cystoscopic examination, then grade 0 was assigned. Grade 1 was assigned when just a single layer of muscle bundle formation was detected. If the muscle bundles were in 2 layers but comprised no more than 50% of the still image (ie, overlapping bundles), it was assigned to grade 2. If 2 layers filled >50% of the cystoscopic field of a still image or if 3 layers were detected in the still image, it was assigned to grade 3. Criteria B were as follows: if the depth of mucosa was considerable but the height of the muscle bundle (near the mucosal base, from the deepest portion of that mucosa) was smaller than the width between those muscle bundles, grade 2 was assigned. If the height was the same as or larger than the width, grade 3 was assigned (Table 1). The cystoscopic grade was determined according to a representative image of higher grade in the same patient. When the grades determined by criteria A and B were different, higher grades were adopted.

Validation of Classification System

Interobserver and Test-retest Reliability. To evaluate the interobserver reliability, the trabeculation grades were read by 9 participants: 3 urologic residents, 3 medical school students, and 3 nursing school students. One of the study investigators (J.H.J.) provided the participants with an illustrative outline of the grading system. Participants were trained to assess the trabeculation of the bladder for 30 minutes. Then, randomly assigned cystoscopic still images of 140 cases (4 per case) were given to participants who had independently determined the grade of the bladder trabeculation of each case within 30 seconds. Test-retest reliability of the cystoscopic grading system of bladder trabeculation was assessed 2 weeks later. Reliabilities were analyzed by the intraclass correlation coefficient and Cronbach alpha.

Correlation Between Fluoroscopic Grades and Cystoscopic Grades. The fluoroscopic grade of bladder trabeculation was evaluated by the 3 investigators (S.-J.O., S.Y.C., and J.H.J.) using the same protocol as the criteria determining cystoscopic trabeculation previously described.[1] Results of fluoroscopic grades were matched with cystoscopic grades. Analysis of statistical significance was performed using correlation analysis.