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The Predictive Values of Various Parameters in the Diagnosis of Stress Urinary Incontinence

Sang Wook Bai, Jin Woo Lee, Jong Seung Shin, Joo Hyun Park, Sei Kwang Kim, and Ki Hyun Park

Department of Obstetrics and Gynecology, Yonsei University College of Medicine, Seoul, Korea.

The Maximum Urethral Closure Pressure (MUCP) and Functional Urethral Length (FUL) are significant parameters of the Urethral Pressure Profile (UPP), while the Q-tip angle and Bladder Neck Descent (BND) are the significant parameters of urethral hypermobility. We performed a study to evaluate the effects and predictive values of each of these parameters in the diagnosis of Stress Urinary Incontinence (SUI). A retrospective study was done involving 90 SUI patients and 38 non-SUI patients who underwent urodynamic study, Q-tip test and perineal ultrasound at Yonsei Medical Center between January, 1999 and February, 2002. There was no statistical difference between the SUI and non-SUI groups in terms of mean age, delivery history, menopausal age and body mass index. While the FUL and Q-tip angle showed significant differences (33.18 ±19.55 vs 33.12±13.37 mm, p=0.002; 65.94±21.69 vs 56.45 ±26.53°, p=0.02,respectively) neither the MUCP nor the BND showed any significant difference between the two groups (60.06±29.92 vs 48.97±42.95 cmH_2O, $p>0.05$; 1.09±0.75 vs 0.85±0.76 cm, $p>0.05$; 0.71±0.80 vs 0.53±0.72 cm, $p>$ 0.05).The odds ratios for the FUL and Q-tip angle were 1.038 (1.014, 1.061) and 1.017 (1.001, 1.033), respectively. The FUL and Q-tip angle had cut-off values of 1.36 cm (sensitivity: 68.8%, specificity : 54.1%, PPV : 73.8%, NPV : 48.1%) and 20.47° (sensitivity : 93.3%, specificity : 18.17%, PPV : 68.2%, NPV : 60%), respectively, in the diagnosis of SUI. The area under the curve (AUC) of the FUL and Q-tip angle were on average 0.625 (p=0.0016) and 0.575 (p=0.0012), respectively. Both the FUL and Q-tip angle showed a significant difference between SUI patients and the normal group. However, their value as a diagnostic tool was trivial, and since their sensitivity, specificity, positive predictive value and negative predictive value showed inconsistent results at each cut-off value, it would be difficult to apply them to clinical use. A further study is required to set-up standard diagnostic values of these variables for clinical use.

Key Words: Stress urinary incontinence, functional urethral length, Q-tip angle

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Reprint address: requests to Dr. Sang Wook Bai, Department of Obstetrics and Gynecology, Yonsei University College of Medicine, 134 Shinchon-dong, Seodaemun-gu, Seoul 120-752, Korea. Tel: 82-2-361-5490, Fax: 82-2-313-8357, E-mail: swbai@yumc.yonsei.ac.kr

INTRODUCTION

The urodynamic study is a method which has been used to diagnose stress urinary incontinence since 1960, but its effectiveness has been found to be minimal.[1-3] The values of the urethral pressure profile (UPP) and cystometrogram in the diagnosis of stress urinary incontinence is known to be low[1-3] and these indicators have only been used to predict the postoperative results and are known to be influenced by various factors.[4]

Furthermore, the role of the above mentioned indicators in distinguishing stress urinary incontinence from continence and evaluating the severity of urinary incontinence has been found to be minimal.[5] The clinical value of the UPP parameters in the diagnosis of stress urinary incontinence has been studied by many researchers.[5,6] Some researchers insisted that the UPP parameters were valuable in the diagnosis of stress urinary incontinence, while others insisted that even though the UPP parameters showed significant differences between women with stress urinary incontinence and normal women,[7,8] they were not effective in the diagnosis of stress urinary incontinence and that the conclusions of previous studies were due to statistical errors.[9-11] Therefore, although the urodynamic study remains a useful tool for discriminating between normal women and women with stress urinary incontinence, there is much controversy regarding its value and accuracy, when used for the diagnosis of stress urinary incontinence. Thus, the purpose of our study was to investigate the diagnostic value and accuracy of the UPP parameters and urethral hypermobility in the diagnosis of stress urinary incontinence and to obtain standard values for these parameters which could be used for the diagnosis of stress urinary incontinence.

MATERIALS AND METHODS

The study population consisted of 138 patients, who underwent urodynamic studies due to lower urinary tract symptoms, at the urogynecology clinic, Yonsei university Medical Center, between January 1999 and February 2002. Among these 138 patients, 90 were diagnosed as suffering from stress urinary incontinence and 48 were found to be normal. All of the patients were assessed with a standard history, physical examination and a urodynamic study. A standard questionnaire including age, parity, menopause, age at menopause, use of hormone replacement therapy, previous gynecologic operation history, diabetes mellitus, chronic obstructive pulmonary disease and herniation of the lumbar disc was given to the patients. The Q-tip test was performed for all patients according to previously reported method. Urethral hypermobility was defined as being present when the Q-tip angle was $\geq 30^\circ$ and non-hypermobility was defined as being when the Q-tip angle of $< 30^\circ$. Stress urinary incontinence was defined as being present when urine leakage occurred during stress without a detrusor contraction.[12] Patients with detrusor instability, urinary tract infections and pelvic organ prolapse over stage II were excluded from the study. Urodynamic studies (Dantec-5000, Copenhagen, Denmark) included uroflowmetry, multi-channel cystometry, urethral pressure profilometry and the measurements of the Valsalva leak point pressure. The Valsalva leak point pressures were determined at a bladder volume of 200 mL with a 7Fr catheter. Urethral pressure profilometry was performed with a 7Fr catheter equipped with a transducer. The intra-abdominal pressure was measured transvaginally and was taken at the point when the patients reported the first sensation to void in the absence of a detrusor contraction. A portable ultrasound scanner (Aloka SSD 500) with a 3.5 MHz curved array transducer was used. The transducer was placed on the perineum in the sagittal direction to obtain views of the bladder, the bladder neck, the urethra and the symphysis pubis. Ultrasound scanning was performed first after filling the bladder with 40 - 50 ml of water and then again after the maximum bladder capacity was attained. All scans were carried out using a filling catheter and a pressure line in situ with the patient in the supine position. Coughing and Valsalva maneuvers were performed in an identical manner and the effects on the bladder neck and proximal urethra were noted. The measurement recorded was the bladder neck descent (BND).[13] These procedures were performed with the patient in both the supine and sitting positions. The Burch operation was performed, or alternatively the Burch operation with paravaginal repair if there were any associated paravaginal defects. We compared the MUCP (Maximal Urethral Closure Pressure), FUL (Functional Urethral Length), BND (Bladder Neck Descent) and Q-tip angle between women with stress urinary incontinence and the normal women. Based on these results we obtained the diagnostic accuracy of those parameters that were significantly different between the stress urinary incontinence group and the normal women group.

The Student t-test, multiple logistic regression and Receiver Operating Characteristics (ROC) curve were used for statistical analysis (SPSS software, SPSS INC, Chicago, Ill, USA). A p value < 0.05 was considered significant. Unless otherwise stated, all terminology conforms to the recommendations of the International Continence Society.[14]

RESULTS

The average age, parity, age at menopause and Body Mass Index (BMI) were not significantly different between the stress urinary incontinence group and the normal group (57.25 ± 9.98 vs 58.43 ± 9.58 years, $p > 0.05$; 3.71 ± 4.37 vs 3.64 ± 1.56, $p > 0.05$; 50.30 ± 4.59 vs 49.45 ± 4.43, $p > 0.05$; 23.62 ± 2.73 vs 23.93 ± 2.90 kg/m^2, $p > 0.05$, respectively) (Table 1). The FUL value was significantly shorter in the stress urinary incontinence group than in the normal group (23.18 ± 19.55 vs 33.12 ± 13.37 mm, respectively, p=0.002) and the Q-tip angle was significantly higher in the stress urinary incontinence group than in the normal group (65.94 ± 21.69 vs 56.45 ± 26.53°, respectively, p=0.02) (Table 2). The odds ratio of the FUL value for the stress urinary incontinence group was 1.038 (1.014, 1.061) when the FUL value was decreased by 1 cm, and the odds ratio of the Q-tip angle was 1.017 (1.001, 1.033) when the Q-tip angle was increased by 1° (Table 3). The accuracy of both the Q-tip angle and the FUL value for the diagnosis of stress urinary incontinence were computed. When the Q-tip angle was 20.47°, the sensitivity, specificity, positive predictive value and negative predictive value were 93.3%, 18.7%, 68.2% and 60%, respectively. When the FUL value was 1.36 cm, the sensitivity, specificity, positive predictive value and negative predictive value were 68.8%, 54.1%, 73.8% and 48.1%, respectively. The area under the curve(AUC) of the FUL and Q-tip angle were on average 0.625 (p=0.0016) and 0.575 (p= 0.0012), respectively (Table 4 and 5, Fig. 1 and 2).

DISCUSSION

Stress urinary incontinence is the most common type of urinary incontinence in women and it is

Table 3. The Odds Ratio of FUL and Q-tip Angle

	OR	95%CI
FUL(mm)	1.038	(1.014, 1.061)
Q-tip(°)	1.017	(1.001, 1.033)

Table 1. General Characteristics of SUI and Non-SUI Patients

	SUI (n=90)	Non-SUI (n=48)	p
Age (yr)	57.25 ± 9.98	58.43 ± 9.58	>.05
Parity	3.71 ± 4.37	3.64 ± 1.56	>.05
Menopause (yr)	50.30 ± 4.59	49.45 ± 4.43	>.05
BMI (kg/m^2)	23.62 ± 2.73	23.93 ± 2.90	>.05

BMI, body mass index.

Table 2. The Difference of Parameters between the SUI and Non-SUI Groups

	SUI (n=90)	Non-SUI (n=38)	p
MUCP (cmH_2O)	60.06 ± 29.92	48.97 ± 42.95	>.05
BND (cm)			
Supine	1.09 ± 0.75	0.85 ± 0.76	>.05
Sitting	0.71 ± 0.80	0.53 ± 0.72	>.05
FUL (mm)	23.18 ± 19.55	33.12 ± 13.37	.002*
Q-tip (°)	65.94 ± 21.69	56.45 ± 26.53	.02*

*p<.05, student t-test.
MUCP, maximum urethral closure pressure; BND, bladder neck descent; FUL, functional urethral length.

Table 4. Accuracy of Q-tip Angle for Diagnosis of SUI

cut-off value(°)	Sensitivity(%)	Specificity(%)	PPV(%)	NPV(%)
20.47	93.3	18.7	68.2	60
16.36	76.6	25	65.7	36.3
14.3	68.8	37.5	67.3	39.1
8.14	53.3	68.7	66.6	37.5

PPV, positive predictive value; NPV, negative predictive value.

Table 5. Accuracy of FUL for Diagnosis of SUI

Cut-off value(cm)	Sensitivity(%)	Specificity(%)	PPV(%)	NPV(%)
0.94	71.1	54.1	74.4	50
1.36	68.8	54.1	73.8	48.1
1.78	62.2	56.2	72.7	44.2
2.2	57.7	58.3	72.2	42.4
2.63	54.4	60.4	72	41.4

PPV, positive predictive value; NPV, negative predictive value.

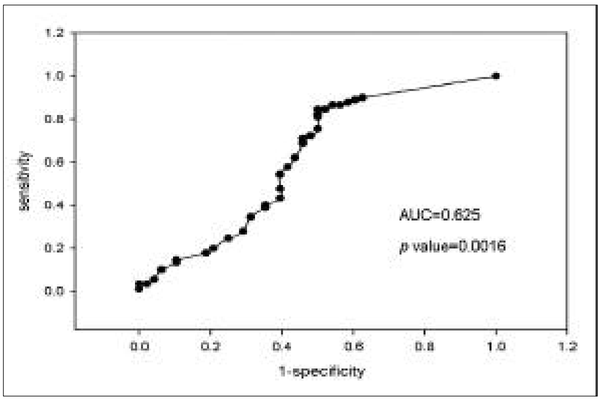

Fig. 1. ROC curve for FUL.

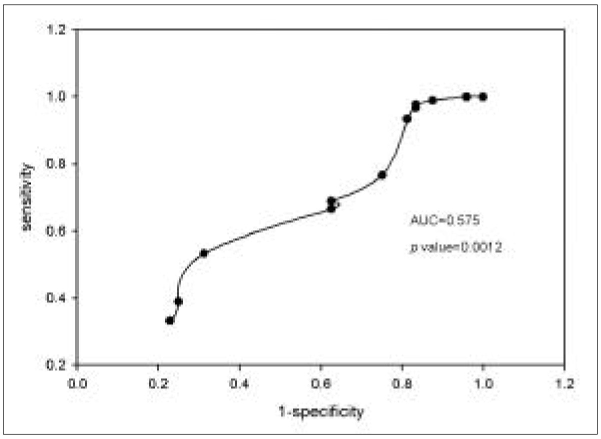

Fig. 2. ROC curve for Q-tip.

defined as involuntary urine leakage occurring during stress without detrusor contractility.[12.14] Its causes are instability of the anatomical supporting system consisting of the urethra, bladder and urethrovesical junction and the incontinence of the urethral sphincter.[15] Dietz and Clarke proposed that the causes of stress urinary incontinence were the relaxation of the anatomical structure that supports the periurethral tissue and the incompetence of the urethral sphincter, and that urethral hypermobility and the insufficiency of the pelvic supporting system were the independent causative factors.[16] In their study involving the use of lateral cystourethrography, Jeffcoate and Roberts reported that 80% of patients with stress urinary incontinence showed the loss of the posterior urethrovesical angle.[17] Green classified stress urinary incontinence by measuring the change in the posterior urethrovesical angle and bladder neck descent by means of the bead chain cystogram.[18] In their videourodynamic study, Blaivas and Olsson were also able to classify stress urinary incontinence by measuring the bladder neck descent.[19] McGuire introduced the concept of intrinsic sphincter deficiency, defining maximal urethral closure pressure of less than 20 cmH_2O, and the urethral pressure profile was used to evaluate the urethral function.[20] McGuire showed that the involuntary loss of urine during moments of increased abdominal pressure can occur in the case of detrusor instability, as shown in the case of stress urinary incontinence. Consequently, urodynamic and fluoroscopic imaging studies have since been used to distinguish between stress urinary incontinence and detrusor instability.[21-24] Some attempts were made to diagnose stress urinary incontinence by using a combination of urodynamic and radiologic imaging studies, but these attempts were met with only limited success.[5,6] Some researchers reported that the urethral pressure profile parameters constituted a useful tool for the diagnosis of stress urinary incontinence, while others insisted that these conclusions were the result of statistical errors.[9-11] Versi reported that 23 of the 30 parameters showed significant differences in the case of stress urinary incontinence, when these parameters were measured by means of videocystourethrography, but the effectiveness of these parameters in the diagnosis of stress urinary incontinence was low, so that their clinical usefulness was limited, and he concluded that no one test could be used to diagnose stress urinary incontinence perfectly.[9] Harvey and Versi reported that the symptoms of stress urinary incontinence were highly specific and could therefore be used for the diagnosis of stress urinary incontinence, and that the signs of stress urinary incontinence were also highly specific. Thus, they concluded that a more accurate diagnosis was possible only if the symptoms and signs of stress urinary incontinence were both taken into consideration, by means of a combined study.[25] Weidner et al reported similar results.[26] We analyzed and compared the urethral pressure profile parameters, Q-tip angle and bladder neck descent in order to determine their value and effectiveness in the diagnosis of stress urinary incontinence, and to propose standard values for these parameters with a view to increasing their diagnostic accuracy. In our study, there were no differences in age, parity, presence of menopause, menopausal age of BMI between the patient and normal women groups, and these results in contrast to the results of studies conducted by others researchers, in which age showed a difference between the normal and patient groups.[27,28] However in other previous studies, a negative correlation was observed between the urethral pressure profile (UPP) parameters, age and parity on the other hand. There are several explanations for the difference in the results of this study and those of previous studies. One possible explanation is that most of the patients in this study were multiparous and postmenopausal, and their average age was higher. Therefore it is difficult to extrapolate meaningful conclusions from this study. It remains to be determined whether the conclusions of this study also hold true for other UPP parameters. Our results concerning the parameters which showed differences between women with stress urinary incontinence and normal women were similar to those of previous reports, while the relative risk of the FUL and Q-tip angle for stress urinary incontinence was minimal, with this result being similar to that of a previous report.[9] The significance of our study is that we attempted to propose standard values for the parameters that showed differences between women with stress urinary incontinence and normal women for use in the diagnosis of stress urinary incontinence and that we evaluated the accuracy of these parameters. However, the variations in the sensitivity, specificity, positive predictive value and negative predictive value were somewhat different and their clinical usefulness was found to be relatively low. In the near future, more standard and objective values of these parameters for the diagnosis of stress urinary incontinence will be obtained by means of a more accurate comparison of these parameters, leading to the establishment of a more accurate and clinically useful diagnostic test.

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