Assessment of Ultrasonography Diagnostic Capacity in Women with Stress Urinary Incontinence with or without Pelvic Prolapse

Tayebe Jahed Bozorgan1, Elham Keshavarz2, Hoda Etemad Zadeh3, Zahra Salehi4*

1Department of Obstetrics and Gynecology, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
2Department of Radiology, Shahid Beheshti University of Medical Science, Mahdieh Hospital, Tehran, Iran.
3Department of Obstetrics and Gynecology, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
4Department of Obstetrics and Gynecology, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

E-mail: Azade1400@yahoo.com

Abstract

**Aim:** The aim of this study was to assess the diagnostic validity of Ultrasonography in women with Stress Urinary Incontinence (SUI) with or without pelvic prolapse.

**Method:** In this cross-sectional study, women with SUI were enrolled. The first group consisted of 25 patients with vaginal anterior wall prolapse, and the other group included 18 patients without vaginal anterior wall prolapse. After systemic and genital examinations, the patients underwent the coughing test and Valsalva maneuver. The urinary leakage was examined during coughing. All the patients with positive coughing test underwent transperineal ultrasound. The posterior urethovesical angle (β angle) as well as the bladder neck funneling were evaluated and recorded at both resting and during Valsalva.

**Results:** In the patients with prolapse, the mean values of β angle were 121.0±25.9 and 137.7±24.5 degrees at the rest and during the Valsalva respectively. In the patients without prolapse, the means of β angle were 124.2 and 142.5 degrees at the rest and during the Valsalva respectively. The sensitivity and specificity of β angle were higher in patients with prolapse. During the Valsalva, β angle >120° and Bladder neck funneling showed higher PPV and NPV in the patients with prolapse than patients without prolapse. At the rest; however, β angle >120° yielded higher PPV and NPV in the patients without prolapse group. At the rest, β angle > 114° rendered the sensitivity and specificity of 80% and 55% respectively. During the Valsalva, β angle >129° revealed the sensitivity and specificity of 80% and 45% respectively.

**Conclusion:** It seems that ultrasound is not appropriate enough to be an alternative diagnostic tool for urodynamic test in detecting SUI.

**Keywords:** Ultrasonography, Stress Urinary Incontinence, Specificity, Pelvic Prolapse.

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**INTRODUCTION**

Urinary incontinence which is characterized with unauthorized leakage of urine is a common condition [1]. It is estimated that roughly 50% of adult women suffer from urinary incontinence; however, only 25-61% of the patients with social symptoms seek health care [2-4]. Actually, the reluctance of patients to discuss about the incontinence and urinary symptoms may be due to either embarrassment, lack of knowledge about treatment options and / or fear of surgery. The Urodynamic test has been the most common diagnostic test for identifying women with SUI [5]. Although the urodynamic test is very helpful in evaluating the function of the lower urinary tract system, this method cannot provide information about the pathologic changes and determine the types of stress incontinence [6]. This method is also an expensive procedure and inaccessible approach in many centers.

The imaging techniques used to examine the lower urinary tract system include MRI, Cystourethrography and transverse pelvic ultrasound [7]. Ultrasonography is a safe, non-invasive, and accessible method in most medical centers. Many studies used trans-spinal ultrasound to evaluate SUI; nevertheless, the values obtained from this diagnostic method require additional standardization. None of the studies using transperineal ultrasound as a diagnostic method for urinary incontinence have compared the validity of this strategy with the standard urodynamic test.

Several parameters and angles have been introduced to evaluate the urinary flow within the urinary tract system. Studies have been carried out to develop valid ultrasound-based diagnostic methods and measures for urinary incontinence. The mobility of the bladder neck has been associated with the integrative function of the structures surrounding the proximal duct. In transperineal ultrasound, the abnormal movements of the bladder neck can be visualized during coughing and also obstructing the Valsalva [8, 9]. Since hypermobility of urethra is important in the etiology of USI, the determination of bladder neck mobility is one of the first indications for the use of transperineal ultrasound.
ultrasonography in the field of urogenital urology. This modality still needs more evaluations to reach more reliable standards, which can be used as a useful diagnostic tool for assessing patients with USI complaints. The aim of this study was to assess the diagnostic validity of ultrasonography in women with SUI with or without pelvic prolapse.

METHODS

Study Design and Patients

In this cross-sectional study, women with SUI who had a positive cough stress test (CST) with or without anterior vaginal herniation were enrolled. The patients had normal urine analysis and culture tests. Based on the presence or absence of vaginal anterior wall prolapse, the patients were divided into the patients with prolapse (25 patients with the condition) and patients without prolapse (18 patients without the condition) groups. This study was conducted in Mahdieh Hospital of Tehran in 2018. All patients were included in study with personal consent and patients' information was kept confidential.

Inclusion and Exclusion Criteria

Inclusion criteria included suffering from SUI, age between 15 and 60 years, and consent to participate in the study. People with chronic diseases such as kidney and liver failure and those who had a history of diseases related to the urinary system and prior pelvic surgery were excluded from the study.

Study Method

First, systemic and genital examinations were performed for all the patients in the lithotomy position. The patients were asked to perform the CST test and then the Valsalva. The urinary flow was examined during coughing. Meanwhile, the pelvic organs were irritated at the anterior or posterior vagina during the Valsalva. The type, level and degree of the defect in the anterior or posterior walls were then determined based on the pop-Q system. The defects with stages 0 and 1 were considered as non-prolapsed while stages above 1 were categorized as prolapsed. Finally, transperineal ultrasound with 3.5-6 MHTz curved array transducer (MHT) was performed for all the patients who had positive CST test with or without anterior wall herniation. The ureterovesical posterior angle (β angle) both at rest and during Valsalva, as well as the proximal bladder neck funneling were evaluated and recorded during ultrasonography using a checklist. Finally, the Urodynamic test was performed for all the patients.

Statistical Analysis

Descriptive data was presented using mean, standard deviation, range and frequency. Depending on the type of variables, the student t-test, ROC curve analysis, sensitivity and specificity were used to compare the results between the patients with prolapse and patients without prolapse groups. A P value ≤0.05 was considered as statistically significant.

RESULTS

Demographic Data

The mean ages of the patients were 46.16±6.14 and 49.7±7.1 years among patients with prolapse and patients without prolapse respectively. Overall, there was no significant difference between the studied groups comparing the demographic variables (p>0.05). The distribution of demographic data in the studied groups has been summarized in table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Patients with prolapse group (n=25) (mean±sd)</th>
<th>Patients without prolapse group (n=18) (mean±sd)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Years)</td>
<td>46.16±6.14</td>
<td>49.7±7.1</td>
<td>0.58</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>29.5±4.4</td>
<td>29.02±4.07</td>
<td>0.45</td>
</tr>
<tr>
<td>Number of parturition</td>
<td>3.7±1.8</td>
<td>4.8±2.3</td>
<td>0.44</td>
</tr>
</tbody>
</table>

Ultrasonography Findings

The main variable in ultrasonography at rest condition and during the Valsalva was β angle. In the patients with prolapse group, the mean β angle at the rest condition was 121.0±25.9 degrees, and 16 (64%) patients represented β angle > 120 degrees; moreover, the mean β angle during the Valsalva was 137.7±24.5 degrees, and 20 (80%) patients showed β angle > 120 degrees. In the patients without prolapse group, the mean β angle at the rest condition was 124.2±22.9 degrees, and 11 (61%) patients had β angle > 120 degrees. This is while the mean β angle in the patients without prolapse subjects was 142.5±24.9 degrees, and 15 (93.3%) patients represented β angle > 120 degrees during the Valsalva. Although the mean β angle was higher in the patients without prolapse than patients with prolapse group, this difference was not statistically significant (p>0.05) (i.e. P values for comparisons at rest condition and during Valsalva were 0.53 and 0.82 respectively, Table 2.). Bladder neck funneling was assessed in the study groups using ultrasonography. The results showed that bladder neck funneling was positive in 10 (40%) and 4 (22.2%) patients in the patients with prolapse and patients without prolapse groups respectively.
Table 2. The mean of β angle at resting condition and during Valsalva in the studied groups

<table>
<thead>
<tr>
<th>Condition</th>
<th>Patients with prolapse</th>
<th>Patients without prolapse</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting</td>
<td>121° ±25.9</td>
<td>124.2°±22.97</td>
<td>0.53</td>
</tr>
<tr>
<td>Valsalva</td>
<td>137.7°±24.5</td>
<td>142.5°±24.9</td>
<td>0.82</td>
</tr>
</tbody>
</table>

Sensitivity and specificity of Ultrasonography

Ultrasonography diagnostic power was evaluated comparing the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) between the studied groups (Table 3). For all the evaluated parameters, sensitivity and specificity were higher in patients with prolapse (i.e. the patients with prolapse group). For β angle >120° during the Valsalva and Bladder neck funneling, PPV and NPV were higher in the patients with prolapse than patients without prolapse group. This was while for β angle >120° at the rest condition, PPV and NPV were higher in the patients without prolapse group. Th comparisons of sensitivity and specificity of β angle >120° at the rest condition and during Valsalva have been shown as ROC curves in figure 1.

Table 3. The sensitivity, specificity, PPV, and NPV of Ultrasonography parameters in the studied groups

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Groups</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>β angle at the rest condition (&gt;120°)</td>
<td>Patients with prolapse</td>
<td>80%</td>
<td>60%</td>
<td>75%</td>
<td>67%</td>
</tr>
<tr>
<td></td>
<td>Patients without prolapse</td>
<td>70%</td>
<td>50%</td>
<td>87%</td>
<td>70%</td>
</tr>
<tr>
<td>β angle at the Valsalva (&gt;120°)</td>
<td>Patients with prolapse</td>
<td>93.3%</td>
<td>40%</td>
<td>87%</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>Patients without prolapse</td>
<td>80%</td>
<td>12.5%</td>
<td>53%</td>
<td>40%</td>
</tr>
<tr>
<td>Bladder neck funneling</td>
<td>Patients with prolapse</td>
<td>53.8%</td>
<td>80%</td>
<td>80%</td>
<td>53%</td>
</tr>
<tr>
<td></td>
<td>Patients without prolapse</td>
<td>10%</td>
<td>62.5%</td>
<td>25%</td>
<td>35%</td>
</tr>
</tbody>
</table>

* Positive predictive value (PPV). **Negative predictive value (NPV).

Figure 1. ROC curves for β angle (>120°) at rest (left) and during the Valsalva (right).

The β angle threshold at resting and Valsalva

We found two thresholds for β angle at resting and during Valsalva. At resting, β angle >114° rendered the sensitivity and specificity of 80% and 55% respectively. During the Valsalva β angle >129° revealed the sensitivity and specificity of 80% and 45% respectively.

DISCUSSION

The present study was designed to evaluate the diagnostic capacity of transperineal pelvic ultrasonography (i.e. the angle of rotational β and bladder neck funneling) at resting and during Valsalva in patients with urinary incontinence. Overall, 15 (60%) and 10 (55%) patients in the patients with prolapse and patients without prolapse groups had abnormal urodynamic test respectively. In the study of Wahba et al., the findings of transperineal ultrasound in patients with SUI were compared with those of urodynamic test; Results
showed that of 20 patients with urinary incontinence 60% had supporting findings in ultrasonography [10]. In comparison, we encountered positive ultrasonography findings in 80% and 90% of patients in the prolapsed and non-prolapsed groups respectively.

In the study of Al-Saadi et al. on patients with SUI, the mean values of β angle were 125.27 and 153.57 at resting and Valsalva respectively which were similar to our study. Also, the β angles were >119 and >141.5 degrees at resting and Valsalva rendering the sensitivities of 63% and 73% and specificities of 60% and 80% respectively.

In their investigation, it was also found that due to wide overlap between groups in study, it is not possible to choose the threshold value for angles [11]. Comparison of results of our study with Al-Saadi et al. showed that in our study, the sensitivity was higher than specificity, but in Al-Saadi et al. study, it was the opposite. In another study, Mohammed S.Sweed et al. applied transperineal ultrasonography to evaluate urinary incontinence and found no statistical difference between the patients with prolapse and patients without prolapse groups at resting condition; however, there were statistically significant differences between the groups comparing posterior urethra angle and the pubourethra distance at the Valsalva. Accordingly, these researchers suggested the transperineal ultrasound as a reliable diagnostic method for SUI [12]. Zhang et al. in a study in China surveyed the applicability of ultrasonography for detecting SUI and determining the type of urinary incontinence and reported higher values for the angle of rotation and motion of ureteroscopic junction, bladder neck funnel, and posterior ureterovesical angle in the patients with prolapse than patients without prolapse group at both rest and stretching conditions [13]. Yin et al.’s findings have shown that the difference between posterior vesicourethral angle at rest and Valsalva, proximal urethral angle is strongly related to stress urinary incontinence [14].

In the present study, there was no significant difference in the beta angle between the two groups (i.e. with and without prolapse) of patients with SUI neither at rest condition nor during Valsalva In the SUI patients with prolapse, elevated beta angle in both rest and Valsalva showed high sensitivity (80% and 93.3% respectively). Furthermore, a higher ratio of patients with concomitant prolapse and SUI (80%) showed elevated bladder neck funneling. As well, ultrasonography and general findings of bladder neck funneling in the prolapse group delivered higher positive and negative predictive values.

In a similar study in 2019, the diagnostic power of transperineal 3D ultrasonography in SUI patients was investigated. 3D ultrasound sensitivity was measured as 66.4% and specificity as 84.5%. Overall, the findings of this study showed that transperineal ultrasound is insufficient in predicting SUI, but it can be effective in diagnosing cases without SUI and reducing unnecessary treatment in patients [15]. Turkoglu et al. reported that during Valsalva maneuver both α and β angles were significantly higher in women with SUI. Also, between Valsalva and rest measurements, α and β angles were significantly higher in women with SUI. The cut-off point for Rα in the diagnosis of stress incontinence was 16° (80% sensitivity, 98% specificity). The pain score in the ultrasound method was significantly lower [16]. In another parallel study, transperineal two-dimensional ultrasound was evaluated in terms of its ability to diagnose stress urinary incontinence. In this study, it was found that α and β angles were significantly higher in SUI group compared to control group [17].

In general, in the present study, the findings showed moderate specificity in relation to the prediction of SUI. In a similar study, it was found that the obtained sizes of rotation angles cannot be considered as a strong predictor of SUI in women [18].

Nowadays, transient perineal sonography in combination with clinical examination and urodynamic test delivers high diagnostic accuracy for functional and structural disorders of the urinary tract system [19]. Also, ultrasound is a non-invasive, convenient and relatively low-cost tool, and the use of two-dimensional ultrasound due to its convenience and availability can be effective in evaluating bladder neck mobility and better understanding SUI [20-22].

In our study, the sensitivity of ultrasound in relation to stress urinary incontinence diagnosis was at an appropriate level; but its feature was reported as average. The findings of present research can be effective in increasing our knowledge regarding diagnostic power of ultrasound and providing new solutions.

One of the limitations of current research was size of examined sample, which was less than expected during one year; but as much as possible, the highest number were included in the study. Another limitation was implementation of research in a treatment center, which for more validity of our evaluation should be done in a larger population and in several centers with different races.

**CONCLUSION**

The Urethra rotational angles are new ultrasonography-based parameters that are used to assess patients with SUI. Although ultrasound is an easy, inexpensive, and affordable method, clinical examinations should be incorporated to improve the diagnostic accuracy of these imaging methods. Nonetheless, our data did not support the applicability of ultrasound as a reliable diagnostic tool for urinary incontinence. More extensive and comprehensive researches are needed to determine the accuracy of other ultrasound-based techniques and measures.

**ETHICS APPROVAL AND CONSENT TO PARTICIPATE**

All the participants signed an informed consent. The project was approved by the Local Research Ethics Committee
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(Shahid Beheshti University of medical sciences, Iran).

COMPETING INTERESTS
The authors declare that they have no competing interest.

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REFERENCES


