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TRANSPERINEAL ULTRASONOGRAPHY: UNVEILING PELVIC FLOOR DYNAMICS IN WOMEN WITH STRESS URINARY INCONTINENCE- A CASE-CONTROL STUDY

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ABSTRACT **Background:** Urinary incontinence (UI), particularly stress urinary incontinence (SUI), significantly impacts women's quality of life. SUI occurs due to defective anatomical support of the bladder neck and proximal urethra, leading to bladder neck hypermobility. Dynamic imaging modalities are crucial for accurate diagnosis. **Methods:** A case control study was conducted on 40 female patients with SUI and 40 female patients without SUI age-matched controls. Participants underwent a detailed clinical assessment and completion of the Questionnaire for Urinary Incontinence Diagnosis (QUID). TPUS measurements included bladder neck position (BNP), α angle, β angle, and bladder neck descent (BND) at rest and during the Valsalva maneuver. Data were analyzed using statistical methods, with a p-value <0.05 considered significant. **Results:** The mean α and β angles were significantly larger in SUI cases compared to controls, both at rest and during Valsalva (p<0.001). BNP at rest showed no significant difference (p=0.651), but BNP on Valsalva and BND were markedly different (p<0.001). **Conclusion:** TPUS is a reliable, non-invasive imaging modality for assessing bladder neck mobility and urethral angles in SUI patients. Its accessibility, cost-effectiveness, and dynamic evaluation capability highlight its potential as a diagnostic tool.

KEYWORDS : Stress urinary incontinence, Transperineal ultrasonography, Bladder neck mobility, Pelvic floor assessment, Bladder neck position (BNP) and Bladder neck descent (BND)

INTRODUCTION

Urinary incontinence (UI) is a prevalent condition that adversely impacts quality of life, defined as the involuntary leakage of urine. Among its various forms, stress urinary incontinence (SUI) stands out as a significant cause of discomfort and social distress, often occurring due to defective anatomical support of the bladder neck and proximal urethra. This leads to bladder neck hypermobility, resulting in the descent of the urethra beyond the intra-abdominal transmission zone.[1]

SUI is characterized by the involuntary passage of small amounts of urine during activities that increase intra-abdominal pressure, such as coughing, sneezing, laughing, or exercising. The urethra's support, primarily provided by the pelvic floor fascia, is crucial in maintaining continence. When this support weakens, the urethra moves downward during moments of elevated abdominal pressure, leading to involuntary urine leakage. Factors such as pregnancy, childbirth, and menopause are common contributors to the development of SUI in women.

The most common types of UI are SUI, urge urinary incontinence (UUI), or a combination of the two, referred to as mixed urinary incontinence (MUI). Differentiating these types is crucial for appropriate management, and tools such as the Questionnaire for Urinary Incontinence Diagnosis (QUID), a validated six-item questionnaire, help distinguish between SUI and UUI.[2]

Magnetic resonance imaging (MRI) is a highly accurate tool for non-invasive evaluation of pelvic floor structures, allowing detailed assessment of ligaments and muscles. However, its high cost and limited availability restrict its routine use.[3] Other imaging modalities, such as cystourethrography, have also been employed for evaluating patients with SUI but are less commonly used due to their invasive nature and exposure to radiation.[4 5]

In recent years, transperineal ultrasonography (TPUS) has emerged as a promising diagnostic tool for evaluating SUI. This real-time imaging modality allows dynamic assessment of pelvic floor structures and bladder neck mobility during activities like coughing or the Valsalva maneuver. TPUS is non-invasive, cost-effective, and well-tolerated by patients, making it an attractive alternative to traditional imaging modalities.

Several parameters, including α angle, β angle, and bladder neck descent, have been investigated using TPUS to assess urethral mobility. TPUS provides valuable insights into pelvic floor muscle (PFM) performance and can evaluate the rotational movement of the proximal urethra during straining.[6] TPUS has shown promise as a reliable modality for assessing bladder neck mobility and PFM contraction.[7 8]

Despite its growing acceptance, standardization of TPUS techniques and parameters is necessary for broader adoption in clinical practice. The present study aims to evaluate the utility of TPUS as a diagnostic tool for SUI, focusing on its ability to provide objective and reliable measurements of urethral and bladder neck mobility. By further elucidating its role in diagnosing SUI, this study seeks to establish TPUS as an effective and accessible imaging modality for clinical use.

Aim Of Study:

To evaluate the pelvic floor dynamics in women with stress urinary incontinence (SUI) by measuring and comparing key parameters (α angle, β angle, bladder neck position and bladder neck descent) using transperineal ultrasonography (TPUS).

MATERIALS AND METHODS

Study Design And Setting

This cross-sectional, age matched case control study was conducted between December 2019 and March 2021in the Department of Radiodiagnosis IGMC Shimla in collaboration with the Department of Obstetrics & Gynaecology and Department of Urology.

Sample Size (Total number of females with SUI and Without SUI referred to Radiology department w.e.f 1st January 2020 to 30th June 2020)

Cases (n=40) : All females with SUI referred to Radiodiagnosis Department during above mentioned study duration

Controls (n=40): Females without SUI referred to Radiodiagnosis department for any other complaint during same duration.

Inclusion Criteria

Women aged greater than 40 years and above.
Cases with confirmed clinical diagnosis of SUI based on QUID
Controls: Age- and sex-matched individuals without SUI

Exclusion Criteria

Neurological diseases (e.g., diabetic neuropathy, multiple sclerosis)
Pregnant women or those within 6 weeks postpartum
Previous surgical treatment for urinary incontinence or pelvic cancer

Data Collection:

Participants underwent detailed history-taking, general physical examination, and completion of the Questionnaire for Urinary Incontinence Diagnosis (QUID) to ascertain UI type.

TPUS was performed using a LOGIQ P6 ultrasound machine with a 3-5 MHz transducer. Measurements were taken at rest and during Valsalva maneuver:

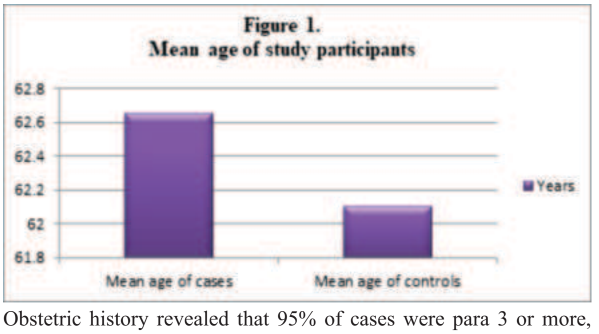
1. Bladder neck position (BNP) relative to the symphysis pubis
2. α angle: Angle between the proximal urethra axis and the central axis of the symphysis pubis
3. β angle: Angle between the proximal urethra and the posterior vesical wall
4. Bladder neck descent (BND)

Statistical Analysis

Data were analyzed using SPSS Version 22. Continuous variables were expressed as mean ± SD, while categorical variables were presented as frequencies and percentages. Comparison was done between cases and control categorical variables. A p-value <0.05 was considered statistically significant.

RESULTS

The study observed no significant difference in mean age between cases (62.65 ± 6.54 years) and controls (62.1 ± 6.48 years, p = 0.734) (Figure 1).



Obstetric history revealed that 95% of cases were para 3 or more, compared to 37.5% in controls, indicating a potential link between higher parity and stress urinary incontinence (SUI) (Figure 2 and 3).

Figure 2
Parity among cases

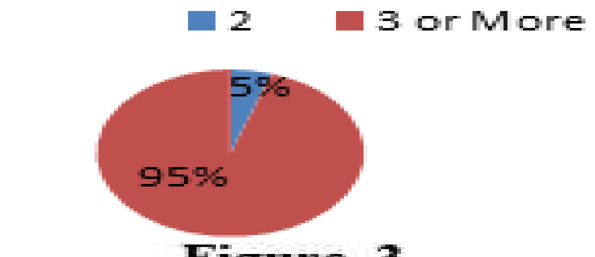
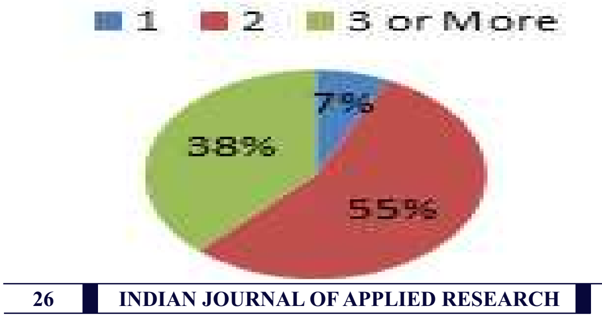
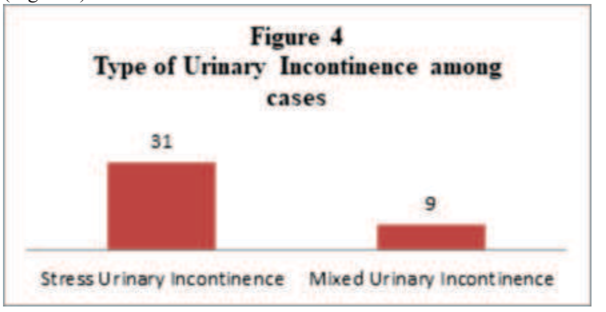


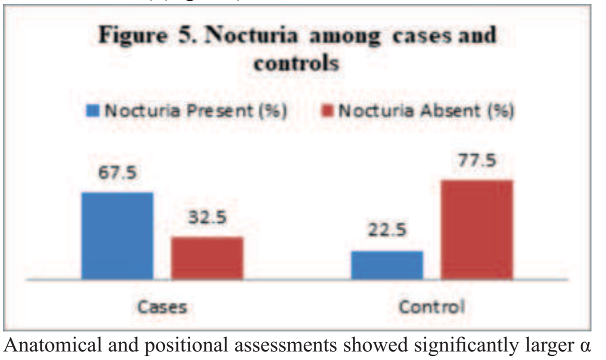
Figure 3
Parity among controls



A higher proportion of cases had a history of lower-segment cesarean section (LSCS) (25% vs. 12.5% in controls). Based on QUID scoring, 31 patients had SUI and 9 had mixed urinary incontinence (SUI + urge) (Figure 4).



Nocturia was significantly more prevalent among cases (67.5% vs. 22.5% in controls) (Figure 5).



Anatomical and positional assessments showed significantly larger α and β angles in cases, both at rest and valsalva ($p < 0.001$). While the bladder neck position (BNP) at rest showed no significant difference ($p = 0.651$), it was significantly lower during valsalva in cases ($p < 0.001$). Additionally, bladder neck descent (BND) was significantly higher in cases ($p < 0.001$) (Table 1).

Table 1. Comparison Of Anatomical And Positional Angles Among Cases And Controls.

Variable	Group	Mean (±SD)	Mean Difference	P Value	Significance
α Angle (Rest)	Control	73.80 (±17.45)	19.65	0.000	Significant
	Case	93.45 (±16.94)			
α Angle (Valsalva)	Control	86.73 (±18.93)	19.72	0.000	Significant
	Case	106.45 (±14.50)			
β Angle (Rest)	Control	112.43 (±18.19)	26.72	0.000	Significant
	Case	139.15 (±17.43)			
β Angle (Valsalva)	Control	126.68 (±18.17)	30.17	0.000	Significant
	Case	156.85 (±13.54)			
BNP (Rest)	Control	18.70 (±3.26)	0.30	0.651	Not Significant
	Case	19.00 (±2.61)			
BNP (Valsalva)	Control	14.70 (±2.65)	3.07	0.000	Significant
	Case	11.63 (±2.48)			
BND	Control	4.00 (±1.28)	-3.33	0.000	Significant
	Case	7.33 (±1.53)			

These findings highlight notable differences in obstetric history, nocturia prevalence, and anatomical angles between the groups.

DISCUSSION

The International Continence Society defines stress urinary incontinence (SUI) as the involuntary leakage of urine associated with increased abdominal pressure in the absence of detrusor contractions. The use of transperineal ultrasonography (TPUS) has gained recognition as a valuable diagnostic tool for evaluating urethral angles and dynamic pubo-urethral descent distances. Since the 1980s, TPUS has been proposed as a safer alternative to urethrocystography, offering comparable information without exposing patients to radiation[9] In our study, the mean age of cases was (62.65 ± 6.54 years) and controls was (62.1 ± 6.48 years) , p=0.734. Nocturia was a prominent complaint among patients with SUI, while it was uncommon in the control group. The presence of nocturia aligns with findings from prior research highlighting its frequent association with SUI.

Evaluation Of Incontinence Types

Using the Questionnaire for Urinary Incontinence Diagnosis (QUID), we categorized patients into stress incontinence and mixed incontinence groups[2] Among the 40 patients, 31 had stress incontinence, and 9 had mixed urinary incontinence (stress + urge). Patients with pure urge incontinence were excluded to ensure a focused analysis of stress and mixed incontinence cases.

Comparison of Urethral Angles

Previous studies have demonstrated that urethral angles differ significantly between individuals with SUI and healthy controls, and these angles undergo dynamic changes during straining (Valsalva maneuver). In our study:

α Angle:

At rest: Significantly higher in cases (93.5 ± 16.94) than in controls (73.80 ± 17.45).

On Valsalva: Significantly higher in cases (106.45 ± 14.50) than in controls (86.73 ± 18.93).

These findings are consistent with prior studies. For example, Wasan Ismail Al-Saadi et al[10]reported lower α angles in both cases and controls. The differences may be attributed to variations in patient demographics, methodologies, or categorizations. Unlike our study, Al-Saadi's research did not classify patients using QUID, potentially leading to a mixed cohort of SUI and urge incontinence cases.

Akram W et al.[11] also supports our findings, showing higher resting α angles in SUI patients compared to controls. Notably, differences in ultrasound techniques (e.g., transvaginal vs. transperineal) might account for variations in absolute angle measurements. Transvaginal ultrasound, for instance, may distort urethral anatomy due to probe pressure, yielding higher values.

The α angle threshold in our study was >101° on Valsalva, with sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of 80%, 82.5%, 82.1%, and 80.5%, respectively. Al-Saadi reported a much lower threshold (>58.5°) but noted that standardized definitions of normal and abnormal values remain elusive.

Posterior Urethrovesical Angle (β Angle)

The β angle, reflecting the functional integrity of proximal urethral supports, was significantly higher in cases than in controls:

At rest: Cases (139.15 ± 17.43) vs. Controls (112.3 ± 18.19).

On Valsalva: Cases (156.85 ± 13.50) vs. Controls (126.68 ± 18.17).These findings align with studies by Wasan Ismail Al-Saadi and Sendag et al,[7] both of which reported significantly higher β angles in SUI patients. Sendag et al. identified a β angle >120° as indicative of poor urethrovesical junction support, corroborating our findings.

Bladder Neck Position and Descent

Our study found no significant difference in bladder neck position (BNP) at rest between cases and controls. However, BNP on Valsalva and bladder neck descent (BND) were significantly different:

BNP on Valsalva: Lower in cases (11.63 ± 2.48 mm) vs. controls (14.70 ± 2.65 mm).

BND: Higher in cases (7.33 ± 1.53 mm) vs. controls (4.00 ± 1.28 mm). These results highlight the importance of dynamic measurements in distinguishing SUI from normal conditions.

Strengths Of Study

Age matching minimized the confounding by age related pelvic floor changes

Use of validated QUID

Enhanced diagnostic accuracy

Limitations Of Study

Small sample size

Limited subgroup analysis

BMI and Hormonal status were not assessed as potential confounders

CONCLUSION:

Our findings emphasize the utility of TPUS in assessing anatomical and functional parameters of the pelvic floor in SUI patients. Significant differences in urethral angles (α and β), BNP on Valsalva, and BND between cases and controls support the role of TPUS as a reliable diagnostic tool. The age matched design ensures the diagnostic utility of TPUS independent of age related pelvic floor changes.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Standardization of TPUS Protocols: Establish uniform guidelines for performing TPUS, including probe placement, imaging parameters, and patient positioning, to ensure consistency across clinical settings.

2.Threshold Values for Diagnosis: Develop universally accepted cutoff values for α angle, β angle, bladder neck position, and bladder neck descent during rest and Valsalva maneuvers to enhance diagnostic accuracy.

3. Integration into Routine Practice: Promote the use of TPUS as a first-line imaging modality for evaluating SUI, given its cost-effectiveness, accessibility, and patient comfort.

4. Training and Education: Implement training programs for healthcare professionals, including radiologists, gynecologists, and urologists, to improve proficiency in performing and interpreting TPUS.

5. Further Research: Conduct larger, multicentric studies to validate TPUS parameters across diverse populations and settings. Explore the potential of TPUS in monitoring the efficacy of therapeutic interventions, such as pelvic floor exercises or surgical treatments.

6. Patient Awareness: Increase awareness among patients about the availability of TPUS as a non-invasive diagnostic option to alleviate anxiety associated with invasive procedures.

7. Collaborative Efforts: Foster collaboration between radiology and clinical departments to integrate TPUS findings into comprehensive management plans for SUI patients.

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