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Posterior vaginal wall support and nocturia: perineal ultrasonographic findings in the context of the integral theory

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ABSTRACT

Objective: To examine the relationship between nocturia, pelvic organ support, and bladder neck mobility by perineal ultrasonography in women with nocturia

Materials and Methods: In this case-control study, 62 women presenting with nocturia were compared with 62 matched controls without nocturia. Groups were matched for age, body mass index (BMI), and apical prolapse (C point). Pelvic organ prolapse was graded using the pelvic organ prolapse quantification system system, and bladder neck descent during the Valsalva maneuver was measured by perineal ultrasonography. The coexistence of stress urinary incontinence (SUI) was documented. A pre-specified subgroup analysis was then performed after excluding patients with SUI to isolate the nocturia-specific results.

Results: Baseline characteristics including age, BMI, and apical prolapse were similar between groups. Women with nocturia had significantly higher gravidity and more vaginal deliveries than controls. Posterior compartment measurements (Ap and Bp points) were significantly greater in the nocturia group, while anterior wall measurements did not differ. Bladder neck descent during Valsalva was also greater among women with nocturia. SUI co-occurred in 79% of the nocturia group versus 38.7% of controls. When SUI cases were excluded, posterior vaginal wall defects remained to be associated with nocturia, whereas the significance in bladder neck descent disappeared.

Conclusion: Nocturia appears to be associated with posterior vaginal wall support defects and increased bladder neck mobility. When cases with SUI are removed from the analysis, posterior compartment abnormalities persist while the bladder neck mobility difference resolves pointing to a mechanism that is at least partly independent of urethral hypermobility. These findings are consistent with Integral Theory.

Keywords: Nocturia; perineal ultrasonography; posterior vaginal wall defects; integral theory

INTRODUCTION

Nocturia is one of the most common lower urinary tract symptoms and is defined as the need to wake from sleep to void one or more times during the night.[1,2] Classically attributed to systemic causes such as nocturnal polyuria, sleep disorders, or detrusor overactivity, its etiology has long been viewed through a predominantly urological or cardiorenal lens.[3] Besides these

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problems, structural pelvic floor dysfunction may also contribute to this symptom.[4]

The Integral Theory of the Pelvic Floor suggests that lower urinary tract symptoms arise from defects in the connective tissue support structures of the pelvic floor.[5] According to this theory, laxity in pelvic ligaments can disrupt the biomechanical balance of the pelvic floor and impair the normal mechanisms responsible for continence and bladder control. As a result, lower urinary tract symptoms may develop.[6]

Several studies have demonstrated that defects in pelvic support structures, particularly those affecting the anterior vaginal wall and urethral support, contribute to stress urinary incontinence (SUI) and bladder dysfunction.[7] However, the relationship between nocturia and specific pelvic compartment abnormalities remains less investigated.

Perineal ultrasonography (PUS) is a non-invasive and widely available method for assessing pelvic floor structures and bladder neck mobility in a dynamic condition.[8] Degree of the bladder neck descent (BND) during the Valsalva maneuver can be used as an indicator of urethral support defect and pelvic floor dysfunction.

Despite growing interest in examining pelvic floor dysfunction with perineal ultrasonography, the role of pelvic support defects in patients presenting with nocturia has not been deeply investigated. Understanding whether nocturia is associated with specific pelvic compartment abnormalities may provide new insights into its pathophysiology and help tailor specific surgical approaches.

The aim of this study was therefore to evaluate pelvic organ support and bladder neck mobility in women with nocturia using pelvic organ prolapse quantification and perineal ultrasonography.

MATERIALS AND METHODS

Study Design and Population

This was a retrospective case-control study conducted at a tertiary urogynecology referral center. We reviewed the medical records of women who underwent PUS as part of their routine urogynecologic evaluation.

Women reporting nocturia were identified and included in the study group. Nocturia was defined according to the International Continence Society terminology as waking from sleep one or more times to void during the night.[9] The control group consisted of women without nocturia who underwent PUS during routine gynecological assessment. Controls were matched on age, body mass index (BMI), and apical pelvic support pelvic organ prolapse quantification (POP-Q) point D to reduce confounding by demographic and anatomical factors.

In total, 124 women were included: 62 with nocturia and 62 matched controls.

Ethical approval was obtained from the Research Ethics Committee of Pamukkale University (date: 14.04.2024, number: 07).

Clinical and Pelvic Floor Evaluation

All participants underwent a structured urogynecologic evaluation including medical and obstetric history. A standardized pelvic examination was performed. Pelvic organ support was graded using the POP-Q system,[10] which provides a standardized method for characterizing prolapse at each vaginal compartment. Measurements were taken at maximal Valsalva in the lithotomy position by the same clinician with expertise in urogynecologic assessment.

Perineal Ultrasonography

All transperineal examinations followed a standardized protocol. Patients were positioned in the lithotomy position with a partially filled bladder. A curved-array probe was applied to the perineum in the midsagittal plane, providing visualization of the symphysis pubis, urethra, and bladder neck. Ultrasound images were obtained in two conditions; at rest and during maximal Valsalva.

The position of the bladder neck was identified relative to the symphysis pubis. The distance between the bladder neck and the symphysis pubis was measured in both resting and Valsalva conditions according to previously described standardized methods. All ultrasound examinations were performed by the same examiner using the same standardized protocol. BND was defined as the displacement of the bladder neck during straining, calculated as the difference between resting and Valsalva bladder neck positions.

Statistical Analysis

Statistical analyses were carried out using the IBM Statistical Product and Service Solutions (version 22, IBM SPSS Statistics for Windows, Armonk, NY) program. Continuous variables are presented as mean ± standard deviation; categorical variables as frequencies and percentages. Group comparisons were performed with independent samples t-tests for continuous variables and chi-square tests for categorical data. Statistical significance was set at $p<0.05$.

A secondary subgroup analysis was conducted after excluding patients with SUI, in order to evaluate whether these associations persisted independently of SUI.

RESULTS

Sixty-two women with nocturia and 62 matched controls were included. The baseline characteristics of these cases are summarized in Table 1. The mean age of cases was 50.1±8.2 years, while that of controls was 47.4±7.4 years. The mean BMI of controls and the cases with nocturia was also comparable (27.8±3.7 vs. 28.6±4.2). Number of vaginal deliveries was higher (2.7 vs. 1.9, $p<0.001$) in the nocturia group. Both groups had similar C point measurements (-6.2±2.3 vs. -5.9±2.6, $p=0.503$).

Anterior compartment measures (points Aa and Ba) did not differ significantly between groups. However, Ap and Bp measurements were significantly greater than that of the controls (-1.9±1.2 vs. -1.4±1.3, $p=0.036$ and -2.0±1.3 vs. -1.3±1.4, $p=0.016$, respectively). When BND was measured during the Valsalva maneuver, greater descent was observed in the group with nocturia (2.3±1.4 vs. 1.8±1.2, $p=0.032$) (Table 2).

SUI was considerably more prevalent among women with nocturia: 79.0% versus 38.7% in the control group ($p<.001$; Table 3). Because of this high co-occurrence, a subgroup analysis described below was performed.

After excluding patients with SUI, the posterior compartment differences persisted in Ap and Bp point. However, BND was found to be similar between the groups (1.7±1.1 vs. 1.9±1.0, $p=0.509$) (Table 4).

Table 1. Baseline characteristics of the study population

	Without nocturia n=62	With nocturia n=62	*p*-value
Age, mean (SD)	47.4 (7.4)	50.1 (8.2)	0.062
BMI	27.8 (3.7)	28.6 (4.2)	0.317
C point	-6.2 (2.3)	-5.9 (2.6)	0.503
Gravida	2.7 (1.4)	3.2 (1.6)	0.045
Vaginal delivery number	1.9 (1.2)	2.7 (1.3)	<0.001

SD: standard deviation; BMI: body mass index

Table 2. Comparison of POP-Q measurements and bladder neck descent in women with and without nocturia

	Without nocturia n=62	With nocturia n=62	*p*-value
Point Aa	-1.5 (1.1)	-1.2 (1.4)	0.209
Point Ba	-1.6 (1.4)	-1.2 (1.6)	0.127
Point Ap	-1.9 (1.2)	-1.4 (1.3)	0.036
Point Bp	-2.0 (1.3)	-1.3 (1.4)	0.016
Bladder neck descent	1.8 (1.2)	2.3 (1.4)	0.032

POP-Q: pelvic organ prolapse quantification system

Table 3. Association of nocturia with the presence of stress urinary incontinence

	Without SUI	With SUI	Total	*p*-value
No nocturia	38 (61.3%)	24 (38.7%)	62 (100.0%)	<0.001
Nocturia	13 (21.0%)	49 (79.0%)	62 (100.0%)	

SUI: stress urinary incontinence

Table 4. Comparison of POP-Q measurements and bladder neck descent in women with and without nocturia after excluding SUI cases

	Without nocturia	With nocturia	*p*-value
Point Aa	-1.6 (1.3)	-1.3 (1.4)	0.496
Point Ba	-1.5 (1.4)	-1.3 (1.6)	0.731
Point Ap	-2.1 (1.0)	-1.2 (1.6)	0.075
Point Bp	-2.1 (1.0)	-0.9 (1.6)	0.032
Bladder neck descent	1.7 (1.1)	1.9 (1.0)	0.509

SUI: stress urinary incontinence; POP-Q: pelvic organ prolapse quantification system

DISCUSSION

The present study investigated the relationship between nocturia, pelvic organ support, and bladder neck mobility using both POP-Q examination and perineal ultrasonography. The findings demonstrate that women with nocturia exhibit greater posterior vaginal wall descent and increased bladder neck mobility compared with matched controls. Importantly, when patients with SUI were excluded, the association between nocturia and posterior compartment support defects persisted, whereas BND became similar. These findings suggest that posterior pelvic support abnormalities may play a role in the pathophysiology of nocturia independent of urethral hypermobility.

Nocturia is a multifactorial symptom, and its association with posterior compartment support defects observed in our study suggests that structural pelvic floor dysfunction may represent an underrecognized contributing mechanism. While systemic etiologies such as nocturnal polyuria and detrusor overactivity remain important, our findings indicate that pelvic floor assessment should be considered in the evaluation of women presenting with nocturia, particularly in the urogynecologic setting.[11,12] Besides these problems, structural pelvic floor dysfunction may also contribute to this symptom. According to the Integral Theory of the Pelvic Floor, urinary symptoms may arise from defects in pelvic connective tissue support structures rather than from primary organ dysfunction alone. Laxity of pelvic ligaments can alter the balance of the forces acting on the bladder base and urethra, consequently affecting the mechanisms responsible for continence.[13,14]

Our findings are consistent with the prediction of Integral Theory. The observation that posterior vaginal wall measurements (Ap and Bp) were significantly greater in women with nocturia suggests that posterior compartment support may indirectly influence bladder function. The posterior vaginal wall is supported by structures such as the rectovaginal fascia and uterosacral ligament complex, which contribute to the stability of the pelvic floor and the proper positioning of the contracting rotational forces.[15] Defects in these support structures may alter continence dynamics, potentially leading to abnormal stimulation of bladder stretch receptors and increased nocturnal voiding.

The association between nocturia and increased BND observed in the overall cohort is also notable. Bladder neck mobility is commonly used as a marker of urethral support deficiency and is generally reported to be associated with SUI.[16] In our study, coexisting SUI was significantly more prevalent among women with nocturia. However, when SUI cases were excluded in the subgroup analysis, BND did not significantly differ between groups. This finding indicates that urethral hypermobility may primarily reflect the presence of SUI rather than representing an independent mechanism underlying nocturia.

In contrast, posterior compartment differences remained evident even in cases of isolated nocturia. This observation suggests that posterior pelvic floor support may influence nocturnal urinary symptoms through mechanisms distinct from those involved in SUI. According to integral theory, defects in the posterior compartment may impair the normal tensioning mechanisms of the pelvic floor that help stabilize the bladder base during filling. These alterations could potentially induce reflex afferent signaling from the bladder that can result in nocturnal urgency or voiding.[17]

PUS has been reported to be a good modality for evaluating pelvic floor dynamics.[8] As a non-invasive and widely available imaging technique, it allows real-time and dynamic assessment of bladder neck mobility and pelvic floor structures. Previous studies have demonstrated the value of PUS in the evaluation of pelvic floor disorders, particularly in assessing urethral mobility and pelvic organ prolapse. Our findings also support its utility as an adjunctive tool in the evaluation of patients presenting with nocturia.

Study Limitations

Several limitations should be considered when interpreting these results. First, the retrospective design limits the ability to conclude a direct causal relationship between pelvic support defects and nocturia. In addition, nocturia was assessed based on patient-reported symptoms rather than voiding diary data, which may introduce recall bias. The study was conducted at a single tertiary center, which may limit the generalizability of the findings to other populations.

Despite these limitations, this study has several strengths. First, cases and controls were carefully matched for important potential confounders such as age, body mass index, and apical pelvic support. Second, pelvic organ support was assessed using the standardized POP-Q system, which provides a reproducible and internationally accepted method for evaluating pelvic floor anatomy. Third, bladder neck mobility was objectively measured using PUS both in resting and during Valsalva.

CONCLUSION

PUS provided an objective method for evaluating pelvic floor dynamics and bladder neck mobility, allowing visualization of structural support defects that may contribute to lower urinary tract symptoms. Our findings support the concept that pelvic floor support mechanisms, particularly those involving the

posterior vaginal compartment, may influence nocturia. Future research involving interventional studies regarding posterior compartment defects may further clarify the causal relationship between pelvic floor structural abnormalities and nocturia in the absence of systemic disorders.

ETHICS

Ethics Committee Approval: Ethical approval was obtained from the Research Ethics Committee of Pamukkale University (date: 14.04.2024, number: 07).

Informed Consent: As the study was retrospective in nature, it was not applicable.

FOOTNOTES

DISCLOSURES

Financial Disclosure: The author declared that this study received no financial support.

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