The relationship between obstructive sleep apnea, nocturia, and daytime overactive bladder syndrome in women

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OBJECTIVE: The purpose of this study was to corroborate the association between obstructive sleep apnea (OSA) and nocturia in a clinical sample of urogynecologic patients and to explore whether night-time urine concentration predicts the presence of OSA.

STUDY DESIGN: Patients with nocturia and control subjects underwent a home sleep study, completed validated nocturia questionnaires, and provided evening and morning urine specimens that were analyzed for osmolarity.

RESULTS: Twenty-one patients with nocturia (16 of whom also had daytime overactive bladder [OAB] symptoms) and 10 control subjects were studied. OSA was present in 17 of 21 women (81%) with nocturia: 13 women (81%) with OAB, 4 women (80%) with nocturia/no OAB, and 4 control subjects (40%; $P < .001$). The percentage of rapid eye movement sleep time was correlated inversely with nocturic frequency ($\rho = -.51$; $P < .004$). The presence of diluted nighttime urine in a patient with nocturia was 88% sensitive for the presence of OSA.

CONCLUSION: We should consider a diagnosis of OSA in all patients with nocturia, even those patients with daytime OAB.

Key words: nocturia, obstructive sleep apnea, overactive bladder syndrome, sleep study

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Nocturia is a bothersome and common symptom[1] that, after stress/anxiety, is the most common cause of disturbed sleep.[2] Nocturia is associated with several chronic medical conditions that include obstructive sleep apnea (OSA),[3,4]which is a condition that is characterized by repetitive episodes of complete or partial upper airway obstruction,[5] which gives rise to negative intrathoracic pressures and increased venous blood flow to the heart, and which causes distention of right atrium and ventricle. To compensate for this, brain-type atrial natriuretic peptide (ANP) is released from the cardiac atrium and ventricle[6,7] and inhibits the secretion of antidiuretic hormone (ADH) and aldosterone and causes diuresis through its effect on glomerular filtration of sodium and water.[8] Treatment of OSA with continuous positive airways pressure (CPAP) prevents upper airway obstruction and the sequence of events that lead to nocturia, which offers a treatment option to patients with nocturia arising from OSA.[9-12] In healthy adults, secretion of ADH normally increases at night, resulting in increased resorption of sodium and water from the collecting tubules and production of lower volumes of concentrated urine.[13] Theoretic considerations suggest that the production of less concentrated urine during the night among patients with OSA (who have altered balance of ADH and ANP) may be a useful clinical indicator of the presence of OSA.

The International Continence Society (ICS) has recommended an assessment algorithm for patients with troublesome nocturia,[14] but the clinical usefulness of this algorithm remains untested. As outlined in Figure 1, the ICS algorithm suggests that sleep disorders may be present even when the clinical picture is consistent with the presence of a bladder storage problem, such as overactive bladder (OAB) syndrome. No previous studies have investigated this association.

In this study we had 3 main objectives: (1) to obtain pilot data concerning the prevalence of OSA in patients with nocturia, especially those patients with a clinical diagnosis of OAB; (2) to explore associations between the quality of sleep and the severity of nocturia; and (3) to determine whether patients with OSA differ from those patients without OSA, with respect to nocturnal urine concentration.

Materials and Methods

After approval by our institutional review board, we recruited subjects to 2 study groups. Participants in the nocturia group reported at least 1 nightly awakening to void. The control group

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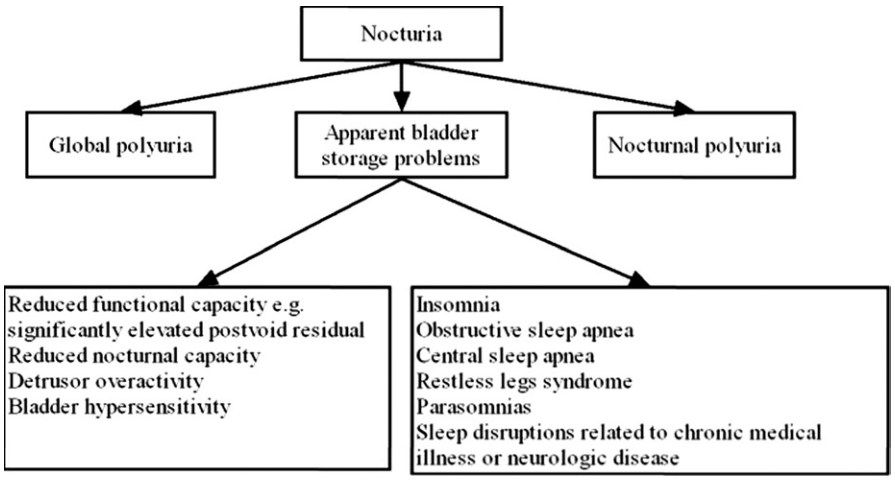
FIGURE 1
ICS algorithm for investigating nocturia



Adapted from van Kerrebroeck P, Abrams P, Chaikin D, et al. The standardisation of terminology in nocturia: report from the Standardisation Sub-committee of the International Continence Society. Neurourol Urodyn 2002;21:179-83.

included women who reported no nocturic episodes or daytime symptoms of urgency or frequency. Control subjects were matched by age and body mass index to women in the nocturia group. We excluded women with diabetes mellitus, diabetes insipidus, finger anomaly, or urinary retention or who were taking hypnotics. Participants completed validated urinary symptom questionnaires concerning nocturia (International Consultation on Incontinence Modular Questionnaire-Nocturia [ICI-N], International Consultation on Incontinence Modular Questionnaire-Nocturia Quality of Life [ICI-Nqol]).[15] and the Medical, Epidemiological and Social Aspects of Aging[16] incontinence screening questionnaire. Diagnoses of OAB were based on clinical evaluation (ie, they reported daytime urgency with or without frequency and/or urge incontinence).[17] Demographic data, including age, race, and medical history were recorded from patients' charts.

All participants had home sleep studies with the use of a Food and Drug Administration–approved ambulatory sleep apnea monitor (Watch PAT-100; Itamar Medical, Cesaria, Israel) that measures sleep (actigraphy) and sympathetic activation levels and oxygen saturation with the use of 2 sensors that are mounted on the fingers of the nondominant hand (Figure 2) and has been shown to detect sleep-disordered breathing events accurately.[18-21] Participants slept with the device for 1 night at home and returned the device the next morning along with 2 urine samples: 1 sample from the last void before bedtime and 1 sample from the first void in the morning. Urine samples were analyzed for osmolarity with a micro osmometer 3MO (Baxter, Deerfield, IL). Patients were considered to be diluting their urine if the osmolarity of their morning urine sample was at least 10 mOsm less than the osmolarity of the sample collected before bedtime.

Overnight sleep studies were considered acceptable if the sleep time was >1.5 hours. *Apnea* was defined as decreased airflow of >90% for a minimum of 10 seconds. *Hypopnea* was defined as decreased airflow of ≥30% and a 3% reduction in oxygen saturation for a minimum of 10 seconds. The apnea hypopnea index (AHI) was calculated as the sum of apnea and hypopnea divided by hours of sleep. Recorded sleep study was analyzed with the automatic algorithm of the WP100, which is based on the peripheral arterial tonus signal amplitude, heart rate, and oxygen saturation. The following parameters were recorded at the end of each sleep study: rapid eye movement (REM) sleep stage, which was divided by the total sleep time to provide the REM percentage (%REM), time of sleep, and AHI. Patients were diagnosed with OSA if the AHI was ≥5.

SPSS software (version 13; SPSS Inc, Chicago, IL) was used for data management and statistical analysis. The Mann-Whitney test was used to compare independent groups with respect to continuous variables. Spearman's testing was used for correlations between independent variables and Fischer's exact test for proportions. A 5% significance level was used for all statistical tests. No 1-sided tests were done.

Results

Thirty-one patients with a median age 65 years (range, 39-81 years) were enrolled in the study: 21 patients in the nocturia group and 10 patients in the control group. Sixteen of the patients (76%) with nocturia had a clinical diagnosis of OAB, and 5 patients had nocturia without daytime OAB symptoms. Median nocturic frequency was 3 (range, 1-4) in the nocturia group. Women with and without nocturia had similar ages and body mass indices (Table).

OSA was significantly more prevalent in the nocturia group: Seventeen women (81%) in the nocturia group and 4 women (40%) in the control group demonstrated OSA during testing ($P < .001$). OSA was detected in 13 of the 16 patients (81%) with nocturia and OAB.

Significantly more patients in the nocturia group (80%) had a decrease in urine osmolarity overnight than in the control group (30%). Among women who had nocturia and also diluted their urine, OSA was highly prevalent at a rate of 88% (14/16 women tested).

The AHI did not correlate with ICI-N, ICI-Nqol, or Medical, Epidemiological and Social Aspects of Aging scores (all $P > .05$). As detailed in the Table, patients with nocturia had lower median %REM sleep time than did control subjects (18 ± 6 vs 23.8 ± 6). % REM sleep time inversely correlated with nocturic frequency ($\rho = -0.51$, $P < .004$). Higher