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SCIENTIFIC INVESTIGATIONS

Incidence and predictors of comorbid insomnia in a sleep surgery clinic

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Study Objectives: The objective was to determine the prevalence and predictors of comorbid insomnia in patients presenting for sleep surgery evaluation. The insomnia severity index (ISI) was utilized to evaluate patients' insomnia severity.

Methods: A retrospective chart review was performed in patients presenting to an otolaryngology sleep surgery clinic; patients also completed a sleep history questionnaire. Patients were divided between those with and without clinically significant insomnia defined as ISI ≥ 15.

Results: A total of 119 patients were included in the study: 50 (42%) with an ISI ≥ 15 and 69 (58%) with an ISI < 15. Clinically significant insomnia was associated with respiratory disturbance index ($P = .028$) but not apnea-hypopnea index or SaO_2 nadir ($P > .05$). Clinically significant insomnia was associated with frequency of wake ups ($P = .008$), time to fall back asleep ($P = .049$), history of continuous positive airway pressure device use ($P = .012$), Epworth Sleepiness Scale ($P = .008$), and Sino-nasal Outcome Test (SNOT-22) ($P < .001$).

Conclusions: Patients reporting to a sleep surgery clinic are at an elevated risk for comorbid insomnia. The relationship between increased respiratory event–related arousals and nonsleep SNOT-22 scores to related sleep-maintenance insomnia supports the connection between insomnia, nasal obstruction, and continuous positive airway pressure intolerance.

Keywords: insomnia, obstructive sleep apnea, sleep surgery

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BRIEF SUMMARY

Current Knowledge/Study Rationale: It is well documented that the prevalence of chronic insomnia is approximately 9% in the general population and is associated with female sex, older age, comorbid medical illness, shift work, lower socioeconomic status, and obstructive sleep apnea. Few studies have explored the prevalence and predictors of insomnia in patients presenting for sleep surgery assessment.

Study Impact: The review of 119 patients revealed a 42% prevalence of clinically significant insomnia and was significantly associated with respiratory disturbance index, frequency of wake ups, time to fall back asleep, history of continuous positive airway pressure device use, Epworth Sleepiness Scale, and Sino-nasal Outcome Test. The data reinforce the importance of recognizing and addressing comorbid insomnia in a unique patient population.

INTRODUCTION

Insomnia is defined by the *International Classification of Sleep Disorders, Third Edition* (ICSD-3), as a persistent difficulty with sleep initiation, duration, consolidation, or quality that occurs despite adequate opportunity and circumstances for sleep, and that results in some form of daytime impairment.[1] Prevalence of chronic insomnia, defined as symptoms lasting greater than 3 months, is approximately 9%, and one-third of adults will complain of insomnia over the course of a year.[2,3] Several observational studies have shown an association between insomnia and increased risk for hypertension, coronary heart disease, and heart failure.[4] Insomnia is associated with female sex, older age, psychiatric and comorbid medical illness, shift work, substance abuse, lower socioeconomic status, and other sleep disorders such as obstructive sleep apnea (OSA), for which polysomnography may be an important adjunct for diagnosis.[1,3,5,6] The diagnosis of insomnia is made by patient history, and polysomnography is not typically recommended for the evaluation of insomnia alone.[3] The insomnia severity index (ISI) is a 7-item questionnaire that has been validated both as a screening tool and for evaluation of clinical treatment response as well as in research and may supplement the clinical history obtained from the patient.[7,8]

The sleep surgeon commonly treats OSA in patients who cannot tolerate continuous positive airway pressure (CPAP) therapy. It is imperative that the surgeon be aware of comorbid sleep disorders, as insomnia has been shown to be prevalent among patients with sleep-disordered breathing and may confound treatment and influence treatment recommendations.[9] We sought to determine the incidence of insomnia comorbid with OSA in a patient population who present to an otolaryngologist for evaluation of alternative treatment options after failing or refusing CPAP therapy. We hypothesized that the incidence of comorbid insomnia in patients not tolerating CPAP therapy and presenting for sleep surgery evaluation is significantly higher than the community prevalence of insomnia.

METHODS

The Institutional Review Board of Thomas Jefferson University Hospital granted approval of this retrospective study in September

2020. In this retrospective chart review, patient demographics, past medical history, and sleep history questionnaire data were collected from all new patients presenting to the otolaryngology clinic for sleep surgery evaluation between January 2020 and September 2020. Demographic characteristics, surgical history, comorbid medical and mental disorders, medications, and ISI scores were recorded and were examined to identify predictors of insomnia.

Patient demographic variables collected include age, race, and sex. Additional history obtained included body mass index, prior sleep surgeries, sleep-related medications, psychiatric history, and tobacco or alcohol use. Each patient's most recent sleep study was reviewed and apnea-hypopnea index (AHI) or respiratory event index, respiratory disturbance index, and O_2 nadir were obtained. A sleep history questionnaire was completed at the first office visit as standard of care. The data collected from the sleep history questionnaire included bedtime, sleep latency, number of nighttime awakenings and sleep reinitiation latency, and final morning awakening; the presence of a shift work profession, history of CPAP, bilevel positive airway pressure, and/or oral appliance use was queried. ISI, Epworth Sleepiness Scale, and Sino-nasal Outcome Test (SNOT-22) scores were also collected.

The ISI scoring guidelines define a cumulative score of 0–7 as "no clinically significant insomnia," 8–14 as "subthreshold insomnia," 15–21 as "clinical insomnia of moderate severity," and 22–28 as "severe clinical insomnia." Patients with moderate to severe clinical insomnia (ISI ≥ 15) were compared with patients with clinically insignificant or subthreshold insomnia (ISI < 15). An unpaired, 2-tailed *t* test was performed to analyze continuous variables, and a Pearson chi-square test was utilized for categorical variables. The Mann-Whitney test was employed for nonparametric and ordinal data. Statistical significance was defined as $P < .05$.

RESULTS

During the study period, 144 charts were reviewed and 25 were excluded due to missing or incomplete sleep history questionnaires, resulting in 119 patient charts analyzed.

ISI

Sixty-nine (58%) participants with an ISI < 15 served as the control group and 50 participants (42%) were included in the "insomnia" group. Thus, the incidence of clinically significant insomnia was 42%.

Demographics

Baseline participant characteristics are shown in **Table 1**. Most patients were male (80% control group vs 76% insomnia group) and White (80% control group vs 88% insomnia group). The average patient was obese (mean body mass index: 31.2 vs 32.2 kg/m^2). Most patients did not smoke (19% control group vs 14% insomnia group) and did drink alcohol at least occasionally (60% control group vs 60% insomnia group). No statistical significance was noted in any of the demographic variables between the insomnia and control groups.

Table 1—Baseline patient characteristics.

	ISI < 15 n = 69	ISI ≥ 15 n = 50	*P*
Age, mean ± SD, y	53.8 ± 14.3	55.8 ± 12.0	.424
Sex			.629
Male	55 (80%)	38 (76%)	
Female	14 (20%)	12 (24%)	
Race			.117
White	53 (80%)	44 (88%)	
Black	8 (12%)	5 (10%)	
Hispanic	1 (2%)	1 (2%)	
Asian	4 (6%)	0	
Current tobacco use	13 (19%)	7 (14%)	.486
Current alcohol use	41 (60%)	28 (60%)	.938
Comorbid conditions			
BMI ≥ 30 kg/m^2, mean ± SD, kg/m^2	31.2 ± 7.0	32.2 ± 7.0	.456
Psychiatric diagnosis	16 (23%)	13 (26%)	.724
Major depressive disorder	13 (19%)	10 (20%)	
Anxiety disorder	6 (9%)	4 (8%)	
Bipolar disorder	3 (4%)	1 (2%)	
Prior sleep medication	14 (20%)	16 (32%)	.146
Zolpidem	11 (16%)	11 (22%)	
Eszopiclone	3 (4%)	3 (6%)	
Temazepam	2 (3%)	4 (8%)	
Trazodone	2 (3%)	3 (6%)	
Quetiapine	1 (1%)	1 (2%)	
Doxepin	1 (1%)	0	
Zaleplon	1 (1%)	0	
Previous sleep surgery	19 (28%)	14 (28%)	.694
Tonsillectomy and adenoidectomy	12 (17%)	9 (18%)	
Septoplasty	6 (9%)	3 (6%)	
FESS	7 (10%)	7 (14%)	
Palate surgery/UPPP	4 (6%)	1 (2%)	
Rhinoplasty	2 (3%)	1 (2%)	
Turbinate reduction	1 (1%)	1 (2%)	

Values are n (%) unless otherwise indicated. BMI = body mass index, FESS = functional endoscopic sinus surgery, ISI = insomnia severity index, SD = standard deviation, UPPP = uvulopalatopharyngoplasty.

Medical and surgical history

The rate of comorbid psychiatric diagnosis in the insomnia cohort was 26%, compared with 23% in the control cohort ($P = .72$). Use of benzodiazepine, benzodiazepine receptor agonist, and antidepressant medications was not significantly different between the cohorts. History of prior sleep surgery, defined as any previous tonsillectomy, adenoidectomy, septoplasty, endoscopic sinus surgery, oropharyngeal palate surgery, rhinoplasty, or turbinate reduction, was found to be essentially equal (28%) between the groups. No significant difference was found for any of the surgeries independently.

Table 2—Comparison of case and control sleep study characteristics.

	ISI < 15	ISI ≥ 15	*P*
Overnight sleep evaluation, n (%)			.850
Home sleep testing	44 (64%)	31 (62%)	
Laboratory polysomnography	25 (36%)	19 (38%)	
AHI/REI, mean ± SD	30.3 ± 25.1	38.7 ± 27.0	.085
RDI, mean ± SD	27.8 ± 25.0	50.9 ± 28.2	.028
O_2 nadir, mean ± SD (%)	80.8 ± 8.1	77.2 ± 14.3	.083

AHI = apnea-hypopnea index, ISI = insomnia severity index, RDI = respiratory disturbance index, REI = respiratory event index, SD = standard deviation.

Table 3—Comparison of case and control sleep questionnaire variables.

	ISI < 15	ISI ≥ 15	*P*
Hours in bed, mean ± SD	7.5 ± 1.2	7.8 ± 1.8	.277
Time to fall asleep in minutes, mean ± SD	20.4 ± 17.3	23.5 ± 19.3	.362
Frequency of wake up, mean ± SD	2.4 ± 1.7	3.5 ± 2.4	.008
Time to fall back asleep in minutes, mean ± SD	10.9 ± 16.6	18.7 ± 21.4	.049
Shift work, n (%)	11 (16%)	12 (24%)	.271
Tried CPAP device, n (%)	53 (77%)	47 (94%)	.012
Full face mask	35 (51%)	34 (68%)	.059
Nasal mask	18 (26%)	19 (38%)	.166
Nasal pillow	19 (28%)	16 (32%)	.598
Tried BPAP device, n (%)	8 (12%)	7 (14%)	.696
Tried oral appliance	10 (15%)	9 (18%)	.606
Epworth Sleepiness Scale, mean ± SD	9.2 ± 6.3	11.9 ± 5.7	.008
SNOT-22, mean ± SD	21.8 ± 14.1	41.5 ± 17.9	< .001
SNOT-22 sleep portion, mean ± SD	9.1 ± 6.2	17.5 ± 5.6	< .001
SNOT-22 nonsleep portion, mean ± SD	13.0 ± 9.8	24.1 ± 15.1	< .001

BPAP = bilevel positive airway pressure, CPAP = continuous positive airway pressure, ISI = insomnia severity index, SD = standard deviation, SNOT-22 = Sino-nasal Outcome Test.

Prior sleep study

Results are shown in **Table 2**. Of the 119 patients included in the analysis, all underwent overnight sleep evaluation. Forty-four (37%) patients underwent laboratory polysomnography, and 75 (63%) underwent home sleep testing. There was no significant difference in the rate of home sleep testing vs in-laboratory testing between the insomnia group and the control group ($P > .05$). No significant difference was seen between AHI/respiratory event index ($P = .083$) or O_2 nadir ($P = .083$) between the control and experimental groups. Patients in the experimental group had a significantly higher respiratory disturbance index than controls (mean: 50.9 vs 27.8; $P = .028$).

Sleep questionnaire

Sleep questionnaire results are shown in **Table 3**. Frequency of nighttime awakenings was significantly higher in the insomnia group (mean: 3.5 vs 2.4; $P = .008$). The insomnia group (ISI > 15) had a significantly longer time to reinitiate sleep after each awakening (mean: 18.7 vs 10.6 minutes; $P = .049$). A significantly larger percentage of patients in the insomnia group had previously tried using a CPAP device (94% vs 77%; $P = .012$).

Validated questionnaires

The insomnia cohort had higher Epworth Sleepiness Scale scores (mean: 11.9 vs 9.2; $P = .008$) and SNOT-22 total score (mean: 41.5 vs 21.8; $P < .001$). Furthermore, the scores for the 5 questions in the SNOT-22 that pertained to sleep were analyzed: difficulty to fall sleep, wake up in the middle of the night, lack of a good night of sleep, wake up tired, and fatigued or tired during the day; the experimental group had significantly higher scores (mean: 17.5 vs 9.05; $P < .001$). The nonsleep portion of the SNOT-22 was significantly higher in the insomnia group (mean: 13.0 vs 24.1; $P < .001$) as well.

DISCUSSION

Patients with OSA have clinically significant insomnia at a rate higher than the population prevalence of insomnia alone, and treatment of OSA with CPAP can be especially problematic for patients with comorbid insomnia.[10,11] This study examines a specific subset of patients within the OSA population: those who present for surgical consultation after CPAP failure or refusal. The finding of an increased incidence of clinically relevant insomnia (42%) concurred with a study by Lam et al[9] that examined patients in a CPAP alternatives clinic and found an ISI ≥ 15 in 59% of patients. In a study of 1115 Norwegian patients presenting for suspicion of OSA, Bjorvatn et al[10] found insomnia in 44–55% of patients with OSA, and found that increased apnea severity was correlated with lower insomnia scale scores.[11] Adherence to CPAP use has been correlated positively with increased OSA severity.[12] Thus, patients presenting for sleep surgery evaluation who do not tolerate CPAP therapy may represent a unique cohort that is at higher risk for insomnia than the general population.

The lack of statistical correlation of demographic variables (age, sex, body mass index, etc) with insomnia in our specific patient population is not in agreement with the established understanding of insomnia risk factors. Specifically, we did not find an increased incidence of insomnia in CPAP-intolerant females nor an association with increased age. Furthermore, psychiatric diagnoses and sleep-related antidepressants and anxiolytic prescriptions were no more common in the insomnia cohort than in the control group. These differences from established risk factors for insomnia further support that the CPAP-intolerant patient population with OSA is a distinct patient population regarding

comorbid insomnia. Future studies will be required to overcome the limitations of underpowering and a male-predominant study group. Additionally, future studies examining the CPAP-adherent patient population can further elucidate the demographics of insomnia in that patient population. Nevertheless, physicians and surgeons caring for CPAP-intolerant patients with OSA must be aware of the extremely high incidence of comorbid insomnia in these patients.

Patients who underwent either overnight in-laboratory polysomnography or home sleep testing demonstrated no difference in AHI or respiratory event index, but the insomnia group had significantly higher respiratory disturbance index. The difference between these indices is respiratory event–related arousals (RERAs). An RERA is defined as a sequence of breaths lasting ≥ 10 seconds characterized by increasing respiratory effort or by flattening of the inspiratory portion of the flow signal, leading to an arousal from sleep when the sequence of breaths do not meet criteria for an apnea or hypopnea.[1] RERAs contribute to a disruption of sleep architecture. The finding of increased RERAs in patients with OSA and comorbid insomnia has been previously reported in a study of patients with posttraumatic stress disorder.[13] An arousal is distinct from an awakening in that a patient may experience an arousal with disruption of sleep stage without being conscious of an awakening. Participants with sleep-maintenance insomnia, that is difficulty reinitiating sleep after an awakening, have been shown by Wickwire et al[14] to have decreased CPAP nightly use and overall adherence. Thus, insomnia may contribute to decreased CPAP efficacy and ultimate presentation to a sleep surgeon's clinic.

It is not surprising that the insomnia cohort patients screened with the SNOT-22 questionnaire reported poorer sleep in the sleep-specific domain of the SNOT-22. However, it deserves mention that the insomnia cohort also fared more poorly in the nonsleep domains. Associations between nasal obstruction, chronic rhinosinusitis, sleep-disordered breathing, and insomnia have been extensively reviewed in a thesis by Bengtsson.[15] Treatment of nasal obstruction can improve adherence to CPAP therapy.[16] Taken together, the study findings of increased RERAs, increased nonsleep SNOT-22 scores, and an increase in reported sleep-maintenance insomnia on the patient questionnaire strengthen the association between nasal obstruction, insomnia, and CPAP intolerance, and deserve continued study.

There is a paucity of literature examining surgical outcomes in patients with comorbid insomnia. A study of 20 veterans found a decreased usage of upper airway stimulation therapy in patients with insomnia; however, the results did not reach statistical significance due to sample size.[16] A study of patients with mild OSA and comorbid insomnia found that surgery alone did not improve complaints of insomnia in the majority of patients despite normalization of AHI; most patients required specific treatment with cognitive behavioral therapy for insomnia (CBT-I) in addition to surgery to improve self-reported sleep quality.[17] Sleep surgery should be undertaken with caution in patients with clinically moderate-to-severe insomnia; the identification of comorbid insomnia preoperatively is invaluable. Patients' expectations should be managed preoperatively to include discussion that there will be a high likelihood of a need for independent nonsurgical treatment of insomnia despite a surgical reduction of apnea effect.

The study has several limitations. The retrospective nature of the study design limits the external validity of the findings. The high percentage of White participants and male participants, while reflective of the demographics of many sleep surgery clinics in the United States, also limits the applicability of the results to all populations. Future prospective studies with greater power, controlled against CPAP-adherent patients, will provide meaningful data. Last, we acknowledge that questionnaire data are self-reported and prone to recall bias.

CONCLUSIONS

CPAP-intolerant patients presenting to a sleep surgery clinic are at very high risk for insomnia. Clinically significant insomnia was associated with higher respiratory disturbance index, increased frequency of nocturnal awakenings, increased time to reinitiate sleep, and elevated Epworth Sleepiness Scale scores. Risk factors typically associated with insomnia, such as female sex, increased age, and psychiatric conditions, were not found in our study group. The finding of increased RERAs and nonsleep SNOT-22 scores in the insomnia cohort suggests nasal obstruction may predispose patients to both CPAP intolerance and insomnia. The association between nasal obstruction and arousal threshold is an area for future research. The treating physician can maximize patient benefit by diagnosing and treating comorbid insomnia in addition to OSA.

ABBREVIATIONS

AHI, apnea-hypopnea index
CPAP, continuous positive airway pressure
ISI, insomnia severity index
OSA, obstructive sleep apnea
RERA, respiratory event–related arousal
SD, standard deviation
SNOT-22, Sino-nasal Outcome Test

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DISCLOSURE STATEMENT

All authors have seen and approved the manuscript. The authors report no conflicts of interest.