University of Colorado
Anschutz Medical Campus

Are we missing sleep apnea in patients with subglottic stenosis?

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Abstract

Objective: Subglottic stenosis (SGS) is a narrowing of the subglottic airway with an impact on daytime dyspnea and reduced peak expiratory flow (PEF). The aim of this study is to characterize the prevalence of obstructive sleep apnea (OSA). We hypothesize a reduced airflow at night with a greater predisposition to OSA and hypoxemia in this population.

Methods: A prospective observational cohort study was conducted on adult subjects at a tertiary academic medical center from 2022- 2023. Subjects with a recent airway dilation (< 3 months), tracheostomy, prior diagnosis of OSA, posterior glottic stenosis, and/or vocal fold paralysis were excluded from enrollment. Demographic data was collected. All subjects completed a PEF measurement and one-night home sleep test (HST). OSA severity was categorized into none (obstructive apnea-hypopnea index (OAHI) < 5), mild (OAHI >=5 & < 15), moderate (OAHI>=15 & < 30), and severe (OAHI >=30). Demographic data were summarized. Prevalence was calculated within this cohort and compared to a matched population via a binomial test. The relationship of PEF% and apnea-hypopnea index (AHI) was evaluated with a partial correlation analysis controlling for age and body mass index (BMI). Binomial logistic regression was conducted to determine if any variables could be predictive of the presence of OSA.

Results: Twenty subjects participated in the study; all were Caucasian females with a mean age of 48.4 (+/-10.4) years and a BMI of 24.1 (+/-3.8). The majority (N=18, 80%) presented with idiopathic SGS, and a mean PEF 288 L/min (+/-71). All studies had more than 6 hours of recording time with OSA present in 40% of subjects, which is significantly greater than the age-matched population (p<0.05). Severity in subjects with OSA was categorized into 5 (25%) mild, 3 (15% moderate), and 0 (0%) severe. Mean O2 nadir was 84.9% (+/-4.9) with mean percent time hypoxemic of 7.5% (+/-11.9%). PEF did not correlate to AHI, adjusting for BMI (p>0.05)

Conclusion: Reduced nighttime airflow is present within a small cohort of patients with SGS demonstrating an elevated prevalence of OSA. Further study of airway dilation's impact on airflow and associated threshold to prevent OSA is necessary to prevent the long-term consequences of untreated OSA.

Introduction

Subglottic stenosis (SGS) is a narrowing of the airway at approximately the level of the cricoid. Dyspnea is debilitating, reducing the ability to complete daily tasks. The quality of life is furthermore altered with voice changes that restrict social life, swallowing impairments, and overall general health.[1] Disease monitoring can be done at home with a peak flow meter, with progressive dyspnea and/or a reduced peak expiratory flow (PEF) as an indication for intervention. Despite the understood daytime respiratory symptoms, the nighttime symptoms of patients with SGS have not yet been explained.

Obstructive sleep apnea (OSA) affects approximately 3-9% of females in the United States, with increased likelihood of developing OSA with age and elevated body mass index (BMI).[2] It is characterized by the collapse of the pharyngeal airway during sleep which leads to intermittent decreases or cessation in airflow often associated with oxygen desaturation. OSA has a wide range of neurocognitive and cardiovascular consequences with patients often reporting decreased quality of life and daytime sleepiness. Identification and treatment of OSA is imperative as it improves quality of life and management of comorbidities and decreases mortality.[2]

OSA severity is associated with anatomic computational flow dynamic (CFD) modeling in patients with OSA,[3] with improved airflow resistance after surgical treatment.[4] This suggests a likely higher prevalence of OSA in patients with SGS that has yet to be identified. We aim to determine the prevalence of OSA in a pilot study of patients with SGS.

Variable	Mean (STD) or N (%)
Age	48.4 (10.4)
Caucasian	20 (100)
BMI	24.1 (3.8)
Prior smoker	1 (5)
Current EtOH use	13 (65)
Comorbidities	
HTN	4 (40)
Asthma	6 (30)
Anxiety	3 (15)
GPA	2 (10)
Medications	
Benzodiazepines	4 (20)
SSRI/SNRI	5 (25)
PEF %	69.9 (17.7)

Table 1: Patient demographic data. *Body mass index (BMI), alcohol (EtOH), hypertension (HTN), granulomatosis polyangittis (GPA), selective erotonin reuptake inhibitors (SSRI) and serotonin-norepinephrine reuptake inhibitors (SNRI, calculated peak expiratory flow percent (PEF%).*

Methods and Materials

- Single institution prospective observational cohort study of subjects with a new or established diagnosis of non-traumatic SGS.
- Subjects with a recent airway dilation (< 3 months), tracheostomy, prior diagnosis of OSA, posterior glottic stenosis, and/or vocal fold paralysis were excluded from enrollment.
- Demographic data was collected from the electronic medical record.
  - PEF (Strive, Monaghan Medical Corp) was obtained at time of enrollment. Peak expiratory flow was calculated as a percent of predicted value (PEF%) as determined by gender, age, and height.[5]
  - HST (Alice NightOne) were distributed and collected within 2 weeks of subject consent
- Demographic data were summarized using descriptive statistics, summarized for continuous variables with mean (standard deviation), and for categorical variables with frequencies and proportions. Prevalence was calculated within this cohort and compared to a matched population via a binomial test. A matched cohort of middle-aged females has a OSA prevalence of 3%.[6] The relationship of PEF% and AHI was evaluated with a partial correlation analysis controlling for age and BMI. Binomial logistic regression was conducted to determine if any variables could be predictive of the presence of OSA. $P < 0.05$ was taken as statistically significant (SPSS Version 28.1).

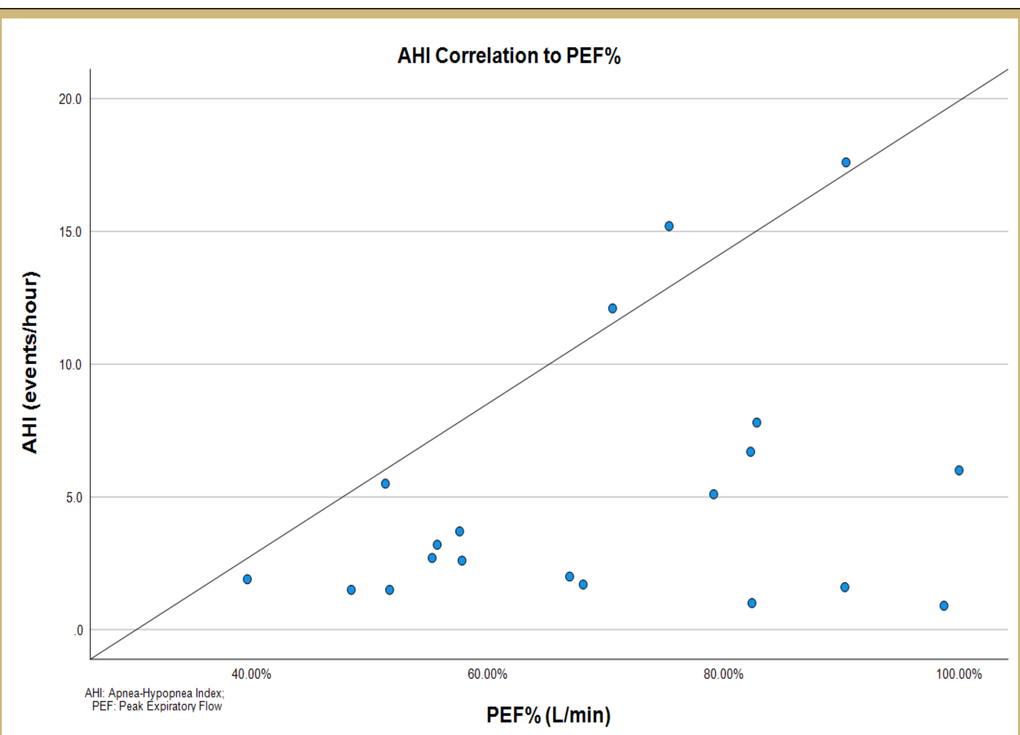

Figure 1: Correlation between percent peak expiratory flow (PEF%) and apnea-hypopnea index (AHI) controlled for BMI and age (p>0.05).

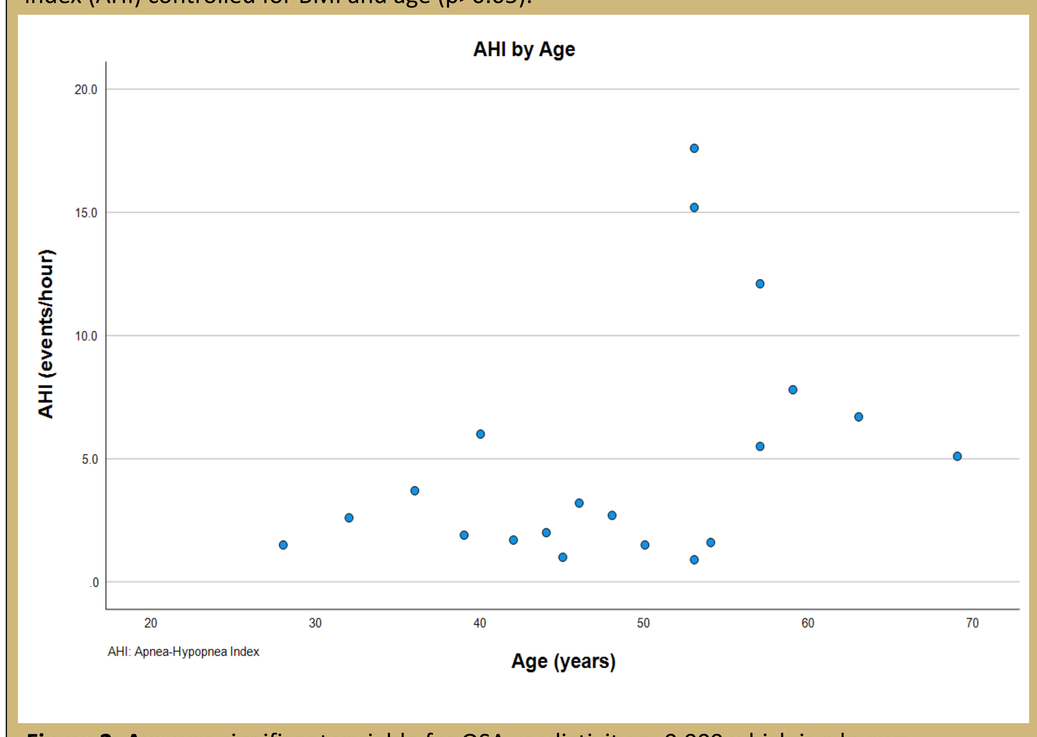

Figure 2: Age was significant variable for OSA predictivity p=0.009 which is a known relationship in the literature.

Variable	Mean (STD) or N (%)
PSG characteristics	
TRT (min)	512.5 (79.6)
OAHI	5.0 (4.8)
CAI	0.2 (0.3)
Supine AHI	6.4 (7.1)
Non-Supine AHI	3.3 (2.9)
O2 Nadir	84.9 (4.9)
Time O2 <89% (min)	42.3 (72.2)
Percent time hypoxic	7.5 (11.9)
OSA present	8 (40)
None	12 (60)
Mild	5 (25)
Moderate	3 (15)
Severe	0 (0)

Table 2: Polysonogram (PSG) characteristics and Obstructive Sleep Apnea (OSA) categories. *Total recording time (TRT), obstructive hypopnea-apnea index (OAHI), central apnea index (CAI), apnea-hypopnea index (AHI), oxygen (O2)*

Results

- All twenty of our participants were Caucasian females with a mean age of 48.4 (+/-10.4) and mean BMI of 24.1 (+/-3.8). Most patients had idiopathic SGS (N=18, 90%). Few comorbidities were presents, with a few collected listed in **Table 1**.
- Mean PEF 288 L/min (+/-71) was found with a reduced calculated PEF% mean of 69.9 (17.7).
- All studies had more than 6 hours of recording time and met good study indicator.
- OSA was present (OAHI >= 5) in 40% of subjects, which is greater compared to a age-gender matched population of 3% (p<0.001).
- OSA severity was categorized as 5 (25%) mild, 3 (15%) moderate, and zero severe OSA (**Table 2**).
- There was no correlation between PEF% and AHI (p>0.05) controlling for BMI and age (**Figure 1**).
- Age and asthma were predictive of the presence of OSA (p<0.05). OSA prevalence is known to increase with age; it's relationship in this study was plotted (**Figure 2**).

Discussion

This is the first study to evaluate for the presence of OSA in adult patients with SGS. We found an elevated prevalence of 40% in this population with is dramatically greater than an age-gender matched population. This is likely an underestimate as OSA diagnosis was excluded in this study. This supports our hypothesis that the limited airflow from SGS is contributing to the presence of OSA.

- We found age was predictive of the presence of OSA. This is unsurprising as OSA presence is known to increase with age. BMI was not a contributing factor which was anticipated as this population was not overweight.
- PEF% was not correlated with severity of OSA (AHI) which we did not anticipate based on previous CFD research. Asthma is not known to correlate with presence of OSA. It is possible that the effects not seen in correlation analysis is due to impact of asthma on PEF% itself.

OSA severity was relatively mild in this cohort. Further investigation is necessary to determine if surgical airway dilation alone is sufficient for OSA treatment. Pellen et al found significant improvement in AHI with use of continuous positive airway pressure (CPAP) on patients with congenital tracheal stenosis (CTS)[7] which may be an available adjunct treatment in subjects with persistent OSA. This is relevant as subjects with multilevel airway stenosis often have multiple comorbidities that are exacerbated by OSA, necessitating management to reduce morbidity and mortality in these patients. Conclusions from this small study is limited.

Conclusions

Reduced nighttime airflow is present within a small cohort of patients with SGS demonstrating an elevated OSA prevalence of 40% compared to matched population. Further study of airway dilation's impact on airflow and associated threshold to prevent OSA is necessary to prevent the long-term consequences of untreated OSA.

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Funding

Matthew Clary, MD, Academic Enrichment Fund

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