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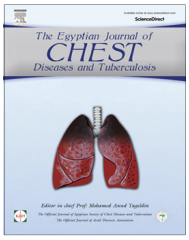

ORIGINAL ARTICLE

Alteration in cervical spine mechanics in obstructive sleep apnea syndrome patients

Abdelbaset Saleh [a,*], **Intisar Sultan** [b], **Yasser Mahfouz** [c]

[a] *Chest Department SGH Al-Madinah, and Chest Medicine, Mansoura University, Egypt*
[b] *Internal Medicine, Taiba University and Cairo University, Egypt*
[c] *Radiology Department, Saudi German Hospital Al-Madinah, Egypt*

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KEYWORDS

Cervical spine mechanics;
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Abstract *Background:* Obstructive sleep apnea syndrome (OSAS) is a multi-factorial disease with many identified risk factors and mechanisms. Little research exists on cervical spine mechanics as a risk factor for OSAS.

Objectives: This study aimed to explore the association and predictive value of alterations in cervical spine mechanics with the severity and positional dependency in patients with OSAS.

Methods: After patient consent and IRB approval, 36 consecutively admitted adult patients (68.1% were males), aged 46 years, who underwent clinical evaluation and standard polysomnography were included in this cross-sectional study. Severity scores were estimated from a full night polysomnography sleep study (apnea hypopnea index (AHI), respiratory disturbance index (RDI), desaturation index, overall severity score, snoring index and episodes). Positional dependency for all severity scores was performed. Cervical spine X-rays (PA and lateral) were performed to measure the atlas angle (relative to the horizontal plane) and Cobb angle (a standard measurement for lordosis), the pre-vertebral soft tissue and pharyngeal air column diameter were measured.

Results: Median BMI (32.63) and sleep apnea indices were high with severe AHI (>30). Positional dependency (63.9%) was significant for RDI. Both the Cobb and atlas angles showed a significantly negative correlation with severity indices and positional dependency. The Cobb angle of lordosis (but not the atlas angle) was a significant negative predictor for all OSAS severity, snoring index and positional dependency.

Conclusion: In OSAS patients, there was a significant association between alterations in cervical spine mechanics, severity and positional dependency. Cervical lordosis, but not the atlas angle, was

* Corresponding author at: Saudi German Hospital Al-Madinah, Department of Chest, Mansoura University, Mansoura 35516, Egypt.
E-mail address: baset.m.saleh@gmail.com (A. Saleh).

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a significant negative predictor of severity and positional dependency. Further studies are needed to validate these results and to study the effect of improving spinal curvature and angular rotation on severity and positional dependency in OSAS patients.

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Introduction

Obstructive sleep apnea syndrome (OSAS) is a disorder that is characterized by obstructive apneas and hypopneas caused by repetitive collapse of the upper airway during sleep. OSAS is a common chronic disorder that often requires lifelong care [1]. One-third of sleep studies in the general adult population show some degree of OSAS [2]. Among adults 30–70 years of age, approximately 13% of men and 6% of women have moderate to severe forms of OSA. Approximately 25% of adults are at risk for some degree of sleep apnea [3]. Over time, OSAS can be a serious disorder with increased risk for poor neurocognitive performance that could impact daily activities and long-term health [2].

The underlying pathophysiology of OSA is multifactorial and may vary considerably between individuals. The important risk factors for OSA are advancing age, male gender, obesity, and craniofacial or upper airway soft tissue abnormalities. Additional risk factors include smoking, nasal congestion, menopause, and family history [4]. The rates of OSAS are also increased in association with certain medical conditions, such as pregnancy, end-stage renal disease, congestive heart failure, chronic lung disease, and stroke. The severity of OSAS in any given individual is influenced by other factors as well, including upper airway anatomy, arousal threshold, upper airway muscle drive, and stability of the respiratory control system. In addition, the underlying pathophysiology may vary by age, as younger patients are more likely to have alterations in ventilatory control and older patients are more likely to have predominant upper airway collapsibility [5,6].

The cervical spine is one structure that may contribute to OSAS with some reported association with specific cervical column pathologies, such as osteochondromas [7] osteophytes [8], and rheumatoid arthritis [9]. Two studies [4,10] found a higher prevalence of morphological spinal deviations in patients with sleep apnea (46% and 43%, endogenous fusions predominantly) than in control subjects (14%). The spinal abnormalities may be explained by two well-known predisposing OSAS factors: craniofacial features and extended head posture. The latter represents a physiological adaptation to maintaining airway patency [11]. Another study [12] found a predominant upper cervical kyphotic spine and occiput among OSAS patients, with the greatest extent of flexion in the most severe OSAS patients.

Loss of cervical spine curvature and alteration in the atlas angle may change our understanding of OSAS pathophysiology in adults and highlight the potential mechanisms underlying this new risk factor that may modulate disease severity. However, there are still only a few investigations aimed at understanding the association, correlation, or the predictive value of altered cervical mechanics in patients with OSAS. Therefore, this study was performed to explore the association and predictive value of alterations in cervical spine mechanics in patients with OSAS.

Methods

Participants

We studied 36 consecutively admitted patients to the "Saudi German Hospital Sleep Center" with confirmed OSAS. All subjects underwent an overnight in-laboratory standard polysomnography study. All sleep studies were scored in a blinded fashion and interpreted by an experienced pulmonary and sleep physician. The polysomnographic data used in this study were extracted from overnight sleep studies. Sleep studies of patients who slept less than 6 h with sleep efficiencies less than 90% were subjected to another night sleep study. The sleep architectures and apneas/hypopneas were scored according to the manual of American Academy of Sleep Medicine, version 2.0 2012 [13]. The AHI is calculated by dividing the number of apnea events plus hypopnea events by the number of hours of sleep. OSAS was defined by an apnea hypopnea index (AHI) $\geqslant 5$ events/h of sleep. AHI values were used to categorize OSAS severity as follows: normal: 0–4; mild: 5–14; moderate: 15–29; and severe: 30 or more [14]. The respiratory disturbance index (RDI) was used to measure the number of recorded apneas, hypopneas, and respiratory effort-related arousals per hour of sleep during the PSG evaluation. The oxygen desaturation index (ODI) was defined as the average number of oxygen desaturations of 4% or more per sleeping hour [15]. The overall sleep apnea severity score was calculated by combining AHI and oxygen desaturation to evaluate both the number of sleep disruptions and the degree of oxygen desaturation. Patients were diagnosed according to the Centers for Medicare & Medicaid Services criteria for the positive diagnosis and treatment of obstructive sleep apnea [16]. A positive OSAS test is established if either of the following criteria using the AHI or the RDI is met: AHI or RDI greater than or equal to 15 events per hour or AHI or RDI greater than or equal to 5 and less than or equal to 14 events per hour in combination with documented symptoms of excessive daytime sleepiness, impaired cognition, mood disorders, insomnia, or documented hypertension, ischemic heart disease, or history of stroke.

Patients were excluded if they had a history of stroke with severe disability or a previous history of spinal surgery or traumas. The protocol was approved by the local "Scientific Review Committee of Research," and informed consent was obtained from all participants. Prior to admission, all participants underwent a detailed history and physical examination, including anthropometric measurements.

Positional AHI dependency, RDI, desaturation index, and snoring. Positional dependency in patients with OSAS was

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