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CLINICAL REVIEW

Supine position related obstructive sleep apnea in adults: Pathogenesis and treatment

Simon A. Joosten [a,b,*], Denise M. O'Driscoll [a,c], Philip J. Berger [b], Garun S. Hamilton [a,b]

[a] Monash Lung and Sleep, Monash Medical Centre, Clayton, Australia
[b] The Ritchie Centre, Monash Institute of Medical Research, Monash University, Clayton, Australia
[c] Department of Medicine, Southern Clinical School, Monash University, Clayton, Australia

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SUMMARY

The most striking feature of obstructive respiratory events is that they are at their most severe and frequent in the supine sleeping position: indeed, more than half of all obstructive sleep apnea (OSA) patients can be classified as supine related OSA. Existing evidence points to supine related OSA being attributable to unfavorable airway geometry, reduced lung volume, and an inability of airway dilator muscles to adequately compensate as the airway collapses. The role of arousal threshold and ventilatory control instability in the supine position has however yet to be defined. Crucially, few physiological studies have examined patients in the lateral and supine positions, so there is little information to elucidate how breathing stability is affected by sleep posture.

The mechanisms of supine related OSA can be overcome by the use of continuous positive airway pressure. There are conflicting data on the utility of oral appliances, while the effectiveness of weight loss and nasal expiratory resistance remains unclear. Avoidance of the supine posture is efficacious, but long term compliance data and well powered randomized controlled trials are lacking. The treatment of supine related OSA remains largely ignored in major clinical guidelines.

Supine OSA is the dominant phenotype of the OSA syndrome. This review explains why the supine position so favors upper airway collapse and presents the available data on the management of patients with supine related OSA.

Introduction

Obstructive sleep apnea (OSA) affects almost one fifth of the adult population[1] in whom it is associated with excessive sleepiness,[2] depression,[3] systemic hypertension,[4,5] the metabolic syndrome,[6] insulin resistance[7] and subsequent cardiac ischemia and arrhythmias.[8]

Within the OSA spectrum, the condition is particularly severe when subjects adopt the supine sleeping position and may occur almost exclusively in this position. Despite important and comprehensive reviews of supine sleep apnea,[9] how the supine position interacts with upper airway anatomy, lung volume, function of upper airway dilator muscles, arousal threshold and ventilatory control instability to bring about upper airway collapsibility is poorly understood. Very few of these physiological parameters have been studied comprehensively in both the lateral and supine sleeping positions to see how they may be affected by moving position.

The high prevalence and severity of OSA in the supine sleeping position has led to the development of a number of treatment strategies for this phenotype of the OSA syndrome. Treatments may be similar to those used in the general sleep apnea population or focus on methods to discourage sleeping supine.

There are still a number of areas where our understanding of supine related OSA is lacking. Longitudinal studies of the effects of supine OSA versus non-supine OSA on morbidity and mortality, physiological studies that observe patients in both the lateral and supine position, and adequately powered randomized controlled trials for the treatment of the condition, are potential foci for future research.

Aim

We review the available evidence relating to the pathogenesis and treatment of supine related obstructive sleep apnea.

* Corresponding author. Monash Lung and Sleep, Monash Medical Centre, 246 Clayton Rd, Clayton, Victoria 3168, Australia. Tel.: +61 412838606; fax: +61 95946811.
E-mail address: drjoosten@hotmail.com (S.A. Joosten).

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Definitions

The definition used to classify patients with a preponderance of respiratory events in the supine position has varied. Many authors consider that supine OSA is present when the apnea and hypopnea index (AHI) is greater than 5 events/h and respiratory events occur at twice the frequency in the supine sleeping position compared to the non-supine sleeping positions.[10,11] A majority of the papers focusing on the diagnosis and treatment of supine related OSA have adopted this definition.

Mador et al.[12] proposed an alternative definition of supine OSA whereby the ratio of events in the supine position to the non-supine positions must be greater than two to one and the AHI in the non-supine positions must be less than 5 events/h. The authors felt this definition was more clinically relevant given that avoidance of the supine sleeping position by patients who fit this description would result in normalization of the AHI and subsequent relief of symptoms of OSA. The Mador definition has been adopted and modified for use in some studies of treatment of positional OSA by avoidance of supine sleep.[13,14]

For clarity in this paper we will use the following definitions:

1) Supine predominant obstructive sleep apnea (spOSA):
   - Overall AHI is greater than 5 events/h, and,
   - The supine AHI is greater than two times the non-supine AHI.
2) Supine isolated obstructive sleep apnea (siOSA):
   - Overall AHI is greater than 5 events/h, and,
   - The supine AHI is greater than two times the non-supine AHI and,
   - Non-supine AHI is less than 5 events/h.

The time that a patient spends in a specific body position can have an important effect on the AHI in that position.[15,16] The vast majority of the papers in the published literature relating to supine OSA describe a minimum time required in the supine position as an inclusion/exclusion criterion. Typically the minimum time required in the supine and non-supine positions to be included in these studies is between 15 and 30 min.[11–13,17,18] The decision to have a time cut off for the definition of supine sleep apnea is an arbitrary one and the effect of changing the definition to shorter or longer time periods is not known.

Both of the aforementioned definitions are widely used throughout the literature regarding supine OSA. Neither definition, however, acknowledges the potentially confounding role of rapid eye movement (REM) sleep in the generation of obstructive events. It is already well established that the supine AHI rises in REM sleep compared with non-rapid eye movement (NREM) sleep.[19] It follows then, that a disproportionate time spent in the supine sleeping position in REM sleep will increase the likelihood of a patient being classified as having spOSA even if the ratio of events in NREM sleep (which makes up the majority of the night) is less than two to one. This may be an important distinction to make if the mechanisms involved in obstruction in REM sleep are different to those in supine sleep.

Epidemiology

Prevalence

The prevalence of spOSA is variably reported as between 50 and 60% of patients who present to sleep clinics for overnight polysomnography,[11,17,18,20] whereas approximately 25–30% of the same population may be classified as having siOSA.[12,17,21] The prevalence of spOSA in the Asian population is higher than for Caucasians at between 67 and 75%.[22,23] There are no reports of the prevalence of either condition in the general population.

Time spent supine

The time in which a subject sleeps supine is an important determining factor of the overall AHI in patients with spOSA and siOSA. Having spOSA or siOSA does not influence the amount of time spent supine as these patients appear to spend as much time in the supine position as unselected patients with OSA,[17] ranging from 32 to 42.7% of total sleep time[17,18,20,24] for spOSA, 40–48.1% for siOSA[12,21] and 27–48% of total sleep time for patients with non-positional obstructive events.[17,18,20,21,24]

Age and gender also do not influence the time spent supine. With increasing age, fewer position shifts are made over the course of the night,[25] although the time spent supine in a small cross-sectional study did not change markedly across a series of age ranges (apart from early childhood).[25] O'Connor et al. demonstrated that men and women spend a similar amount of time supine during sleep.[26] The amount of time spent in supine sleep in unselected general populations is not known.

The published studies relating to the classification and polysomnographic features of supine OSA are largely based on single night observations. Although the correlation of overall AHI across nights is strong,[27] there is a considerable individual variability in overall AHI using Bland-Altman analysis.[28] It is unclear how much variability in time spent supine contributes to this night-to-night variability in total AHI. Several studies have explored the possible contributors to night-to-night variability in overall AHI,[29–31] including various polysomnographic and demographic features. Although the mean AHI in specific body positions and sleep stages does not change significantly across nights,[28] the individual variability of the position specific AHI from night-to-night has not been reported.

Clinical features

Like OSA in general, spOSA is more likely to be seen in men than women. The male to female ratio is 11.1:1 for all severities of OSA,[26] and 2.6:1 in mild-moderate OSA,[17] with the discrepancy between these figures likely arising from the increased male prevalence of severe OSA.[26]

Patients with spOSA differ from non-positional patients: their body mass index (BMI) is less at 29.3–31.6 kg/m^2 [11,12,17] versus 31.9–38 kg/m^2,[11,12,18] and their ages differ at 49.5 - 52.9 y[11,17] versus 54.9-59.2 y.[11,12] These differences in BMI and age hold true for siOSA patients compared to non-positional patients,[12] even when controlling for the lower overall AHI found in the siOSA group.[17]

One of the most common presentations to the sleep physician is loud snoring. It has long been recognized by patients and their partners that the loudness of snoring is worse when supine.[32] As distinct from OSA, simple snoring without apnea is louder and more frequent in the supine sleeping position.[33] The distinction between simple snoring and spOSA and siOSA is an important one in the context of body position and the goals of treatment. As discussed in the treatment section of this article, positional therapies for siOSA and spOSA may not reduce complaints of snoring,[13] unless the snoring is louder or occurs predominantly in the supine position.

Supine predominant patients have been reported as subjectively more sleepy[17] than other OSA patients, whereas with siOSA patients no differences are reported.[12] Conversely, with regard to objective determinants of sleepiness, multiple sleep latency test (MSLT) data from Oksenberg et al.[11] demonstrate a trend toward reduced sleepiness in spOSA patients compared to non-positional