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The interplay between obstructive sleep apnea and metabolic syndrome: A review

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Abstract

Obstructive Sleep Apnea (OSA) and metabolic syndrome are two prevalent conditions with significant health implications. This review explores the bidirectional relationship between OSA and metabolic syndrome, highlighting their shared pathophysiological mechanisms, mutual exacerbation, and potential therapeutic interventions. Understanding this complex interplay is crucial for comprehensive patient management and improving clinical outcomes.

Keywords: OSA (Obstructive sleep apnea), metabolic syndrome, hyperlipidemia, Hypoxea

Introduction

Obstructive sleep apnea (OSA) and metabolic syndrome are multifactorial disorders associated with considerable morbidity and mortality worldwide. Obstructive sleep apnea is a fairly common sleep disorder marked by repeated episodes where the upper airway partially or completely collapses during sleep. This airway blockage results in reduced airflow, causing significant disruptions in gas exchange and frequent awakenings. The condition has a range of health impacts. Without treatment, it can cause persistent daytime sleepiness, cognitive issues, reduced job performance, and a decline in overall quality of life. Observational and experimental evidence also suggests that obstructive sleep apnea may contribute to the development of systemic hypertension, cardiovascular disease, and abnormalities in glucose metabolism. OSA, characterized by repetitive episodes of partial or complete upper airway obstruction during sleep, affects approximately 936 million individuals globally. In 2008, Punjabi NM^[1] estimated that the prevalence of the disease ranged from 3% to 7% with certain subgroups of the population bearing higher risk. Several factors can raise the risk of developing the disorder, including older age, being male, obesity, a family history of the condition, menopause, craniofacial abnormalities, and certain lifestyle habits such as smoking and alcohol consumption^[1]. The metabolic syndrome consists of a group of interconnected risk factors for cardiovascular disease (CVD) and diabetes. These factors include dysglycemia, raised blood pressure, elevated triglyceride levels, low high-density lipoprotein cholesterol levels, and obesity particularly central adiposity^[2]. Tasali E *et al.*^[3] in 2008 have Discussed that Metabolic syndrome, comprise of a cluster of interconnected metabolic abnormalities including central obesity, hypertension, dyslipidemia, and insulin resistance, affects around 20-25% of the global adult population. They have also discussed how OSA contribute to Glucose Dysregulation which is a key component of Metabolic Syndrome and despite being distinct entities, emerging evidence suggests a bidirectional relationship between OSA and metabolic syndrome, which warrants further exploration.

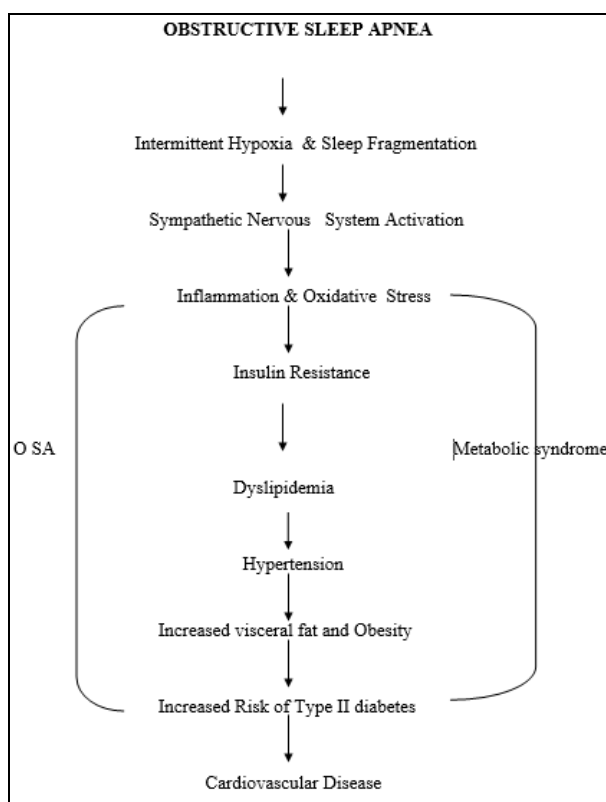
Pathophysiological Mechanisms

Several shared pathophysiological mechanisms underlie the relationship between OSA and metabolic syndrome. Chronic intermittent hypoxia, sympathetic nervous system activation, oxidative stress, inflammation, and hormonal dysregulation contribute to both conditions^[4,5].

Hypoxia-induced sympathetic activation and inflammation promote insulin resistance, dyslipidemia, and adipose tissue dysfunction, thereby exacerbating metabolic syndrome. Conversely, obesity-related structural changes in the upper airway predispose individuals to OSA, leading to further metabolic derangements^[6].

Clinical Implications: The coexistence of OSA and metabolic syndrome significantly amplifies the risk of cardiovascular disease, type 2 diabetes, stroke, and other adverse health outcomes. Moreover, untreated OSA may impede the management of metabolic syndrome by perpetuating insulin resistance and dyslipidemia^[7]. Conversely, metabolic syndrome exacerbates OSA severity by promoting adipose tissue deposition in the upper airway and worsening sleep-disordered breathing. Therefore, early recognition and integrated management of both conditions are imperative to mitigate their deleterious effects on health.

Mechanisms of OSA and Metabolic Syndrome Interaction: Beyond shared pathophysiological mechanisms, several interrelated factors contribute to the bidirectional relationship between OSA and metabolic syndrome. Chronic sleep fragmentation and disturbances in circadian rhythm, common features of OSA, disrupt hormonal regulation and glucose metabolism, predisposing individuals to insulin resistance and dyslipidemia^[7]. Conversely, obesity-related adipose tissue accumulation in the upper airway exacerbates airway narrowing and collapsibility during sleep, thereby promoting OSA severity^[8]. Furthermore, OSA-induced sympathetic activation and oxidative stress exacerbate endothelial dysfunction and arterial stiffness, contributing to the development and progression of metabolic syndrome^[9, 10]. The reciprocal interactions between OSA and metabolic syndrome underscore the importance of comprehensive evaluation and tailored therapeutic interventions to address both conditions simultaneously.



Clinical Implications and Prognosis: The coexistence of OSA and metabolic syndrome confers a greater risk of cardiovascular events, stroke, and all-cause mortality compared to either condition alone^[11, 12]. Furthermore, untreated OSA may undermine the effectiveness of lifestyle modifications and pharmacotherapy in managing metabolic syndrome, leading to poorer clinical outcomes^[13]. Longitudinal studies have demonstrated that effective treatment of OSA, particularly with CPAP therapy, improves insulin sensitivity, blood pressure control, and lipid profile, thereby mitigating the cardiovascular risk associated with metabolic syndrome^[14, 15]. Conversely, successful management of metabolic syndrome through weight loss and pharmacotherapy has been shown to reduce OSA severity and improve sleep quality^[16, 17]. However, the optimal treatment strategies and their impact on long-term prognosis in individuals with coexisting OSA and metabolic syndrome warrant further investigation.

Future Directions: Future research endeavors should focus on elucidating the mechanistic underpinnings of the bidirectional relationship between OSA and metabolic syndrome and identifying novel therapeutic targets. Advances in precision medicine, incorporating genetic, epigenetic, and biomarker-based approaches, may facilitate personalized risk stratification and treatment optimization for individuals with coexisting OSA and metabolic syndrome^[18]. Moreover, large-scale prospective studies are needed to evaluate the efficacy and safety of emerging interventions, such as hypoxia-inducible factor (HIF) stabilizers and upper airway neuromodulation devices, in mitigating the adverse health outcomes associated with OSA and metabolic syndrome^[19]. Collaborative efforts between multidisciplinary healthcare teams, including sleep specialists, endocrinologists, cardiologists, and bariatric surgeons, are essential to implement integrated care models and improve clinical outcomes in this high-risk population.

Treatment modalities for OSA: Therapeutic strategies targeting OSA and metabolic syndrome should encompass lifestyle modifications, pharmacotherapy, and, in select cases, surgical interventions along with fabrication of intraoral devices. Weight reduction through dietary modifications and regular exercise remains the cornerstone of management for both conditions. Continuous positive airway pressure (CPAP) therapy is the primary treatment for OSA and has been shown to improve metabolic parameters and reduce cardiovascular risk. Pharmacological agents targeting insulin resistance, dyslipidemia, and hypertension may also confer additional benefits in patients with OSA and metabolic syndrome. Furthermore, bariatric surgery may be considered in severely obese individuals with refractory metabolic syndrome and OSA. The selection of treatment is influenced by the condition's severity, the patient's preferences, and any existing comorbidities. The use of intra Oral appliances like mandibular advancement device, tongue retaining device and palatal lift appliance have been shown to improve symptoms of mild to moderate cases of obstructive sleep apnea, they are easy to use and economical, and the patients who are claustrophobic and are unable to afford CPAP the oral appliances are a better treatment modality^[20].

Conclusion

In conclusion, the intricate interplay between obstructive sleep apnea and metabolic syndrome underscores the importance of holistic patient assessment and individualized management strategies. Addressing shared pathophysiological mechanisms, optimizing lifestyle interventions, and implementing targeted pharmacotherapy are essential components of comprehensive care for individuals with coexisting OSA and metabolic syndrome.

The bidirectional relationship between OSA and metabolic syndrome underscores the importance of a multidisciplinary approach to patient care. Clinicians should remain vigilant for the presence of one condition when managing the other and prioritize interventions that target shared pathophysiological mechanisms. Further research is needed to elucidate the optimal management strategies and long-term outcomes in individuals with coexisting OSA and metabolic syndrome.

Conflict of Interest

Not available

Financial Support

Not available

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