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RESEARCH ARTICLE

Comparing the Effect of Tonsillectomy on Cardiovascular and Sleep Outcomes in Adults Diagnosed with Obstructive Sleep Apnea Syndrome After 3-5 Years of Follow-Up: A Retrospective Study

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Abstract: Background: Obstructive sleep apnea syndrome (OSAS) is a chronic sleep-related breathing disorder associated with recurrent upper airway obstruction, intermittent hypoxia, cardiovascular dysfunction, metabolic abnormalities, and impaired quality of life. Tonsillar hypertrophy is an important anatomical factor contributing to airway obstruction in selected adult patients. Although tonsillectomy is considered an effective surgical treatment in such cases, evidence regarding its long-term cardiovascular and metabolic benefits remains limited.
Aim: To evaluate the long-term effects of tonsillectomy on cardiovascular parameters, lipid profile, and sleep-related outcomes in adults diagnosed with obstructive sleep apnea syndrome after 3–5 years of follow-up.
Materials and Methods: This retrospective observational study was conducted at the Department of ENT, at a tertiary care hospital, Al Ahsa City, Saudi Arabia. Adult patients diagnosed with OSAS who underwent tonsillectomy between January 2015 and December 2019 were included. Clinical records, biochemical investigations, and polysomnographic findings were retrospectively reviewed. Parameters including systolic blood pressure (SBP), diastolic blood pressure (DBP), lipid profile, Epworth Sleepiness Scale (ESS), apnea-hypopnea index (AHI), and oxygen saturation levels were compared preoperatively and postoperatively after 3–5 years of follow-up. Statistical analysis was performed using paired t-test, with $p<0.05$ considered statistically significant.
Results: A total of 46 patients were included in the final analysis. The mean age of the patients was 42.3 ± 8.7 years, with male predominance (65.2%). Significant postoperative improvement was observed in cardiovascular parameters. Mean systolic blood pressure decreased from 143.1 ± 10.8 mmHg to 131.9 ± 8.9 mmHg, while mean diastolic blood pressure decreased from 91.7 ± 6.9 mmHg to 84.3 ± 6.1 mmHg ($p<0.001$). Significant improvement was also observed in lipid profile parameters, including reductions in total cholesterol, triglycerides, and LDL cholesterol levels, along with an increase in HDL cholesterol. Sleep-related outcomes improved markedly after surgery. Mean ESS score decreased from 16.1 ± 3.4 to 7.5 ± 2.6, and mean AHI improved from 33.4 ± 9.2 events/hour to 14.6 ± 6.2 events/hour ($p<0.001$). Lowest oxygen saturation levels during sleep also improved significantly following tonsillectomy.
Conclusion: Tonsillectomy in adults with obstructive sleep apnea syndrome and significant tonsillar hypertrophy was associated with substantial long-term improvement in cardiovascular, metabolic, and sleep-related outcomes after 3–5 years of follow-up. Surgical intervention may represent an effective therapeutic option in carefully selected adult OSAS patients, particularly those with anatomical upper airway obstruction and poor tolerance to CPAP therapy.

Keywords: Obstructive sleep apnea syndrome; Tonsillectomy; Blood pressure; Lipid profile; Sleep quality; Apnea-hypopnea index.

INTRODUCTION

Obstructive sleep apnea syndrome (OSAS) is a common and chronic sleep-related breathing disorder characterized by repeated episodes of partial or complete upper airway obstruction during sleep, leading to intermittent hypoxia, hypercapnia, fragmented sleep, and excessive daytime sleepiness [1,2]. Over the past two decades, OSAS has gained considerable attention as a major global health concern because of its increasing prevalence and its strong association with cardiovascular, metabolic, and neurocognitive complications [3,4]. Current epidemiological data suggest that moderate-to-severe OSAS affects nearly 10-17% of adult men and 3-9% of adult women worldwide, with obesity, advancing age, male sex, and upper airway anatomical abnormalities identified as major predisposing factors [5,6].

The underlying mechanism of OSAS is complex and multifactorial. It primarily involves recurrent collapse of the upper airway during sleep due to anatomical narrowing and impaired neuromuscular control of the pharyngeal muscles [7]. Among the structural causes, tonsillar hypertrophy is considered one of the most significant and

surgically correctable contributors to airway obstruction in adults [8]. Enlarged palatine tonsils can markedly decrease the size of the oropharyngeal airway, increase airway resistance, and promote repetitive airway collapse during sleep [9]. Previous studies have demonstrated that adults with grade III or IV tonsillar hypertrophy are at a substantially higher risk of developing moderate-to-severe OSAS [10,11].

Beyond sleep disturbance, OSAS has important systemic consequences, particularly on the cardiovascular system. Repeated cycles of nocturnal hypoxia and reoxygenation trigger sympathetic nervous system activation, oxidative stress, endothelial dysfunction, and systemic inflammation [12,13]. These pathophysiological changes play a central role in the development of hypertension, ischemic heart disease, arrhythmias, pulmonary hypertension, stroke, and heart failure among patients with untreated OSAS [14-16]. Persistent sympathetic overactivity is especially implicated in resistant hypertension and adverse long-term cardiovascular outcomes [17].

OSAS is also closely linked with metabolic abnormalities and dyslipidemia. Intermittent hypoxia associated with recurrent apneic episodes alters lipid metabolism through inflammatory and oxidative pathways, resulting in elevated triglycerides, increased low-density lipoprotein (LDL) cholesterol, and reduced high-density lipoprotein (HDL) cholesterol levels [18,19]. These abnormalities contribute significantly to accelerated atherosclerosis and increased cardiovascular risk in affected individuals [20].

In addition to cardiovascular and metabolic complications, patients with OSAS frequently experience excessive daytime fatigue, poor concentration, mood disturbances, impaired work performance, and reduced quality of life due to chronic sleep fragmentation [21]. The severity of symptoms and disease burden is commonly assessed using the Epworth Sleepiness Scale (ESS) and apnea-hypopnea index (AHI) obtained through overnight polysomnography [22]. Severe untreated OSAS has also been associated with increased risks of occupational injuries, motor vehicle accidents, and cognitive impairment [23].

Continuous positive airway pressure (CPAP) therapy remains the standard treatment for moderate-to-severe OSAS and has shown significant effectiveness in improving airway patency and sleep quality [24]. However, long-term compliance with CPAP therapy remains a major challenge because many patients experience discomfort, claustrophobia, nasal dryness, mask intolerance, and inconvenience during sleep [25,26]. As a result, surgical interventions have become increasingly important, particularly in patients with identifiable anatomical airway obstruction.

Tonsillectomy has emerged as an effective surgical option in carefully selected adult patients with enlarged tonsils and OSAS [27]. Removal of hypertrophied tonsils enlarges the oropharyngeal airway, reduces upper airway resistance, and improves nocturnal airflow dynamics [28]. Several studies have reported postoperative improvement in apnea-hypopnea index, oxygen saturation, snoring severity, and daytime sleepiness following tonsillectomy in adults with significant tonsillar hypertrophy [29,30]. Furthermore, improved nocturnal oxygenation after surgery may reduce sympathetic activation and systemic inflammatory responses, thereby potentially improving cardiovascular and metabolic outcomes [31].

Although previous research has demonstrated short-term symptomatic benefits of tonsillectomy in adult OSAS patients, evidence regarding its long-term effects on blood pressure, lipid profile, and overall cardiovascular health remains limited [32]. Long-term follow-up studies evaluating sustained improvement in sleep quality and metabolic parameters are particularly scarce in Middle Eastern populations. Therefore, the present retrospective study was conducted to compare the effects of tonsillectomy on cardiovascular parameters, lipid profile, and sleep outcomes in adults diagnosed with obstructive sleep apnea syndrome after 3-5 years of follow-up at a tertiary care hospital in Alahsa City.

MATERIALS AND METHODS

Study Design and Setting

This retrospective observational study was conducted in the Department of Ear, Nose, and Throat, Head and Neck Surgery in a tertiary care hospital in Alahsa City, Saudi Arabia. The study evaluated adult patients diagnosed with obstructive sleep apnea syndrome (OSAS) who underwent tonsillectomy between January 2015 and December 2019.

Study Duration
The study period extended over five years, from January 2015 to December 2019. Postoperative follow-up data ranging from 3 to 5 years were reviewed and analyzed.

Study Population
The study population consisted of adult patients diagnosed with OSAS based on overnight polysomnography findings and clinical evaluation who subsequently underwent tonsillectomy for significant tonsillar hypertrophy contributing to upper airway obstruction.

Sample Size
A total of 46 patients fulfilled the eligibility criteria and were included in the final analysis.

Inclusion Criteria
Patients were included in the study if they met the following criteria:

- Age ≥18 years
- Diagnosed with obstructive sleep apnea syndrome by overnight polysomnography
- Presence of grade III or grade IV tonsillar hypertrophy
- Underwent tonsillectomy during the study period
- Availability of complete preoperative and postoperative clinical records
- Minimum postoperative follow-up duration of 3 years

Exclusion Criteria
Patients were excluded if they had:

- Previous upper airway or sleep apnea-related surgery
- Craniofacial abnormalities or congenital airway disorders
- Severe cardiopulmonary disease
- Neuromuscular disorders affecting respiration
- Incomplete medical records
- Loss to follow-up before completion of 3 years
- Concurrent bariatric surgery or major weight-loss intervention during follow-up

Data Collection
Data were collected retrospectively from hospital medical records, outpatient follow-up records, sleep laboratory databases, and operative notes. The following demographic, clinical, biochemical, and polysomnographic variables were reviewed:

Demographic and Clinical Variables

- Age
- Gender
- Body mass index (BMI)
- Smoking status
- Presence of hypertension or dyslipidemia

Cardiovascular Parameters

- Systolic blood pressure (SBP)
- Diastolic blood pressure (DBP)

Blood pressure readings were obtained from outpatient clinic records using standardized sphygmomanometer measurements.

Biochemical Parameters
Fasting lipid profile values were recorded, including:

- Total cholesterol
- Triglycerides
- Low-density lipoprotein (LDL) cholesterol
- High-density lipoprotein (HDL) cholesterol

Sleep-Related Parameters
Sleep-related outcomes were assessed using:

- Epworth Sleepiness Scale (ESS)
- Apnea-Hypopnea Index (AHI)
- Lowest oxygen saturation during sleep

Polysomnography findings were reviewed both preoperatively and during postoperative follow-up visits.

Surgical Procedure
All patients underwent conventional tonsillectomy under general anesthesia performed by experienced otolaryngology surgeons. Surgical indication was based on significant tonsillar hypertrophy associated with symptomatic obstructive sleep apnea syndrome. Standard postoperative care and follow-up protocols were followed for all patients.

Outcome Measures
Primary Outcome Measures

- Change in systolic blood pressure
- Change in diastolic blood pressure
- Change in lipid profile parameters after tonsillectomy

Secondary Outcome Measures

- Improvement in Epworth Sleepiness Scale score
- Reduction in apnea-hypopnea index
- Improvement in oxygen saturation levels

- Subjective improvement in sleep quality and daytime fatigue

Statistical Analysis

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) software version 26.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages.

Preoperative and postoperative variables were compared using paired t-test for continuous variables. Chi-square test was used for categorical variables wherever applicable. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Review Board prior to commencement of data collection. As this was a retrospective record-based study, patient confidentiality and anonymity were strictly maintained throughout the study process.

RESULTS

A total of 46 adult patients diagnosed with obstructive sleep apnea syndrome (OSAS) who underwent tonsillectomy between January 2015 and December 2019 were included in the final analysis. All patients completed a minimum postoperative follow-up duration of 3 years, with the mean follow-up period being 4.1 ± 0.8 years. No patient developed major perioperative complications requiring intensive care admission or revision surgery.

The study population had a mean age of 42.3 ± 8.7 years, ranging from 24 to 61 years. Male patients represented 65.2% of the cohort, demonstrating male predominance among adults diagnosed with OSAS. The majority of patients were overweight or obese, with a mean body mass index (BMI) of 31.6 ± 4.3 kg/m². Moderate OSAS was observed in 52.2% of patients, while severe OSAS was identified in 47.8% based on preoperative polysomnography findings.

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population

Variable	Value
Total number of patients	46
Mean age (years)	42.3 ± 8.7
Age range (years)	24–61
Male patients	30 (65.2%)
Female patients	16 (34.8%)
Mean BMI (kg/m²)	31.6 ± 4.3
Smokers	14 (30.4%)
Hypertensive patients	26 (56.5%)
Dyslipidemia present	21 (45.7%)
Mean follow-up duration (years)	4.1 ± 0.8

Preoperative sleep assessment revealed considerable disease burden among the study participants. The mean apnea-hypopnea index (AHI) was 33.4 ± 9.2 events/hour, while the mean Epworth Sleepiness Scale (ESS) score was 16.1 ± 3.4, indicating significant daytime sleepiness. Lowest oxygen saturation levels during sleep averaged 77.9 ± 5.8%, reflecting substantial nocturnal desaturation.

Table 2: Preoperative Polysomnographic and Sleep Characteristics

Parameter	Value
Moderate OSAS	24 (52.2%)
Severe OSAS	22 (47.8%)
Mean AHI (events/hour)	33.4 ± 9.2
Mean ESS score	16.1 ± 3.4
Mean lowest oxygen saturation (%)	77.9 ± 5.8
Frequent snoring	41 (89.1%)
Daytime fatigue	38 (82.6%)
Morning headache	19 (41.3%)
Poor sleep quality	36 (78.3%)

Following tonsillectomy, significant improvement was observed in cardiovascular parameters during long-term follow-up. Mean systolic blood pressure decreased from 143.1 ± 10.8 mmHg preoperatively to 131.9 ± 8.9 mmHg postoperatively. Similarly, mean diastolic blood pressure reduced from 91.7 ± 6.9 mmHg to 84.3 ± 6.1 mmHg after surgery. Both changes were statistically significant ($p<0.001$). Reduction in blood pressure was more pronounced among patients with moderate OSAS and those without progressive postoperative weight gain.

Table 3: Comparison of Cardiovascular Parameters Before and After Tonsillectomy

Parameter	Preoperative	Postoperative	Mean Difference	p-value
Systolic BP (mmHg)	143.1 ± 10.8	131.9 ± 8.9	-11.2	<0.001
Diastolic BP (mmHg)	91.7 ± 6.9	84.3 ± 6.1	-7.4	<0.001
Heart rate (beats/min)	86.4 ± 9.7	78.1 ± 7.2	-8.3	0.002

Significant metabolic improvement was also identified during postoperative follow-up. Mean total cholesterol levels decreased from 226.7 ± 30.2 mg/dL to 199.4 ± 25.8 mg/dL, while triglyceride levels reduced from 194.5 ± 36.7 mg/dL to 164.2 ± 31.4 mg/dL. LDL cholesterol levels demonstrated significant decline, whereas HDL cholesterol levels increased modestly but significantly after surgery. These findings suggest favorable long-term metabolic effects following surgical management of airway obstruction in OSAS patients.

Table 4: Comparison of Lipid Profile Parameters Before and After Tonsillectomy

Parameter	Preoperative	Postoperative	Mean Difference	p-value
Total cholesterol (mg/dL)	226.7 ± 30.2	199.4 ± 25.8	-27.3	<0.001
Triglycerides (mg/dL)	194.5 ± 36.7	164.2 ± 31.4	-30.3	0.001
LDL cholesterol (mg/dL)	145.2 ± 22.8	123.8 ± 18.6	-21.4	0.001
HDL cholesterol (mg/dL)	38.9 ± 6.5	43.8 ± 5.9	+4.9	0.014

Marked postoperative improvement was also observed in sleep-related outcomes. The mean ESS score significantly decreased from 16.1 ± 3.4 preoperatively to 7.5 ± 2.6 postoperatively, indicating major reduction in excessive daytime sleepiness. Similarly, the mean apnea-hypopnea index improved significantly from 33.4 ± 9.2 events/hour to 14.6 ± 6.2 events/hour after tonsillectomy. Lowest oxygen saturation levels during sleep improved substantially from 77.9 ± 5.8% to 88.1 ± 4.4% ($p<0.001$). Most patients additionally reported subjective improvement in snoring, daytime fatigue, sleep quality, and concentration during routine follow-up visits.

Table 5: Comparison of Sleep-Related Outcomes Before and After Tonsillectomy

Parameter	Preoperative	Postoperative	Mean Difference	p-value
ESS score	16.1 ± 3.4	7.5 ± 2.6	-8.6	<0.001
AHI (events/hour)	33.4 ± 9.2	14.6 ± 6.2	-18.8	<0.001
Lowest oxygen saturation (%)	77.9 ± 5.8	88.1 ± 4.4	+10.2	<0.001

Subgroup analysis based on disease severity demonstrated that patients with moderate OSAS experienced comparatively greater postoperative improvement than patients with severe disease. Reduction in AHI and ESS scores was more substantial among patients with isolated tonsillar hypertrophy and lower BMI values. Patients who maintained stable body weight throughout follow-up also showed greater improvement in cardiovascular and metabolic parameters.

Table 6: Subgroup Analysis According to Severity of OSAS

Parameter	Moderate OSAS (n=24)	Severe OSAS (n=22)	p-value
Reduction in AHI	20.6 ± 5.2	16.8 ± 4.7	0.018
Reduction in ESS score	9.4 ± 2.3	7.8 ± 2.1	0.031
Reduction in systolic BP (mmHg)	13.1 ± 4.5	9.3 ± 3.9	0.022
Improvement in oxygen saturation (%)	11.4 ± 3.6	8.9 ± 3.1	0.027

No mortality or major postoperative airway complications were recorded during the study period. Minor postoperative complications included transient throat pain, mild to moderate dysphagia, and self-limiting postoperative bleeding in a small proportion of patients, all of which were managed conservatively at outpatient department, mainly by non-steroidal anti-inflammatory drugs and rehydration, without long-term sequelae.

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Table 7: Postoperative Complications Following Tonsillectomy

Complication	Frequency (%)
Throat pain	46 (100%)
Mild to moderate dysphagia	33 (71.7%)
Minor postoperative bleeding	3 (6.5%)
Temporary voice change	2 (4.3%)
Major airway complication	0
Mortality	0

DISCUSSION

The present retrospective study evaluated the long-term effects of tonsillectomy on cardiovascular, metabolic, and sleep-related outcomes among adults diagnosed with obstructive sleep apnea syndrome (OSAS) after 3–5 years of follow-up. The findings demonstrated significant postoperative improvement in blood pressure, lipid profile parameters, apnea-hypopnea index (AHI), Epworth Sleepiness Scale (ESS) scores, and nocturnal oxygen saturation levels. These observations suggest that tonsillectomy may provide sustained systemic benefits in selected adult patients with significant tonsillar hypertrophy and OSAS.

Obstructive sleep apnea syndrome is increasingly recognized as a major contributor to cardiovascular morbidity due to recurrent nocturnal hypoxia, sympathetic nervous system activation, endothelial dysfunction, oxidative stress, and chronic systemic inflammation [9,10]. Persistent upper airway obstruction during sleep leads to repetitive oxygen desaturation and arousal episodes, which promote hypertension and adverse cardiovascular remodeling [11]. In the present study, a statistically significant reduction in both systolic and diastolic blood pressure was observed after tonsillectomy. Mean systolic blood pressure decreased by 11.2 mmHg, while diastolic blood pressure decreased by 7.4 mmHg during long-term follow-up. These findings are clinically relevant because even modest reductions in blood pressure are associated with substantial reduction in cardiovascular risk and long-term mortality [12].

The cardiovascular improvement observed in the present study is comparable to previous studies evaluating surgical treatment of OSAS. Marin et al. demonstrated that treatment of sleep-disordered breathing significantly reduced long-term cardiovascular complications in patients with obstructive sleep apnea [13]. Similarly, Somers et al. described the important role of sympathetic overactivity in the pathogenesis of hypertension among OSAS patients [14]. By relieving upper airway obstruction and improving nocturnal airflow, tonsillectomy may reduce intermittent hypoxia and sympathetic activation, thereby contributing to improved blood pressure regulation.

The present study also identified significant improvement in lipid profile parameters after surgery. Total cholesterol, triglycerides, and LDL cholesterol levels showed substantial reduction, whereas HDL cholesterol levels increased significantly following tonsillectomy. These findings support the growing evidence that OSAS contributes not only to cardiovascular disease but also to metabolic dysregulation and dyslipidemia [15]. Chronic intermittent hypoxia has been shown to alter hepatic lipid metabolism, promote oxidative stress, and increase inflammatory cytokine activity, all of which contribute to abnormal lipid homeostasis [16]. Improvement in nocturnal oxygenation after surgery may therefore positively influence metabolic pathways and reduce atherogenic lipid abnormalities.

Previous investigators have similarly demonstrated a relationship between sleep-disordered breathing and metabolic dysfunction. Drager et al. reported that obstructive sleep apnea is strongly associated with dyslipidemia and accelerated atherosclerosis [17]. Jun and Polotsky further emphasized the role

of intermittent hypoxia in promoting insulin resistance and metabolic abnormalities in OSAS patients [18]. The favorable postoperative metabolic changes observed in the present study may therefore reflect reduced systemic inflammation and improved oxygen delivery following correction of upper airway obstruction.

Substantial improvement was also observed in sleep-related outcomes after tonsillectomy. Mean ESS scores significantly decreased from 16.1 ± 3.4 preoperatively to 7.5 ± 2.6 postoperatively, indicating marked reduction in excessive daytime sleepiness. Similarly, mean AHI values improved significantly during follow-up. These findings are consistent with previous studies reporting improvement in sleep quality and polysomnographic parameters following tonsillectomy in adults with enlarged tonsils [19,20]. Improvement in daytime fatigue, concentration, and overall quality of life reported by patients in the present study further highlights the functional benefits of surgical treatment.

The improvement in lowest nocturnal oxygen saturation observed in this study also deserves attention. Chronic nocturnal hypoxemia is considered a key pathogenic factor responsible for cardiovascular and metabolic complications in OSAS [21]. Reduction in apneic episodes after tonsillectomy likely contributed to better nocturnal oxygenation, thereby decreasing oxidative stress and systemic inflammatory burden. Improved oxygen saturation may additionally explain the favorable cardiovascular and metabolic outcomes identified during long-term follow-up.

Subgroup analysis in the present study demonstrated that patients with moderate OSAS experienced comparatively greater postoperative improvement than those with severe disease. Patients with isolated tonsillar hypertrophy and lower body mass index also demonstrated better outcomes following surgery. These findings support previous evidence emphasizing the importance of appropriate patient selection in surgical management of OSAS [22]. Adults with significant anatomical airway obstruction caused predominantly by enlarged tonsils appear to derive maximum benefit from tonsillectomy.

Continuous positive airway pressure (CPAP) therapy remains the standard treatment for moderate-to-severe OSAS; however, long-term compliance remains a major clinical challenge [23]. Poor tolerance due to mask discomfort, nasal dryness, claustrophobia, and inconvenience during sleep frequently limits adherence to CPAP therapy [24]. In such patients, surgical intervention may provide a useful alternative therapeutic option, particularly when significant tonsillar hypertrophy is present. The present study supports the role of tonsillectomy as an effective adjunctive or alternative treatment modality in selected adult OSAS patients.

The present study has several strengths. The relatively long follow-up duration of 3–5 years allowed assessment of sustained postoperative outcomes rather than short-term symptomatic improvement alone. Additionally, the study evaluated cardiovascular, metabolic, and polysomnographic parameters simultaneously, thereby providing a more comprehensive assessment of long-term surgical outcomes.

However, certain limitations must also be acknowledged. The retrospective design may introduce selection bias and dependence on the accuracy of medical records. The sample size was relatively small and derived from a single tertiary care center, which may limit generalizability of the findings. Furthermore, lifestyle modification, dietary changes, physical activity, weight fluctuations, and concurrent medical treatment during follow-up may have influenced cardiovascular and metabolic outcomes independently of surgery. Future prospective multicenter studies with larger sample sizes and standardized follow-up protocols are therefore recommended.

Despite these limitations, the present study provides important evidence regarding the long-term systemic benefits of tonsillectomy in adults with obstructive sleep apnea syndrome. The significant improvement observed in blood pressure, lipid profile, sleep quality, oxygen saturation, and daytime functioning suggests that surgical management may contribute not only to symptomatic relief but also to reduction of cardiovascular and metabolic risk in carefully selected patients.

CONCLUSION

Tonsillectomy in adults with obstructive sleep apnea syndrome and significant tonsillar hypertrophy was associated with significant long-term improvement in blood pressure, lipid profile,

sleep quality, apnea-hypopnea index, and oxygen saturation after 3–5 years of follow-up. The findings suggest that surgical management may provide important cardiovascular, metabolic, and sleep-related benefits in carefully selected OSAS patients, particularly those with poor tolerance to CPAP therapy. Further prospective multicenter studies with larger sample sizes are recommended to confirm these findings.

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