EVALUATING THE ROLE OF FUNCTIONAL NASAL SURGERY IN IMPROVING SLEEP QUALITY IN OBSTRUCTIVE SLEEP APNEA PATIENTS

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ABSTRACT
Background: Obstructive sleep apnea (OSA) is a common sleep-related breathing disorder characterized by recurrent upper airway obstruction during sleep, resulting in excessive daytime sleepiness, impaired quality of life, and increased cardiovascular morbidity. Nasal obstruction caused by structural abnormalities such as deviated nasal septum and turbinate hypertrophy may exacerbate OSA symptoms and negatively affect sleep quality. Functional nasal surgery has been proposed as an adjunctive treatment to improve nasal airflow and alleviate sleep-related symptoms.
Objective: To evaluate the role of functional nasal surgery in improving sleep quality among patients with obstructive sleep apnea using the Epworth Sleepiness Scale (ESS).
Methods: This prospective interventional study was conducted from January 2024 to June 2025 in a tertiary care teaching hospital. Ninety adult patients diagnosed with OSA and symptomatic nasal obstruction underwent functional nasal surgery. Preoperative and postoperative daytime sleepiness was assessed using the ESS. Surgical procedures included septoplasty, inferior turbinate reduction, septoplasty with turbinate reduction, and nasal valve correction. Patients were followed for three months postoperatively. Statistical analysis was performed using SPSS version 26.0, with $p < 0.05$ considered statistically significant.
Results: The majority of participants were male (67.8%) and overweight or obese (82.2%). Deviated nasal septum was the most common nasal pathology (52.2%). Mean ESS scores significantly decreased from 13.84 ± 3.21 preoperatively to 8.21 ± 2.74 postoperatively ($p < 0.001$). The proportion of patients with normal ESS scores increased from 20.0% to 75.6%, while moderate and severe daytime sleepiness decreased substantially after surgery. Patients with normal body mass index demonstrated greater postoperative improvement than obese individuals ($p = 0.032$).
Conclusion: Functional nasal surgery significantly improved daytime sleepiness and subjective sleep quality in patients with OSA and nasal obstruction. These findings support its role as an effective adjunctive intervention in the multidisciplinary management of obstructive sleep apnea.

Keywords: Obstructive Sleep Apnea; Functional Nasal Surgery; Epworth Sleepiness Scale; Nasal Obstruction; Septoplasty; Sleep Quality.

INTRODUCTION
Obstructive Sleep Apnea (OSA) is a prevalent sleep-related breathing disorder characterized by recurrent episodes of complete or partial upper airway obstruction during sleep, resulting in intermittent hypoxemia, hypercapnia, and sleep fragmentation [1].

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These repetitive respiratory events adversely affect sleep architecture and are associated with excessive daytime sleepiness, impaired cognitive function, reduced work productivity, and diminished quality of life. Furthermore, untreated OSA has been linked to several systemic complications, including hypertension, cardiovascular disease, cerebrovascular accidents, insulin resistance, and metabolic syndrome [2].
The global prevalence of OSA has increased substantially over recent decades, largely due to rising rates of obesity, aging populations, and increased awareness of sleep disorders. Current estimates suggest that nearly one billion adults

worldwide may be affected by OSA, making it a major public health concern [3]. Despite its high prevalence, OSA remains underdiagnosed, particularly in developing countries where access to sleep laboratories and polysomnography may be limited.

The pathophysiology of OSA is multifactorial and involves both anatomical and neuromuscular factors that contribute to upper airway collapse during sleep. Structural abnormalities affecting the nasal cavity, pharynx, soft palate, tongue base, and craniofacial skeleton can increase upper airway resistance and predispose individuals to airway obstruction [4]. Among these factors, nasal obstruction has emerged as an important contributor to sleep-disordered breathing. Nasal airflow resistance accounts for a significant proportion of total airway resistance, and chronic nasal obstruction may promote mouth breathing, increase pharyngeal collapsibility, and worsen symptoms associated with OSA [5].

Common causes of nasal obstruction include deviated nasal septum, inferior turbinate hypertrophy, chronic rhinosinusitis, allergic rhinitis, and nasal valve dysfunction. These conditions can impair nasal breathing, disrupt sleep continuity, and contribute to snoring and daytime fatigue [6]. Several studies have demonstrated an association between nasal obstruction and poor sleep quality, emphasizing the importance of addressing nasal pathology in patients with sleep-disordered breathing [7].

Continuous Positive Airway Pressure (CPAP) therapy remains the gold standard treatment for moderate-to-severe OSA. However, long-term adherence to CPAP therapy is often suboptimal due to discomfort, mask intolerance, nasal congestion, dryness, and poor patient acceptance [8]. Nasal obstruction is recognized as a significant factor affecting CPAP compliance, as increased nasal resistance may reduce patient tolerance and therapeutic effectiveness [9]. Consequently, interventions aimed at improving nasal airflow have gained increasing attention as adjunctive strategies in the management of OSA.

Functional nasal surgery encompasses surgical procedures designed to restore normal nasal airflow and reduce nasal resistance. Common procedures include septoplasty, inferior turbinate reduction, septorhinoplasty, and nasal valve reconstruction. Although nasal surgery alone may not completely eliminate OSA, it has been shown to improve nasal breathing, reduce snoring, enhance sleep quality, and facilitate CPAP adherence in appropriately selected patients [10]. Improvement in subjective symptoms following nasal surgery may provide substantial benefits in overall patient well-being and daily functioning.

Assessment of treatment outcomes in OSA requires evaluation of both objective and subjective parameters. While polysomnography remains the diagnostic gold standard, subjective measures are valuable for assessing symptom burden and patient-perceived improvement. The Epworth Sleepiness Scale (ESS), developed by Johns in 1991, is one of the most widely used and validated instruments for measuring daytime sleepiness [11]. The ESS consists of eight situations in which respondents rate their likelihood of falling asleep, generating a total score ranging from 0 to 24. Higher scores indicate greater daytime sleepiness and poorer functional outcomes. The simplicity, reliability, and clinical relevance of the ESS have made it a standard tool in sleep medicine research and clinical practice [12].

Several investigations have reported significant reductions in ESS scores following correction of nasal obstruction, suggesting that functional nasal surgery may improve daytime alertness and sleep-related quality of life [13]. Nevertheless, evidence regarding the magnitude of benefit remains variable, and further research is needed to clarify the role of nasal surgery in patients with OSA.

Therefore, the present study aims to evaluate the effectiveness of functional nasal surgery in improving sleep quality among patients with obstructive sleep apnea by assessing changes in daytime sleepiness using the Epworth Sleepiness Scale. The findings may contribute to a better understanding of the role of nasal surgery in the multidisciplinary management of OSA and provide evidence for optimizing treatment strategies in patients with coexisting nasal obstruction.

MATERIALS AND METHODS

Study Design and Setting

This prospective interventional study was conducted in the Department of Otorhinolaryngology of a tertiary care teaching hospital from January 2024 to June 2025. The study aimed to evaluate the effectiveness of functional nasal surgery in improving sleep quality and daytime sleepiness among patients diagnosed with obstructive sleep apnea (OSA) associated with symptomatic nasal obstruction.

The study protocol was reviewed and approved by the Institutional Ethics Committee prior to commencement. Written informed consent was obtained from all participants before enrollment. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and its subsequent amendments.

Study Population

Adult patients presenting to the Otorhinolaryngology outpatient department with symptoms suggestive of OSA and clinically significant nasal obstruction were screened for eligibility.

Inclusion Criteria

1. Patients aged 18 years and above.
2. Diagnosed cases of obstructive sleep apnea based on clinical evaluation and/or sleep study findings.
3. Presence of symptomatic nasal obstruction attributable to anatomical abnormalities such as deviated nasal septum, inferior turbinate hypertrophy, or nasal valve dysfunction.
4. Patients scheduled to undergo functional nasal surgery.
5. Willingness to participate and provide written informed consent.

Exclusion Criteria

1. Previous nasal or upper airway surgery.
2. Craniofacial abnormalities affecting the upper airway.
3. Nasal obstruction secondary to sinonasal malignancy.
4. Neurological disorders causing excessive daytime sleepiness.
5. Uncontrolled psychiatric illness.
6. Patients requiring multilevel sleep surgery during the study period.
7. Inability to complete study questionnaires or attend follow-up visits.

Sample Size

A total of 90 patients fulfilling the eligibility criteria were recruited consecutively during the study period. The sample size was determined based on feasibility considerations and previous studies evaluating subjective sleep outcomes following nasal surgery in patients with OSA.

Preoperative Assessment

All participants underwent a comprehensive evaluation that included detailed history taking, clinical examination, and diagnostic nasal endoscopy.

Baseline demographic and clinical variables recorded included:

- Age
- Sex
- Body Mass Index (BMI)
- Duration of nasal obstruction
- Snoring history
- Comorbidities (hypertension, diabetes mellitus, cardiovascular disease)
- Smoking status

A complete otorhinolaryngological examination was performed to identify anatomical causes of nasal obstruction.

Assessment of Daytime Sleepiness

Daytime sleepiness was assessed using the Epworth Sleepiness Scale (ESS), a validated self-administered questionnaire consisting of eight items that evaluate the likelihood of falling asleep in different daily situations.

Each item is scored from 0 to 3, resulting in a total score ranging from 0 to 24. Higher scores indicate greater daytime sleepiness. ESS assessments were performed preoperatively and repeated at follow-up visits after surgery.

Surgical Intervention

All surgical procedures were performed by experienced otorhinolaryngologists under appropriate anesthesia.

The type of functional nasal surgery was determined according to individual anatomical abnormalities and included one or more of the following procedures:

- Septoplasty
- Inferior turbinate reduction
- Septoplasty with turbinate reduction
- Nasal valve correction where indicated

Standardized surgical techniques were employed in all cases. Postoperative care was provided according to institutional protocols.

Follow-up Assessment

Patients were followed for three months after surgery.

During follow-up visits, participants underwent:

- Clinical assessment of nasal patency
- Evaluation of postoperative complications
- Repeat administration of the Epworth Sleepiness Scale

The primary outcome measure was the change in ESS score from baseline to three months postoperatively.

Outcome Measures

Primary Outcome

- Change in Epworth Sleepiness Scale score following functional nasal surgery.

Secondary Outcomes

- Improvement in subjective nasal breathing.
- Reduction in symptoms of daytime fatigue.
- Association between demographic factors and postoperative ESS improvement.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies and percentages.

Normality of data distribution was assessed using the Shapiro–Wilk test.

For comparison of preoperative and postoperative ESS scores, the paired t-test was used for normally distributed data, while the Wilcoxon signed-rank test was applied for non-normally distributed variables.

Associations between categorical variables were analyzed using the Chi-square test or Fisher's exact test, as appropriate.
Multivariable linear regression analysis was performed to identify independent predictors of postoperative improvement in ESS scores.
A p-value <0.05 was considered statistically significant.

RESULTS

A total of 90 patients diagnosed with obstructive sleep apnea (OSA) and symptomatic nasal obstruction were enrolled in the study. All patients completed the preoperative and postoperative assessments and were included in the final analysis.

Table 1. Demographic and Clinical Characteristics of the Study Population (n = 90)

Variable	Frequency (%)
Age Group (Years)	
18–30	18 (20.0)
31–40	29 (32.2)
41–50	25 (27.8)
51–60	14 (15.6)
>60	4 (4.4)
Gender	
Male	61 (67.8)
Female	29 (32.2)
BMI Category (Kg/M²)	
Normal (<25)	16 (17.8)
Overweight (25–29.9)	43 (47.8)
Obese (≥30)	31 (34.4)

Table 1 presents the demographic and clinical profile of the study participants. Among the 90 patients included in the study, the majority belonged to the 31–40 years age group (32.2%), followed by the 41–50 years age group (27.8%). Male patients constituted 67.8% of the study population, whereas females accounted for 32.2%. With respect to body mass index (BMI), 47.8% of participants were overweight and 34.4% were obese, indicating that excess body weight was highly prevalent among patients with obstructive sleep apnea. These findings suggest that OSA associated with nasal obstruction predominantly affected middle-aged, overweight, and male individuals in the present study.

Table 2. Distribution of Nasal Pathology among Study Participants

Nasal Pathology	Frequency (%)
Deviated Nasal Septum (Dns)	47 (52.2)
Inferior Turbinate Hypertrophy	18 (20.0)
Dns With Turbinate Hypertrophy	21 (23.3)
Nasal Valve Dysfunction	4 (4.5)
Total	90 (100.0)

Table 2 demonstrates the distribution of anatomical nasal abnormalities among the study participants. Deviated nasal septum (DNS) was the most common pathology, affecting 52.2% of patients. Combined DNS with inferior turbinate hypertrophy was observed in 23.3% of cases, while isolated turbinate hypertrophy accounted for 20.0%. Nasal valve dysfunction was identified in only 4.5% of patients. The findings indicate that septal deviation, either alone or in combination with turbinate enlargement, represented the predominant cause of nasal obstruction in patients with OSA.

Table 3. Types of Functional Nasal Surgery Performed

Surgical Procedure	Frequency (%)
Septoplasty	42 (46.7)
Turbinate Reduction	16 (17.8)
Septoplasty + Turbinate Reduction	28 (31.1)
Nasal Valve Surgery	4 (4.4)
Total	90 (100.0)

Table 3 summarizes the surgical procedures performed in the study population. Septoplasty was the most commonly performed surgery, accounting for 46.7% of cases. Combined septoplasty with turbinate reduction was performed in 31.1% of patients, while isolated turbinate reduction was undertaken in 17.8%. Nasal valve surgery was required in only 4.4% of participants. These findings reflect the predominance of septal abnormalities among the study population and highlight septoplasty as the principal surgical intervention for restoring nasal airflow.

Table 4. Comparison of Preoperative and Postoperative ESS Scores

Variable	Mean ± SD	Mean Difference	T-Value	P-Value
Preoperative ESS Score	13.84 ± 3.21			
Postoperative ESS Score	8.21 ± 2.74	5.63	18.92	<0.001*

Table 4 compares the mean Epworth Sleepiness Scale (ESS) scores before and after functional nasal surgery. The mean preoperative ESS score was 13.84 ± 3.21, indicating moderate daytime sleepiness among the participants. Following surgery, the mean ESS score significantly decreased to 8.21 ± 2.74. The mean reduction of 5.63 points was statistically highly significant ($t = 18.92$, $p < 0.001$). This substantial improvement demonstrates that functional nasal surgery effectively reduced daytime sleepiness and enhanced subjective sleep quality in patients with obstructive sleep apnea and nasal obstruction.

Table 5. Severity of Daytime Sleepiness before and After Surgery

Ess Category	Preoperative N (%)	Postoperative N (%)
Normal (0–10)	18 (20.0)	68 (75.6)
Mild (11–12)	19 (21.1)	12 (13.3)
Moderate (13–15)	32 (35.6)	7 (7.8)
Severe (16–24)	21 (23.3)	3 (3.3)
Total	90 (100.0)	90 (100.0)

Table 5 illustrates the distribution of patients according to ESS severity categories before and after surgery. Prior to intervention, only 20.0% of participants had normal ESS scores, while the majority exhibited mild, moderate, or severe daytime sleepiness. Postoperatively, the proportion of patients with normal ESS scores increased markedly to 75.6%. Concurrently, the percentages of patients with moderate and severe sleepiness decreased substantially from 35.6% and 23.3% to 7.8% and 3.3%, respectively. These findings indicate a significant shift toward normal daytime functioning following functional nasal surgery.

Table 6. Association between BMI and Postoperative Improvement in ESS Score

Bmi Category	Mean Ess Improvement (Mean ± Sd)	P-Value
Normal Weight	6.42 ± 2.10	
Overweight	5.71 ± 2.36	
Obese	4.87 ± 2.28	0.032*

Table 6 evaluates the relationship between body mass index and improvement in ESS scores after surgery. Patients with normal BMI demonstrated the greatest improvement in ESS scores (6.42 ± 2.10), followed by overweight patients (5.71 ± 2.36). Obese individuals showed comparatively lower improvement (4.87 ± 2.28). The association between BMI and postoperative ESS improvement was statistically significant ($p = 0.032$). These findings suggest that lower BMI may be associated with greater symptomatic benefit following functional nasal surgery, whereas obesity may limit the extent of improvement in daytime sleepiness.

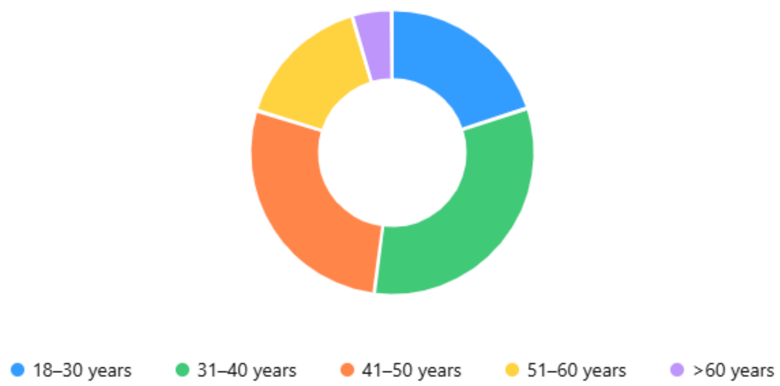

Figure 1. Percentage Distribution of Patients across Age Groups (n = 90)

Figure 1. The largest proportion of patients belonged to the 31–40 years age group (32.2%), followed by the 41–50 years age group (27.8%). Participants aged above 60 years constituted only 4.4% of the study population. The findings indicate that OSA associated with nasal obstruction predominantly affected middle-aged adults.

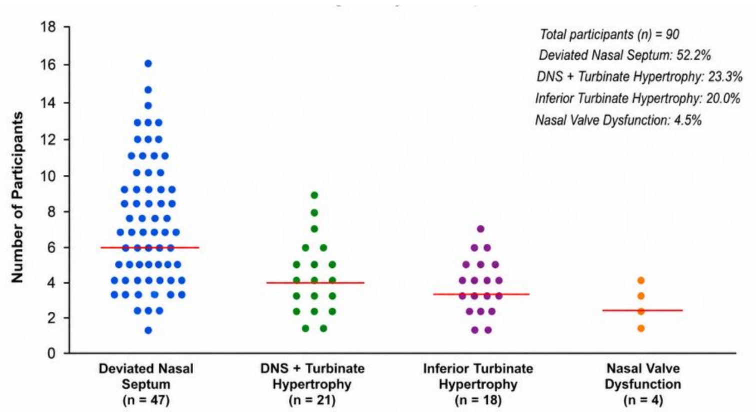

Figure 2. Distribution of underlying nasal pathologies among study participants

Figure 2. Illustrates the distribution of anatomical nasal pathologies identified among the 90 study participants undergoing functional nasal surgery for obstructive sleep apnea. Deviated nasal septum (DNS) was the most prevalent pathology, observed in 47 patients (52.2%), and followed by combined DNS with inferior turbinate hypertrophy in 21 patients (23.3%). Isolated inferior turbinate hypertrophy was present in 18 patients (20.0%), while nasal valve dysfunction constituted the least common pathology, affecting only 4 patients (4.5%). The predominance of septal abnormalities, both alone or in combination with turbinate hypertrophy, highlights their significant contribution to nasal obstruction in patients with obstructive sleep apnea and underscores the importance of corrective nasal surgery in this population.

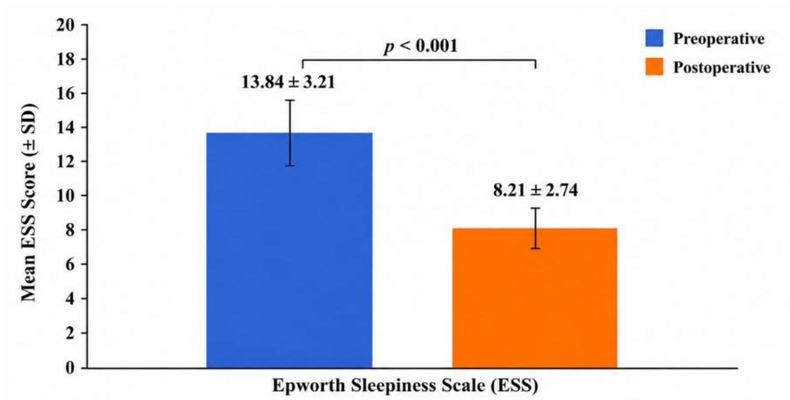

Figure 3. Comparison of mean preoperative and postoperative Epworth Sleepiness Scale (ESS) scores

Figure 3. Comparison of mean preoperative and postoperative Epworth Sleepiness Scale (ESS) scores. A significant reduction in mean ESS score was observed following functional nasal surgery, decreasing from 13.84 ± 3.21 preoperatively to 8.21 ± 2.74 postoperatively **(**p < 0.001**).** These findings indicate substantial improvement in daytime sleepiness and subjective sleep quality after surgical correction of nasal obstruction.

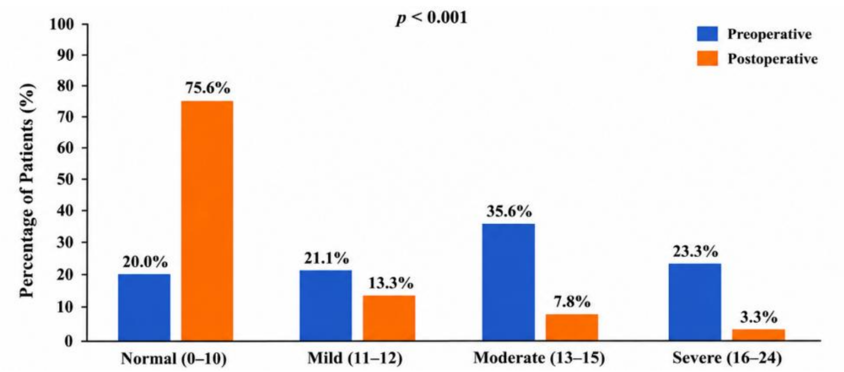

Figure 4. Distribution of ESS severity categories before and after functional nasal surgery

Figure 4. Prior to surgery, the majority of patients exhibited moderate (35.6%) or severe (23.3%) daytime sleepiness. Following functional nasal surgery, the proportion of patients with normal ESS scores increased substantially from 20.0% to 75.6%, whereas moderate and severe ESS categories declined to 7.8% and 3.3%, respectively. The findings demonstrate a marked postoperative improvement in daytime sleepiness and overall sleep-related quality of life.

DISCUSSION

The present prospective study evaluated the effectiveness of functional nasal surgery in improving daytime sleepiness among patients with obstructive sleep apnea (OSA) and symptomatic nasal obstruction using the Epworth Sleepiness Scale (ESS). The findings demonstrated a statistically significant reduction in postoperative ESS scores, indicating that correction of nasal obstruction may contribute substantially to improved sleep-related outcomes and daytime functioning.

In the present study, the majority of participants were males (67.8%), and most belonged to the 31–50-year age group. These findings are consistent with the established epidemiological profile of OSA, which predominantly affects middle-aged men. Peppard et al. reported a significantly higher prevalence of OSA among males, with increasing age and obesity acting as important risk factors for disease development [14]. Similarly, Senaratna et al. identified male sex and middle age as major demographic characteristics associated with OSA worldwide [15].

The current study demonstrated that overweight and obesity were highly prevalent among participants, accounting for more than 80% of the study population. Obesity is recognized as one of the strongest risk factors for upper airway collapse during sleep. Young et al. demonstrated a strong association between increasing body mass index and the severity of sleep-disordered breathing [16]. The high prevalence of excess body weight observed in the present study therefore reflects the known pathophysiological relationship between obesity and OSA.

Regarding anatomical abnormalities, deviated nasal septum was identified as the most common nasal pathology, either alone or in combination with inferior turbinate hypertrophy. These findings support previous observations that structural nasal obstruction contributes significantly to increased nasal airway resistance and impaired sleep quality. Georgalas highlighted the importance of nasal obstruction as a contributor to snoring and sleep-disordered breathing, particularly in patients with underlying anatomical abnormalities of the nasal cavity [6].

Septoplasty, either alone or combined with turbinate reduction, constituted the most frequently performed surgical intervention in the present study. This distribution reflects the predominance of septal pathology among enrolled patients and is comparable with previous reports evaluating nasal surgery in OSA populations [10].

The principal finding of the study was the significant reduction in mean ESS score from 13.84 ± 3.21 preoperatively to 8.21 ± 2.74 postoperatively ($p < 0.001$). This reduction indicates a clinically meaningful improvement in excessive daytime sleepiness following functional nasal surgery. Similar findings have been reported in the literature. Li et al. demonstrated significant postoperative improvements in subjective sleepiness and quality-of-life measures following nasal surgery in OSA patients [10]. Likewise, Wu et al. reported significant reductions in subjective sleep-related symptoms following nasal surgery, emphasizing the beneficial effect of improved nasal airflow on sleep quality [17].

An important observation in the present study was the marked shift in ESS severity categories following surgery. The proportion of patients with normal ESS scores increased from 20.0% preoperatively to 75.6% postoperatively, whereas moderate and severe daytime sleepiness decreased substantially. These findings suggest that functional nasal surgery not only improves mean symptom scores but also facilitates clinically meaningful improvement in symptom severity categories. Similar improvements have been described by Ishii et al., who reported significant reductions in daytime sleepiness and enhanced patient-reported outcomes after correction of nasal obstruction [13].

The beneficial effects of nasal surgery may be explained by several physiological mechanisms. Restoration of nasal airflow decreases upper airway resistance, promotes nasal breathing, reduces inspiratory negative pressure, and may lessen pharyngeal collapsibility during sleep. Improved nasal patency can also enhance sleep continuity and reduce nocturnal arousals, thereby improving daytime alertness. Verse and Pirsig emphasized that correction of nasal obstruction may contribute to better sleep quality through improvements in airway mechanics and breathing patterns during sleep [18].

The present study further demonstrated that patients with normal body mass index experienced greater improvement in ESS scores compared with obese individuals. This finding suggests that obesity may continue to contribute to upper airway obstruction despite correction of nasal pathology. Similar observations have been reported by Friedman et al., who noted that surgical outcomes tend to be more favorable in carefully selected patients with lower body mass indices and less extensive upper airway involvement [19].

Although nasal surgery alone may not completely eliminate OSA in all patients, the findings of the present study support its role as an effective adjunctive intervention in appropriately selected individuals with symptomatic nasal obstruction. Improvement in daytime sleepiness represents a clinically relevant outcome because excessive sleepiness is associated with impaired quality of life, reduced occupational performance, and increased risk of accidents.

The study has certain limitations. Objective postoperative polysomnographic parameters such as the apnea–hypopnea index were not assessed, and follow-up was limited to three months. Nevertheless, the use of the validated Epworth Sleepiness Scale enabled robust assessment of patient-reported outcomes. Future studies incorporating larger sample sizes, long-term follow-up, and objective sleep parameters may provide additional insight into the comprehensive impact of functional nasal surgery on OSA severity.

Overall, the findings indicate that functional nasal surgery significantly improves daytime sleepiness among patients with OSA and nasal obstruction. The observed reduction in ESS scores and favorable shift in ESS severity categories support the incorporation of nasal airway evaluation and management into the multidisciplinary treatment approach for obstructive sleep apnea.

CONCLUSION

The present study demonstrated that functional nasal surgery significantly improved daytime sleepiness in patients with obstructive sleep apnea and symptomatic nasal obstruction, as evidenced by a substantial reduction in Epworth Sleepiness Scale (ESS) scores following surgical intervention. A marked postoperative shift from moderate-to-severe sleepiness categories toward normal ESS scores was observed, indicating clinically meaningful improvement in sleep-related quality of life and daytime functioning. Deviated nasal septum was the most common underlying pathology, and septoplasty with or without turbinate reduction was the predominant surgical procedure performed. Although functional nasal surgery may not represent a definitive treatment for all cases of obstructive sleep apnea, the findings support its role as an effective adjunctive intervention in carefully selected patients with nasal obstruction. Incorporation of nasal airway assessment and appropriate surgical management may contribute significantly to optimizing the multidisciplinary treatment of obstructive sleep apnea.

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