Effect of Nasal Cavity Expansion Surgery on Subjective and Objective Sleep Symptoms in Patients with Obstructive Sleep Apnea-Hypopnea Syndrome: Postprint

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Abstract

Objective: To investigate the impact of nasal cavity expansion surgery on subjective and objective sleep symptoms in patients with obstructive sleep apnea-hypopnea syndrome (OSAHS), and to provide clinical evidence for its application in OSAHS. Methods: Fifty-six OSAHS patients who underwent nasal cavity expansion surgery in the Department of Otolaryngology of our hospital were selected as study subjects; polysomnography results and scores on the nasal obstruction scale, sleepiness scale, and snoring scale were compared before and after surgery. Results: Following nasal cavity expansion surgery, the apnea-hypopnea index (AHI) in OSAHS patients decreased compared with preoperative values (12.3±4.0 vs 6.3±1.7, $P<0.05$), while both mean oxygen saturation (80.6%±11.3% vs 88.1%±14.4%) and minimum oxygen saturation (71.2%±10.7% vs 79.8%±13.5%) increased ($P<0.05$); scores on the snoring scale (5.7±1.6 vs 3.2±0.7), nasal obstruction scale (8.9±2.0 vs 2.8±0.7), and sleepiness scale (12.1±2.7 vs 5.6±1.5) decreased compared with preoperative values ($P<0.05$). Conclusion: Nasal cavity expansion surgery demonstrates significant efficacy in alleviating the severity of obstructive sleep apnea and improving symptoms of snoring, nasal obstruction, and daytime sleepiness in OSAHS patients, holding important clinical significance for the treatment of OSAHS patients.

Full Text

Preamble

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Effect of Nasal Dilation on Subjective and Objective Sleep Symptoms in Patients with Obstructive Sleep Apnea-Hypopnea Syndrome

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Abstract: **Objective** To investigate the effect of nasal dilation on subjective and objective sleep symptoms in patients with obstructive sleep apnea-hypopnea syndrome (OSAHS) and provide clinical evidence for the application of nasal dilation surgery in OSAHS. **Methods** Fifty-six OSAHS patients who underwent nasal dilation surgery in our department of otolaryngology were selected as study subjects. Polysomnography results and scores from the Nasal Obstruction Scale, Sleepiness Scale, and Snoring Scale were compared before and after surgery. **Results** Following nasal dilation surgery, OSAHS patients showed a decrease in the apnea-hypopnea index (12.3±4.0 vs 6.3±1.7, $P<0.05$), while both mean oxygen saturation (80.6%±11.3% vs 88.1%±14.4%) and lowest oxygen saturation (71.2%±10.7% vs 79.8%±13.5%) increased significantly ($P<0.05$). Scores on the Snoring Scale (5.7±1.6 vs 3.2±0.7), Nasal Obstruction Scale (8.9±2.0 vs 2.8±0.7), and Sleepiness Scale (12.1±2.7 vs 5.6±1.5) all decreased significantly compared with preoperative values ($P<0.05$). **Conclusion** Nasal dilation surgery demonstrates significant efficacy in alleviating the severity of obstructive sleep apnea and improving sleep snoring, nasal obstruction, and daytime sleepiness symptoms in OSAHS patients, holding important clinical significance for OSAHS treatment.

Keywords: sleep apnea-hypopnea syndrome; nasal dilation; subjective and objective sleep symptoms

Sleep-disordered breathing has an extremely high prevalence, with epidemiological statistics indicating rates up to 60% among middle-aged and elderly individuals[1], of which obstructive sleep apnea-hypopnea syndrome (OSAHS) poses the greatest health risks. OSAHS is defined as a sleep breathing disorder characterized by an apnea-hypopnea index (AHI) 5 (or 30 apnea events) during 7 hours of nocturnal sleep, with each apnea episode lasting >10 seconds[2]. The development of OSAHS can cause pathological changes in multiple organs and systems including the cardiovascular, cerebrovascular, and pulmonary systems, representing a serious health hazard[3-5]. In recent years, nasal dilation surgery has become a research focus in OSAHS treatment[6]. However, its therapeutic role remains controversial. Some scholars believe nasal dilation can relieve or eliminate nasal obstruction and thereby cure OSAHS, while others argue that it only alleviates nasal obstruction symptoms without curative effects on OSAHS itself. This study investigates the impact of nasal dilation on subjective and objective sleep symptoms in OSAHS patients to provide clinical evidence for its application.

1.1 General Data

Fifty-six OSAHS patients who underwent nasal dilation surgery in our department of otolaryngology between October 2014 and December 2016 were selected as study subjects. All patients received detailed physical examinations and nasal endoscopy before enrollment. Inclusion criteria were: (1) age 18-60 years; (2) diagnosis of OSAHS according to the diagnostic guidelines published by the Editorial Board of *Chinese Journal of Otorhinolaryngology-Head and Neck Surgery*; (3) nasal obstruction VAS score 7.0 and nasal resistance (NR) detection graded 3 (moderate nasal obstruction); (4) informed consent signed voluntarily. Exclusion criteria included: (1) patients with nasal trauma, inverted papilloma, or other nasal diseases; (2) patients with chronic sinusitis; (3) those with poor compliance. Patient data including age, gender, preoperative BMI, and BMI at 6 months postoperatively showed no statistically significant difference between pre- and postoperative BMI (t=1.931, 0.281, 1760, P>0.05, Table 1).

1.2 Surgical Methods

All 56 patients underwent minimally invasive nasal dilation surgery under general anesthesia via an endoscopic system. The procedure began with a vertical incision through the mucosa at the anterior septum to expose the perichondrium, followed by triple-line tension-releasing septoplasty. The bony framework and cartilage support were preserved as much as possible to prevent subsequent nasal dorsum collapse. Polypoid lesions of the middle and inferior turbinates and neoplasms were completely resected. A dissector was used to press inward from the nasal root, displacing the middle turbinate to widen the middle meatus. For patients with concomitant sinus disease, the sinus ostia were opened and the sinuses irrigated with saline. Biomembranes were placed in the middle meatus to prevent postoperative adhesions. The inferior turbinate was fractured at its root and displaced laterally to enlarge the nasal cavity volume and open the common nasal meatus. After surgery, the nasal cavity was packed with expandable sponge for hemostasis. Once vital signs were stable, the endotracheal tube was removed. To prevent postoperative asphyxiation, non-invasive positive pressure ventilation was used perioperatively. Patients were then transferred to the sleep center ward for observation.

1.3 Assessment Methods

1.3.1 Nasal Endoscopy All patients underwent preoperative and 6-month postoperative examinations of the nasal cavity, nasopharynx, and sinus structures using a German Storz nasal endoscope.

1.3.2 Nasal Resistance Measurement Nasal resistance was measured preoperatively and at 6 months postoperatively using the ATMOS Rhinomanometer 300 (Germany). All measurements were performed by the same experienced technician, with the total resistance of both nasal cavities recorded as the measurement value (average of three measurements). Based on total nasal resistance values, five grades were defined: NR 0.19 as grade 0 (hyperventilation); NR=0.20-0.39 as grade 1 (normal ventilation); NR=0.40-1.26 as grade 2 (mild obstruction); NR=1.27-3.0 as grade 3 (moderate obstruction); NR=3.01-7.77 as grade 4 (severe obstruction); and NR 7.78 as grade 5 (complete obstruction).

1.3.3 Objective Sleep Symptom Monitoring All patients underwent standard polysomnography (PSG) using the Alice LE Philips Respironics system at 1 week preoperatively and 6 months postoperatively to measure AHI, lowest oxygen saturation (MSaO), and mean oxygen saturation (LSaO). Apnea was defined as complete cessation or >90% reduction in oral-nasal airflow from baseline lasting 10 seconds. Hypopnea was defined as >30% reduction in oral-nasal airflow from baseline with >4% SaO decrease lasting 10 seconds, or >50% reduction with >3% SaO decrease lasting 10 seconds.

1.3.4 Subjective Sleep Symptom Scoring (1) Epworth Sleepiness Scale (ESS)[7]: Evaluated daytime sleepiness through patient self-assessment. Total score ranges 0-24; >6 indicates sleepiness, >11 excessive sleepiness, and >16 dangerous sleepiness (Cronbach' s =0.80).
(2) Nasal Obstruction Scale[8]: A 10-cm ruler-shaped visual analog scale with cartoon expressions at both ends (smiling and extreme distress). Patients self-rated nasal obstruction severity by moving a slider: 0=no symptoms; 1-3=mild obstruction; 4-6=obstruction affecting life but tolerable; 7-10=intolerable obstruction affecting life and work (Cronbach' s =0.81).
(3) Snoring Scale[9]: Evaluated snoring through semi-objective self-assessment: 0=no snoring; 1-3=mild snoring affecting bed partner; 4-6=moderate snoring affecting roommate; 7-9=severe snoring affecting nearby people; 10=roommate leaving due to intolerable snoring (Cronbach' s =0.78).

1.4 Statistical Methods

All data were analyzed using SPSS 21.0 software. Count data were expressed as case numbers and analyzed using ^{2} tests. Measurement data were expressed as mean±standard deviation and analyzed using two-sided t-tests. $P<0.05$ was considered statistically significant.

2 Results

2.1 Nasal Endoscopic Findings

Preoperative endoscopy showed deviated nasal septum, hypertrophic inferior turbinates, paradoxical middle turbinates, and narrowing of the common nasal meatus (Figure 1 [Figure 1: see original paper]A). At 6 months postoperatively, most patients showed enlarged maxillary sinus ostia, well-opened ethmoid sinus cavities, and good epithelialization of the surgical cavity (Figure 1B).

2.2 Surgical Efficacy and Changes in Nasal Resistance

All 56 OSAHS patients were followed up postoperatively with nasal resistance testing. According to the 2009 diagnostic and efficacy criteria of the OSAHS Professional Group of the Otolaryngology-Head and Neck Surgery Branch of the Chinese Medical Association, 13 patients were cured, 31 showed marked improvement, and 12 showed improvement, yielding a cure rate of 23.2% and an overall effectiveness rate of 100%. Preoperative nasal resistance was 2.67±0.43, which decreased significantly to 0.74±0.29 at 6 months postoperatively ($t=27.847$, $P<0.05$).

2.3 Comparison of Pre- and Postoperative PSG Monitoring

All patients underwent PSG monitoring before and after surgery. Results showed significant postoperative increases in lowest oxygen saturation and mean oxygen saturation ($P<0.05$) and a significant decrease in AHI ($P<0.05$, Table 2).

2.4 Comparison of Subjective Sleep Symptoms

Postoperative scores for sleepiness scale, nasal obstruction scale, and snoring scale were all significantly lower than preoperative scores ($P<0.05$, Table 3).

3 Discussion

The prevalence of OSAHS is 9% among middle-aged and elderly women and as high as 24% in middle-aged and elderly men[10]. OSAHS is associated with daytime sleepiness, nasal obstruction, and snoring, severely impacting quality of life for patients and their families, and can cause pathological changes in multiple organs including the cardiovascular, cerebrovascular, and pulmonary systems, potentially inducing hypertension, pulmonary heart disease, coronary heart disease, respiratory failure, and even sudden death[11-14]. The pathogenesis of OSAHS is complex and not fully understood, with major contributing factors including nasal and pharyngeal pathology, obesity, neuroendocrine factors, and genetics[15-16]. Recent clinical studies have found that most OSAHS patients have narrowing at multiple upper airway levels including the hypopharynx and nasopharynx, suggesting that anatomical obstruction and narrowing of the upper airway may be the pathophysiological basis of OSAHS. Upper airway narrowing increases respiratory resistance, with nasal resistance accounting for approximately 50% of total airway resistance. When nasal obstructive disease occurs, nasal airflow resistance increases significantly, and increased negative pharyngeal pressure may cause collapse of pharyngeal soft tissues, leading to apnea. Additionally, reduced nasal airflow decreases reflexive stimulation of pharyngeal dilator muscles, weakening their regulatory role in breathing and causing hypoventilation or even apnea[17]. Therefore, nasal ventilation dysfunction may be a primary cause and aggravating factor of OSAHS. Improving or eliminating nasal ventilation obstruction through nasal dilation surgery may have important clinical significance for OSAHS treatment.

This study treated 56 OSAHS patients with significant nasal obstruction using nasal dilation surgery, resulting in 13 cured cases and marked improvement in the remaining 43 patients, with a cure rate of 23.2% and effectiveness rate of 100%. Endoscopic observation revealed enlarged maxillary sinus ostia and well-opened ethmoid sinus cavities postoperatively, representing clear improvement from preoperative narrowing of the common nasal meatus. Nasal resistance testing showed significant postoperative reduction ($P<0.05$), indicating that nasal dilation surgery effectively resolved nasal obstruction. Comparison of pre- and postoperative PSG monitoring revealed significant increases in MSaO and LSaO levels ($P<0.05$) and significant decrease in AHI ($P<0.05$). Huai et al.[18] reported an 11.9% cure rate for OSAHS patients treated with nasal dilation as a basic procedure, while Li et al.[19] conducted a meta-analysis of 13 studies on nasal surgery for OSAHS and found an overall cure rate of 16.7%. The cure rate in our study was notably higher than previous reports, possibly because we selected OSAHS patients with severe nasal obstruction (VAS 7.0), whereas other studies did not screen patients based on nasal obstruction severity. Postoperative nasal dilation significantly increased nasal ventilation volume in these severely obstructed patients, effectively reducing upper airway resistance and relieving pharyngeal soft tissue collapse caused by negative airway pressure, thereby restoring normal nasal physiological functions of air humidification and warming and maintaining normal nasopulmonary and nasocardiac reflexes to improve sleep breathing.

Our results demonstrated that OSAHS patients showed significant improvement not only in objective indicators including MSaO , LSaO , and AHI, but also in subjective symptoms such as daytime sleepiness, nasal obstruction, and snoring. Postoperative scores on the sleepiness scale, nasal obstruction scale, and snoring scale decreased significantly. Daytime sleepiness is one of the most common OSAHS symptoms, causing irresistible drowsiness in inappropriate situations that affects learning, work efficiency, and social functioning. Nasal obstruction not only impacts daily life and work but is also associated with heart disease, respiratory disease, anxiety, and memory decline. Sleep snoring severely affects sleep quality for patients and their partners. The substantial reductions in all three scale scores in our study are consistent with findings from Peng et al.[20].

These results suggest that nasal dilation surgery significantly improves daytime sleepiness, nasal obstruction, and snoring symptoms, enhancing quality of life for patients and their families. This may be related to the surgery' s ability to relieve upper airway obstruction, reduce negative pressure gradients in the pharyngeal lumen, increase effective ventilation during sleep, and improve nocturnal oxygen metabolism. In conclusion, nasal dilation surgery effectively alleviates OSAHS symptoms, improves sleep quality, and may even achieve cure, particularly in OSAHS patients with severe nasal obstruction. Nasal dilation surgery holds important clinical significance for OSAHS treatment and deserves broader clinical application.

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Note: Figure translations are in progress. See original paper for figures.