



The effect of nasal surgery on apnea-hypopnea index

Navid Nourizadeh (MD)¹, Mohammad Reza Majidi (MD)², Amir Rezaei Ardani (MD)³, Bashir Rasoulia (MD)^{1*}, Fariborz Rezaeitalab (MD)⁴, Hadi Asadpour (MD)⁵, Kamran Khazaeni (MD)²

¹Department of Otorhinolaryngology, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

²Sinus and Surgical Endoscopic Research Center, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

³Department of Psychiatry, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

⁴Department of Neurology, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

⁵Head of Sleep clinic, Ibn-Sina Hospital, Mashhad University of Medical Sciences, Mashhad, Iran

ARTICLE INFO

ABSTRACT

Article type

Review article

Article history

Received: 4 Feb 2014

Revised: 17 Feb 2014

Accepted: 19 Feb 2014

Keywords

Nasal obstruction

Obstructive sleep apnea

Snoring

One of the factors, which is involved in obstructive sleep apnea, is anatomic or inflammatory pathologies of nasal airway obstruction. Thus, it is logical to observe improvement of polysomnographic parameters of sleep-disordered breathing after nasal surgery. The authors performed a review of the literature, up to 2013, to determine the impact of nasal surgery on obstructive sleep apnea. Most current idea in this field is based on case series studies while randomized controlled trials evaluating the effect of surgery for nasal obstruction on sleep apnea are few and far between. According to these studies, surgery for nasal obstruction does not improve objective parameters of sleep apnea. Although nasal obstruction is one of the factors involved in obstructive apnea, one has to keep in mind that surgery will not result in major reduction of obstructive sleep apnea severity to relieve nasal obstruction. Detailed upper airway analysis has to be considered when surgery is an option for obstructive sleep apnea. Thus, nasal surgeries are beneficial when they are part of a multilevel approach in obstructive sleep apnea treatment.

Please cite this paper as:

Nourizadeh N, Majidi MR, Ardani AR, Rasoulia B, Rezaeitalab F, Asadpour H, Khazaeni K. The effect of nasal surgery on apnea-hypopnea index. *Rev Clin Med.* 2014;1(2):75-81.

Introduction

Nasal airway is the preferred airway during sleep in normal conditions; on the other hand, most of our airway resistance is

determined by nasal airway (1). Therefore, obstructing pathologies will increase the resistance to airflow and this will lead to

***Corresponding author:** Bashir Rasoulia.

Department of Otorhinolaryngology, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

E-mail: rasoulia891@mums.ac.ir

Tel: 051-38012689

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

higher negative intraluminal pressure and higher possibility of pharyngeal collapse (2). Considering these facts, one can predict the coexistence of nasal obstructing pathologies and sleep related breathing disturbances. Sleep apnea is the most common of these disturbances and it is characterized by temporary obstructions of upper airway during sleep. These disturbances will lead to daytime sleepiness or fatigue which may cause daytime dysfunction and alter quality of life. Therefore, addressing obstructing pathologies that cause sleep disturbances is necessary.

This review article will discuss the results of relieving the nasal obstruction by surgery on sleep apnea.

The relation between nasal obstruction and breathing disturbances during sleep

There are many studies about the relation between nasal obstruction and sleep disorder breathing (SDB). There are two types of studies in this regard. The first group studied the relationship between SDB and obstructing pathologies (anatomic or inflammatory), in the second group, the obstruction was simulated artificially and the relationship to SDB was studied.

Wisconsin cohort study, on 1032 patients, showed the nighttime nasal congestion was an independent risk factor for habitual snoring. In patients with severe nasal congestion (every night or almost every night), there was a 3-fold increase in the possibility of habitual snoring that was independent from sex, age, body mass index, cigarette smoking and asthma (3).

Iofaso et al. performed an anterograde study on 528 patients with snoring and reported nasal obstruction as an independent OSA (obstructive sleep apnea) risk factor. In this study, nasal obstruction was confirmed with posterior rhinomanometry and AHI (apnea-hypopnea index) >15 was considered

as OSA existence. Nasal obstruction was the reason for 2/3 % of total AHI variance (4). In 2002, Serrano carried out a study on 10033 patients with nasal polyposis and showed the negative results of nasal polyposis on quality of life and sleep. In this study, they used questionnaires to evaluate the effects of nasal disease on the quality of life and sleep disorder. 50.5 percent of patient with polyposis had snoring, while this was 35.7 in normal population (5).

In studies, in which nasal obstruction was simulated artificially, there was a correlation between nasal obstruction and SDB. Nasal packing, for example, was associated with more apnea and microarousals, reduction in deep sleep status, worse oxygen desaturation index and in general, lower quality of sleep (6-8).

Effective mechanisms proposed for coexistence of nasal obstructions and SDB

As already mentioned, one of the factors involved in SDB, is anatomic or inflammatory pathologies obstructing the nasal airway. In this section, we paid attention to the mechanisms describing the relationship between nasal obstruction and SDB.

1. Increased airway resistance (starling model)

Regarding this model, the entrance with a relative resistance is in the nose and the collapsible segment is in the oropharynx. Therefore, one can predict that increased nasal airway resistance will cause increased negative oropharyngeal airway pressure and collapse (9).

2. Change from nasal breathing to oral breathing

The preferred airway in a normal person is the nasal airway. This is true in the sleep or awake time (10). If the nasal airway is blocked, breathing is switched to oral airway but this causes some physiologic

problems. During oral breathing, total airway resistance increases 2.5 fold (11). On the other hand, during oral breathing, mandible moves downward and backward and tongue will do the same. This retraction will cause retroglossal diameter to decrease (12). A study showed that mouth opening with 1.5 centimetre (cm) distance between incisors, will cause 1 cm mandibular angle dislocation (13). These factors will increase upper airway collapse.

3. Disturbed nasal reflexes

Nasal receptor, which is activated during nasal breathing, will have positive effect on autonomous ventilation. In fact, studies showed that not only minute ventilation is larger with nasal breathing but also increasing nasal flow will result in increased minute ventilation (14). After nasal obstruction, nasal airway is bypassed and nasal receptor functions will decline. Thus, muscle tone, respiratory rate and minute ventilation decrease. There are studies showing that blocking the function

of these receptors by local anesthesia will result in more obstructive apnea and lower genioglossus muscle activity (15,16).

The effect of nasal surgery on sleep breathing disorder

Accepting the hypothesis that nasal obstruction will cause SDB, based on previously mentioned studies, is logical to observe recovery if nasal obstruction is relieved.

In this review, we discussed the effect of nose surgical treatment on the breathing pattern in the patients with nasal obstruction during sleep. (Table 1)

In contrast to studies trying to evaluate the effect of medical therapies and nasal dilators on breathing disorder during sleep for nasal pathologies, randomized controlled trials evaluating the effect of surgery for nasal obstruction on sleep apnea are few. Most current idea in this field is based on case series.

On the other hand, in these studies, pathologies creating nasal obstruction were

Table 1. Selected studies assessing effect of surgery on AHI

Author Reference	Patients	Design	Intervention	Outcome
Friedman (28)	patients with OSA* 50 and nasal obstruction	Case series	Septoplasty±ITR**	RDI*** increased
Kim (23)	patients with OSA 21 and nasal obstruction	Case series	Septoplasty±ITR	Decreased in RDI
Koutsourelakis (26)	49 patients with snoring and nasal obstruction, some with OSA	Randomized, control trial	Septoplasty±ITR vs sham surgery	No change in AHI****
Li (30)	patients with OSA 52 and nasal obstruction	Case series	Septoplasty±ITR	No change in AHI
Choi (24)	patients with OSA 22 and nasal obstruction	Case series	Combination of septoplasty±ITR±ESS*****	No change in AHI
Sufioglu (25)	patients with OSA 28 and nasal obstruction	Case series	Combination of septoplasty±ITR±ESS	No change in AHI

*OSA: obstructive sleep apnea; **ITR: inferior turbinate reduction; ***RDI: respiratory disturbance index; ****AHI: apnea-hypopnea index; *****ESS: endoscopic sinus surgery

heterogenous such as septal deviation, nasal vault deformity, inferior conchal hypertrophy and nasal polyposis. Even in one study, the researchers used different surgical options for a myriad of different obstructive pathologies. Surgical success was also defined differently. Thus, it is difficult to compare the effect of nasal airway surgery on SDB in different studies.

The effect of nasal surgery on sleep parameters are divided into two categories, subjective and objective. Objective parameters are from polysomnographic data but subjective parameters were different in various studies and are based on quality of life questionnaire, bed partner data and Epworth sleepiness scale. In our review literature study, we evaluated the effect of nasal surgery on apnea-hypopnea index, the most important polysomnographic parameter.

Most studies evaluating the effect of nasal surgery on OSA during the past 3 decades showed that nasal surgery is not successful in the improvement of objective sleep parameters. Studies in 1980s and 1990s evaluating the effects of septoplasty on snoring used subjective criteria (questionnaire or visual analog scale) and showed decreased snoring with a rate of 50-75% (17-19). Verse et al. did a meta-analysis in 2003 (20) and they mentioned that only 9 study had data about AHI before and after nasal surgery until 2000. Overall, these studies had 102 patients with OSA and had a short follow-up period of 1 month to 44 months. Of these studies, one study (21) reported a statistically significant improvement in OSA severity (AI decreased from 37.8 to 26.7). The final result of this meta-analysis was that the overall success rate of nasal surgeries about OSA was lower than 20 percent (20).

Studies during 1999 to 2009 about nasal surgery and sleep apnea were the basis of

another meta-analysis by Li et al. in 2011. This meta-analysis contained 13 studies and the weighted mean AHI in nine studies decreased from 35.2 ± 22.6 to 33.5 ± 23.8 postnasal surgery ($P=0.69$). According to this study, the overall success rate of nasal surgery was 16.7 percent in OSA treatment (22).

Evaluating the studies in Li's meta-analysis separately, showed that there was no statistically significant decrease in AHI except for one study (23). This study was conducted by Kim et al. on 21 patients with nasal obstruction and snoring and they evaluated the effect of septoplasty and conchal resection on sleep apnea. The results of this study were the following: respiratory disturbance index (RDI) decreased from 39 to 29 ($P=0.0001$) and apnea index decreased from 19 to 16 ($P=0.0209$). In fact, this was the only study in Li meta-analysis that showed improvement in polysomnographic parameters post-surgery (23).

Other studies evaluated the effect of nasal surgery on sleep apnea in recent years. Choi (24) and Sufioglu (25), in two separate studies, evaluated the effect of nasal surgery on OSA and finally concluded that despite improvement in sleep structure, there was no statistically significant change in AHI, arousal or minimum arterial O₂ saturation. In Sufioglu et al. study, the mean apnea-hypopnea duration showed a decrease (25).

The only randomized single-blind controlled trial by Koutsourelakis et al. on 49 patients with OSA and nasal obstruction due to septal deviation, compared septoplasty and sham surgery and showed no statistically significant difference in AHI and minimal O₂ saturation (26).

On the other hand, there are several studies that have not shown sleep parameters improvement postnasal surgery, but have indicated worsening of breathing status during sleep. Verse et al. studied two patients with nasal polyposis. AHI and excessive

daily sleepiness increased unexpectedly post-FESS (functional endoscopic sinus surgery) and REM duration decreased (27).

Freidman et al. studied the effect of septoplasty and inferior conchal resection on 50 patients with nasal obstruction and OSA. They concluded that RDI level in patients with mild obstructive apnea significantly increased. In this study, total RDI level also showed an increase (31.6 before surgery and 39.5 after surgery), but this increase was not significant (28). The justification of these researchers was that the improvement of nasal breathing after surgery as well as accommodation of patients to polysomnography test conditions resulted in deeper sleep which increased the possibility of airway collapse. Paradoxical results from these studies indicate that one cannot judge the effect of nasal surgery on sleep quality and this needs further evaluation.

Causes of nasal surgery failure on polysomnographic parameter improvement

1. Not paying attention to multilevel assessment in upper airway evaluation

Series et al. study showed that normal cephalometry would help to determine the group of patients with nasal obstruction and mild OSA who will benefit from operation. According to this study, all patients except for one had improvement in AHI and sleep fragmentation in the group with normal cephalometric study and the arousals decreased. In the group with abnormal cephalometry, these two parameters remained unchanged (29).

In the study by Li et al. on 42 patients with OSA and nasal obstruction, the effect of septoplasty and inferior conchal resection on snoring and AHI was assessed and they tried to determine the predicting factors for the final result of surgery on snoring. This

study showed subjective improvement in post-surgery snoring and low tonsillar sizes were a predictor for more improvement (30).

Morinaga et al. studied pharyngeal morphologic factors that could possibly predict the effect of nasal surgery on the patient with OSA. High soft palate and wide retroglossal space were the predictors of surgical success but tonsillar size was not a predicting factor despite Li study (31). The results stated above, show the necessity of paying attention to different upper airway levels in surgeries related to obstructive sleep apnea. If the surgeon focuses only on obstructing factors in the nasal airway, he might not be successful in the treatment.

2. Increased sleep depth following surgery

The other theory, hypothesized for the unsuccessfulness of nasal surgery for OSA is that opening the nasal airway following surgery will result in better sleep quality and subsequent deep sleep. This may lead to increased apnea. In fact, this paradoxical result of nasal surgery is the cause of lack of improvement in the AHI (28).

Sufioglu et al. showed that nasal surgery results in better sleep structure by increasing the rate of deep sleep but there was no statistically significant change in AHI. This was justified that deeper sleep levels induced due to better nasal breathing will lead to higher possibility of upper airway collapse (25).

3. Habitual mouth opening after surgery

This is possible that patients with chronic nasal obstruction will face more mouth opening during sleep and this might continue habitually after the treatment of nasal obstruction. Knowing that mandible opening is related to increased airway collapsibility, this may justify that AHI has not changed (32). This theory should be assessed by measuring the mouth opening

during sleep in follow-up polysomnography.

4. Delayed recovery of nasal receptor functions

When we consider that sleep breathing indexes are not changed, one of the explanations is that nasal receptors function and nasal mucosa afferents have delayed post-surgery recovery (32). As mentioned previously, the normal function of these receptors is necessary to control the dilator function of pharyngeal muscles, ventilation and respiratory rate.

Conclusion

Although nasal obstruction is one of the factors involving in obstructive apnea, one has to keep in mind that surgery to relieve nasal obstruction will not result in major reduction of OSAS severity. Detailed upper airway analysis has to be considered when surgery for obstructive sleep apnea is an option. Thus, nasal surgeries are beneficial when they are a part of a multilevel approach in obstructive sleep apnea treatment.

Acknowledgement

We would like to thank Clinical Research Development Center of Ghaem Hospital for their assistant in this manuscript. This study was supported by a grant from the Vice Chancellor for Research of the Mashhad University of Medical Sciences for the research project as a medical student thesis with approval number of 901068.

Conflict of Interest

The authors declare no conflict of interest.

References

- Ferris BG, Mead J, Opie LH. Partitioning of respiratory flow resistance in man. *J Appl Physiol.* 1964;19:653-658.
- Ryan CM, Bradley TD. Pathogenesis of obstructive sleep apnea. *J Appl Physiol.* 2005;99:2440-2450.
- Young T, Finn L, Palta M. Chronic nasal congestion at night is a risk factor for snoring in a population-based cohort study. *Arch Intern Med.* 2001;161:1514-1519.
- Lofaso F, Coste A, d'Ortho MP, et al. Nasal obstruction as a risk factor for sleep apnoea syndrome. *Eur Respir J.* 2004;16:639-643.
- Serrano E, Neukirch F, Pribil C, et al. Nasal polyposis in France: impact on sleep and quality of life. *J Laryngol Otol.* 2005;119:543-549.
- Suratt PM, Turner BL, Wilhoit SC. Effect of intranasal obstruction on breathing during sleep. *Chest.* 1986;90:324-329.
- Lavie P, Fischel N, Zomer J, et al. The effects of partial and complete mechanical occlusion of the nasal passages on sleep structure and breathing in sleep. *Acta Otolaryngol.* 1983;95:161-166.
- Zwillich C, Pickett C, Hanson F, et al. Disturbed sleep and prolonged apnea during nasal obstruction in normal men. *Am rev respire dis.* 1981;124:158-160.
- Park SS. Flow-regulatory function of upper airway in health and disease: a unified pathogenetic view of sleep-disordered breathing. *Lung.* 1993;171:311-333.
- Fitzpatrick MF, Driver HS, Chatha N, et al. Partitioning of inhaled ventilation between the nasal and oral routes during sleep in normal subjects. *J Appl Physiol.* 2003;94:883-890.
- Fitzpatrick MF, McLean H, Urton AM, et al. Effect of nasal or oral breathing route on upper airway resistance during sleep. *Eur Respir J.* 2003;22:827-832.
- Meurice JC, Marc I, Carrier G, et al. Effects of mouth opening on upper airway collapsibility in normal sleeping subjects. *Am J Respir Crit Care Med.* 1996;153:255-259.
- Kuna ST, Remmers JE. Neural and anatomic factors related to upper airway occlusion during sleep. *Med Clin North Am.* 1985;69:1221-1242.
- McNicholas WT, Coffey M, Boyle T. Effects of nasal airflow on breathing during sleep in normal humans. *Am Rev Respir Dis.* 1993;147:620-623.
- White DP, Cadieux RJ, Lombard RM, et al. The effects of nasal anesthesia on breathing during sleep. *Am Rev Respir Dis.* 1985;132:972-975.
- Garpestad E, Basner RC, Ringler J, et al. Phenylephrine-induced hypertension acutely decreases genioglossus EMG activity in awake humans. *J Appl Physiol.* 1992;72:110-115.
- Low WK. Can snoring relief after nasal septal surgery be predicted? *Clin Otolaryngol Allied Sci.* 1994;19:142-144.
- Ellis PD, Harries ML, Ffowcs Williams JE, et al. The relief of snoring by nasal surgery. *Clin Otolaryngol Allied Sci.* 1992;17:525-527.
- Fairbanks DN. Effect of nasal surgery on snoring. *South Med J.* 1985;78:268-270.
- Verse T, Pirsig W. Impact of impaired nasal breath-

- ing on sleep disordered breathing. *Sleep Breath.* 2003;7:63-76.
21. Rubin AHE, Eliaschar I, Joachim Z, et al. Effects of nasal surgery and tonsillectomy on sleep apnea. *Bull Eur Physiopathol Respir.* 1983;19:612-615.
 22. Li HY, Wang PC, Chen YP, et al. Critical appraisal and metaanalysis of nasal surgery for obstructive sleep apnea. *Am J Rhinol Allergy.* 2011;25:45-49.
 23. Kim ST, Choi JH, Jeon HG, et al. Polysomnographic effects of nasal surgery for snoring and obstructive sleep apnea. *Acta Otolaryngol.* 2004;124:297-300.
 24. Choi JH, Kim EJ, Kim YS, et al. Effectiveness of nasal surgery alone on sleep quality, architecture, position, and sleep-disordered breathing in obstructive sleep apnea syndrome with nasal obstruction. *Am J Rhinol Allergy.* 2011;25:338-341.
 25. Sufioğlu M, Ozmen OA, Kasapoglu F, et al. The efficacy of nasal surgery in obstructive sleep apnea syndrome: a prospective clinical study. *Eur Arch Otorhinolaryngol.* 2012;269:487-494.
 26. Koutsourelakis I, Georgouloupoulos G, Perraki E, et al. Randomised trial of nasal surgery for fixed nasal obstruction in obstructive sleep apnoea. *Eur Respir J.* 2008;31:110-117.
 27. Verse T, Pirsig W, Kroker B. Obstructive sleep apnea and obstructive nasal polyposis. *Laryngorhinootologie.* 1998;77:150-152.
 28. Friedman M, Tanyeri H, Lim JW, et al. Effect of improved nasal breathing on obstructive sleep apnea. *Otolaryngol Head Neck Surg.* 2000;122:71-74.
 29. Se'rie's F, St Pierre S, Carrier G. Surgical correction of nasal obstruction in the treatment of mild sleep apnoea: importance of cephalometry in predicting outcome. *Thorax.* 1993;48:360-363.
 30. Li H, Lee L, Wang P, et al. Nasal surgery for snoring in patients with obstructive sleep apnea. *Laryngoscope.* 2008;118:354-359.
 31. Morinaga M, Nakata S, Yasuma F, et al. Pharyngeal morphology: a determinant of successful nasal surgery for sleep apnea. *Laryngoscope.* 2009;119:1011-1016.
 32. McLean HA, Urton AM, Driver HS, et al. Effect of treating severe nasal obstruction on the severity of obstructive sleep apnea. *Eur Respir J.* 2005;25:521-527.