Chula Med J Vol. 66 No. 2 April - June 2022;243-248 DOI : 10.14456/clmj.2022.XX

Original article

Nasal obstruction and positional obstructive sleep apnea

Kornkla Panprapakorn[a, b, c, *], Prakobkiat Hirunwiwatkul[b,c], Busarakum Chaitusaney[b, c], Natamon Charakorn[b, c]

[a]Department of Otorhinolaryngology Head and Neck surgery, Charoenkrung Pracharak Hospital, Bangkok, Thailand.
[b]Department of Otorhinolaryngology Head and Neck Surgery, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand
[c]Excellence Center for Sleep Disorders, King Chulalongkorn Memorial Hospital, Thai Red Cross Society, Bangkok, Thailand

Background: Nasal obstruction is one of common risk factors of obstruction in obstructive sleep apnea (OSA) which can be caused by structural abnormalities. Positional obstructive sleep apnea (POSA) is defined that severity of OSA will be worsen in supine position. However, the correlation between nasal obstruction and POSA are unclear.

Objectives: The aim of this study was to investigate the prevalence of nasal obstruction in OSA patients and find the correlation between nasal obstruction and respiratory disturbance index (RDI) in these subjects. We also aimed to determine find the correlations in OSA patients POSA and those without POSA.

Methods: This study was a descriptive study that collected data form medical records and polysomnography. A total of 340 OSA patients were recruited in the study. All of them underwent overnight polysomnography and nasal examination. We defined the severity of nasal obstruction (nasal septum deviation and inferior turbinate hypertrophy) for 4 grades: normal, mild, moderate and severe obstruction. Correlations between nasal obstruction and RDI were calculated.

Results: The prevalence of nasal obstruction in OSA patient was 77.6 %. Nasal obstruction was not correlated with severity of OSA () in all parameters. RDI of 128 POSA patients was significantly correlation with nasal septum score ($r = 0.196$, $P = 0.027$) and total nasal obstruction score ($r = 0.203$, $P = 0.022$).

Conclusion: The prevalence of nasal obstruction in Thai OSA patients was high. Total nasal obstruction score and nasal septum deviation was found to be significantly correlated with the severity of POSA. Nasal examination is essential to identify nasal pathology and beneficial in OSA patients, especially POSA.

Keywords: Nasal obstruction, OSA, positional OSA, POSA.

Obstructive sleep apnea (OSA) is a common sleep disorder that recurrently collapses the upper airway during sleep, resulting in marked airflow reduction, causing oxygen desaturation and arousals during sleep. (1, 2) This disorder is associated with multiple morbidities such as excessive daytime sleepiness, weight gain, depression and risk of cardiovascular disease. (3)

Nasal obstruction is one of common risk factors of OSA (4) which can be caused by structural abnormalities and inflammatory mucosal disease. The pathophysiology between nasal obstruction and OSA can be described in many ways such as an increase in upper airway collapsibility due to greater negative intraluminal pressure according to the Starling resister model's theory (5), compensatory oral breathing that leads to higher airway resistance and narrower and longer pharyngeal lumen (6) and deactivation of nasal-ventilatory reflex by blunting of nasal receptors. (7)

Body position has a profound effect on breathing during sleep in OSA patients. Positional obstructive sleep apnea (POSA), described by Cartwright in 1984 in which supine AHI was at least two times greater than non-supine AHI, was very common in Asian populations.(8) POSA patients tend to have different characteristics from those without POSA, such as younger age, thinner, and milder severity of OSA. (9)

***Correspondence to:** **Kornkla Panprapakorn,** Department of Otorhinolaryngology Head and Neck Surgery, Bangkok 10120, Thailand.
E-mail: mic6257@gmail.com
Received: February 21, 2021
Revised: Mar 24, 2021
Accepted: May 18, 2021

Worsening of breathing during supine position in POSA may be explained by several mechanisms such as unfavorable airway geometry due to gravity effect, reduced lung volume, and an inability of airway dilator muscles to adequately compensate as the airway collapses.[10] Body position may also have some effects on nasal obstruction as nasal resistance was found to increase in most patients during supine position.[11] These effects may possibly be different between patients with POSA and patients without POSA.

Materials and methods

Patient population

Subjects who aged more than 18 years old, had respiratory disturbance index (RDI) of more than 5 events per hour and complete medical record of nasal examination performed by an otolaryngologist at sleep disorder clinic and OSA clinic, King Chulalongkorn Memorial Hospital between July 2018 and July 2019, were recruited into the study. Exclusion criteria included craniofacial anomalies, nasal masses, nasal examinations post nasal surgeries, and incomplete or missing medical records of nasal examination.

Study design

This study was a descriptive study that collected data form medical record and polysomnography. Ethical considerations for the study design and protocols have been approved by the Institutional Review Board (IRB), Faculty of Medicine, Chulalongkorn University (IRB no. 532/62).

Materials and methods

General demographic data such as age, gender, body mass index (BMI), minimum oxygen saturation, Epworth sleepiness scale (ESS), RDI and arousal index were collected.

Nasal evaluation

We defined the severity of nasal obstruction by the inferior turbinate size and nasal septum deviation. The inferior turbinate size and nasal septum deviation were graded according to Camacho's study.[12] For the inferior turbinate size, the score was 0 when the inferior turbinate size was defined as normal, in which less than 25.0% of total nasal airway space was occupied. The score was 1 when the inferior turbinate size was defined as mild, in which inferior turbinate occupied 26.0 – 50.0% of the space. The score was 2 when the inferior turbinate size was defined as moderate, in which inferior turbinate occupied 51.0 - 75.0% of the space. Finally, the score was 3 when the inferior turbinate size was defined as severe, with 76.0 – 100.0 % of space occupation.

For nasal septum deviation, normal was defined when there was less than 25.0% deflection from midline toward the lateral wall and was scored as 0. Mild (26.0 – 50.0% deflection) was scored as 1. Moderate (51.0 – 75.0% deflection) was scored as 2, and severe (76.0 – 100.0% deflection) was scored as 3. We then summed up inferior turbinate score and nasal septum score into total nasal obstruction score for evaluating severity of nasal obstruction. We classified degrees of nasal obstruction severity according to total nasal obstruction score (inferior turbinate score + nasal septum score). Zero was no nasal obstruction: 1 or 2 was mild nasal obstruction; 3 or 4 was moderate nasal obstruction; and, 5 or 6 was severe nasal obstruction. We determined patients who had total nasal obstruction score of at least 3 points (moderate to severe nasal obstruction) as patients with significant nasal obstruction.

Obstructive sleep apnea

The definitions of RDI followed the recommended criteria in the manual of the American Academy of Sleep Medicine for the scoring of sleep and associated events 2012.[13] The respiratory disturbance index (RDI) represents the combined number of apneas, hypopneas and respiratory effort related-arousal (RERA) that occur per hour of sleep: mild OSA (RDI ≥ 5 and < 15), moderate OSA (RDI ≥ 15 and ≤ 30) and severe OSA (RDI > 30).[13] As for POSA, we used the following definitions:1) overall RDI is greater than 5 events/h.; 2) the supine RDI is greater than two times the non-supine RDI.[10]

Statistical analysis

The demographic data are presented with descriptive statistics as mean ± standard deviation for normally distributed variables or median (interquartile ranges) for non-normally distributed variables. To identify the correlation between nasal obstruction and RDI, the data were evaluated by Spearman and Pearson correlation test, which were analyzed as continuous scores. A $P < 0.05$ was considered as significant. All statistical analyses were conducted using SPSS version 23.0 (SPSS Inc., Chicago, IL, USA).

Results

Inclusion criteria were met in 340 patients. 218 patients were male (64.1%) and 122 patients were female (35.9%). Their average age was 48.5 ± 14.0 years old. The mean RDI was 45.5 ± 28.6 event/hour. The clinical characteristics of the patients are described in Table 1.

Table 1. Baseline and demographic data.

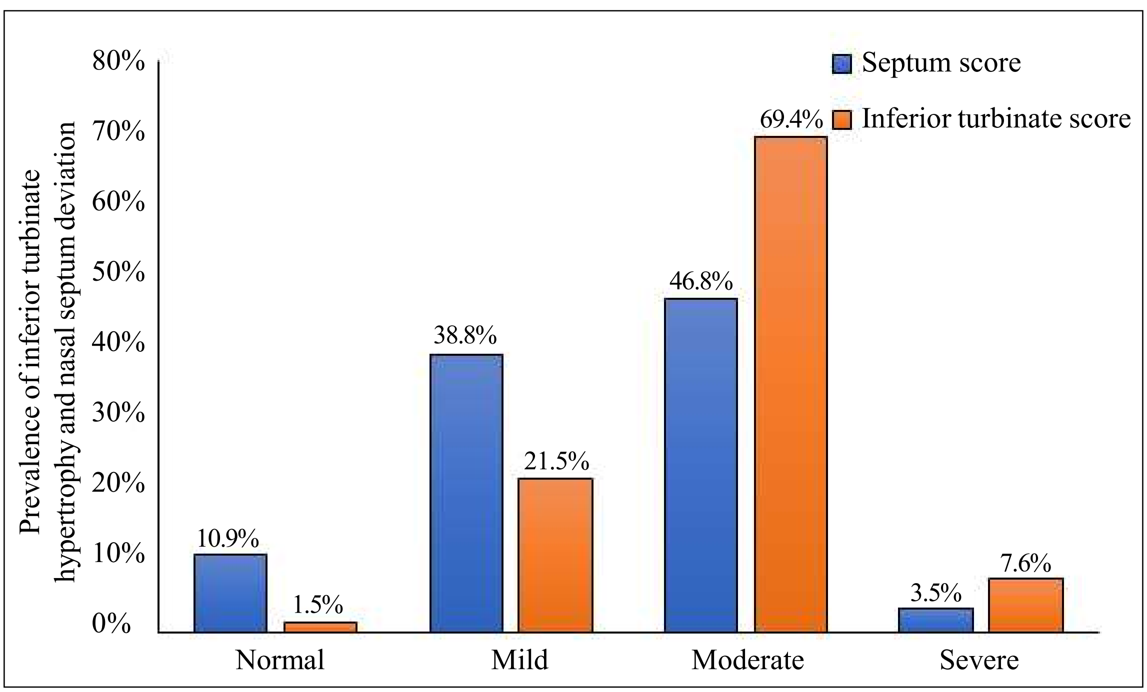
	Mean ± SD
Age	48.5 ± 14.0
BMI	29.3 ± 7.6
ESS	9.8 ± 4.0
Arousal-index	39.5 ± 24.2
Minimal oxygen saturation	78.1 ± 12.7
RDI	45.5 ± 28.6
POSA RDI (n = 128)	31.4 ± 19.4

The inferior turbinate size was defined as normal, mild, moderate and severe in 5 patients (1.5%), 73 patients (21.5%), 236 patients (69.4%), and 26 patients (7.6%), respectively. Nasal septum deviation was defined as normal, mild, moderate and severe in 37 patients (10.9%), 132 patients (38.8%), 159 patients (46.8%), and 12 patients (3.5%), respectively (Figure 1).

Total nasal obstruction scores were 0 in 4 patients (1.2%), 1 in 17 patients (5.0%), 2 in 55 patients (16.2%), 3 in 97 patients (28.5%), 4 in 147 patients (43.2%), 5 in 19 patients (5.6%) and 6 in 1 patient (0.3%). There was 77.6% of the patients with significant nasal obstruction in which total nasal obstruction scored of at least 3 (Table 2).

Nasal obstruction was not correlated with RDI in all parameters including inferior turbinate score, nasal septum score and total nasal obstruction score. Additionally, we calculated the correlation between nasal obstruction and RDI in POSA and non-POSA groups. In all, 128 patients in POSA had significant correlation between nasal septum score and RDI (correlation coefficient = 0.196, P = 0.027) and between total nasal obstruction score and RDI (r = 0.203, P = 0.022). However, there was no significant correlation between RDI and inferior turbinate score in POSA (r = 0.073, P = 0.412) (Table 3), (Figure 2).

In non-POSA patients, correlations between nasal obstruction, in terms of inferior turbinate score, septum score and total nasal obstruction score, and RDI are not significantly demonstrated (Table 3).



Normal = score 0, Mild = score 1, Moderate = score 2, Severe = score 3

Figure 1. Prevalence of inferior turbinate hypertrophy and nasal septum deviation.

Table 2. Prevalence of nasal obstruction by total nasal obstruction score, inferior turbinate score and nasal septum score.

Parameters / Score	Inferior turbinate score n (%)	Nasal septum score n (%)	Total nasal obstruction score n (%)
0	5 (1.5)	37 (10.9)	4 (1.2)
1	73 (21.5)	132 (38.8)	17 (5)
2	236 (69.4)	159 (46.8)	55 (16.2)
3	26 (7.6)	12 (3.5)	97 (28.5)
4	-	-	147 (43.2)
5	-	-	19 (5.6)
6	-	-	1 (0.3)

Table 3. The correlation between nasal obstruction and severity of OSA in all patients and POSA.

Total (n = 340)	Septum score	*P - value*	Inferior turbinate score	*P - value*	Total nasal obstruction score	*P - value*
RDI (n = 340)	- 0.013	0.807	- 0.030	0.585	- 0.043	0.424
POSA RDI (n = 128)	0.196	0.027*	0.073	0.412	0.203	0.022*
Non-POSA RDI (n = 96)	- 0.093	0.365	- 0.141	0.170	-0.161	0.118

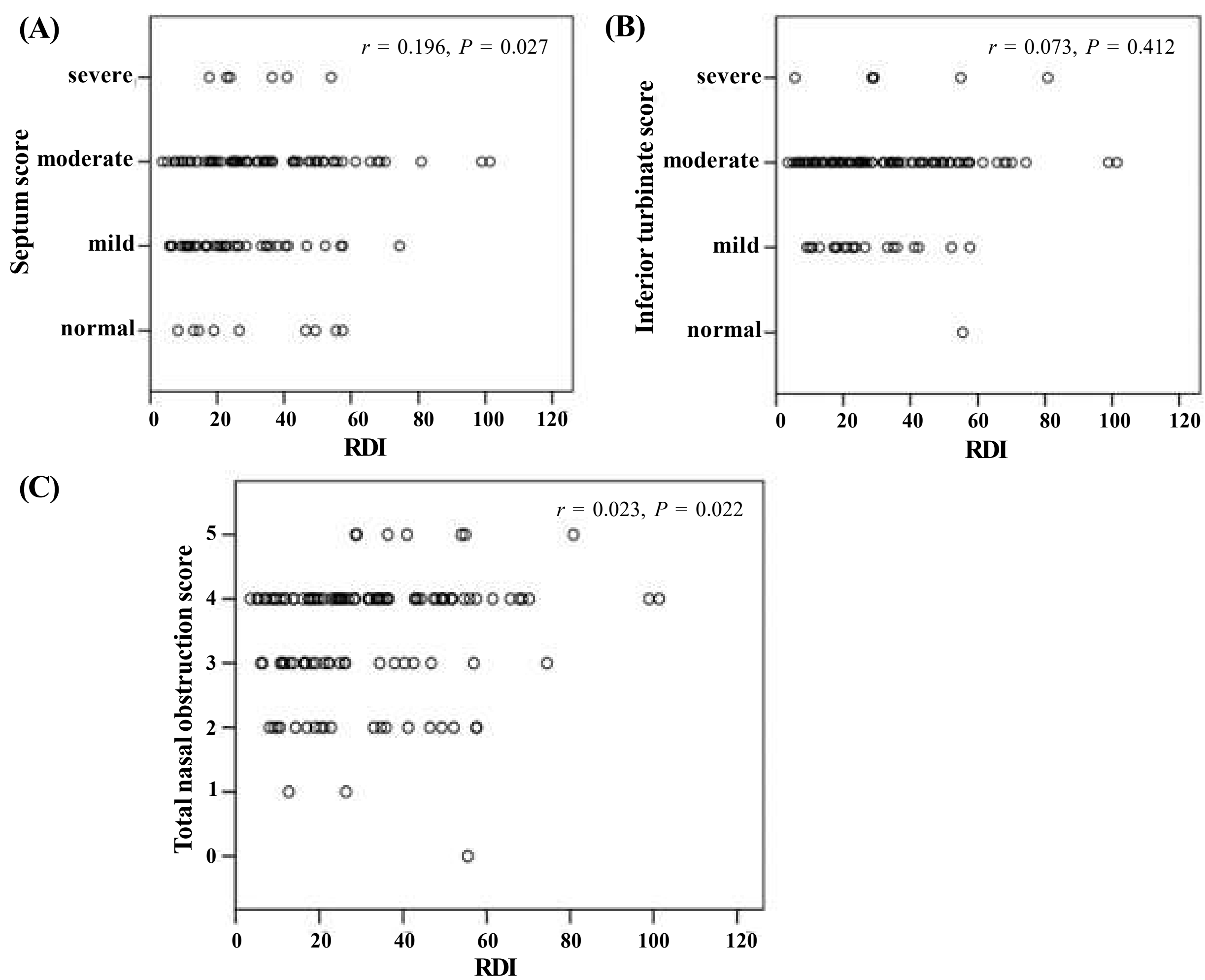


Figure 2. Scatter plot in POSA group. **(A)** correlation between nasal septum score and RDI, **(B)** correlation between inferior turbinate score and RDI, **(C)** correlation between total nasal obstruction score and RDI.

Discussion

Nasal obstruction was common in OSA.[14 - 16] In the other way, OSA was also more prevalent in the patient who has a disease of nasal obstruction such as allergic rhinitis.[4] Human normally breath through the nose both during asleep and awake unless there are nasal obstruction.[16] Breathing while mouth open is associated with reduction of the retropalatal and retroglossal areas, lengthening of the pharynx and shortening of the MP-H (mandible and hyoid bone) in the upper airway, assessed by lateral cephalometry and fiberoptic nasopharyngoscopy.[6] Narrowing and lengthening of the upper airway may affect the severity of OSA.

In this study, the prevalence of nasal obstruction in OSA patient is 77.6%. Our study was consistent with previous studies in which the prevalence ranged between 64.0 - 85.0%[14, 15, 17], confirming that nasal obstruction was common among OSA patients.

Correlations between nasal obstructions, in terms of inferior turbinate size, nasal septal deviation and total obstruction score, and RDI are not demonstrated in this study. These findings are consistent with most recent studies which statistically significant correlation between nasal obstruction and OSA was not demonstrated.[17 - 18] In contrast, significant correlation between OSA and nasal septal deviation was reported in Rodrigues's[19] study, which evaluated nasal obstruction by using compute tomography.

Nevertheless, when dividing the patients into POSA and non-POSA groups, only the POSA group that the statistically significant positive correlation was demonstrated between nasal obstruction and RDI, in terms of nasal obstruction score and septal deviation. In POSA group, side-sleep may relief gravity effect from the oropharyngeal soft tissue which was worsened by negative pressure effect created by nasal obstruction.[20, 21]

As POSA is quite common[8], a focus on evaluating and treating nasal obstruction in these patients would be beneficial. A study of Hu B, *et al*. demonstrated much better improvement of OSA in the POSA group, in comparison with non-POSA group, when nasal obstruction was properly treated.[22] On the other hand, positional therapy might also be useful in the OSA patient who has nasal obstruction with septal deviation.

We studied the prevalence of nasal obstruction in adults with OSA and focused on the risk factor between POSA and non-POSA. For the best of our knowledge, this is the first research that demonstrates the correlation between nasal obstruction and POSA. Our populations were diagnosed as OSA by using the comprehensive level I polysomnography. The limitation of our study was that we used subjective nasal evaluation. Unlike previous studies which evaluate noses with various measurements such as acoustic rhinomanometry[14] or CT scan[19] and selective bias from descriptive study, the physician subjective nasal evaluation with nasal speculum is a simple method in everyday practice that was practical and affects treatment decision and can be easily learned and applied.

Conclusion

In summary, our study demonstrates that over 70.0% of Thai adult OSA patients may have significant nasal obstruction based on physical examination with anterior rhinoscopy. Nasal obstruction has correlation with positional OSA. Performing nasal examination is essential to identify nasal pathology and has benefit in OSA patients, especially in POSA.

Conflict of interests

The authors received no financial support and they declare no conflict of interests related to this study.

References

1. Sleep-related breathing disorders in adults: recommendations for syndrome definition and measurement techniques in clinical research. The Report of an American Academy of Sleep Medicine Task Force. Sleep 1999;22:667-89.
2. McNicholas WT. Diagnostic criteria for the sleep apnoea syndrome: time for consensus. Eur Respir J 1996;9:634-5.
3. Colish J, Walker JR, Elmayergi N, Almutairi S, Alharbi F, Lytwyn M, et al. Obstructive sleep apnea: effects of continuous positive airway pressure on cardiac remodeling as assessed by cardiac biomarkers, echocardiography, and cardiac MRI. Chest 2012;141: 674-81.
4. Young T, Finn L, Kim H. Nasal obstruction as a risk factor for sleep-disordered breathing. The University of Wisconsin Sleep and Respiratory Research Group. J Allergy Clin Immunol 1997;99: S757-62.
5. Egan KK, Kezirian EJ, Kim DW, Nasal obstruction and sleep-disordered breathing. Oper Tech Otolaryngol 2006;17:268-72.
6. Lee SH, Choi JH, Shin C, Lee HM, Kwon SY, Lee SH.

How does open-mouth breathing influence upper airway anatomy? Laryngoscope 2007;117:1102-6.
7. Douglas NJ, White DP, Weil JV, Zwillich CW. Effect of breathing route on ventilation and ventilatory drive. Respir Physiol 1983;51:209-18.
8. Teerapraipruk B, Chirakalwasan N, Simon R, Hirunwiwatkul P, Jaimchariyatam N, Desudchit T. Clinical and polysomnographic data of positional sleep apnea and its predictors. Sleep Breath 2012;16: 1167-72.
9. Oksenberg A, Silverberg DS, Arons E, Radwan H. Positional vs nonpositional obstructive sleep apnea patients: anthropomorphic, nocturnal polysomnographic, and multiple sleep latency test data. Chest 1997;112:629-39.
10. Joosten SA, O'Driscoll DM, Berger PJ, Hamilton GS. Supine position related obstructive sleep apnea in adults: pathogenesis and treatment. Sleep Med Rev 2014;18:7-17.
11. De Vito A, Berrettini S, Carabelli A, Sellari-Franceschini S, Bonanni E, Gori S, et al. The importance of nasal resistance in obstructive sleep apnea syndrome: a study with positional rhinomanometry. Sleep Breath 2001;5:3-11.
12. Camacho M, Zaghi S, Certal V, Abdullatif J, Modi R, Sridhara S, et al. Predictors of Nasal Obstruction: Quantification and Assessment Using Multiple Grading Scales. Plast Surg Int 2016;2016:6945297.
13. Epstein LJ, Kristo D, Strollo PJ Jr, Friedman N, Malhotra A, Patil SP, et al. Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. J Clin Sleep Med 2009;5:263-76.
14. Assanasen P, Banhiran W, Kositchaiwat N, Bunnag C. Prevalence of chronic rhinitis in Thai patients with obstructive sleep disordered breathing. J Med Assoc Thai 2013:96:1169-74.
15. Clark DW, Del Signore AG, Raithatha R, Senior BA. Nasal airway obstruction: Prevalence and anatomic contributors. Ear Nose Throat J 2018;97:173-6.
16. Fitzpatrick MF, Driver HS, Chatha N, Voduc N, Girard. Partitioning of inhaled ventilation between the nasal and oral routes during sleep in normal subjects. J Appl Physiol (1985) 2003;94:883-90.
17. Zonato AI, Bittencourt LR, Martinho FL, Júnior JFS, Gregório LC, Tufik S. Association of systematic head and neck physical examination with severity of obstructive sleep apnea-hypopnea syndrome. Laryngoscope 2003;113:973-80.
18. Leitzen KP, Brietzke SE, Lindsay RW. Correlation between nasal anatomy and objective obstructive sleep apnea severity. Otolaryngol Head Neck Surg 2014; 150:325-31.
19. Rodrigues MM, Gabrielli MFR, Junior OAG, Filho VAP, Passeri LA. Nasal airway evaluation in obstructive sleep apnoea patients: volumetric tomography and endoscopic findings. Int J Oral Maxillofac Surg 2017; 46:1284-90.
20. Miyazaki S, Itasaka Y, Ishikawa K, Togawa K. Influence of nasal obstruction on obstructive sleep apnea. Acta Otolaryngol Suppl 1998;537:43-6.
21. Georgalas C. The role of the nose in snoring and obstructive sleep apnoea: an update. Eur Arch Otorhinolaryngol 2011;268:1365-73.
22. Hu B, Han D, Li Y, Ye J, Zang H, Wang T. Polysomnographic effect of nasal surgery on positional and non-positional obstructive sleep apnea/hypopnea patients. Acta Otolaryngol 2013; 133:858-65.