ENT Updates

RESEARCH ARTICLE

ENT UPDATES 11(2):87-89
DOI: 10.5152/entupdates.2021.21358

Total Nasal Airway Resistance With Different Head Positions in Allergic Rhinitis Patients: A Four-Phase Rhinomanometric Study

ABSTRACT

Objective: To investigate the changes in nasal airway patency with different head positions in patients with allergic rhinitis (AR).

Methods: A total of 30 patients diagnosed with AR were included. The patients were asked to stand upright (temperature, 22-24°C; humidity, 40-70%), to lie down at an angle of 45° from the horizontal position, and to lie down in a supine position, maintaining each position for 20 minutes. A four-phase rhinomanometric (4PR) evaluation was performed on them in these 3 body positions. The effective and vertex resistances during inspiration and expiration were evaluated utilizing HRR2 4PR (RhinoLab GmbH, Hamburg, Germany).

Results: There was a significant decrease in nasal resistance and an obvious increase in nasal conductance with the alteration from the supine to the 45° inclined position ($P < .05$). There were noteworthy differences in the 4PR scores between the standing and supine positions and the supine and 45° inclined positions ($P < .05$). In contrast, no remarkable differences were detected in the 4PR scores between the standing and 45° inclined positions ($P > .05$).

Conclusion: Our results showed that head elevation impacts nasal resistance and airflow conductance in patients with AR. Objective measures of nasal obstruction are more evident in the supine position than in the standing and 45° inclined positions. These findings might enable some practical recommendations which our patients can follow to relieve their nasal obstruction caused by AR.

Keywords: Allergic rhinitis, four-phase rhinomanometry, head position

INTRODUCTION

Allergic rhinitis (AR) is the inflammation of the nasal mucosa, characterized by an IgE-mediated hypersensitive reaction to trigger molecules, that range widely from animal dander to grass.[1] Once a patient is sensitized to a particular antigen, every exposure results in an increased outflow of various mediators such as histamine, interleukins, platelet-activating factor, etc.[2] The main consequences of this hyperactive response by a sensitized mucosal lining are a watery nasal discharge, nasal obstruction, sneezing, and nasal itching.[3] As the most prominent symptom of AR, nasal obstruction is linked with inflammatory nasal edema. Although the nasal airway is affected by various external factors, the dynamic nature of nasal mucosal tissue also makes it over-reactive to various physiological changes, such as hormonal, neural, vascular, etc.[4] Allergic rhinitis is one of the many reasons for nasal obstruction. Nasal obstruction in AR occurs via nasal mucosal swelling and hypertrophy of the conchae.

A review of the literature reveals studies measuring nasal resistance with postural changes using anterior rhinomanometry and acoustic rhinometry.[5] Postural changes affect the nasal airway resistance and intranasal geometry. In normal subjects without any nasal disease, there is an increase in nasal airway resistance and a reduction in the cross-sectional area while lying down.[6,7] Currently, there are several techniques to objectively measure nasal airway resistance. Rhinomanometry has been used as a functional test for understanding nasal physiology since the 1950s. Four-phase rhinomanometry (4PR) is an objective method to assess nasal airway resistance and conductance, both in

Leman Veziroğlu Birdane[1]
Nagehan Erdoğmuş Küçükcan[2]

[1]Department of Otorhinolaryngology, Bursa City Hospital, Bursa, Turkey
[2]Department of Otorhinolaryngology, Çukurova State Hospital, Adana, Turkey

Cite this article as: Veziroğlu Birdane L, Erdogmuş Kucukcan N. Total nasal airway resistance with different head positions in allergic rhinitis patients: A four-phase rhinomanometric study. *ENT Updates*. 2021;11(2):87-89.

Corresponding author:
Nagehan Erdogmuş Kucukcan
Email: *nagehannerdogmus@gmail.com*
Received: *June 25, 2021*
Accepted: *July 12, 2021*

the inspiratory and expiratory phases.[8] In the current study, we aimed to investigate the alterations in nasal airway patency with different head positions in AR patients.

METHODS

A total of 30 patients with a diagnosis of AR were included. The study was conducted according to the principles of the Declaration of Helsinki and approved by the Eskişehir Osmangazi University institutional review board (June 30, 2016/80558721G-216). Written informed consent was obtained from all participants. All patients underwent detailed ear, nose, and throat examinations. The exclusion criteria were a history of treatment for turbinate hypertrophy, severe septal deviation, nasal deformity, nasal malignancies, and nasal polyps. In addition, we excluded those patients who had a history of any medications, smoking, or other factors that could cause nasal mucosal swelling. We aimed to focus on the patients with nasal obstruction caused only due to hypertrophic inferior turbinates as a result of AR.

The measurements were obtained under temperature (22-24°C) and humidity (40-70%)-controlled conditions. The subjects were first asked to stand upright, then to lie down at an angle of 45° from the horizontal position, and finally, to lie down in a supine position, maintaining each position for 20 minutes. Four-phase rhinomanometric evaluation was performed on the patients in these 3 body positions. The effective resistance in inspiration and expiration (Reffin, Reffex) and vertex resistance during inspiration and expiration (VRin, VRex) were assessed using HRR2 4PR (Rhino Lab GmbH, Hamburg, Germany). We followed the recommendation of the Standardization Committee on Objective Measurement of The Upper Airway for classification of nasal resistance and conductance, based on the resistance value, as follows: <0.75, very low resistance/high conductance; 0.75-1.00, low resistance/high conductance; 1.00-1.25¼, moderate resistance/moderate conductance; 1.25-1.50, high resistance/low conductance; and >1.50, very high resistance/very low conductance.

Statistical Analysis

The goodness of fit for the normal distribution of all variables was analyzed using the Shapiro–Wilk test. The differences in the mean values between the treatment groups were evaluated with the one-way repeated measures analysis of variance. The power of each test performed with type I error rate alpha = 0.050 was calculated. The maximum power of the tests was calculated as 97.6% at a sample size of 30 patients. The results were expressed as mean ± standard deviation and the level of significance was set at a *P*-value <.05. The analysis of our data was carried out with Sigma Stat for Windows version 3.5 (SYSTAT Software Inc., California, United States).

RESULTS

Our series consisted of 13 male and 17 female patients with an average age of 37 years (range 21-67 years). All our patients had symptoms and signs consistent with nasal obstruction and stuffiness associated with congestion of the turbinate mucosa. With the alteration from the supine to the 45° inclined position ($P < .05$), the nasal resistance decreased remarkably and there was an obvious increase in nasal conductance. The 4PR results for both nasal cavities are presented in Tables 1 and 2. Analysis of the rhinomanometric results indicated a statistically significant difference in the 4PR scores between the standing and supine positions, as well as the supine and 45° inclined positions ($P < .05$). However, no statistically significant difference was detected in the 4PR scores between the standing and 45° inclined positions ($P > .05$; Tables 3 and 4).

DISCUSSION

Reducing the nasal obstruction is the main goal of rhinologists in treating any kind of nasal pathology.[9] Nasal physiology has a complex nature, and many internal and external forces affect the mucosal thickness and nasal airway patency. The objective parameters obtained from 4PR revealed that the standing and 45° inclined positions of the head significantly decrease nasal airway resistance in AR patients. Parallel to our findings, Roithmann et al.[10] suggested that the postural alteration from the sitting to supine position leads to a decrease in nasal cross-sectional area and volume, both in controls and the patients with symptoms of rhinitis. This is due to the passive process that occurs due to increased venous pressure in the head in the supine position, which diminishes the venous drainage from the inferior and middle turbinates. Hellgren et al.[11] demonstrated that nasal patency decreased after a change from the sitting to supine positions in healthy individuals. However, in obstructive sleep apnea patients, this phenomenon is absent, possibly due to the altered neural network of the nasal mucosa in an affected patient, caused by the disease process.

In our patient group, postural changes––especially from the supine to the standing and 45° inclined positions––resulted in a significant decrease in nasal airway resistance, even with an altered mucosal architecture due to Ig-E-mediated rhinitis. These findings might be attributed to the different pathogenesis of each disease, and point out the complex nature of the nasal mucosal neurovascular network. Thus, the alterations of the

MAIN POINTS

- Postural changes affect the nasal airway resistance and intranasal geometry.
- Head elevation influences nasal resistance and airflow conductance in patients with AR.
- Nasal obstruction is more evident in the supine position than in the standing and 45° inclined positions.

Table 1. Four-Phase Rhinomanometry Measurements for Right Nasal Cavity

Body Position	Reffin	Reffex	VRin	VRex
Standing	1.32 ± 0.45	1.24 ± 0.44	1.21 ± 0.42	1.18 ± 0.39
45° inclined	1.42 ± 0.42	1.30 ± 0.40	1.37 ± 0.37	1.26 ± 0.37
Supine	1.60 ± 0.43	1.49 ± 0.40	1.59 ± 0.37	1.47 ± 0.34

Table 2. Four-Phase Rhinomanometry Measurements for Left Nasal Cavity

Body Position	Reffin	Reffex	VRin	VRex
Standing	1.21 ± 0.40	1.26 ± 0.41	1.23 ± 0.34	1.15 ± 0.36
45° inclined	1.26 ± 0.37	1.12 ± 0.33	1.26 ± 0.21	1.15 ± 0.23
Supine	1.43 ± 0.47	1.33 ± 0.43	1.41 ± 0.40	1.34 ± 0.37

Values are mean ± standard deviation, in units of $Pa/cm^3 \cdot s$.
Reffex, effective resistance in expiration; Reffin, effective resistance in inspiration; VRex, vertex resistance in the process of expiration; VRin, vertex resistance in the process of inspiration.

Table 3. Comparison of 4PR Scores Between Body Positions (Right)

Comparison (Right Nasal Cavity), Body position	Reffin, *P*	Reffex, *P*	VRin, *P*	VRex, *P*	Statistically Significant Difference
Standing/45° inclined	.256	.504	.072	.339	No
45° inclined/supine	.045	.033	.012	.016	Yes
Standing/supine	.003	.504	.001	.001	Yes

Table 4. Comparison of 4PR Scores Between Body Positions (Left)

Comparison (Left Nasal Cavity), Body position	Reffin, *P*	Reffex, *P*	VRin, *P*	VRex, *P*	Statistically Significant Difference
Standing/45° inclined	.549	.989	.689	.917	No
45° inclined/supine	.024	.007	.038	.013	Yes
Standing/supine	.005	.007	.015	.010	Yes

airway patency depend not only on the position of the head relative to the gravitational forces, but also on the numerous mediators which are in charge during the inflammatory reactions on the nasal mucosa, specifically for patients with AR. According to our findings, we might conclude that after adjusting the optimal medical therapy for the AR patients, a clinician can recommend his patients to elevate the head instead of being supine, while sleeping or at rest. Although our results might enable such practical recommendations, we need further studies with larger populations and an additional questionnaire to investigate subjective outcomes in the future.

CONCLUSION

The results of our current study reveal that head elevation influences nasal resistance and airflow conductance in patients with AR, and nasal obstruction is more evident in the supine position than in the standing and 45° inclined positions. These findings might enable us to offer some practical recommendations for our patients with AR. However, further trials are needed to confirm our findings.

Ethics Committee Approval: Ethical committee approval was received from the Eskişehir Osmangazi University Ethics Committee (June 30, 2016/80558721G-216).

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

Peer Review: Externally peer-reviewed.

Author Contributions: Concept - L.B., N.E.; Design - L.B., N.E.; Supervision - L.B., N.E.; Resource - L.B., N.E.; Materials - L.B., N.E.; Data Collection and/or Processing - L.B., N.E.; Analysis and/or Interpretation - L.B., N.E.; Literature Search - L.B., N.E.; Writing - N.E.; Critical Reviews - L.B., N.E.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Turner PJ, Kemp AS. Allergic rhinitis in children. *J Paediatr Child Health*. 2012;48(4):302-310. [CrossRef]
2. Gelfand EW. Inflammatory mediators in allergic rhinitis. *J Allergy Clin Immunol*. 2004;114(5)(suppl):S135-S138. [CrossRef]
3. Bousquet J, Neukirch F, Bousquet PJ, et al. Severity and impairment of allergic rhinitis in patients consulting in primary care. *J Allergy Clin Immunol*. 2006;117(1):158-162. [CrossRef]
4. McEvoy RD, Sharp DJ, Thornton AT. The effects of posture on obstructive sleep apnea. *Am Rev Respir Dis*. 1986;133(4):662-666. [CrossRef]
5. Karlsson A, Persson M, Mjörnheim AC, Gudnadottir G, Hellgren J. Total nasal airway resistance while sitting predicts airway collapse when lying down. *J Laryngol Otol*. 2020;134(10):1-8. [CrossRef]
6. Fouke JM, Jackson AC. Acoustic rhinometry: effects of decongestants and posture on nasal patency. *J Lab Clin Med*. 1992;119(4):371-376.
7. Hellgren J, Yee BJ, Dungan G, Grunstein RR. Altered positional regulation of nasal patency in patients with obstructive sleep apnoea syndrome. *Eur Arch Otorhinolaryngol*. 2009;266(1):83-87. [CrossRef]
8. Vogt K, Jalowayski AA, Althaus W, et al. 4-Phase-rhinomanometry (4PR): Basics and practice 2010. *Rhinol Suppl*. 2010;21:1-50.
9. Stewart MG, Smith TL, Weaver EM, et al. Outcomes after nasal septoplasty: Results from the Nasal Obstruction Septoplasty Effectiveness (NOSE) study. *Otolaryngol Head Neck Surg*. 2004;130(3):283-290. [CrossRef]
10. Roithmann R, Demeneghi P, Faggiano R, Cury A. Effects of posture change on nasal patency. *Braz J Otorhinolaryngol*. 2005;71(4):478-484. [CrossRef]
11. Rundcrantz H. Postural variations of nasal patency. *Acta Otolaryngol*. 1969;68(5):435-443. [CrossRef]