Peak nasal inspiratory flow and peak expiratory flow. Upright and sitting values in an adult population*

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Abstract

Background: Nasal obstruction is correlated with a decreased quality of life. An easy way to evaluate nasal patency is the peak nasal inspiratory flow (PNIF) measurement. Normal PNIF values have been published by many authors. However, some authors evaluated volunteers in a sitting position, while others have measured PNIF values in standing volunteers.
Body position has been shown to influence pulmonary function, with differences between sitting and upright positions. As nasal and pulmonary flows are strictly related, the present pilot study tried to establish whether PNIF/PEF changed with body position in adults.

Methodology: PNIF and PEF were measured in sitting and standing positions with the order of testing randomized in 76 healthy volunteers, 30 male (40 ± 16 years).

Results: In the group as a whole between sitting and upright position, PEF was significantly different (p=0.009), while PNIF showed a trend towards a significant difference (p=0.10).

Conclusions: The present study, although showing a generally positive effect of the standing position on PEF values, does not show a clear effect on PNIF.

Key words: Nasal flow, PNIF, PEF, body position, adults, nasal patency, normal values

Introduction

Nasal airway obstruction is a common problem in ENT practice and has been shown to correlate with decreased quality of life as a result of, amongst others, decreased quality of sleep, (chronic) rhinosinusitis, otitis media and asthma [1]. Therefore the measurement of nasal patency is of considerable importance for physicians [2].

A cheap, simple and easy way to evaluate nasal patency is represented by the measurement of the Peak Nasal Inspiratory Flow (PNIF) [3]. PNIF, in fact, has been used for the evaluation of the treatment in allergic rhinitis patients [4], to study nasal valve collapse [5,6] and for the evaluation of septoturbinoplasty outcome [7]. In the recent past, normal PNIF values both for adult and paediatric populations have been published by many authors [2, 8-13], also unilaterally [14], allowing the application of this technique to the results of septoplasty [15]. In studying PNIF values, some authors applied PNIF to sitting volunteers [2,8,10,11,13,16], whilst others to standing volunteers [9,12].

An attractive and simple method for the measurement of ventilatory capacity is represented by the measurement of Peak Expiratory Flow (PEF). This method is widely known and is used by clinicians and by patients at home [17]. Compared with other instruments which measure ventilatory capacity, PEF has several advantages such as its relative cheapness, size, independence

of electrical power, and the speed with which the test can be performed [18].

It has been suggested that body position can influence pulmonary function [19]. The ability of a muscle fibre to generate active tension is dependent on its length. Changes in body position, by altering the respiratory muscles length (such as the diaphragm muscle), can affect their ability to generate tension [20]. It has been suggested that pulmonary function can be different between sitting and upright positions since, in the latter condition, respiratory muscle mechanics seem to be more efficient [21]. Considering a group of patients who had undergone abdominal surgery, a recent paper showed that the patients in an upright position presented the highest increases in forced vital capacity. The standing position has thus been suggested by the authors to provide greater mechanical advantage to the respiratory muscles and to generate higher ventilation pressures [22], confirming a previous suggestion from Townsend [23] who found that FEV1 and forced vital capacity were significantly greater in the standing than in the sitting posture in a group of 90 healthy volunteers [23].

Less is known about the influence of body position on nasal patency [24] and to date most studies have focused on nasal patency differences between sitting and supine positions [25] or between wakefulness and sleep [26].

The present pilot study tried to establish whether PNIF and/or PEF changed with body position (sitting vs upright) in healthy adults.

Materials and methods

A population of 76 subjects (30 male, 46 female, mean age 40 ± 16 years) was recruited at the Department of Neurosciences, Otolaryngology Section, of Padua University (from colleagues and patients' relatives). On enrolment into the study, all subjects were asked to complete a SNOT 22 questionnaire [27]. They were also asked if they were experiencing nasal blockage or any other nasal problem, if they were smokers, asthmatic or had undergone any previous surgery on the nose and paranasal sinuses. All the subjects with a score < 1 on the SNOT 22, who were non-smokers, non-asthmatic and without any previous sinonasal surgery were asked their age, race and medications used. None of the volunteers included into the study took any medication, such as β-blockers or corticosteroid, which could have affected nasal patency. The present investigation was conducted in accordance with the 1996 Helsinki Declaration and was approved by the internal committee of the Section.

A portable Youlten peak flow meter (Clement Clark International) was used for the measurement of PNIF, while a Mini-Wright portable peak flow meter (Clement Clark International) was used for the measurement of PEF.

Recording PNIF values, volunteers were encouraged to inhale as hard and fast as they could through the nose with the mouth tightly closed and the mask firmly over the face, starting from the end of a full expiration. Recording PEF values, volunteers were encouraged to exhale through the mouth as hard and fast as they could through the mouthpiece of the instrument starting from the end of a full inspiration. Three satisfactory maximal inspirations and expirations were respectively obtained in sitting and standing positions with the order of testing randomized. The highest value of three inspirations was taken as the PNIF, while the highest value of three expirations was taken as the PEF.

Statistical analysis

We reported continuous variables as mean, standard deviation, and range. To compare continuous variables we used the Wilcoxon signed rank paired test, assuming a non-normal distribution. The level of significance was set at 0.05.

Results

Table 1 shows the main characteristics of the study population. There was no significant age difference between male and female populations (p=0.26). Figure 1 shows PNIF and PEF distribution of the difference between sitting and standing positions for the whole group. Although PEF values were significantly different when volunteers were tested while sitting or in upright position (p=0.009), PNIF values only showed a trend towards a significant difference (p=0.10).

Discussion

It is well known that there is an association between the mechanics of breathing and body position. In particular, the changes in body position give considerable changes in the pulmonary end-expiratory pressure, compliance, and mechanical resistance. These changes have been demonstrated to occur in the different body positions despite similar respiratory rates and tidal volumes [13]. A significant difference in spirometric results has been also demonstrated between sitting and upright positions in normal subjects [23,28].

In the recent past it has been clearly demonstrated that lower and upper airways are strictly correlated both in healthy and pathological subjects [8,29]. In particular, it has been demonstrated that the value of PEF is informative in predicting PNIF and that the larger the value of PEF, the larger the value of PNIF both in healthy adults [8] and children/adolescents [30]. Furthermore, investigating the association between asthma and lung function on PNIF, it has recently been shown that PNIF was significantly and directly associated with asthma and FEV1 [29].

The effect of body position on nasal function has been poorly investigated. Roithmann and colleagues investigated nasal patency by means of acoustic rhinometry in a group of 20 volunteers (10 healthy and 10 affected by rhinitis) in relation to body position (sitting vs supine). The authors found that posture change (from sitting to supine position) produced a decrease

Table 1. Main demographic characteristics of the study population.

	Males (n=30)		Females (n=46)	
	Mean	SD	Mean	SD
Age (years)	43.1	16.6	38.8	16.1
Height (cm)	175.9	6.8	162.8	6.4
Weight (kg)	78.2	19.2	65.5	11.1
BMI (Kg/m^2)	25.2	3.9	24.8	3.1

in nasal cross-sectional area and volume in both normal and pathological subjects [25]. Furthermore, two different studies have evaluated the effect of changing body position (sitting vs standing) in healthy volunteers. Whilst in the first paper the authors demonstrated that minimum cross-sectional area significantly increased when volunteers changed from sitting to standing position [31], in the second paper a different picture was shown [32]. In fact, in this larger group of healthy subjects (n=40), acoustic rhinometry failed to find a significant change in total nasal volume or minimal cross-sectional area between sitting and upright position [32]. However, acoustic rhinometry, unlike PNIF, is not effort dependent.

In the present study, we evaluated for the first time both PNIF and PEF in a randomly selected sitting/upright position in a larger group of healthy volunteers. Whilst we found a significant PEF differences between sitting and upright position, with upright PEF values higher than sitting PEF values, PNIF values showed only a trend towards a significant difference between the sitting and upright position, the latter being higher than the former.

Conclusion

In conclusion, the findings of the present study, although showing a generally positive effect of the standing position on PEF values, are not clearly showing an effect on PNIF. From the present study, it seems that previous normal PNIF values produced by different authors, in different positions (sitting vs standing), can roughly be considered acceptable and comparable.

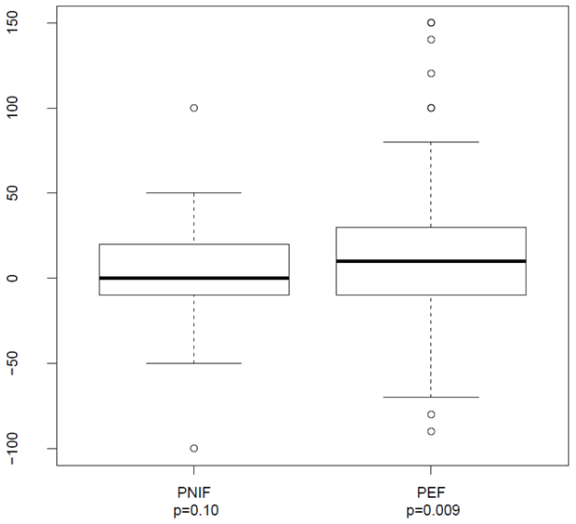

Figure 1. Boxplots of PNIF and PEF distribution of the difference between standing and sitting position for all individuals. P-value of the Wilcoxon signed rank paired test comparing the two positions is reported under each boxplot.

Authorship contribution

GO: writing the paper, discussion; GS: discussion; VI: collecting data; BS: statistics; AM: discussion, supervision; VL: discussion, supervision

Conflict of interest

None

References

1. Corey JP, Houser SM, Ng BA. Nasal congestion: a review of its etiology, evaluation, and treatment. Ear Nose Throat J 2000;79:690-693.
2. Ottaviano G, Scadding GK, Coles S, Lund VJ. Peak nasal inspiratory flow. Normal range in adult population. Rhinology 2006;44:32-35.
3. Chaves C, de Andrade CR, Ibiapina C. Objective measures for functional diagnostic of the upper airways: practical aspects. Rhinology 2014;52:99-103.
4. de Souza Campos Fernandes S, Ribeiro de Andrade C, da Cunha Ibiapina C. Application of Peak Nasal Inspiratory Flow reference values in the treatment of allergic rhinitis. Rhinology 2014;52:133-136.
5. Poirrier AL, Ahluwalia S, Kwame I, Chau H, Bentley M, Andrews P. External nasal valve collapse: validation of novel outcome measurement tool. Rhinology 2014;52:127-132.
6. Hellings PW, Nolst Trenite GJ. Improvement of nasal breathing and patient satisfaction by the endonasal dilator Airmax®. Rhinology 2014;52:31-34.
7. Balikci HH, Gurdal MM. Use of peak nasal inspiratory flowmetry and nasal decongestant to evaluate outcome of septoplasty with radiofrequency coblation of the inferior turbinate. Rhinology 2014;52:112-115.
8. Ottaviano G, Lund VJ, Coles S, Staffieri A, Scadding GK. Does peak nasal inspiratory flow relate to peak expiratory flow? Rhinology 2008;46:200-203.
9. Papachristou A, Bourli E, Aivazi D, et al. Normal peak nasal inspiratory flow rate values in Greek children and adolescents. Hippokratia 2008;12:94-102.
10. Klossek JM, Lebreton JP, Delagranda A, Dufour X. PNIF measurement in a healty French population. A prospective study about 234 patients. Rhinology 2009;47:389-392.
11. Bouzgarou MD, Saad HB, Chouchane A, et al. North african reference equation for peak nasal inspiratory flow. J laryngol Otol 2011;125:595-602.
12. da Cunha Ibiapina C, Ribeiro de Andrade C, Moreira Camargos PA, Goncalves Alvim C, Augusto Cruz A. References values for peak

nasal inspiratory flow in children and adolesccent in Brazil. Rhinology 2011;49:304-308.
13. Van Spronsen E, Ebbens FA, Fokkens WJ. Normal peak nasal inspiratory flow rate values in healthy children aged 6 to 11 years in the Netherlands. Rhinology 2012;50:22-25.
14. Ottaviano G, Scadding GK, Scarpa B, Accordi D, Staffieri A, Lund VJ. Unilateral peak nasal inspiratory flow, normal values in adult population. Rhinology 2012;50:386-392.
15. Ottaviano G, Lund VJ, Nardello E, et al. Comparison between unilateral PNIF and rhinomanometry in healthy and obstructed noses. Rhinology 2014;52:25-30.
16. Marioni G, Ottaviano G, Staffieri A, Zaccaria M, Lund VJ, Tognazza E, Coles S, Pavan P, Brugin E, Ermolao A. Nasal functional modifications after physical exercise: olfactory threshold and peak nasal inspiratory flow. Rhinology 2010;48:277-280.
17. Virchow JC, Backer V, de Blay F, et al. Defining moderate asthma exacerbations in clinical trials based on ATS/ERS joint statement. Respir Med 2015;109:547-556 .
18. Gregg I, Nunn AJ. Peak expiratory flow in normal subjects. BMJ 1973;3:282-284.
19. Naitoh S, Tomita K, Sakai K, Yamasaki A, Kawasaki Y, Shimizu E. The effect of body position on pulmonary function, chest wall motion, and discomfort in young healthy participants. J Manipulative Physiol Ther 2014;37:719-725.
20. Costa R, Almeida N, Ribeiro F. Body position influences the maximum inspiratory and expiratory mouth pressures of young healthy subjects. Physiotherapy 2015;101:239-241.
21. Gea J. The Evolution of the Human Species: A Long Journey for the Respiratory System . Arch Bronconeumol 2008;44:263–270.
22. Martinez BP, Silva JR, Silva VS, Neto MG, Forgiarini Júnior LA. Influence of different body positions in vital capacity in patients on postoperative upper abdominal. Braz J Anesthesiol 2015;65:217-221.
23. Townsend MC. Spirometric forced expiratory volumes measured in the standing versus the sitting posture. Am Rev Respir Dis 1984;130:123-124.
24. Davis SS1, Eccles R. Nasal congestion: mechanisms, measurement and medications. Core information for the clinician. Clin Otolaryngol Allied Sci 2004;29:659-666.
25. Roithmann R, Demeneghi P, Faggiano R, Cury A. Effects of posture change on nasal patency. Braz J Otorhinolaryngol 2005;71:478-484.
26. Rohrmeier C, Schittek S, Ettl T, Herzog M, Kuehnel TS. The nasal cycle during wakefulness and sleep and its relation to body position. Laryngoscope 2014;124:1492-1497.
27. Hopkins C, Gillett S, Slack R, Lund VJ, Browne JP. Psychometric validity of the 22-item Sinonasal Outcome Test. Clin Otolaryngol 2009;34:447-454.
28. Lalloo UG, Becklake MR, Goldsmith CM. Effect of standing versus sitting position on spirometric indices in healthy subjects. Respiration 1991;58:122-125.
29. Thorstensen WM, Sue-Chu M, Bugten V, Cvancarova M, Steinsvåg SK. The determining factors of peak nasal inspiratory flow and perception of nasal airflow in asthmatics. Rhinology 2014;52:348-354.
30. Chaves C, Ibiapina Cda C, de Andrade CR, Godinho R, Alvim CG, Cruz ÁA. Correlation between peak nasal inspiratory flow and peak expiratory flow in children and adolescents. Rhinology 2012;50:381-385.
31. Kase Y, Hilberg O, Pedersen OF. Posture and nasal patency: evaluation by acoustic rhinometry. Acta Otolaryngol 1994;114:70-74.
32. Gudziol H, Stadeler M. Do the effects of posture change and climbing stairs on nasal patency differ in acoustic rhinometry? Laryngorhinootologie 2008;87:252-256.

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