Peak Nasal Inspiratory Flow: A Diagnostic Tool to Determine the Need for Septoplasty

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ABSTRACT

The nose is a major contributing factor for nasal resistance. The nasal airway is responsible for approximately 50% of the total airway resistance. The most common metrics used to assess nasal breathing are subjective, which can lead to inaccurate and inconsistent results. Hence, objective tests are used which give a more accurate and reliable idea of the degree of nasal resistance.

Materials and methods: A cross-sectional study on 100 patients with symptomatic DNS was conducted at Sri Venkateshwara ENT Institute attached to Bangalore Medical College and Research Institute, Karnataka, India. This was a cross-sectional study conducted on 100 patients with symptomatic deviated nasal obstruction. The visual analog score (VAS) was used to clinically determine the severity of nasal obstruction and a peak nasal inspiratory flow (PNIF) meter was used to objectively test the severity of nasal obstruction. The Spearman linear correlation coefficient was used to analyze the correlation between VAS and PNIF, age and VAS, and age and PNIF of the subjects in the sample.

Results: Of the 100 patients, 59 were male and 41 were female. The mean VAS was 6 and the mean PNIF was 149.7 L/minute. A positive correlation between VAS and PNIF for nasal obstruction ($p = 0.032$) was found but the same was not seen between age and PNIF and also between age and VAS.

Conclusion: The PNIF meter is a viable, non-invasive, easy-to-handle, and cost-effective alternative for the evaluation of nasal patency. It has proved to be one more reliable tool to aid in the diagnosis as well as the follow-up of nasal, clinical, or surgical treatments.

Keywords: Nasal obstruction, Peak nasal inspiratory flow, Septoplasty.

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INTRODUCTION

The nose acts as the conduit to the respiratory system and its main function is as an airway. Nasal breathing is inherent to the human being and has the important role of preparing the air to reach the lungs. The nose performs few important functions, it warms, cleans, and humidifies the inspired air, and cools and removes water from the expired air, and also adds quality to speech production. The nose also forms a major contributing factor for nasal resistance. The nasal airway is responsible for approximately 50% of the total airway resistance. The relative position of the turbinate and lateral wall mucosa to the septum can facilitate or disturb the airflow. The part of the airway thought to have the largest impact is the valve region. The nasal valve area is the narrowest portion of the nasal passage. The nasal valve is a specific slit-like segment between the caudal margin of the upper lateral cartilage and the septum. It is measured in degrees and normally ranges between 10° and 15°.2

The most common metrics used to assess nasal breathing are subjective assessment by the patient of their symptoms and subjective assessment by the physician of the patient’s intranasal anatomy by headlight or endoscope.3 Ideally, objective tests that assess nasal patency must be comfortable, accurate, standardized, and easy to perform, clinically applicable, and must not impact nasal anatomy-physiology. The most commonly used objective methods to study nasal airflow are computerized rhinomanometry and acoustic rhinometry.

The peak nasal inspiratory flow (PNIF) meter is a viable, non-invasive, easy to handle, and cost-effective alternative for the evaluation of nasal patency. It is an indirect measure of nasal obstruction, which considers that the increase in nasal resistance modifies the nasal airflow and consequently, the PNIF.

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Patients on nasal decongestants.
Patients with benign and malignant nasal masses.

One hundred patients were included in the study, from the age group of 18–55 years. All patients were interviewed and were asked to rate the severity of their symptoms based on the visual analog score (VAS). The VAS was used to clinically determine the severity of nasal obstruction (Fig. 1).

A peak inspiratory flow meter was used to objectively test the nasal obstruction. We used a Clement Clark International Limited model IN-CHECK ORAL ATM device to analyze PNIF (Fig. 2). This device is made up of a plastic cylinder which is 20 cm long, with a diameter varying between 3 and 4 cm, with two ends: one of them has holes from where the inspired air passes, the other end is coupled to a facial mask which is in contact with the patient’s face (Fig. 3). Inside the cylinder, there is a diaphragm that moves according to the maximum air inflow. The diaphragm stops moving when the flow stops, then the measurement is carried out on a scale that varies between 30 and 370 L/minute, which is branded on the cylinder’s surface. The device was disinfected after each use.

The patient’s nasal inspiratory flow was measured, with the device coupled to the anterior region of the nose through a small mask connected to a plastic cylinder through which the forced inspired air passes. The PNIF measurements were done three times on each patient and the average of the readings was taken as the score. SPSS (Statistical project for social services) software was used for data analysis. The Spearman linear correlation coefficient was used to analyze the correlation between VAS and PNIF, age and VAS, and age and PNIF of the subjects in the sample (Table 1). A p value of <0.05 was taken as significant.

Results

One hundred patients were included in the study of whom, 59 were male and 41 female (Fig. 4). Figure 4 depicts the demographic characteristics of the sample. The age group studied ranged from 18 to 60 years, with the mean age being 27.5 (Fig. 5). The VAS was completed by every patient to assess the severity and impact of symptoms for nasal obstruction. The VAS ranges from 0 for symptoms not troublesome at all to 10 for the worst imaginable level of symptoms. The mean VAS was 6 and the mean PNIF was 149.7 L/minute. On analysis, a positive correlation between the VAS and PNIF for nasal obstruction (p = 0.032) was noted (Fig. 6). No statistically significant correlation was seen between age and VAS and also between age and PNIF scores.

Discussion

The nose and paranasal sinuses serve important functions for our general health, safety, and comfort. Because of their intricate anatomical design, the nose and paranasal sinuses condition the air that we breathe and prepare it for delivery to the lungs. Nasal resistance appears to play an important role in normal pulmonary function. There is evidence that nasal resistance is involved in adequate diaphragmatic excursion during inspiration and that it is necessary to slow expiration, thereby permitting proper oxygen and carbon dioxide exchange in the lungs.

The nasal resistance is produced by two resistors in parallel and each cavity has a variable value produced by the nasal cycle. The resistance is made up of two elements; one essentially fixed comprising the bone, cartilage, and attached muscles, and the other variable, the mucosa. The nasal valve is a slit-like structure associated with the entrance to the nasal passages. The nasal valve has both external and internal components. It has been described anatomically as the cross-sectional area of the nasal cavity with the greatest overall resistance to airflow, thus acting as the dominant determinant for nasal inspiration. The internal nasal valve is located around 1.3 mm from the nares (nostril opening) and corresponds to the region under the upper lateral cartilages, bound medially by the dorsal septum, inferiorly by the head of the inferior turbinate, and laterally by the upper lateral cartilage.

Nasal airway obstruction is a common problem in ENT practice hence, the measurement of nasal patency has long interested rhinologists and respiratory physiologists. It is of considerable value to assess the degree of nasal obstruction, especially for indications like pretreatment and posttreatment assessment.

Indications and advantages of objective tests have been evaluated by various previous authors. Objective tools can be used in
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• Pretreatment and posttreatment assessment: for both medical and surgical treatments.  
• Selection of patients for surgery.  

Rhinomanometry is a well-established method to assess nasal airway resistance. Although it is an acceptable and safe method to assess nasal airway obstruction with a small error of the method, it is time-consuming, needs experience, is not easily transportable and the equipment is rather expensive. In 1980, Youlten presented the PNIF meter, which is a modification of the Wright peak flow meter and consists of a face mask which the patient applies over the nose (without touching it) with the mouth closed. The patient sniffs air through the nose and the peak flow is recorded by a cursor. In previous studies by Holmström et al. and Jones et al. done independently have shown that PNIF is correlated highly with nasal airway resistance and is as good an indicator of objective nasal patency as formal rhinomanometry.

In our study, the mean PNIF was 149.7 L/minute. In the literature, authors usually adopt a cutoff point of 120 L/minute for symptomatic individuals, this sensitivity and specificity higher than 75%. In this study, a statistically significant relation was found between VAS and PNIF for nasal obstruction ($p = 0.032$) was noted.

**Table 1: Statistical analysis showing a correlation between VAS, PNIF score, age, and sex**

|                | PNIF score | VAS | Sex | Age |
|----------------|------------|-----|-----|-----|
| PNIF score     | 1          | −0.214* | −0.081 | −0.013 |
| Sig (two-tailed)| 0.032 | 0.421 | 0.895 | 
| N              | 100        | 100  | 100  | 100  |
| VAS            | −0.214*    | 1    | −0.071 | 0.02 |
| Sig (two-tailed)| 0.032 | 0.485 | 0.84 |  
| N              | 100        | 100  | 100  | 100  |
| Sex            | −0.081     | −0.071 | 1    | 0.065 |
| Sig (two-tailed)| 0.421 | 0.485 | 0.521 |  
| N              | 100        | 100  | 100  | 100  |
| Age            | −0.013     | 0.2   | 0.065 | 1    |
| Sig (two-tailed)| 0.895 | 0.84  | 0.521 |  
| N              | 100        | 100  | 100  | 100  |

Spearman’s Rho

**Fig. 4:** Gender distribution

**Fig. 5:** Age distribution

*Correlation is significant at the 0.05 level (two-tailed)
Similarly, another study by Fairley et al.\textsuperscript{14} has demonstrated a good correlation between PNIF and the subjective sensation of nasal patency in adults. Bhatia et al.\textsuperscript{15} in their study also utilized the PNIF as the only assessment method for nasal patency improvement in seasonal rhinitis, comparing the treatment between desloratadine and intranasal budesonide.

In the present study, age and PNIF value did not show any statistically significant correlation. Contrary to the study done by Ottaviano et al.,\textsuperscript{16} that studied the normal PNIF range in adult healthy volunteers, the effect of the three variables with PNIF was found to be significant, in particular, the effect of age and sex. Peak nasal inspiratory flow meter proved to be a reliable method to detect changes to nasal patency due to obstructive causes. It is an inexpensive, easily applied, fast, portable, simple-to-measure tool that does not depend on computers to analyze the data and has good reproducibility.

**Conclusion**

Peak nasal inspiratory flow meter is one more tool in our existing arsenal, to aid in the diagnosis as well as the follow-up of nasal, clinical, or surgical treatments. It is a reliable, fast, and low-cost method, with reproducible results.

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