

RELATIONSHIP BETWEEN MORPHOLOGY AND SEVERITY OF SEPTAL DEFORMITY AND THE DEGREE OF NASAL OBSTRUCTION

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ABSTRACT

Objectives: The correlation between the type and severity of septal deviation and the degree of nasal obstruction remains unclear. This study aimed to evaluate this relationship using three patient-reported measures of nasal obstruction in conjunction with peak nasal inspiratory flow (PNIF).

Methods: A total of 212 subjects from a general ENT clinic were included. Patients reported symptoms using the NOSE scale and a visual analog scale (VAS). PNIF was measured, and septal deviation was classified according to the Mladina classification (type) and the Salihoglu classification (severity).

Results: The mean NOSE, VAS, and PNIF values were 28.6, 5.3, and 96.8 L/min, respectively. Only the NOSE score showed a significant correlation with septal deviation type, severity, and PNIF. Septum with bilateral vertical deformities had the highest NOSE scores and the lowest PNIF values.

Conclusions: Subjective symptom scores demonstrated limited correlation with PNIF. Decisions regarding septoplasty should integrate patient history, physical examination, and both subjective and objective assessments.

Keywords: Septal deviation, nasal obstruction, VAS, NOSE, peak nasal inspiratory flow.

I. INTRODUCTION

Nasal obstruction is a common complaint that significantly reduces quality of life [1]. It may result from various causes, among which septal deviation is frequently diagnosed during clinical examination [2].

Assessment of nasal obstruction often relies on subjective tools such as the NOSE scale and the visual analog scale (VAS). Objective methods, including rhinomanometry and acoustic rhinometry, are available but are costly and not widely accessible. In recent years, peak nasal inspiratory flow (PNIF) has been increasingly studied as a cheaper, faster, and simpler objective method for evaluating nasal obstruction. Several studies have demonstrated that PNIF is at least as sensitive as acoustic rhinometry and active anterior rhinomanometry, the latter being considered the gold standard for measuring nasal resistance [3-5]. Consequently, PNIF has emerged

as a simple, inexpensive, and reliable objective assessment tool.

This study aimed to determine the relationship between PNIF, subjective nasal obstruction, and septal deviation type (Mladina classification) and severity (Salihoglu classification) [6, 7].

II. METHODS

This cross-sectional study was approved by the Ethics Committee of Hue University of Medicine and Pharmacy (IRB Number: H2023/142).

2.1. Participants

Patients aged 18 years or older who presented to our clinic with various ear, nose, and throat complaints were invited to complete a questionnaire and undergo a clinical examination as part of a routine otorhinolaryngology evaluation. Between March 2023 and August 2024, a total of 212 patients were enrolled.

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Patients were excluded if they had a history of nasal trauma or nasal surgery within the previous year; self-reported allergy; acute or chronic rhinosinusitis; inferior turbinate hypertrophy; middle turbinate concha bullosa; nasal septal perforation; allergic rhinitis; current use of topical nasal vasoconstrictors; nasal valve dysfunction; or nasopharyngeal carcinoma.

After obtaining informed consent, patients were asked to report their functional symptoms, including nasal obstruction, nasal discharge, postnasal drip, sneezing, hyposmia, headache, facial pain, and persistent cough. Symptom severity over the preceding month was assessed using the visual analog scale (VAS; 0 = no nasal obstruction, 10 = complete nasal obstruction) [8] and the Nasal Obstruction Symptom Evaluation (NOSE) scale [9].

2.2. Research methods

A general otorhinolaryngologic clinical examination was performed, followed by nasal endoscopy to evaluate the nasal cavity and septum. Assessments were conducted by two experienced specialists, and any discrepancies were resolved by a third senior specialist to minimize interobserver variability.

Septal deviation type was classified according to the Mladina classification [6]. Type 0 represents no septal deviation. Type 1 is an anterior vertical deviation that does not affect the nasal valve region, whereas type 2 obstructs normal nasal valve function. Type 3 is located at the head of the middle turbinate. Type 4 is a combination of types 2 and 3 on opposite sides. Type 5 corresponds to a unilateral horizontal spur, and type 6 is similar to type 5 but includes a contralateral unilateral intermaxillary bone wing with a “gutter” between them. The most significant deviation was recorded for analysis [10].

The severity of septal deviation was graded using the Salihoglu classification, ranging from score 0 to score 3 [7, 10]. Score 0 indicates no significant deviation or a minor deviation (e.g., a small vertical ridge). A score of 1 (“mild deviation”) was assigned when approximately one-third of the nasal cavity was obstructed. A score of 2 (“moderate deviation”) corresponded to obstruction of two-thirds of the

nasal cavity, and a score of 3 (“severe deviation”) indicated complete obstruction of the nasal cavity.

Nasal patency was measured using a PNIF meter (In-Check Nasal, Clement Clarke International, United Kingdom). Before testing, participants were asked to sit and rest for 10 minutes. They were instructed to remove their glasses and sit upright. The mask of the inspiratory device was fitted securely over the face, and participants were asked to perform a maximal nasal inspiration. The maneuver was repeated three times, and the highest recorded value was accepted as the PNIF measurement (L/min).

Computed tomography (CT) scans were reviewed when available. CT imaging was used to assess the angle and type of septal deviation according to the Mladina classification, and the findings were compared with endoscopic examination results. The angle of septal deviation was measured by drawing one line from the crista galli to the maxillary crest and a second line from the crista galli to the point of maximal septal deviation.

2.3. Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics version 20.0. Normality was assessed using the Kolmogorov-Smirnov test. PNIF values were compared across age, BMI, septal deviation type, and severity using the Kruskal-Wallis test, and between genders using the Mann-Whitney U test. Correlations were evaluated using Spearman’s correlation coefficients.

Variables with $p \leq 0.25$ in univariate analysis were included in a multivariable linear regression model. Statistical significance was set at $p \leq 0.05$.

2.4. Ethical approval

This study was approved by the Ethics Committee of Hue University of Medicine and Pharmacy (IRB Number: H2023/142; May 22, 2023).

2.5. Funding

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III. RESULTS

3.1. Patient characteristics

Mean age was 40 years (range, 18-79), and nasal obstruction was reported in 75.5% of cases (Table 1).

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Table 1: Patient characteristics

Total patients (n=212)	
Gender (n, %)	
Males	93 (43.9)
Females	119 (56.1)
Age (years): Mean (SD)	40.04 (15.81)
Presenting symptoms	
Nasal congestion	160 (75.5)
Headache and facial pain	114 (53.8)
Sneezing	60 (28.3)
Hyposmia	15 (7.1)

Abbreviation: SD, standard deviation

The mean VAS and NOSE scores were 5.26 and 28.6, respectively. The distribution of nasal congestion according to VAS and NOSE is shown in Figure 1.

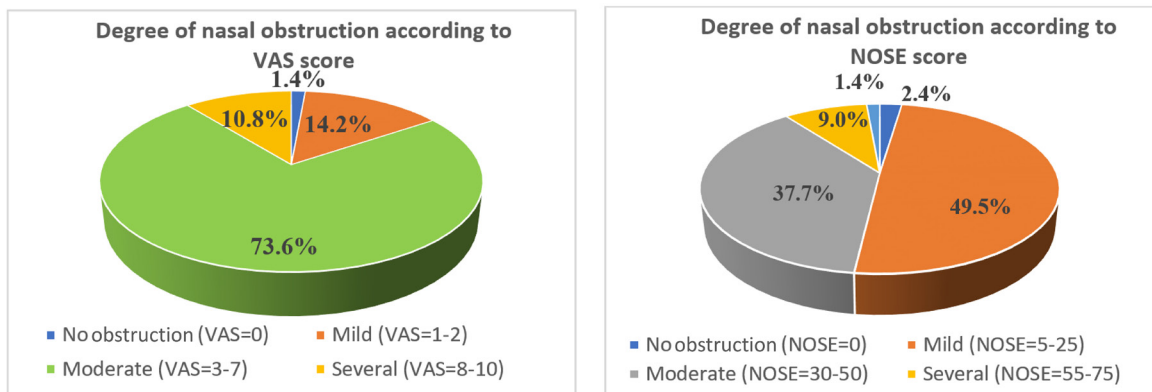


Figure 1: Degree of nasal congestion according to VAS score and NOSE score

3.2. Subjective vs objective scores

NOSE score correlated with deviation type and severity ($p < 0.001$). The VAS score did not correlate significantly with deviation type ($p = 0.488$) or severity ($p = 0.061$) (Table 2).

Table 2: NOSE and VAS by deviation type and severity

Mladina type of septal deviation	%	Mean VAS (SD)	Mean NOSE (SD)
0	13.2	4.54 (2.55)	11.25 (8.46)
1	22.2	5.38 (2.30)	34.47 (21.09)
2	12.3	5.65 (2.16)	45.58 (17.17)
3	15.6	5.74 (1.92)	27.58 (15.57)
4	1.4	4.37 (2.66)	38.33 (7.64)
5	28.8	5.26 (2.24)	24.10 (16.19)

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Mladina type of septal deviation	%	Mean VAS (SD)	Mean NOSE (SD)
6	6.6	4.62 (2.49)	32.12 (13.97)
		p = 0.488	p < 0.001
Septal deviation severity	%	Mean VAS (SD)	Mean NOSE (SD)
0	20.3	4.49 (2.43)	12.33 (8.68)
1	62.3	5.48 (2.10)	30.30 (18.23)
2	16.0	5.51 (2.50)	40.00 (16.88)
3	1.4	3.90 (2.31)	58.33 (10.41)
		p = 0.061	p < 0.001

3.3. PNIF results

Males had significantly higher PNIF values than females (108.55 ± 31.06 vs. 87.65 ± 23.56 L/min; $p < 0.001$). PNIF values also differed significantly among septal deviation types ($p = 0.035$) (Table 3).

Table 3: PNIF by deviation type

Mladina classification	Mean PNIF (SD)
0	113.39 (33.39)
1	97.45 (29.39)
2	91.35 (25.83)
3	89.70 (28.67)
4	70.00 (8.66)
5	97.21 (25.96)
6	92.50 (29.14)
$p = 0.035$	

PNIF values in patients with Mladina types 2, 3, 4, and 6 septal deviations were significantly different from those in patients with type 0 (Table 4).

Table 4: Differences in PNIF values between each pair of Mladina types

p	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Type 0	0.063	0.024	0.003	0.011	0.051	0.042
Type 1		0.489	0.162	0.065	0.997	0.467
Type 2			0.571	0.127	0.472	0.874
Type 3				0.194	0.143	0.763
Type 4					0.063	0.167
Type 5						0.456

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3.4. Relationship between severity of septal deviation and PNIF value

PNIF decreased with increasing severity (grade 0: 107.09 ± 31.76 L/min; grade 3: 68.3 ± 23.09 L/min).

3.5. Linear regression models between PNIF and anthropometric factors in patients with septal deformities

In the models below, we have excluded subjects with Mladina type 0 (no septal deviation) (Figure 2).

(1): $PNIF = 123.554 - 19.024 * Gender$. Gender = 1 (male); = 2 (female) ($p < 0.001$).

(2): $PNIF = 108.223 - 0.348 * Age$ ($p = 0.007$).

(3): $PNIF = -100.851 + 1.216 * Height$ ($p < 0.001$).

(4): $PNIF = 55.689 + 0.681 * Weight$ ($p = 0.003$).

(5): $PNIF = 69.440 + 0.687 * Weight - 0.351 * Age$.

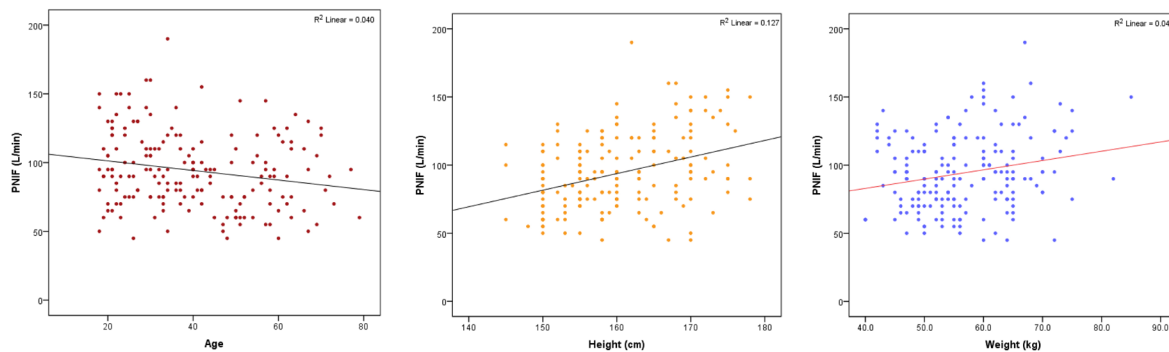


Figure 2: Simple linear regression models between PNIF and anthropometric factors

Neither age nor weight remained significant predictors of PNIF after height was added to the model.

When gender was subsequently included, height was no longer significant. Consequently, gender was the only independent predictor of PNIF.

3.6. Linear regression models between PNIF and type and degree of deformity in all subjects in the study (including Mladina type 0)

(6): $PNIF = 113.393 - 15.946 * Mla1 - 22.047 * Mla2 - 23.696 * Mla3 - 43.393 * Mla4 - 16.180 * Mla5 - 20.893 * Mla6$ ($p = 0.018$).

Based on the regression equation, Mladina type 4 was associated with the lowest PNIF value.

(7): $PNIF = 107.093 - 12.245 * Sa1 - 13.122 * Sa2 - 38.760 * Sa3$ ($p = 0.025$).

The model demonstrated an inverse relationship between Salihoglu grade and PNIF, with more severe deformities associated with lower PNIF values.

IV. DISCUSSION

The mean age and gender distribution of our study population were similar to those reported previously [10, 11]. Patients younger than 40 years accounted for a relatively large proportion of the cohort. The mean VAS score for nasal obstruction was 5.26 ± 2.27 , comparable to earlier reports [12, 13] but higher than in some studies, possibly reflecting a younger and more symptomatic population [14].

NOSE scores also differed from those observed in international cohorts, likely because of variations in study populations and methodologies [15, 16].

Type 5 septal deviation was the most common subtype in our cohort, in agreement with some studies but differing from others [17]. Subjective symptom scores varied considerably among patients with similar deformities. Although NOSE scores correlated significantly with deviation severity, VAS scores did not, supporting the view that subjective perception of nasal obstruction is inconsistent and should be complemented by objective assessment [18].

Objective evaluation of nasal airflow remains important in rhinologic practice. PNIF is currently one of the most practical, rapid, non-invasive, reliable, and affordable tools for assessing nasal airway function. The mean PNIF value in our study was 96.82 ± 28.96 L/min, comparable to that reported by Xavier et al. [19] and higher than values from studies including only patients with septal deviation [19, 20]. Male patients consistently

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demonstrated higher PNIF values, consistent with previous findings [21, 22]. Patients without septal deviation (type 0) had the highest PNIF values, whereas patients with type 4 deviations had the lowest values, reflecting greater airflow obstruction. These findings generally align with previous reports, although discrepancies regarding the deviation subtype associated with the lowest PNIF may reflect differences in sample size and population characteristics [20, 23]. Increasing septal deviation severity was associated with progressively lower PNIF values [21]. PNIF also showed a weak but significant correlation with NOSE scores, supporting its role as an adjunct to subjective assessment tools [20, 23].

Multivariable regression analysis identified gender as the strongest independent predictor of PNIF, followed by anthropometric factors.

V. CONCLUSION

Subjective perception of nasal obstruction varies widely, even among patients with similar septal deformities. The NOSE score, but not the VAS, correlated with the severity of deviation. PNIF decreased with increasing severity and was lowest in type 4 deviations, supporting its clinical utility. Decisions regarding septoplasty should therefore integrate patient history, thorough clinical examination, subjective symptom assessment, and PNIF as an inexpensive, objective, and practical measure of nasal airflow.

Conflict of interest

All authors declare no conflicts of interest.

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