Role of rhinomanometry to assess nasal airflow and resistance in patients undergoing septoplasty

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Abstract Nasal obstruction is a common symptom. Rhinomanometry is a tool to objectively assess the nasal airway. A prospective study was undertaken to assess the nasal airflow and nasal resistance in 25 patients of deviated nasal septum undergoing septoplasty using rhinomanometry preoperatively and postoperatively. Rhinomanometric improvement in nasal airflow and decreased nasal resistance were found in 88% patients after surgery.

Keywords Nasal obstruction · Rhinomanometry · Nasal resistance · Nasal airflow · Septoplasty

Introduction

The etiologic factors for nasal obstruction include anatomic variations of nose and various local and systemic diseases. Objective assessment of the nasal airway helps in diagnosis, treatment, research and medicolegal documentation.

The rhinological literature identifies four nasal valves as flow limiting areas: external valve, internal valve, septal valve (nasal septum) and inferior turbinates.[1] The external valve is a dynamic structure formed by the alar cartilage, columella and nasal vestibule. The internal nasal valve refers to the cross sectional area of nasal cavity bordered by the junction of the caudal margin of the upper lateral cartilage and the nasal septum. Typically, a 10° to 15° angle is circumscribed by this relationship. It is the narrowest and most flexible area of nasal airway [2].

The nasal septum divides the nose into two compartments. The caudal border is the initial contact point of creating air turbulence and divides the inspired air column precisely. As a part of nasal valve area, septum also helps to configure inspiratory air currents. Anterior deviations have a major effect on airflow, whereas small or posterior deviations have minimal effect [3].

Rhinomanometry is the most commonly used method of objectively assessing the nasal airway. Here the simultaneous recording of the transnasal pressure and airflow is done. Three methods of transnasal pressure detection which are currently in use are: anterior rhinomanometry, posterior rhinomanometry and postnasal rhinomanometry. Recording of results of rhinomanometry can be on a strip chart recorder, oscilloscopes, X-Y plotters and computers. The present study was planned to evaluate objectively by anterior rhinomanometry, the change in patency of nasal cavity, preoperatively and post septoplasty and the results were correlated with subjective improvement in symptoms.

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Material and Methods

The present study was conducted in the Department of Otorhinolaryngology, Pt. B.D. Sharma PGIMS, Rohtak. The study was conducted on 25 patients having deviated nasal septum in the age group of 15–40 years. Patients with septal perforation, adenoid hypertrophy, totally obstructed nose, inferior/middle turbinate hypertrophy, allergy and polyps were not included in the study. Anterior rhinomanometry was performed preoperatively and again repeated one month after septoplasty. It was performed according to the specifications of International committee of Standardization of Rhinomanometry. Anterior rhinomanometry during spontaneous breathing was performed by ATMOS rhinomanometer 300. After the instillation of xylometazoline nasal drops patients were rested for 30 minutes in sitting position before testing. Nasal resistance was reported either at pressure of 75, 150 and 300 Pa (if reached) or at radius of 2. Rhinomanometric values were expressed in SI units with pressure expressed in Pascals and flow in cm^3/sec . Nasal resistance was reported in $\text{Pa}/\text{cm}^3/\text{sec}$. Patients were asked about the subjective improvement before doing the rhinomanometry postoperatively.

Paired 't' test was applied for comparing preoperative and postoperative nasal airflow and nasal resistance. Chi square test was applied for comparing the rhinomanometric improvement of total nasal flow and resistance with the subjective improvement of the patients. 'p' value <0.05 was considered as significant, 'p' value <0.001 was considered as highly significant.

Observations

Maximum number of patients (52%) were in the age group of 15–20 years followed by 24% patients in 21–25 years. Youngest patient was 16 years old and the oldest patient was 35 years old. There were 24 males and one female.

Bilateral nasal obstruction was the commonest symptom present in 48% of patients followed by left sided nasal obstruction in 44% of patients. 8% patients had right sided nasal obstruction.

Duration of nasal obstruction in 80% of the patients varied between 0–5 years. 76% patients had combined cartilaginous and bony deformity, 24% had only cartilaginous deformity while none of the patients had bony deformity alone. On rhinomanometry preoperative nasal airflow ranged between 4–744 cm^3/sec and postoperative airflow ranged between 24–796 cm^3/sec . On preoperative rhinomanometry, values of nasal resistance ranged from 0.24–37.5 $\text{Pa}/\text{cm}^3/\text{sec}$ and postoperatively value of resistance ranged from 0.24–6.25 $\text{Pa}/\text{cm}^3/\text{sec}$. Distribution of patients according to preoperative and postoperative rhinomanometrical findings of nasal airflow and resistance is shown in detail in Tables 1 and 2.

Postoperative nasal airflow was higher than the preoperative airflow on both left as well as right side including the total airflow and the 'p' values ($p < 0.001$) were found highly significant using paired 't' test (Table 3).

Postoperative resistance was lower as compared to the preoperative values. Moreover, the resistance on right side was lower in comparison to left side which accounts for the higher number of patients of obstruction on left side. The 'p' value was calculated using paired 't' test and was found

Table 1 Distribution of patients according to pre and postoperative rhinomanometrical findings of nasal airflow (cm^3/sec)

Range	Preoperative			Postoperative		
	Left nasal airflow	Right nasal airflow	Total (L+R)	Left nasal airflow	Right nasal airflow	Total (L+R)
0–100	76%	36%	12%	20%	8%	0%
100–200	12%	32%	28%	20%	8%	4%
200–300	8%	16%	16%	44%	32%	4%
>300	4%	16%	44%	16%	52%	92%

Table 2 Distribution of patients according to pre and postoperative rhinomanometrical findings of resistance to nasal airflow ($\text{pa}/\text{cm}^3/\text{sec}$)

Range	Preoperative			Postoperative		
	Left sided resistance	Right sided resistance	Total resistance (LXR/ L+R)	Left sided resistance	Right sided resistance	Total resistance (LXR/ L+R)
0.01–1.0	16%	44%	76%	72%	92%	100%
1.0–2.0	32%	36%	24%	20%	0%	0%
2.0–3.0	16%	12%	0%	0%	8%	0%
3.0–4.0	8%	4%	0%	4%	0%	0%
>4.0	28%	4%	0%	4%	0%	0%

Table 3 Comparison of pre and postoperative nasal airflow (cm³/sec).

Side of obstruction	Preoperative nasal airflow		Postoperative nasal airflow		P value
	Range	Mean±S.D	Range	Mean±S.D	
Left	4-424	94.56±98.86	24-396	211.84±104.20	<0.001
Right	16-628	181.48±144.28	72-628	340.16±155.98	<0.001
Total	92-744	276.04±162.08	152-796	552.00±194.06	<0.001

Table 4 Comparison of pre and postoperative resistance (pa/cm³/sec).

Side of obstruction	Preoperative nasal airflow		Postoperative nasal airflow		P value
	Range	Mean±S.D	Range	Mean±S.D	
Left	0.52-37.5	4.81±7.79	0.38-6.25	1.12±1.23	<0.05
Right	0.24-9.38	1.57±1.79	0.24-2.08	0.60±0.47	<0.001
Total	0.20-1.63	0.75±0.43	0.19-0.99	0.32±0.17	<0.001

significant ($p < 0.05$) for left side whereas highly significant for right sided ($p < 0.001$) and total resistance ($p < 0.001$) (Table 4).

18 out of 25 patients (72%) had subjective improvement while 7 patients (28%) did not have any subjective improvement of symptoms postseptoplasty. Rhinomanometric improvement of nasal airflow alongwith decrease in resistance and subjective improvement were found to co-exist in 16 patients (64%). Out of the 7 patients, who denied any subjective improvement, 6 patients had significant postoperative increase in nasal airflow along with decrease in resistance while only one patient had postoperative decrease in nasal airflow along with increased resistance. 3 patients (12%) did not have rhinomanometric improvement, out of which 2 patients had subjective improvement. Only one patient had both findings of decreased postoperative nasal airflow along with increased resistance and no subjective improvement. 'p' value was calculated using chi square test and was found highly significant ($p < 0.001$).

Discussion

Improvement in values of nasal airflow and decrease in the nasal resistance postoperatively can be explained by the correction of septal deformity. In our study the mean total resistance calculated preoperatively was found to be 0.75 Pa/cm³/sec. Broms, Johnson and Malm reported the preoperative mean total nasal resistance to be 0.2 Pa/cm³/sec [4]. whereas Gordon et al reported the mean total preoperative nasal resistance to be 0.3 Pa/cm³/sec [5]. In our study, the mean total resistance, calculated postoperatively was 0.32 pa/cm³/sec. Broms, Johnson and Malm reported the mean total postoperative resistance to be 0.15 pa/cm³/sec [4] whereas Gordon et al reported the mean total postoperative resistance to be 0.2 pa/cm³/sec [5].

Pallanch has reported mean total normal resistance in 80 normal individuals to be 0.2 pa/cm³/sec [6] Cole has

reported mean total normal nasal airway resistance to be 0.26 pa/cm³/sec [7]. and Sipila has reported total mean nasal resistance to be 0.15 pa/cm³/sec in a study on 97 healthy volunteers [8].

In the study conducted by Broms, Johnson and Malm, comparison of preoperative and postoperative nasal airway resistance showed that there was a significant decrease in total nasal airway resistance ($p < 0.01$) [4]. In the study conducted by Gordon et al, there was a highly significant decrease in postoperative resistance ($p < 0.001$) [5]. This is in concordance with our study.

Broms, Johnson and Malm reported that decrease in postoperative resistance was not found in 17% patients while 26% denied of any subjective improvement [4]. This is in concordance with our study. In the study conducted by Holmstrom and Kumlien, postoperative decrease in nasal airway resistance was not found in 19% patients and 19% denied of any subjective improvement [9]. In the study conducted by Piccini, Biagini and Sensini, only 4% patients did not have postoperative decrease in rhinomanometrically measured nasal airway resistance and 88% patients had significant subjective improvement [10].

Rhinomanometry with properly decongested nasal mucosa is indispensable when selecting candidates for septum surgery and while controlling the effect of surgery. It is a valuable tool not only for scientific work but also for the continuous clinical evaluation of patients before operation and for continuous quality control of the clinical treatment. It can be concluded from the study that rhinomanometry can be of enormous help in the selection of cases for septoplasty as well as in predicting the results of septoplasty.

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