Acta Scientific Otolaryngology (ISSN: 2582-5550)

Volume 5 Issue 9 September 2023

Research Article

Evaluation of Pre and Post-Operative Pulmonary Function Tests in Patients with Nasal Septal Deformity

Arjun Saini and Brajpal Singh Tyagi*

Junior Consultant, Professor, Harsh ENT Hospital, RDC, Ghaziabad, India

***Corresponding Author:** Brajpal Singh Tyagi, Junior Consultant, Professor, Harsh ENT Hospital, RDC, Ghaziabad, India.

Received: April 07, 2023

Published: August 10, 2023

Abstract

Background: Deviation of septum leads to dysfunction of the respiratory system and this affects the functions and vitality of other related systems. Pulmonary function tests give valuable information on the state of airways, lung volumes and lung functions.

Aims: To evaluate the effectiveness of nasal septal correction on pulmonary function tests in symptomatic deviated nasal septum cases.

Methods and Material: A total of 50 patients with deviated nasal septum were involved in the study. Demographic data, clinical and physical examination including anterior rhinoscopy and diagnostic nasal endoscopy was performed. Diagnostic nasal endoscopy employed to study nasal septal deformity in particular and other structures of nasal cavity in general. Also, Cottle's line was used to classify deviations as anterior or posterior and to note deviation in particular Cottle's area. RMS Helios 401 spirometer was used to perform pulmonary function tests. Forced vital capacity (FVC), forced expiratory volume (FEV_1) in 1 second, peak expiratory flow rate (PEFR), and the ratio of FEV_1 to FVC (FEV_1/FVC) were the parameters measured.

Statistical Analysis: SPSS V. 24.

Results: The deviation was most commonly seen on the left side (52%), affecting mostly the cartilaginous septum (52%). After septoplasty, the post-operative values of FVC, FEV_1, peak expiratory flow rate and FEV_1/FVC were higher than the preoperative values and the results were statistically significant. Barring some age groups, especially elderly age group, marked improvement in FVC, FEV_1 and FEV_1/FVC was observed. There was more improvement in FVC, FEV_1, and FEV_1/FVC following correction of posterior deviation while improvement in PEFR is more following correction of anterior deviation.

Conclusions: Correction of deviated nasal septum leads to a favorable outcome on nasal obstruction as well as pulmonary function. This has been corroborated and endorsed by the improvement in the mean values of various PFT parameters analyzed in this study. Pathophysiological processes that affect one component of this integrated system often concurrently impact other portions of the airway and by virtue of this isolated disease in one area has potential to infringe on the other areas also.

Keywords: Deviated Nasal Septum; Pulmonary Function Tests; Septoplasty

Introduction

The nasal septum is midline and key support structure of the nasal cavity [1,2]. Also it regulates the respiration and nasal airflow [3]. A straight septum ensures laminar airflow and optimizes air for gaseous exchange by warming, cleaning and humidifying the inspired air [3]. Conversely, if deviated, it can lead to varying degrees of obstruction and altered respiration [3-6]. Although the importance of nose in facial aesthetics has been emphasized, the most important function lies in respiratory physiology [1].

Numerous clinical studies and reviews have established interdependence of upper and lower respiratory tracts leading to unified airway concept [7]. More than 100 years ago, Kratschmer was the first to report naso-laryngeal reflexes causing bradycardia and apnea [8]. According to unified airway model, the respiratory tract behaves as an integrated functional system which is well organized. Several mechanisms have been postulated to explain that common inflammatory processes appear to be involved in diffuse airway inflammation [9-11]. There have been observations that by testing pulmonary function preoperatively, the degree of symptomatic improvement could be predicted following corrective nasal surgery [4].

Septoplasty is the definite surgical treatment for correction of deviated septum which is aimed at straightening the partition between the two nasal cavities. It may involve judicious realignment or excision of a portion of the bone or cartilage or both [12]. With regard to the importance of septoplasty and its vital role in the recuperation of patients suffering from nasal septal deviation, in this study, we aim to evaluate the impact of septoplasty on pulmonary function by performing pulmonary function test before and after septal correction and comparing preoperative and postoperative status.

Methods

Patients fulfilling the selection criteria were identified and explained about the nature of the study and a written, informed consent was obtained before enrollment. Systemic random sampling was carried out where every fourth patient with symptomatic deviated nasal septum was incorporated in the study. A total of 50 patients in the age range 15-65 years were included in the study. All the patients were subjected to pulmonary function test both pre and postoperatively.

Selection criteria

Patients with symptomatic deviated nasal septum with no previous pulmonary disorders and who were willing to undergo septoplasty were included in the study. All cases with known restrictive or obstructive pulmonary diseases, cardiac diseases, nasal polyps and space-occupying lesions of the nose and paranasal sinuses and vasomotor rhinitis were exempted from the study.

Data collection

Demographic data including age, sex, and complaints of nasal obstruction, the side and duration of nasal obstruction, headache, sneezing, allergy, previous history of trauma and prior surgery were enquired from the patient. Physical examination including anterior and posterior rhinoscopy was performed. These findings were recorded on a predesigned and pretested proforma.

Diagnostic nasal endoscopy using 4-mm and 0-degree John Hopkins rigid nasal endoscopy was performed to validate the clinical diagnosis. The laterality of deviation and the involvement of the Cottle's areas, the type of deviation classified according to Cottle's classification, the involvement of bony/cartilaginous septum, and the presence of other contributory factors such as spur and inferior turbinate hypertrophy (ITH) were noted. Pre- and postoperative pulmonary function tests were performed on the day before surgery and 3 months after septoplasty using RMS Helios 401 spirometer. Forced vital capacity (FVC), forced expiratory volume in 1 second (FEV_1), peak expiratory flow rate (PEFR), and the ratio of FEV_1 to FVC were the parameters measured. Septoplasty was performed under general anesthesia. Nasal packing was done post- surgery and removed on second post-operative day. Patients were administered with parenteral antibiotics followed by oral antibiotics, antihistamines, and nonsteroidal anti-inflammatory drugs for 1 week after surgery.

Statistics

The data obtained were coded and tabulated into Microsoft excel worksheet. SPSS v24.0 was used to analyze the data. The significance of difference between the means was assessed and comparison was done using ANOVA and paired and unpaired t test. A p-value ≤ 0.05 was considered as statistically significant.

Results

Age range of the patients in our study was 16 to 65 years with mean age of 31.86 ± 12.61 years. Maximum patients were in the age group of 16-25 years (21, 42%) followed by 26-35 years (12, 24%). 36 were males (72%) and 14 were females (28%) with male to female ratio of 2.57: 1. Left sided nasal obstruction was predominantly complained i.e. by 28 patients (56%) while right sided nasal blockage was complained by 12 patients (24%). 10 patients (20%) had bilateral nasal obstruction. History of nasal blockage for 0-2 years in 17 patients (34%), followed by 2-4 years in 13 patients (26%) was observed. Only 9 patients i.e. 18 %, had history of trauma while majority of patients (41, 82%) lacked history of trauma. Two third of the patients (35, 70%) had no history of allergy while 15 (30%) patients had nasal allergy.

Diagnostic nasal endoscopy was employed to study nasal septal deformity in particular and other structures of nasal cavity in general (Table 1).

	Right	%	Left	%	Bilateral	%	Absent	%
DNS	14	28	26	52	10	20	-	
Inferior turbinate hypertrophy	18	36	10	20	14	28	8	16
Spur	10	20	6	12	-		34	68

Table 1: Diagnostic Nasal Endoscopy findings in patients of DNS.

Patients were analyzed depending on site of deviation i.e. cartilaginous or bony and anterior or posterior deviation. Cottle's line was used as anatomical demarcation to divide deviation as anterior and posterior. (Table 2).

	Deviation	No of patients	Percentage
1.	Bony Deviation	14	28
	Cartilaginous Deviation	26	52
	Both	10	20
2.	Anterior Deviation	30	60
	Posterior Deviation	20	40
	Total	50	100

Table 2: Distribution of patients according to site of deviation of nasal septum.

13 patients (26%) with the involvement of area 2, followed by 12 patients (24%) with DNS in area 4 and 5 patients (10%) with involvement of area 5 were observed. In some patients, DNS involved more than one Cottle's area (Table 3).

Cottle's area involved	No of patients	Percentage
Area 2	13	26
Area 4	12	24
Area 5	5	10
Area 2+Area 4	9	18
Area 2+Area 5	3	6
Area 4+Area 5	5	10
Area 2+Area 4+Area 5	3	6
Total	50	100

Table 3: Frequency of involvement of Cottle's area in DNS.

The postoperative values of FVC (p = 0.0001), FEV_1 (p = 0.0001), PEFR (p = 0.0001) and FEV_1/FVC (p = 0.0001) were higher than the preoperative ones, and the results were statistically significant (Table 4).

Variables	Pre-operative	Post-operative	p-Value
FVC	3.36	3.41	0.0001
FEV_1	3.05	3.15	0.0001
FEV_1/FVC	90.88	92.40	0.0001
PEFR	6.52	6.60	0.0001

Table 4: Pre and postoperative pulmonary function test results in patients with nasal septal deviation.

FVC, $FEV_{1,}$ $FEV_{1/}$FVC and PEFR values were separately analyzed in anterior and posterior deviations. In both anterior and posterior deviations difference between FVC, $FEV_{1,}$ $FEV_{1/}$FVC and PEFR values pre and postoperatively were statistically significant (p value <0.005) (Table 5).

	FVC		FEV_1		FEV_1/FVC		PEFR	
Site of deviation	Pre-op FVC	Post-op FVC	Pre-op FEV_1	Post-op FEV_1	Pre-op FEV_1/F VC	Post-op FEV_1/F VC	Pre-op PEFR	Post-op PEFR
Anterior deviation	3.23 ± 0. 28	3.27 ± 0.3 0 (3.94, p = 0.000 1, S)	2.96 ± 0. 25	3.04 ± 0.2 9 (6.51, p = 0.000 1, S)	91.90 ± 3 .85	93 ± 3.52 (3.44, p = 0.002, S)	6.50 ± 0. 21	6.60 ± 0.2 4 (6.34, p = 0.000 1, S)
Posterior deviation	3.55 ± 0. 12	3.61 ± 0.1 3 (10.30, p = 0.000 1, S)	3.18 ± 0. 15	3.30 ± 0.1 7 (6.70, p = 0.000 1, S)	89.35 ± 2 .79	91.50 ± 3 .96 (3.91, p = 0.001, S)	6.54 ± 0. 16	6.61 ± 0.1 7 (4.40, p = 0.000 1, S)

Table 5: Comparison of site of deviation and improvement in pulmonary function test.

Patient were divided into different age brackets (16-25 years, 26,-35 years, 36-45 years, 46-55 years, 56-65 years) and pre-operative and post-operative values of FVC, FEV_1, FEV_1/FVC and PEFR were studied. Barring some age groups, especially elderly age group, marked improvement in FVC, FEV_1 and FEV_1/FVC (Table 6).

		FVC		FEV_1	FEV_1/FVC		PEFR	
Age group	Pre-op FVC	Post-op FVC	Pre-op FEV_1	Post-op FEV_1	Pre-op FEV_1/FVC	Post-op FEV_1/FVC	Pre-op PEFR	Post-op PEFR
16-25 yrs	3.35 ± 0.32	3.41 ± 0.33 (5.78, p = 0.0001, S)	3.03 ± 0.26	3.12 ± 0.29 (7.03, p = 0.0001, S)	90.54 ± 3.39	91.72 ± 3.23 (2.85, p = 0.010, S)	6.58 ± 0.23	6.66 ± 0.26 (4.39, p = 0.0001, S)
26-35 yrs	3.38 ± 0.15	3.46 ± 0.12 (4.77, p = 0.0001, S)	3.09 ± 0.13	3.24 ± 0.18 (4.77, p = 0.0001, S)	91.33 ± 2.49	93.83 ± 3.06 (4.77, p = 0.0001, S)	6.49 ± 0.08	6.57 ± 0.09 (4.77, p = 0.0001, S)
36-45 yrs	3.53 ± 0.13	3.60 ± 0.13 (8.12, p = 0.0001, S)	3.17 ± 0.11	3.26 ± 0.12 (5.69, p = 0.0001, S)	89.77 ± 2.16	90.66 ± 2.29 (2.91, p = 0.014, S)	6.52 ± 0.13	6.62 ± 0.17 (4.19, p = 0.001, S)
46-55 yrs	3.17 ± 0.33	3.14 ± 0.39 (13.28, p = 0.0001, S)	2.88 ± 0.41	2.93 ± 0.47 (10.25, p = 0.0001, S)	90.60 ± 7.09	93 ± 7.14 (2.28, p = 0.052, NS)	6.35 ± 0.21	6.41 ± 0.24 (5.25, p = 0.0001, S)
56-65yrs	2.97 ± 0.28	2.95 ± 0.19 (0.74, p = 0.49, NS)	2.89 ± 0.21	2.87 ± 0.16 (1.42, p = 0.22, NS)	97.50 ± 2.12	97.50 ± 0.70 (9.79, p = 0.0001, S)	6.38 ± 0.14	6.56 ± 0.21 (1.31, p = 0.25, NS)

Table 6: Comparison of age with improvement in pulmonary function test.

The values of FVC, FEV_1, FEV_1/FVC and PEFR were studied gender wise comparison pre-septoplasty and post-septoplasty was done. In males as well as females, mean values of all the indices demonstrated increase postoperatively (Table 7).

	FVC		FEV_1		FEV_1/FVC		PEFR	
Gender	Pre-op FVC	Post-op FVC	Pre-op FEV_1	Post-op FEV_1	Pre-op FEV_1/F VC	Post-op FEV_1/F VC	Pre-op PEFR	Post-op PEFR
Males	3.32 ± 0.29	3.37 ± 0.31 (4.77, p = 0.0001, S)	3.02 ± 0.26	3.11 ± 0.30 (6.82, p = 0.0001, S)	91 ± 3.84	92.33 ± 4.04 (3.65, p = 0.001, S)	6.52 ± 0.21	6.60 ± 0.24 (5.21, p = 0.0001, S)
Female	3.44 ± 0.23	3.51 ± 0.24 (8.01, p = 0.0001, S)	3.12 ± 0.18	3.24 ± 0.18 (6.54, p = 0.0001, S)	90.57 ± 3.25	92.57 ± 2.95 (4.06, p = 0.001, S)	6.51 ± 0.14	6.62 ± 0.15 (12.93, p = 0.0001, S)

Table 7: Comparison of gender and improvement in pulmonary function test.

Patients with and without allergy were subjected to pulmonary function tests both pre and post- operatively. It was observed that all the indices i.e. FVC, FEV_1, FEV_1/ FVC and PEFR demonstrated better improvement in non-allergic individuals than those with nasal allergy. On statistical analysis this difference in improvement of allergic and non-allergic patients was found to be significant (Table 8).

	FVC		FEV_1		FEV_1/FVC		PEFR	
Allergy	Pre-op FVC	Post-op FVC	Pre-op FEV_1	Post-op FEV_1	Pre-op FEV_1/FVC	Post-op FEV±/FVC	Pre-op PEFR	Post-op PEFR
Present	3.30 ± 0.27	3.39 ± 0.31 (4.77, p = 0.0001, S)	3.12 ± 0.24	3.22 ± 0.30 (6.82, p = 0.0001, S)	92 ± 2.81	94.33 ± 3.04 (3.65, p = 0.001, S)	6.42 ± 0.18	6.50 ± 0.22 (5.21, p = 0.0001, S)
Absent	3.40 ± 0.19	3.62 ± 0.26 (8.01, p = 0.0001, S)	3.24 ± 0.16	3.32 ± 0.12 (6.54, p = 0.0001, S)	94.57 ± 3.27	98.57 ± 2.91 (4.06, p = 0.001, S)	6.64 ± 0.13	6.72 ± 0.15 (12.93, p = 0.0001, S)

Table 8: Comparison of patients with and without allergy with improvement in pulmonary function test.

Conclusions

In the present study, patients mostly were in the age group of 16-25 years (21, 42%) followed by 26-35 years (12, 24%). Remarkably number of patients declined with the advancing age. Observations of other investigators that majority of patients reporting in earlier decade and seeking treatment matches closely with our study [13-15]. Factors like physical and economic productivity associated with younger decades of life might make patient seek medical opinion. This apart occasional association of nasal septal deviation with external deformity and thus cosmetic consideration might be the reason for patients opting early treatment.

Out of the 50 patients included in our study, majority were males (36, 72%) while balance 14 (28%) were females. Strong male preponderance with M: F ratio of 2.57:1 was noted in present study. The prevalence of DNS to be more in males have also been observed by Tuel., *et al*. [16] and Subaric and Mladina [17]. This proclivity can be attributed to various socioeconomic factors, gender discrimination, higher chances of trauma in males in assaults, sport and other injuries. However, Rehman., *et al*. [18], in a study observed that females have more prevalence of deviated nasal septum.

Almost half of the patients presented with left sided nasal obstruction (28, 56%) while 12(24%) patients with right sided nasal obstruction and 10(20%) patients with bilateral nasal obstruction were noted. In consonance with our observations, left sided nasal obstruction as a principal complaint has been reported by Panicker., *et al*. [13] Intrauterine position, birth moulding theory, developmental aspect, nasal cycle and status of nasal turbinate may play a role in nasal obstruction predominantly on left side. It is noteworthy that majority of the septal deviation occur after the neonatal period as a result of accidental trauma [19].

About one third of the patients (17, 34%) presented with duration of nasal obstruction of 2 years, 13 (26%) patients had duration of obstructive complaint from 4 years while 12 (24%) patients had complaint of nasal obstruction from 6 years. Common observation of above studies that patient generally report with shorter duration of symptoms is in agreement with our study [13-15]. As the time elapses probably by virtue of adaptation patient get used to the symptom and hence loath to seek treatment.

Two third of the patients (35,70%) had no history of allergy while 15 (30%) patients had nasal allergy. Though in our study we observed better improvement in non-allergic patients as compared to people with allergy. This dimension has not been studied in literature nd hence no comparison is feasible.

Diagnostic nasal endoscopy was employed to study and analyze nasal septal deformity and other structures of nasal cavity. Almost half of the patient were found to have left sided deviation of septum (26, 52%) while right sided deviation was observed in 14 patients (28%). Deviation on both sides was noted 10 patients (20%). Panicker., *et al*. [13] noted left sided deviation in 54.28%, right sided deviation in 31.4% and deviation on both sides in 14.28%. This is comparable to studies conducted by Peacock., *et al*. [20] and Verma., *et al*. [21]. We feel various factors like genetic, racial, intrauterine, developmental and environmental are responsible for predilection of nasal septum to particular side. Almost half of the patients (26, 52%) were found to have cartilaginous deviation, followed by bony deviation in 14 (28%) patients. Composite deviation of both cartilaginous and bony part was found in 10 patients (20%). In a similar study, it was noted that out of 50 patients, 19 (54.28%) patients had cartilaginous deviation, 6 (17.14%) patients had bony deviation and 10(28.57%) patients had both cartilaginous as well as bony deviation. While stating clinical implication of this, Garcia., *et al*. observed that anterior deviation can be much more vital in patients' respiratory function than posterior deviation [22]. Another important implication is that due to better accessibility of cartilaginous part of septum, its correction lead to better functionality and more improvement in post-operative pulmonary function tests as compared to bony or composite deviations [13]. All the 50 patients with nasal septal deviation in our study were divided according to the Cottle's five areas. In our study, 13 patients (26%) with the involvement of area 2, followed by 12 patients (24%) with DNS in area 4 and 5 patients (10%) with involvement of area 5 were observed. In some patients, DNS involved more than one Cottle's area. Our findings of most common involvement of area 2 followed by 4 agrees well with the findings of Panicker., *et al*. [13]. They found area 2 involvement in 10 (28.53%) patients followed by area 4 in 7 (20%) patients. However in contrast, Rehman., *et al*. [18] reported area 1 (19%) to be most frequently involved followed by area 3 (10.48%) and area 4 (7%). Etiological factors, racial considerations, developmental features apart from variation in sample size, study settings and subjectivity in assessment all may contribute to these variation in finding. Mean preoperative FVC was found to be 3.36 and post-operative FVC values was observed to be 3.41. This difference was found to be statistically significant (p value 0.0001). There are many studies which reinforces our observation [13-15]. Correction of nasal septal deviation will improve aero dynamics of nasal breathing and also bring some improvement in functioning of external and internal nasal valve thus improved pulmonary function. Nasopulmonary reflex may also contribute to this augmentation [23,24].

Preoperatively mean FEV_1, in our study was found to be 3.05 while post-operative FEV_1 was observed to be 3.15 and difference between them was statistically significant (p value of 0.0001). We speculate that improved nasal function owing to surgical intervention, autonomic innervation and vasomotor phenomenon are some of the vectors responsible for the improved pulmonary function in general and FEV_1 in particular as supported by other investigators [13-15].

Mean FEV_1/FVC preoperative ratio was found to be 90.88 while post-operatively it was noted to be 92.40 (statistically significant, p value of 0.0001). Panicker., *et al*. [13] and other observers [14,15] found significant improvement in mean FEV_1/FVC values. However, in study conducted by Nanda., *et al*. [14], there was a fall in mean FEV_1/FVC value post-operatively. Mean PEFR pre- operative was found to be 6.52 and post-operative PEFR values was observed to be 6.60 and the difference was statistically significant (p value of 0.0001). Improved PEFR after surgical correction of nasal septum as compared to preoperative PEFR observed in our study is in agreement with other investigators [13,14]. As regard to FVC, in our study all age groups (16-25 years, 26-35 years, 36-45 years, 46-55 years, 56-65 years) showed betterment in mean FVC post operatively which was statistically significant except in the age bracket of 56-65 years (p value 0.49). In all age groups there was improvement in FEV_1 which was statistically significant (p value 0.0001) except 56 to 65 years (p value 0.22). As regards ratio of FEV_1/FVC, we noted better mean value postoperatively except 46-55 years (p value 0.052). Likewise regarding PEFR we found statistically significant improvement in the mean value after surgical intervention except 56-65 years age bracket (p value 0.25). Panicker., *et al*. [13] while studying age groups of 18-20 years, 21-30 years and 31-40 years found difference between preoperative and postoperative values to be statistically insignificant and hence commented that age as a variable did not play much role in enhancement of pulmonary function following correction of deviated nasal septum. On the contrary, barring some age group especially elderly age group, we observed marked improvement in FVC, $FEV_1$and FEV_1/FVC suggesting that septal correction has definite effect on pulmonary function in earlier decades of life. When anterior and posterior deviation were compared, FVC, FEV_1, FEV_1/FVC showed more improvement in posterior deviation while PEFR showed improvement in anterior deviation. It was observed that all the indices i.e. FVC, FEV_1, FEV_1/FVC and PEFR demonstrated better improvement in non-allergic individuals than those with nasal allergy. As regards to site of deviation and allergy, we did not come across studies illuminating this area, so we cannot compare our findings with other studied and recommend further studies.

We found significant improvement in pulmonary indices 3 months after surgery and the results were both clinically and statistically significant. Similar results were obtained by various other studies in literature. Significant improvement in nasal as well as pulmonary function was noted by Bulcan., *et al*. [25]. Mengi., *et al*. indicated that correction of anterior deviations is effective in both improving airway function and aesthetic evaluation, validated by quality of life [26]. Panicker., *et al*. [13] had analysis that patients with septum deviated to left had better improvement in pulmonary function postseptoplasty. Whether side of deviation is significant in postseptoplasty pulmonary function has not been studied in literature [13]. Shturman-Ellstein., *et al*. [27] showed worsened lower airway function in mouth breathers with obstructed nose as compared to nasal breathers. Similar improvements were observed by Niedzielska., *et al*. [28] after adenoidectomy and Karuthedath., *et al*. [29] after endoscopic sinus surgery. Majority of patients who underwent septoplasty showed marked improvement in disease specific symptoms, good quality of life, satisfaction. Severe preoperative nasal obstruction indicated a higher predicted improvement [13,14]. Pathophysiological processes that affect one component of this integrated system often concurrently impact other portions of the airway, and by virtue of this isolated disease in one area has potential to infringe on the other areas. In light of this concept of a unified airway, we feel that the present study assumes a high degree of significance.

Acknowledgments

Both the authors have contributed equally.

Funding

No funding sources.

Conflict of Interest

None declared.

Bibliography

1. Sykes J., *et al*. "The Importance of the Nasal Septum in the Deviated Nose". *Facial Plastic Surgery* 27.5 (2011): 413-421.

2. Godley FA. "Nasal septal anatomy and its importance in septal reconstruction". *Ear Nose and Throat Journal* 76.8 (1997): 498-501.

3. Kurtaran H., *et al*. "The effect of anterior nasal packing with airway tubes on pulmonary function following septoplasty". *Turkish Journal of Medical Sciences* 39 (2009): 537-540.

4. Ogura JH., *et al*. "Baseline values in pulmonary mechanics for physiologic surgery of the nose. Preliminary report". *Annals of Otology, Rhinology and Laryngology* 77.3 (1968): 367-397.

5. Ogura JH., *et al*. "Experimental observations of the relationships between upper airway obstruction and pulmonary function". 85 (1964): 40-64.

6. Ibrahim G and Bioprabhu S. "Deviated nasal septum correction by septoplasty with turbinoplasty and intranasal flexible plastic splint". *IOSR Journal of Dental and Medical Sciences* 14.12 (2015): 106-108.

7. Krouse JH. "The Unified Airway—Conceptual Framework". *Otolaryngologic Clinics of North America* 41.2 (2008): 257-266.

8. Chowdhury T., *et al*. "The Trigeminocardiac Reflex — An Example of Reflexive Heart Rhythm Change". *Abnormal Heart Rhythms* 94.5 (2015): e484.

9. Hagy GW and Settipane GA. "Risk factors for developing asthma and allergic rhinitis. A 7-year follow-up study of college students". *The Journal of Allergy and Clinical Immunology* 58.2 (1976): 330-336.

10. Guerra S., *et al*. "Rhinitis as an independent risk factor for adult-onset asthma". *The Journal of Allergy and Clinical Immunology* 109.3 (2002): 419-425.

11. Huovinen E., *et al*. "Incidence and prevalence of asthma among adult Finnish men and women of the Finnish Twin Cohort from 1975 to 1990, and their relation to hay fever and chronic bronchitis". *Chest* 115.4 (1999): 928-936.

12. Ibrahim G and Bioprabhu S. "Deviated nasal septum correction by septoplasty with turbinoplasty and intranasal flexible plastic splint". *IOSR Journal of Dental and Medical Sciences* 14.12 (2021): 106-108.

13. Panicker V and Belaldavar B. "Effectiveness of septoplasty on pulmonary function tests in symptomatic deviated nasal septum cases: a prospective study". *International Journal Of Otorhinolaryngology and Head and Neck Surgery* 4.3 (2018): 800-807.

14. Nanda Manpreet K and Mandeep D Rama. "Impact of septoplasty on pulmonary function". *National Journal of Physiology, Pharmacy and Pharmacology* (2019).

15. Tuzuner A., *et al*. "Pulmonary function improvement following septoplasty: How lower airways are effected?" *European Respiratory Journal* 44 (2014): P3665.

16. Teul I., *et al*. "Deformation of the nasal septum in children, adolescents, and adults in Western Pomerania Province of Poland". *European Journal of Medical Research* 14.4 (2009): 244-247.

17. Mladina R and Subarić M. "Are some septal deformities inherited? Type 6 revisited". *International Journal of Pediatric Otorhinolaryngology* 67.12 (2003): 1291-1294.

18. Rehman A., *et al*. "A Prospective Study of Nasal Septal Deformities in Kashmiri Population Attending a Tertiary Care Hospital". *International Journal of Otorhinolaryngology and Head and Neck Surgery* 1.3 (2012): 77-84.

19. Salih A., *et al*. "Assessment of nasal septal deformities by anterior rhinoscopy and nasal endoscopy". (2010): 14-20.

20. Peacock MR. "Sub-mucous resection of the nasal septum". *Journal of Laryngology and Otology* 95.4 (1981): 341-356.

21. Verma D., *et al*. "Comparative evaluation of conventional versus endoscopic septoplasty for deviated nasal septum". *Otolaryngology Open Access Journal* 1.3 (2016): 000112.

22. Garcia GJM., *et al*. "Septal Deviation and Nasal Resistance: An Investigation using Virtual Surgery and Computational Fluid Dynamics". *American Journal of Rhinology and Allergy* 24.1 (2010): 46-53.

23. James JEA., *et al*. "Reflex respiratory and cardiovascular effects of stimulation of receptors in the nose of the dog". *Journal of Physiology* 220.3 (1972): 673-696.

24. Whicker JH and Kern EB. "The Nasopulmonary Reflex in the Awake Animal". *Annals of Otology, Rhinology and Laryngology* 82.3 (1973): 355-358.

25. Bulcun E., *et al*. "Effects of septoplasty on pulmonary function tests in patients with nasal septal deviation". *Journal of Otolaryngology-Head and Neck Surgery* 39.2 (2010): 196-202.

26. Mengi E., *et al*. "Evaluation of operation success in patients with nasal septal deviation with quality of life scale and objective methods". *The Turkish Journal of Ear Nose and Throat* 21.4 (2011): 184-191.

27. Shturman-Ellstein R., *et al*. "The beneficial effect of nasal breathing on exercise-induced bronchoconstriction". *The American Review of Respiratory Disease Returns* 118.1 (1978): 65-73.23.

28. Niedzielska G., *et al*. "Assessment of pulmonary function and nasal flow in children with adenoid hypertrophy". *International Journal of Pediatric Otorhinolaryngology* 72.3 (2008): 333-335.

29. Karuthedath S., *et al*. "Impact of Functional Endoscopic Sinus Surgery on the Pulmonary Function of Patients with Chronic Rhinosinusitis: A Prospective Study". *Indian Journal of Otolaryngology and Head and Neck Surgery* 66.4 (2014): 441-448.