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A Study to Assess the Improvement in Pulmonary Function Tests after Septoplasty or Submucosal Resection of Nasal Septum

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Abstract
Deviated nasal septum (DNS) is the most common cause of nasal obstruction. A narrow nasal airway would result in a decreased airflow in the lungs. Surgical correction of deviated nasal septum by septoplasty or submucosal resection results in alterations in the upper and lower airway resistance and improves nasal symptoms and general quality of life (QOL). The improvement in pulmonary function tests can be assessed with the help of this study. After obtaining the ethical committee clearance, 60 patients who meet the inclusion criteria were enrolled in the study and were asked to undergo pulmonary function test (PFT) like spirometry and 6 minutes' walk test (6MWT) and fill the SNOT22 questionnaire before surgery. Septoplasty or SMR was performed. Patients were followed up after 1 month and 6 months after surgery and spirometry, 6MWT were done at that time. SNOT22 questionnaire was filled. Different parameters of spirometry, 6MWD and SNOT-22 scores before and after surgery were analysed. The mean age of the patients was 31.5 years.63.3% patients were males and 36.7% were females. 65% had DNS to left, while 30% had DNS to right side.5% had S shaped DNS. The mean difference in post-op and pre-op values was statistically significant for FEV1, FVC, FEV1/FVC RATIO, FEF25-75% (P-value < 0.001). The overall mean percentage SNOT-22 Score was decreased by 57.2. The overall 6MWD was increased by 6.80% after 6 months. Considerable improvement was seen in the symptoms, QOL and exercise capacity.
Keywords: *nasal septum, septoplasty, spirometry, quality of life.*

Introduction

Deviation of nasal septum (DNS) is the most important and frequent cause of nasal obstruction. About 50% of the population have some deviated nasal septum but most of them are asymptomatic. Symptomatic patients usually present with nasal obstruction. Trauma and errors of development form the two important factors in the causation of deviated septum. There is no age and sex bar but usually males are affected more than females. DNS is more common in Caucasians. In some hereditary cases, it runs in families.[1] Minor degrees of septal deviation with no symptoms are commonly seen in patients and require no treatment. An operation called septoplasty or submucosal resection (SMR) is advised when the deviated nasal septum produces

mechanical nasal obstruction or the symptoms associated with it like headache, epistaxis etc.

A narrow nasal airway would result in decreased airflow in the lungs. Surgical correction of deviated nasal septum results in alterations in the upper and lower airway resistance.[2] Septoplasty improves nasal symptoms and general quality of life.[3,4] Nasal aerodynamics is important for tissue oxygenation during exercise and reducing the nasal airway resistance provides improvement of exercise capacity.[5]We can assess the improvement in pulmonary function tests after septoplasty or SMR.

Aims and Objectives

1) To study the improvement of pulmonary function tests after septoplasty or submucosal resection of nasal septum.[5]
2) To analyze the lower airway improvement and exercise capacity after septoplasty by using spirometry before and after surgery.[5]
3) To observe the correlation of subjective nasal airway function improvement by SNOT 22 (Sinonasal outcome test) questionnaires.[3,6,7]
4) To assess improvement in quality of life after septoplasty.[3,8]

Materials and Methods

I. This prospective study was carried out at Kempegowda Institute of Medical Sciences Hospital and Research Centre, Bangalore from November 2016 to May 2018.

II. Patients of age group 18-55 years, both males and females, complaining of chronic nasal obstruction due to isolated deviated nasal septum and giving consent for surgery were included in the study. A written informed consent was taken from the patients for inclusion in the study. Patients undergoing septoplasty or SMR in combination with sinus or other nasal surgeries were excluded. Patients having comorbidities such as such as hypertension, coronary artery disease, diabetes mellitus, chronic smoking, chronic obstructive pulmonary disease, asthma, excessive turbinate hypertrophy, chronic sinusitis or nasal polyposis were excluded.[4,5] And patients having history of previous septal surgeries were not included. Patients who are unable to perform 6 minutes' walk test or spirometry and patients who failed to follow up post operatively were also excluded.[5]

III. Total 60 patients having deviated nasal septum who agreed for the surgery and who gave consent to be part of this study were examined in the ENT OPD. Detailed history was taken and ENT examination was done. Routine blood investigations and chest X-ray was done.

IV. The patients were asked to undergo pulmonary function test-spirometry before the proposed surgery (septoplasty or SMR). Spirometry was repeated post operatively at 1 month and 6 months interval.

A. Considering how severe the problem is when you experience it and how frequently it happens, please rate each item below on how "bad" it is by circling the number that corresponds with how you feel using this scale:

	No Problem	Very Mild Problem	Mild or Slight Problem	Moderate Problem	Severe Problem	Problem as bad as it can be	Most important items
1. Need to blow nose	0	1	2	3	4	5	[ ]
2. Sneezing	0	1	2	3	4	5	[ ]
3. Runny nose	0	1	2	3	4	5	[ ]
4. Nasal obstruction	0	1	2	3	4	5	[ ]
5. Loss of smell or taste	0	1	2	3	4	5	[ ]
6. Cough	0	1	2	3	4	5	[ ]
7. Post-nasal discharge	0	1	2	3	4	5	[ ]
8. Thick nasal discharge	0	1	2	3	4	5	[ ]
9. Ear fullness	0	1	2	3	4	5	[ ]
10. Dizziness	0	1	2	3	4	5	[ ]
11. Ear pain	0	1	2	3	4	5	[ ]
12. Facial pain/pressure	0	1	2	3	4	5	[ ]
13. Difficulty falling asleep	0	1	2	3	4	5	[ ]
14. Waking up at night	0	1	2	3	4	5	[ ]
15. Lack of a good night's sleep	0	1	2	3	4	5	[ ]
16. Waking up tired	0	1	2	3	4	5	[ ]
17. Fatigue	0	1	2	3	4	5	[ ]
18. Reduced productivity	0	1	2	3	4	5	[ ]
19. Reduced concentration	0	1	2	3	4	5	[ ]
20. Frustrated/restless/irritable	0	1	2	3	4	5	[ ]
21. Sad	0	1	2	3	4	5	[ ]
22. Embarrassed	0	1	2	3	4	5	[ ]
TOTALS (each column):							
GRAND TOTAL SCORE (all columns together):							

Fig 1. SNOT-22 Questionnaire[3]

Informed consent was obtained from all individual participants included in the study. The patients underwent septum correction surgeries classified as SMR (Submucosal Resection) and Septoplasty. Pulmonary function tests (Spirometry) and six-minute walking test were carried out before surgery and 1 month and 6 months of surgery. Patients also

answered SNOT 22 questionnaire every time. (Figure 1) The values of all parameters of PFT, six-minute walking distance and SNOT 22 Score were recorded and analysed by using different statistical tests.

Results

The results of this statistical analysis are as described:

Most of the patients i.e. 48.3% (n=29) were in the age group of 21-35 years, 26.7% (n=16) patients were between 36 to 50 years of age. 18.3% (n=11) patients were less than 20 years old. Only 6.7% (n=4) patients were more than 50 years of age. The mean age of the patients was 31.5 years. Out of 60 patients, 63.3% (n=38) patients were males and remaining 36.7% (n=22) were females. (Table 1) 39 out of 60 patients (65%) had DNS to left, while 18 patients (30%) had DNS to right side. Only 3 patients (5%) had S shaped DNS. In 60% patients (n=36) SMR was done, while septoplasty was done in remaining 40% (n=24) patients.

Table 1. Age-wise and gender-wise distribution of study participants

Age and Gender distribution among study patients			
Variables	Category	n	%
Age	< 20 yrs	11	18.3%
	21-35 yrs	29	48.3%
	36 - 50 yrs	16	26.7%
	> 50 yrs	4	6.7%
	Mean & SD	31.5	10.3
	Range	18 - 55	
SEX	Males	38	63.3%
	Females	22	36.7%

Mean values of the spirometry values (like FEV1, FVC, FEV1/FVC ratio, FEF 25-75% and PEFR) between different time intervals i.e. pre-op, post op 1 month and post op 6 months were compared using Friedman's test followed by Wilcoxon Signed Ranked Test. According to the analysis, P-Value for all the parameters except PEFR was less than 0.001.i.e. statistically significant.

Similarly, the mean values of SNOT 22 score and six-minute walking distance were calculated and compared. The mean value of pre-op SNOT 22 was 50.1 which decreased to 38.35 after 1 month of surgery and it still decreased after 6 months of surgery (21.3). The mean six-minute walking distance increased from 456.13m (pre-op) to 472.58m after one month of surgery. The mean distance after 6 months was 486.95. The mean difference in post-op and pre-op values was statistically significant for FEV1, FVC, FEV1/FVC RATIO, FEF25-75%, SNOT22 SCORE and SIX-MINUTE WALKING DISTANCE. PEFR didn't show significant improvement.

Comparison of mean difference values of spirometry, six-minute walking distance, SNOT22 score between SMR and Septoplasty surgeries during pre-op period, post-op after 1 month and post-op after 6 months was done by using Wilcoxon Signed Rank test. The p-value was significant for FEV1, FVC, FEF25-75%, SNOT-22 and 6MWD.

Depending upon the types of DNS, comparison of mean Spirometry values, SNOT22 scores and 6 Min Walking distance was done using Kruskal Wallis Test. This comparison was done pre-op, post-op after 1 month and after 6 months. There was no specific relation between the type of DNS and the postoperative improvement in values.

Gender-wise comparison of mean values of Spirometry, SNOT 22- and 6-Min walking distance was done using Mann Whitney U Test, which showed postoperative increase in mean spirometry values, decrease in SNOT-22 Score and increase in the 6MWD in both males and females. But the differences compared between males and females didn't show statistical significance. This shows that septal surgeries are not gender-biased and almost similar symptom and QOL improvement can be seen in males and females.

Spirometry values were compared after 1 month and 6 months postoperatively, the mean values of spirometry are increased after septoplasty and SMR but the difference between SMR and Septoplasty values is not statistically significant.

Comparison of mean values of SNOT-22 Scores was done between Septoplasty and SMR. There is definite improvement in the score postoperatively

but no statistically significant difference is not seen between Septoplasty and SMR. Comparison of mean 6MWD between septoplasty and SMR was done pre-operatively and postoperatively. There is increase in the mean walking distance, However, the comparison of post-operative 6MWD of patients who underwent septoplasty and SMR shows almost equal increase in mean walking distance.

The mean percentage increase in spirometry values at 6 months follow-up was calculated using Mann Whitney U Test. In patients who underwent SMR, there is 29.03% increase in FEV1 value, 23.66% increase in FVC, 6.86% increase in FEV1/FVC ratio, 52.92% increase in FEF 25-75% and 12.44% increase in PEFR. Similarly, in patients who underwent Septoplasty showed percentage increase in FEV1 (24.50%), FVC (18.92%), FEV1/FVC (5.83%), FEF25-75% (48.25%) and PEFR (9%).

At the 6 months follow-up period, comparison of mean percentage decrease in SNOT-22 Score and increase in 6MWD were calculated using Mann Whitney U Test. There was 56.96% decrease in SNOT-22 Score in SMR patients and 57.62% decrease in Septoplasty patients. Overall 57.22% decrease was seen in SNOT-22 Score at the end of 6 months. 6MWD was increased by 6.39% in SMR patients and by 7.41% in Septoplasty patients. Overall 6.80% increase was seen in 6MWD.

This shows that the degree of symptoms relief and the QOL improvement were almost similar in patients who underwent septoplasty and SMR. Hence both the surgeries show parallel results and can be performed interchangeably to give desired improvement in symptoms.

Discussion

According to Ahmed R, a clinically significant deviated nasal septum is defined as the one with sufficient deviation that would make the patient a candidate for septoplasty if the nasal obstructive symptoms do not respond to medical therapy.[9]

Surgical correction of DNS should improve nasal breathing and pulmonary mechanics. Very few studies have been done so far in the literature showing the effect of septoplasty on pulmonary function test. Hence, this encouraged us to observe the effect of septoplasty and SMR on PFT.

In our study mean age of the patients was 31.5 years and most of the patients were in 21-35 years age group. There was male predominance (63.3%) in our study. 65% patients had DNS to left side. These results are consistent with the results in a study done by Panicker V B. A recent prospective study by Panicker V B et al done in 2018 showed that out of 35 patients included in the study, DNS was most commonly seen on left side (54%), followed by right side, followed by S-shaped. Post-operative values of FVC, FEV1 and PEF were higher than preoperative values and the results were statistically significant. In this study most of the patients were in the age group of 21-30 years with male predominance.[10]

A study conducted by Ogura JH et al showed that nasal blockage had a deleterious effect on pulmonary function. And it was seen that the amount of symptomatic improvement after corrective nasal surgery could be expected by doing preoperative pulmonary function test.[11] In a similar study by Amer and Abdullah, age incidence was between second and fifth decade.[12] A study conducted by Bulcun et al in Turkey also reported statistically significant improvement in both nasal symptoms and pulmonary function test values after septoplasty. They also concluded that septoplasty may have favourable effects on bronchial hyperresponsiveness.[4]

In 2013, Anne-Lise Poirrier et al in London, conducted a study to evaluate the SNOT-22 Score as a quality-of-life outcome measure in septorhinoplasty surgery. They carried out a prospective case series in 76 patients undergoing septorhinoplasty. SNOT-22 Scores were compared preoperatively and post-operatively. The mean age of the patients was 35.53 years (± 11.41). The mean preoperative SNOT-22 Score was 39.95(±2.47) and the mean post-operative SNOT-22 Score was 21.22(± 2.24). Surgical improvement was highly significant ($p<0.0001$). Overall post-operative score was improved in 90.79% patients.[13] In our study, the mean value of pre-op SNOT 22 was 50.1 which

decreased to 38.35 after 1 month of surgery and it still decreased after 6 months of surgery (21.3).

In 2013, Dr. H. S. Satish and Dr. K. T. Sreedhar carried out a prospective study of SNOT-22 questionnaire which was done to analyze the effectiveness of septoplasty by noting the improvement of nasal symptoms and general quality of life (QOL).[3] The questionnaire was given to the patients preoperatively and 8 weeks after the surgery. In this study, out of 70 patients 48 patients (68.6%) were males and 22 patients (31.4%) were females. Mean age of the patients was 29.1 years. Mean preoperative SNOT-22 Score was 26.93, mean post-operative score was 17.01 and the difference was 9.92.

The study showed significant improvement in the following symptoms i.e. need to blow nose, sneezing, running nose, nasal obstruction, loss of smell/taste, cough, post nasal discharge, facial pain/pressure, difficulty in falling asleep, waking up at night, lack of good night's sleep, waking up tired, reduced productivity and embarrassed.

A study conducted by ArzuTuzuner et al (2016) in Turkey was aimed at evaluation of alterations in pulmonary function test following septoplasty using spirometry and 6-minute walking test (6MWT) and it also revealed the correlation of symptom score improvement with nasal obstruction score (NOSE) and sino-nasal outcome test (SNOT-22) questionnaires following surgery. 30 patients were enrolled in the study (22 men and 8 women), with mean age of 33.4±10.9 years (range 17 to 59 years).[5] The mean total walking distance was 702.3±68.2 m preoperatively and it improved to 753.2±72.6 m post-operatively, the difference being statistically significant ($p<0.001$). The analysis of spirometry values showed that FEV1, FVC, FEV1/FVC ratio, FEF 25-75% and FEF50% values did not change statistically when preoperative and post-operative values were compared. FIF50% scores were statistically significantly higher after septoplasty ($p<0.001$). PEF values improved from 6.6±1.6 to 7.6±1.9 and the difference was significant ($p<0.001$). This improvement suggests that following surgical correction of the nasal breathing pattern, respiratory capacity and the deepness of respiration increase when compared to preoperative period. Preoperative and post-operative comparison of NOSE scores was found to be significant ($p<0.001$) and SNOT-22 score was decreased from 57.3±16.1 to 39.5±16.1, which was significant as well ($p<0.001$).

In our study, mean values of the spirometry values (like FEV1, FVC, FEV1/FVC ratio, FEF 25-75% and PEFR) between different time intervals i.e. pre-op, post op 1 month and post op 6 months were compared. According to the analysis, P-Value for all the parameters except PEFR was less than 0.001.i.e. statistically significant. According to Morinaga et al., nasal surgery tends to reduce apnea hypopnea index with significant improvements in the nocturnal oxygenation.14 Dogan et al. used septal sutures after septoplasty and did not find any significant differences between pre and post-operative PFT parameters after septoplasty in early post-operative period.[15]

Karaman et al. performed septoplasty in 40 patients and compared spirometry values preoperatively and 3 months after surgery and they showed that mean FVC, FEV1, FEV1/FVC, FEF 25-75% and FEF75% increased statistically significantly and FEF25% decreased significantly.[16] In a study performed by Niedzielska et al. (2008) showed PFT differences in children after adenoidectomy and they found significant differences for vital capacity, FEV1, FVC, PEF, FEV1/FVC. They concluded that resolving the nasal obstruction with adenoidectomy improved PFT values in postoperative period.[17]

Nasal aerodynamics is important for tissue oxygenation during exercise. Reducing the nasal airway resistance provides improvement of exercise capacity. To determine the exercise capacity in nasal obstruction, Boas et al. used 6mWT in healthy individuals without any pulmonary diseases to compare mouth breathers and nose breathers and the results concluded that mouth breathers had lower scores compared to nose breathers.[18] Borghi-Silva et al. used 6mWT for revealing the response of physical training on exercise capacity and they found statistically significant increase in heart rate

following exercise on 6th and 12th week compared to baseline. Total distance was increased in this study.[19]

S. Prakash et al.[20] from Nepal carried out a study in 2011 to assess the subjective benefits to the patients undergoing septoplasty using SNOT-10 scoring system. Total 135 (90 cases and 45 controls) patients with deviated nasal septum were included in the study. The total mean score improvement was from 7.73(SD- 3.2) to 2.23(SD-1.69) i.e. 71.13% one month after surgery. There was statistically significant improvement ($p<0.001$) in postoperative SNOT-10 score in patients who underwent septoplasty. However, improvement in control group was not significant. Mean age of the patients was 25.6 years (range-13-52 years). According to Ho et al. (2004) probability of 50% reduction of nasal obstruction was 73% after 3 months of surgery.[21] Jessen M et al. in 1989 conducted a study to compare the effect of septoplasty at 9 months and 9 years after surgery and they showed that benefits of septoplasty had dropped considerably from 73% to 27% after 9 years.[22]

In 2014, Hirbod Behnam et al.[2] published a study in Iran which was aimed at evaluating the improvement in respiratory function after septoplasty with the help of acoustic rhinometry and rhinomanometry. The mean age of the patients was 24.76±4.52 years. 75 were males and 25 were females. Rhinomanometry tests showed that preoperative resistance of nasal airways (mean-0.385) was significantly decreased after surgery (mean- 0.381) ($p=0.0001$).

Conclusion

Deviated nasal septum is the most common cause of nasal obstruction. Not all patients of DNS need septal surgery. Only the patients with symptomatic nasal septal deviation are advised to undergo septal surgery known as Submucosal Resection (SMR) or Septoplasty.

The patients most commonly present with chief complaints of unilateral or bilateral nasal obstruction, headache, recurrent sneezing, post-nasal drip, loss or decreased sense of smell, wheezing, epistaxis, difficulty in sleeping, lack of good night's sleep, fatigue, feeling sad/ embarrassed etc.

The conditions commonly associated with DNS include allergic rhinitis, sinusitis, middle ear infections and if not treated adequately and in time can lead to chronic rhinosinusitis, mouth breathing, snoring and obstructive sleep apneas, asthma. Hence, the symptomatic deviated nasal septum should be treated with septoplasty or SMR as early as possible. Nasal septal surgeries cause improvement in the quality of life. SMR and Septoplasty cause relief of symptoms due to DNS and increase the exercise capacity postoperatively.

From this study it shows that SMR and Septoplasty cause improvement in the pulmonary function tests, quality of life and exercise capacity. This improvement can be assessed by doing pulmonary function test, six-minute walk test and filling the SNOT-22 questionnaire in the pre-operative period and postoperative period. Both the surgeries show almost similar improvement and a long- term follow-up is needed to assess the improvement in PFT.

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