

Pulmonary function tests after septoplasty with inferior turbinectomy

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Received 08 September 2021

Revised 29 October 2021

Accepted 08 November 2021

Published 31 March 2022

Pan Arab Journal of Rhinology 2021, 11:134–138

Background

Deviated nasal septum causes variable resistance to inspired air currents, which directly and indirectly influences the efficiency of pulmonary functions.

Aim

To compare pulmonary function tests performed before and following septoplasty with turbinectomy in patients complaining of nasal obstruction caused by a deviated septum with hypertrophic inferior turbinate.

Patients and methods

The study was conducted on 60 patients diagnosed with deviated nasal septum with hypertrophied inferior turbinate. All were subjected to complete history taking, external nasal examination, and anterior rhinoscopy, which was performed with a nasal speculum. Additionally, all patients in this study underwent a nasal endoscopy, computed tomography, and spirometry. Septoplasty and turbinectomy were performed for all cases with regular follow-up, and the spirometry was repeated after 3 months.

Results

After surgery, the preoperative forced vital capacity (FVC) of 3.14 ± 0.70 increased to 4.43 ± 1.01 , with a highly statistically significant difference ($P < 0.001$). Forced expiratory volume in the first second (FEV1) was significantly greater postoperatively (2.66 ± 0.55) than preoperatively (3.96 ± 0.81) ($P < 0.001$). The preoperative FEV1/FVC ratio of $85.08 \pm 5.47\%$ improved to $90.39 \pm 8.75\%$ after surgery, with a statistically significant increase ($P = 0.001$). The preoperative peak expiratory flow rate of 5.57 ± 1.47 increased to 7.07 ± 2.26 following surgery, a difference that was highly statistically significant ($P < 0.001$). The preoperative forced expiratory flow of 25–75% of vital capacity of 2.73 ± 1.13 increased to 3.73 ± 1.28 after surgery, a change that was highly statistically significant ($P < 0.001$).

Conclusion

FVC, FEV1, FEV1/FVC, PEF, and forced expiratory flow of 25–75% showed a significant increase after operation.

Keywords:

pulmonary function, septoplasty, turbinectomy

Pan Arab J Rhinol 11:134–138

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Introduction

The nose is the most physiologic route of respiration that performs important functions such as filtration, heat exchange, humidification, and olfaction. The nasal septum divides the nasal cavity into two halves composed of cartilaginous and osseous tissues [1].

The most frequent reasons of a deviated nasal septum include trauma, environmental factors, and genetic factors. Some nasal disorders, such as allergic and vasomotor rhinitis, are associated with the development of permanent turbinate hypertrophy producing chronic nasal obstruction. Others are associated with anatomic bony turbinate enlargement owing to progressive ossification throughout adulthood [2]. The nasal obstruction by deviated nasal septum with hypertrophied inferior turbinate may cause nasal handicap to the patients [3].

Deviation of the nasal septum and consequent pathological alterations such as hypertrophied inferior turbinate are frequently identified to cause changes in respiratory mechanics and arterial blood compositions [1].

Pulmonary function tests (PFTs) provide useful information on the state of the airways, lung volumes, and lung function; hence, deviated nasal septum poses variable resistance to inspired air currents, which directly and indirectly influences the efficiency of pulmonary functions [4].

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It was observed that the degree of symptomatic improvement succeeding corrective nasal surgery could be expected by preoperative PFT [5]. Hence, this prompted us to examine the effect on pulmonary function in symptomatic deviated nasal septum and hypertrophied inferior turbinate cases following septoplasty and turbinectomy, which directly and indirectly influences the efficiency of pulmonary functions.

The objective of this study was to evaluate PFTs before and after septoplasty with turbinectomy in patients claiming to be experiencing nasal blockage as a result of a deviated septum with hypertrophic inferior turbinate.

Patients and methods

This prospective cross-sectional study was conducted at the Otorhinolaryngology Department, Benha University hospitals, Benha, Egypt, over the period of 1 year, starting from January 2020 till January 2021.

A total of 60 cases diagnosed with deviated nasal septum with hypertrophied inferior turbinate were included in the current study.

Inclusion criteria

The following were the inclusion criteria:

- (1) Patients experiencing severe nasal obstruction.
- (2) Patients with deviated nasal septum.
- (3) Patients with hypertrophied inferior turbinates.

Exclusion criteria

The following were the exclusion criteria:

- (1) Nasal polyps.
- (2) Smoking.
- (3) Any lung diseases.
- (4) Allergic fungal sinusitis.
- (5) Previous nasal operations.
- (6) Pregnancy.
- (7) Any systemic illnesses, including heart failure, hypertension, and diabetes, as well as any lung disorders.

All participants provided signed informed permission after a thorough discussion of the advantages and disadvantages of each intervention. The research was approved by the local ethics committee of Benha University's School of Medicine.

All patients were subjected to history taking, routine general examination, and external nasal examination. The external nasal contour was examined with close attention to any bony and cartilaginous deformities,

looking for evidence of prior trauma, the structural integrity of the nasal tip, and indentation or depression of the surrounding nasal bones. The examiner manually elevated the nasal tip to a neutral (rather than exaggerated) position and assessed improvement of the nasal airflow. The clinician also examined airflow both during shallow and deep inspiration. Anterior rhinoscopy was also done for all patients: anterior rhinoscopy was performed with a nasal speculum, along with a bright light source to improve visualization. Examination of the nose was conducted with the patient's head tilted back and the clinician sitting directly opposite. The assessment started at the level of the naris, looking for mucosal abnormalities, patency, and collapse of the soft tissues with respiration. Anterior rhinoscopy provided assessment of the size and caliber of the inferior turbinate's and the position of the anterior to mid-nasal septum.

After preparation of the nose with topical decongestant and/or topical anesthetic spray, a rigid or flexible endoscope was used to directly examine the cause of nasal obstruction. The following structures were examined: the middle meatus, posterior aspects of the nasal cavity, and the nasopharynx to identify polyps, posterior turbinate hypertrophy, middle and posterior nasal septal deviations, adenoid hypertrophy, nasal tumors, choanal atresia, and purulent discharge draining posteriorly in rhinosinusitis.

The identical computed tomography (CT) equipment (Siemens Somatom Sensation 16; Siemen, Munich, Germany) was used to scan all patients in a series of axial slices with a thickness of 3 mm. For the present research, raw CT images from each patient were further rebuilt into 0.75-mm-thick slices parallel to the hard palate using a bone window. These axial views of the nasal septum have been reformatted in the frontal plane to reveal the nasal septal morphology.

All patients in this research underwent spirometry (MIR, spiro-doc, Italy); all patients were instructed to sit in a comfortable posture with no restriction on chest mobility (like heavy or tight clothes). The same physician observed all patients and determined the best trial out of three successful trials or until the patient completed eight trials.

The surgical procedure was done as follows:

- (1) Septoplasty and turbinectomy were performed for all cases.
- (2) All operations were performed under general anesthesia.
- (3) Endoscopy was performed to verify that the deviated nasal septum was corrected adequately.
- (4) The deviated cartilage or bone of the nasal septum

was excised and rebuilt, with cartilage in the midline being replaced.

- (5) The inferior turbinate's posterior portion was removed only to prevent empty nose syndrome.
- (6) Finally, a nasal septal splint is implanted, followed by the retention of merocel packs in the nose.

Postoperative care

- (1) All cases were transferred to the recovery room and then to the internal ward.
- (2) Patients were kept 48 h after the surgery.
- (3) Antibiotics were given for 10 days after surgery, along with alkaline nasal douching.

Follow-up

- (1) Regular follow-up was scheduled over the first 3 months after operation.
- (2) Nasal packs were removed 48 h after surgery; however, nasal septal splints were retained for 7 days.
- (3) PFTs were repeated for all cases 3 months after surgery. The same parameters recorded before operation were recorded to be compared with the preoperative values.

Statistical analysis

Software (SPSS, Version 26.0 for Windows. SPSS Inc., Chicago, IL) was used for the university, bivariate, and stratified analyses of the data. Qualitative variables were analyzed by constructing contingency tables with Pearson x2 test or fisher exact test, when conditions for the former were not met. The Student test was applied for the comparison of quantitative variables after establishing their normal distribution by means of the Shapiro-Wilk test and Levene test for equality of variance. Analysis of variance was used for multiple comparisons of quantitative variables.

Correlations among variables were studied by using the Pearson coefficient and binary logistic regression models (Wald method), obtaining adjusted odds ratios (OR) with 95% confidence intervals (CI) for the association between prostate volume greater than 30 mL and AGA. Difference were considered significant at $P \leq .05$ and marginally significant at $.05 < P \leq 1$.

Results

This research comprised 60 patients ranging in age from 19 to 40 years, with a mean of 25.9 ± 6.10 years. There were 42 (70%) men and 18 (30%) women, with a mean BMI of 28.43 ± 2.80 (Table 1).

Preoperative pulmonary function values were compared with the postoperative readings. The results showed that the preoperative forced vital capacity (FVC) of 3.14 ± 0.70 increased to 4.43 ± 1.01 after the surgery, with a very significant difference ($P < 0.001$). The forced expiratory volume in the first second (FEV1) postoperatively (2.66 ± 0.55) significantly increased than the preoperative FEV1 (3.96 ± 0.81) ($P < 0.001$). The preoperative FEV1/FVC ($85.08 \pm 5.47\%$) became $90.39 \pm 8.75\%$ after the surgery. This improvement was statistically significant ($P = 0.001$). The preoperative peak expiratory flow rate (PEFR) of 5.57 ± 1.47 increased to 7.07 ± 2.26 , with a very statistically significant change after surgery ($P < 0.001$). The preoperative forced expiratory flow of 25–75% (FEF 25–75%) of 2.73 ± 1.13 increased to 3.73 ± 1.28 after the surgery, with a highly statistically significant difference ($P < 0.001$) (Table 2).

Discussion

In our study, males represented 70% of the included cases, whereas the remaining patients were females. In the same context, Tuzuner *et al.* [6] also reported the superiority of male sex in cases with nasal septum deviation, as males formed 73.33% of the included cases. An additional study confirmed the previous findings [7].

In the current study, FVC showed a significant increase after operation, as it had mean values of 3.14 and 4.43

Table 1 Distribution of the studied group (n=60)

	Mean	SD	Range
Age	25.9	6.10	19.0-40.0
Sex [n (%)]			
Male	42 (70.0)		
Female	18 (30.0)		
Height (cm)	170.7	5.95	160.0-180.0
Weight (kg)	82.73	8.06	65.0-97.0
BMI	28.43	2.80	22.46-33.66

Table 2 Differences of forced vital capacity, forced expiratory volume in the first second, forced expiratory volume in the first second/forced vital capacity, peak expiratory flow rate, and forced expiratory flow among the studied group between preoperative and postoperative values

	Before (n=60)		After (n=60)		Paired t test	P
	Mean	SD	Mean	SD		
FVC	3.14	0.70	4.43	1.01	8.49	<0.001**
FEV ₁	2.66	0.55	3.96	0.81	11.58	<0.001**
FEV ₁ /FVC	85.08	5.47	90.39	8.75	3.62	0.001**
PEFR	5.57	1.47	7.07	2.26	3.9	<0.001**
FEF 25-75%	2.73	1.13	3.73	1.28	4.05	<0.001**

FEF 25-75%, forced expiratory flow of 25-75%; FEV₁, forced expiratory volume in the first second; FVC, forced vital capacity; PEFR, peak expiratory flow rate, ** equal Highly Significance.

l before and after operation, respectively ($P<0.001$). This improvement after surgical correction of the nasal breathing pattern was believed to be a result of widening nasal cavity and increase of both the respiratory capacity and the respiratory volume as compared with the preoperative period.

Likewise, Mandour *et al.* [8] also reported significant increase in FVC after the same operation ($P<0.001$). It increased from 3.1 up to 4.47 l after operation. Moreover, a more recent study conducted in 2021 [9] reported similar findings, as FVC increased from 3.41 l before surgery up to 3.904 l after it ($P<0.001$).

Furthermore, Elsherif *et al.* [10] reported that FVC had a mean value of 4.126 l before surgery, which increased to 4.662 l after it ($P<0.001$). Moreover, other authors reported the same improvement in the same parameter after partial inferior turbinectomy ($P<0.001$), as it increased from 4.34 l before operation to 4.55 l after it [7].

On the contrary, another study negated any significant difference between the two time points regarding FVC ($P=0.191$). Before and after surgery, it had mean values of 4.09 and 4.13 l, respectively [6].

Of note, other authors reported a significant decrease of FVC after septoplasty with nasal packs ($P=0.008$), as it had mean values of 4.175 and 3.985 l before and after surgery, respectively. The same authors reported no significant changes at the same parameter after performing the same operation with septal suturing ($P>0.05$), which had mean values of 4.235 and 4.152 l at the same time intervals, respectively [11].

It is apparent from the previous findings that there is a marked heterogeneity of results in the existing literature, and these changes are not only owing to different techniques and different patients but also owing to a change in any step in the surgery itself, which could alter postoperative outcomes (e.g., use of nasal packs).

FEV1 significantly increased after operation in the present research, with mean values of 2.66 and 3.95 l before and after surgery, respectively ($P<0.001$).

In agreement with our findings, another study conducted in 2018 [8] showed that following surgery, there was a significant rise in FEV1 ($P=0.001$). It increased from 2.63 before surgery up to 3.83 l/s after it. In addition, another study [10] reported a significant increase in FEV1, which increased from 3.401 l before septoplasty up to 3.86 l after it ($P<0.001$). Elzayat and Moussa [7] reported significant increase in FEV1 after partial inferior turbinectomy ($P<0.001$), as it increased from 3.613 l before operation up to 3.88 l after it.

In contrary with our findings, Tuzuner *et al.* [6] also noted comparable values of FEV1 before and after surgery ($P=0.428$). It had mean values of 3.45 and 3.49 l/s in the same time points, respectively.

Dogan *et al.* [11] reported that septoplasty with nasal packing had a significant negative effect on FEV1, as it decreased from 3.468 l before surgery down to 3.042 after it.

Our results indicated that after surgery, FEV1/FVC raised substantially ($P<0.001$). Before and after surgery, it had mean values of 85.08 and 90.39, respectively.

Mandour and colleagues concur with our findings. Mandour *et al.* [8] demonstrated that mean FEV1/FVC ratios were 84.6 and 88.53 before and after surgery, respectively. It was evident that FEV1/FVC ratio showed a significant increase after operation ($P=0.001$). Furthermore, in the study conducted by Arifa *et al.* [9], FEV1/FVC increased from 82.93 before operation to 85.77 after it. Elzayat and Moussa [7] also reported a significant increase in FEV1/FVC ratio from 83.1 to 85.29 after partial inferior turbinectomy ($P<0.001$).

On the contrary, Dogan *et al.* [11] reported comparable findings between preoperative and postoperative readings of FEV1/FVC ratio, neither with nasal packing nor with suturing. Preoperative values were 83.18 and 82.04, whereas postoperative values were 76.94 and 79.04 in nasal packing and nasal septal suture groups, respectively ($P>0.05$).

In the current study, PEFr showed a significant increase after operation ($P<0.001$), as it increased from 5.57 before operation to 7.07 l/s after it.

Another research study corroborated our findings [8]. It reported a significant increase in PEFr after operation ($P<0.001$), as it changed from 5.53 l/s before it to 7.07 l/s following it [8]. Also, Arifa *et al.* [9] reported that PEFr increased from 6.8 l/s before operation up to 7.17 l/s after it ($P<0.001$). Furthermore, Elzayat and Moussa [7], reported that PEFr increased from 6.72 to 8.18 l/min after partial inferior turbinectomy ($P<0.001$).

This suggests that following surgical correction of nasal breathing pattern, respiratory capacity and the deepness of the respiration increased when compared with the preoperative period.

In the present study, FEF 25–75% showed a significant increase after surgery, as it increased from 2.73 ± 1.13 to 3.73 ± 1.28 , with a highly statistically significant difference ($P<0.001$).

Mandour *et al.* [8] concur with our findings. They revealed that the preoperative FEF 25–75% of 2.7 ± 1.14 l increased to 3.7 ± 1.35 l after surgery, a change that was highly statistically significant ($P < 0.001$).

Elzayat and Moussa's [7] findings are in contradiction to ours. They revealed that the postoperative FEF 50% (4.100 ± 0.17811 l/M) was not substantially different from the preoperative FEF 50% (4.0233 ± 0.165 l/M) ($P = 0.673$).

The mechanism of improvement in PFTs that occurred in our study after Arafa septoplasty may be due to removal of trigger areas in the nose and sinuses that can induce the release of leukotrienes, prostaglandins, and other inflammatory mediators that may affect the lower airways. Moreover, it may be attributed to the postoperative use of intranasal corticosteroid sprays [12].

Our study has some limitations: first of all, it is a single-center study. In addition, it included a sample size that was relatively small. Furthermore, another different technique should have been applied to elucidate if the technical details could alter the PFTs results. These drawbacks should be covered in the upcoming studies.

Conclusion

Based on the results of our study, it could be concluded that there was a significant increase in the mean values of postoperative FVC, FEV1, FEV1/FVC, PEF, and FEF 25–75% compared with preoperative values.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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