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Evaluation of Patients with Septal Deviation Using Respiratory Function Tests Before and After Septoplasty

Septoplasti Ameliyatı Öncesi ve Sonrası Respiratuar Fonksiyon Testleri Kullanarak Septal Deviasyonlu Hastaları Değerlendirme

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ABSTRACT

Objectives: To assess the effect of nasal septal deviation on pulmonary function tests by comparing preoperative and postoperative pulmonary function tests (PFT).

Material and Methods: Forty patients who had septoplasty were evaluated. Pulmonary functions were measured twice in each subject, one before surgery and the other three months after surgery. The highest level for forced vital capacity (FVC), forced expiratory volume in one second (FEV 1), peak expiratory flow (PEF), and maximal expiratory flow 75%, 50%, 25% of FVC (FEF 75%, FEF50%, and FEF25%, respectively) were obtained independently. Preoperative and postoperative PFT results were compared.

Results: Postoperative all PFT values, except for FEF 25 value, were significantly higher than the preoperative values. Postoperative FEF 25 value was significantly lower than preoperative value.

Conclusions: Pulmonary function tests measured by spirometry are not only useful for the diagnosis of pulmonary disease, but also for determining the upper airway obstruction . Nasal cavity is a part of upper airways and septal deviation is one of the most important diseases which cause nasal obstruction. Correction of nasal obstruction resulted in improvement of pulmonary function tests.

Keywords

Nasal obstruction; septal deviation; pulmonary function tests; pulmonary functions

ÖZET

Amaç: Septal deviasyonlu hastalarda, preoperatif ve postoperatif solunum fonksiyon testi sonuçlarını karşılaştırarak, solunum fonksiyon testlerinin önemini belirlemek.

Gereç ve Yöntemler: Septoplasti ameliyatı yapılan 40 hasta çalışmaya alındı. Her hastaya uygun teknikle ameliyat öncesi bir kez, ameliyattan sonraki 3. ay bir kez olmak üzere iki kez solunum fonksiyon testi yapıldı. FVC, FEV 1, PEF, FEF %75, FEF%50, FEF%25 değerleri belirlendi. Preoperatif ve postoperatif solunum fonksiyon testlerinin sonuçları karşılaştırıldı.

Bulgular: FEF 25 değeri dışındeki tüm postoperatif solunum fonksiyon testi değerleri, preoperatif değerlerden anlamlı olarak yüksek bulundu. Postoperatif FEF25 değeri anlamlı olarak preoperatif değerden düşüktü.

Sonuç: Respiratuar fonksiyon testleri flow volüm spirometri ile ölçüldü. Spirometri sadece akciğer hastalıklarında yararlı değil, fakat üst solunum yolu tıkanıklıklarının belirlenmesinde de kullanılır. Nazal kavite üst solunum yolunun bir kısmını oluşturur ve septal deviasyon, nazal tıkanıklığa neden olan en önemli patolojik hastalıklardan biridir. Bu çalışmanın amacı, septoplasti ameliyatının öncesi ve sonrasında respiratuar fonksiyon testlerindeki değişiklikleri belirlemek.

Anahtar Sözcükler

Burun tıkanıklığı; septum deviasyonu; solunum fonksiyon testleri; solunum fonksiyonu

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INTRODUCTION

Chronic upper airway obstruction is frequently unrecognized or misdiagnosed as other conditions such as asthma or chronic airflow obstruction (CAO). Clinical features such as stridor may lead to diagnosis or it may initially be suspected from the results of pulmonary function tests ordered for another reason. The classification of upper airway obstruction (UAO) based on the location of the lesion (intrathoracic or extrathoracic) and the nature of the lesion (fixed or variable) must be emphasized. The airway may be divided functionally into three levels: peripheral airways with a diameter of 2 mm or less; larger or major airways from 2 mm diameter up to the main carina; and the upper airways which include the trachea, larynx, pharynx, and nose or mouth. The effects of any obstruction of the upper airways will depend on several variables which include (a) the size of the airways at the site of obstruction, (b) the location of the obstruction, (c) the nature of the lesion, and (d) phase of respiration.[1]

Whether a lesion produces symptoms or not depends on the severity of the obstruction. For instance, it has been shown that a lesion which reduces the diameter of the upper airway to about 8 mm produces symptoms on exercise. A 5 mm diameter airway at the site of obstruction produces inspiratory obstruction at rest giving rise to the characteristic physical finding of stridor.[1]

Extrathoracic upper airway is surrounded by athmospheric pressure whereas the intrathoracic upper airway is surrounded by pleural pressure. The difference between the intrathoracic pressure and the external pressure is transmural pressure. If the external pressure exceeds the intratracheal pressure, i.e., in case of, a positive transmural pressure, the airway tends to collapse. A negative transmural pressure tends to open the airway.[1]

The nature of the obstruction, whether it is stiff or pliable, determines the severity of changes in relation to changes in transmural pressure. In this context, a stiff lesion (septal deviation) causes a fixed obstruction. The effects of a fixed UAO, that is, one that does not change in severity with the phase of respiration, will not be affected by the level of the obstruction. A fixed extrathoracic UAO will cause the same effects as a fixed intrathoracic obstruction. With an upper airway obstruction, flow at higher lung volumes may be limited by the obstruction. At lower lung volumes, flow may be limited not by the upper airway obstruction but by the collapse of intrathoracic airways. Generally, flow measurements made at low lung volumes reflect the function of peripheral airways only, whereas those made at high lung volumes reflect both upper and lower airway function.[1]

The flow volume plot of a forced expiratory and inspiratory vital capacity maneuver would be particularly helpful in categorizing UAO. They simulate major airway obstruction by having normal subjects breath through fixed resistances, and have found that flow rate increased to a certain level early in both inspitarion and expiration and than plateaued. The plateau was reached at lower flow rates as the resistances were progressively increased. The effect of a fixed lesion, either intrathorasic or extrathorasic, will be apparent during both inspiration and expiration. With a fixed UAO, the plateau and limitation of flow is seen both in the expiratory and inspiratory flow volume loops.[1]

Spirometry; a simple plot of a FVC maneuver of volume versus time, the timed spirogram, also gives some clues to the presence of upper airway obstruction. Rotman et al[2] compared various tests in patients with upper airway obstruction and chronic obstructive pulmonary disease and normal subjects. In this study, they identified four variables which ususally distinguish patients with upper airway obstructions from patients with chronic airflow obstruction. The values are obtained from the flow volume plot and the spirogram.

1) FIF 50%≤ 100 L/min

2) FEF 50% /FIF 50%≥ 1

3) FEV 1/PEFR≥ 10 ml/min (The PEFR is proportionately more reduced by the UAO compared to the FEV1)

4) FEV1/FEV 0.5≥1.5 (The FEV 0.5 is proportionately more reduced by obstruction of the upper airway than FEV 1) the ratio can be obtained from the spirogram tracing alone.[2]

The abbreviations used above are as follows; FIF 50%, forced inspiratory flow at 50 percent of the vital capacity, FEF 50%, forced expiratory flow at 50 percent of the vital capacity, PEFR, peak expiratory flow

rate measured in litres per minute; FEV 1, forced expiratory volume in one second measured in milimeters; and FEV 0.5, forced expiratory volume in ½ second measured in milimeters. These values are readily available from most pulmonary function labs and may be included in a computer printout in those with automated reporting. The inclusion of one or more of these indices in routine reporting should lead to unsuspected cases of upper airway obstruction being discovered as well as their use in patients already suspected of having such problems.[2]

Some recent studies reported that alterations of normal nasal physiology effects pulmonary functions considerably and the relationships between upper and lower airways can not be neglected.[3,4] Most of the pulmonary pathologies are caused by incoordination of ipsilateral pulmonary and nasal cavity reflexes.[5]

Since most lesions which cause UAO require surgical treatment, an anatomical and pathologic diagnosis is required following identification of a physiologic abnormality. In this paper, we did not argue the necessity of pulmonary function tests for the patients who had septal deviation, since the obstruction area can be easily found with physical examination. The aim of this study was to determine the pulmonary function test alterations before and after septoplasty.

MATERIAL AND METHODS

From March to July 2006, a total of 40 patients who had septoplasty were enrolled in the study. The study group included 25 males and 15 females with a mean age of 32 years (range of 18-57 years). Diagnosis of septal deviation was based on history and detailed nasal examination including anterior rhinoscopy and nasal endoscopy. Nasal obstruction was graded according to septal deviation as follows: normal structure (0), mild deviation (1), moderate deviation (2), severe deviation (3), and more severe deviation (4) Patients with turbinate hypertrophy, allergic rhinitis, nasal polyposis and chronic pulmonary disease were excluded. No medical treatment was used before surgery.

All patients had septoplasty under local anesthesia. Nasal packs were removed on the second day of their postoperative period and they were ordered for saline nasal irrigation three times a day. They were called back for the control visit postoperatively at 1st week,1st month and 3rd month. The improvement of nasal obstruction symptoms was estimated and PFT values were also measured two times in all participants; one before surgery and the another three months after the surgery. The improvement of nasal obstruction was evaluated with subjective parameters. All patients took a questionnaire at postoperative 3rd month visit.

The questionnaire included only one question, "How can you describe the improvement of your nasal obstruction?". The results were recorded as subjective values and graded as none (0), mild (1), modarate (2), well (3), excellent (4).

The PFT values included; forced vital capacity (FVC), forced expiratory volume first second (FEV 1), FEV1 /FVC ratio, peak expiratory flow (PEF), FEF 25%, FEF 50%, FEF 75% and FEF 25/75 ratio. All the preoperative and postoperative PFT values recorded as objective values and compared. We have informed all patients about the study and their informed consents were obtained. Since this study does not ned any ethics committee approval, we did not apply for it.

Statistical Analysis

SPSS (Statistical Package for social Science) for Windows 15. 0 program was used for statistical analysis and Paired T Test was used for quantitative analysis.

RESULTS

On the first visit, nasal obstruction was graded according to septal deviation. Twenty patients' septal deviation were severe, 12 of them were modarate and four of them were mild (Table 1) and they all had flow volume spirometry. The PFT values were recorded.

Table 1. Distrubition of patients according to their nasal obstruction score.

	Septal Deviation	
Degree	Patient (n)	%
0	0	0
1	4	10
2	12	30
3	20	40
4	4	10

After septoplasty, improvement of nasal obstruction was found as follows: 70% (n: 28) graded it as excellent, 20% (n: 8) graded it as well and 10% (n:4) graded it as moderate (Table 2). All of the patients indicated that they could breathe more comfortably. At the same visit they also had spirometry. Paired sample t Test was used for comparing preoperative and postoperative PFT values (Table 3).

Postoperative all prediction and average PFT values, except forced expiratory flow 25 (FEF 25), were statistically significantly increased ($p< 0.01$). FEF 25 value was statistically significantly decreased ($p< 0.01$) .

Table 2. Improvement of nasal obstruction at postoperative third month.

Improvement	Patient (n)	%
Excellent	28	70
Well	8	20
Moderate	4	10
No improvement	0	0
Total	**40**	**100**

DISCUSSION

Nasal cavity is one of the most important parts of the upper airways and it is often neglected in physiological studies on pulmonary function. It has many functions such as respiration, defense of lower airways, warming and moisturizing the inspired air. Nasal cavity has defense mechanisms for lower airways by stimulating the trigeminal and olfactory nerves in the nasal mucosa to start the sneezing reflex.[6] Practically, we know that there are relationships between the respiration and many organs with reflex mechanisms including ear, throat, heart, lungs, diaphragm and abdominal organs.[7, 8]

There are a number of studies about the relationships of nasal cavity and pulmonary function. Ogura and Harvey[9] stated that nasal obstruction could change the pulmonary functions by nasopulmonary reflex system. Mink[5] reported a relationship between nasal cavity and ipsilateral hemithorax. In this study, patients with nasal stenosis had a limited mobility range of ipsilateral diaphragm (2-5 cm) during respiration. Widdicombe[10] reported that the nasal cavities produced a pressure difference between nostrils and lungs.

According to Albert and Winters[7] and Edison and Kerth,[8] oral respiration cannot create sufficient lung elasticity in patients with nasal obstruction. Because of

Tablo 3. The mean values of preoperative and postoperative respiratory function test results.

		Preoperative Mean ± SD	Postoperative Mean ± SD	p
FVC(lt)	Average	4.19 ± 0.84	4.43 ± 0.86	0.001**
	Prediction%	97.05 ± 1.39	102.69 ± 1.14	0.001**
FEV1(lt)	Average	3.54 ± 0.68	3.74 ± 0.70	0.001**
	Prediction%	97.06 ± 1.59	102.74 ± 1.61	0.001**
FEV1/FVC	Average	83.06 ± 2.06	84.30 ± 2.22	0.001**
	Prediction%	101.61 ± 1.17	103.13 ± 1.95	0.001**
PEF(lt/sn)	Average	8.01 ± 1.38	8.46 ± 1.40	0.001**
	Prediction%	93.93 ± 1.18	99.26 ± 0.72	0.001**
FEF25/75 (lt/sn)	Average	4.19 ± 0.57	4.30 ± 0.57	0.001**
	Prediction%	96.05 ± 1.39	98.53 ± 1.23	0.001**
FEF25(lt/sn)	Average	7.50 ± 1.10	7.32 ± 1.09	0.001**
	Prediction%	101.62 ± 0.79	99.12 ± 0.59	0.001**
FEF50(lt/sn)	Average	4.74 ± 0.58	4.97 ± 0.59	0.001**
	Prediction%	97.08 ± 1.05	101.78 ± 1.06	0.001**
FEF75(lt/sn)	Average	2.07 ± 0.34	2.29 ± 0.35	0.001**
	Prediction%	93.94 ± 2.09	103.82 ± 2.43	0.001**

Paired Sample t test was used *** p<0.01*

FVC: Forced Vital Capacity; FEV1: Forced Expiratory Volume first second; FEV1/FVC: Forced Expiratory Volume first second/ Forced Vital Capacity PEF: Peak Expiratory Flow; FEF25/75: Forced Expiratory Flow 25/75; FEF25: Forced Expiratory Flow 25; FEF50: Forced Expiratory Flow 50; FEF75: Forced Expiratory Flow 75.

weak ventilation, atelectasis can be observed in microareas of lungs. It was stated that 'nasal resistance is necessary for pulmonary elasticity'. They agreed that both nasal resistance and nasal reflexes increase the pulmonary activities.

PEF indicates pulmonary high flow volume, while FEV1 indicates pulmonary low flow volume. Therefore PEF is useful for nasal obstruction but FEV1 is not a sensitive test for this. In upper airway obstructions, FEV1 can be normal while PEF is abnormal.[11] Similarly FEF 25/75 value can be found in low levels.

At the 3rd month visit after surgery, 90% of patients defined their nasal obstruction improvement as excellent or well, 10% of them defined it as moderate. We measured pulmonary function and capacity with spirometry. Eventually mean FVC value measured as 97.05% preoperatively significantly increased to 102.69% postoperatively. PEF values, which is a sensitive test for upper airway obstruction, was 93.93% preoperatively while it was 98.53% postoperatively. Preoperative and postoperative FEF 25/75 values were 96.05% and 98.53%, respectively. Preoperative FEF 25 values decreased from 101.62% to 99.12%. FEF 50 values increased from 97.08% to 101.78%. A significant increase was found at FEF 75 values (preoperative 93.94 and postoperative 103.82%).

The results of our study are similar with the results of Gaitman,[12] Owens and Murphy[13] and Rotman et al.[2] On the other hand, previous studies did not indicate a relationship between preoperative and postoperative FEV 1/FVC values, before our study. There are many investigations on laryngeal obstruction and pulmonary functions.[2,11,13,14] We evaluated the relationship between nasal obstruction and lungs with objective data such as PFT values. Our significant results support the claims of the many rhinologists like Cottle.[5,12,14,15]

CONCLUSION

Nasal obstruction due to septal deviation has a negative effect on pulmonary fuctions. This negative effect can be evaluated with pulmonary function tests measured by flow volume spirometry and can be reduced after a successful septoplasty. The pulmonary function tests are useful in diagnosis and follow-up for both upper airway obstructions and pulmonary function alterations. Correction of nasal obstruction resulted in improvement of pulmonary function tests.

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