



# The effect of functional endoscopic sinus surgery on right ventricular function in patients with nasal polyps

Nazal polipli hastalarda fonksiyonel endoskopik sinüs cerrahisinin sağ ventrikül fonksiyonu üzerine etkisi

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## ABSTRACT

**Objectives:** This study aims to evaluate the right ventricular functions before and after functional endoscopic sinus surgery (FESS) in patients with nasal polyps (NPs).

**Patients and Methods:** A total of 56 patients (36 males, 20 females; mean age 30±10 years; range 19 to 40 years) with grade II and III NP were included in the study between March 2015 and January 2016. The conventional echocardiographic parameters, pulmonary artery systolic pressure (PASP), tricuspid annular plane systolic excursion (TAPSE), right ventricular fractional change area (RVFAC), and peripheral oxygen saturation with a pulse oximeter were measured in all patients before and one month after surgery.

**Results:** The PASP statistically significantly decreased during the postoperative period (p=0.003). Right ventricular fractional change area and TAPSE, which are right ventricular systolic parameters, improved significantly after FESS (p=0.005 and p=0.009, respectively). Peripheral oxygen saturation increased from 94.0±0.9 to 94.7±0.8 during the postoperative period (p=0.005).

**Conclusion:** Our study results indicate that treatment of upper airway obstruction in adult patients with NP may result in improved right ventricular systolic functions and provide a substantial decrease in PASP values.

**Keywords:** Functional endoscopic sinus surgery; nasal polyposis; right ventricular function.

## ÖZ

**Amaç:** Bu çalışmada nazal polipli (NP) hastalarda fonksiyonel endoskopik sinüs cerrahisi (FESS) öncesi ve sonrası sağ ventrikül fonksiyonları değerlendirildi.

**Hastalar ve Yöntemler:** Mart 2015 - Ocak 2016 tarihleri arasında grad II ve III NP'li toplam 56 hasta (36 erkek, 20 kadın; ort yaş 30±10 yıl; dağılım 19-40 yıl) çalışmaya dahil edildi. Tüm hastalarda cerrahiden önce ve bir ay sonra konvansiyonel ekokardiyografik parametreler, pulmoner arter sistolik basıncı (PASP), triküspit anüler plan sistolik hareketi (TAPSE), sağ ventrikül fraksiyonel alan değişimi (RVFAC) ve pulse oksimetre ile periferik oksijen satürasyonları ölçüldü.

**Bulgular:** Ameliyat sonrası dönemde PASP istatistiksel olarak anlamlı düzeyde azaldı (p=0.003). Sağ ventrikül sistolik parametrelerinden RVFAC ve TAPSE değerleri, FESS sonrası anlamlı düzeyde iyileşme gösterdi (sırasıyla p=0.005 ve p=0.009). Periferik oksijen satürasyonu, ameliyat sonrası dönemde 94.0±0.9'ten, 94.7±0.8'e yükseldi (p=0.005).

**Sonuç:** Çalışma sonuçlarımız NP'li erişkin hastalarda üst solunum yolu tıkanıklığının tedavisinin sağ ventrikül sistolik fonksiyonları iyileştirebileceğini ve PASP değerinde önemli bir azalma sağlayabileceğini göstermektedir.

**Anahtar Sözcükler:** Fonksiyonel endoskopik sinüs cerrahisi; nazal polip; sağ ventrikül fonksiyon.



Nasal polyposis (NP) is a chronic inflammatory pathology with edematous swellings of nasal mucosa characterized by dangling masses into nasal cavities and paranasal sinuses. Nasal polyposis is one of the most common causes of upper airway obstruction in adults and has an incidence about 1-4%.<sup>[1]</sup> Over time, this obstruction causes chronic alveolar hypoxia and hypercapnia leading to increased pulmonary vascular resistance and pulmonary hypertension (PHT).<sup>[2,3]</sup> Unless the pathology leading to PHT is diagnosed and treated, it may consequently result in right ventricular hypertrophy and dilatation, increase in right ventricular (RV) pressure, hepatic congestion, peripheral edema and ascites.<sup>[2,3]</sup> Right ventricular failure is not solely an isolated process. Because of its interaction with the left ventricle, over time it impairs the left ventricular functions leading to systemic disease. As a result, early diagnosis and treatment is important before RV dysfunction develops.

In daily practice, RV functions can be easily and noninvasively evaluated and accurately determined by conventional echocardiographic parameters.<sup>[4]</sup> In our study, we aimed to evaluate the RV functions of NP patients before and after functional endoscopic sinus surgery (FESS).

#### **PATIENTS AND METHODS**

This study was performed between March 2015 - January 2016. Approval for the study was granted by Erzurum Regional Training and Research Hospital Ethical Committee. The study was designed consistent with the principles of Declaration of Helsinki. All of the patients were informed about the study and their written consents were taken. A total of 56 NP patients (36 males, 20 females; mean age 30±10 years; range 19 to 40 years) who were admitted to our otorhinolaryngology clinic with symptoms of nasal congestion, rhinorrhea and snoring, diagnosed by anterior rhinoscopy, rigid endoscopy and coronal plane paranasal sinus tomography were included in the study. These patients had grade II and III NP. The grading was made according to the endoscopic imaging<sup>[5]</sup> as follows: grade 0: No polyps, grade I: Polyp under middle concha, can be seen only by endoscopy, grade II: a protruding polyp under middle concha, can be seen even without endoscopy, grade III: massive polyposis. Endoscopic examination

was performed with a 4 mm rigid, 0-30 degree (Karl-Storz® GmbH&Co. Tuttlingen, Germany) endoscope. The LundMackay system was used for paranasal sinus computed tomography (CT) staging<sup>[6]</sup> In the each sinus side: there was no sinus opacification 0, partial opacification 1, 2 for complete opacification; 0 for osteomeatal complex open, and 2 for obstructed osteomeatal complex. Thus, the highest score for each side was 12, 24 in total.

Patients with known cardiovascular disease, signs of RV failure, pulmonary disease, grade I NP and who had history of another disease such as asthma, aspirin sensitivity and excessive allergic symptoms and findings which cause nasal congestion were excluded from the study.

The study patients were evaluated before, and one month after the surgery. The peripheral oxygen saturation of all patients was measured by pulse oxymeter before, and one month after the surgery. None of the patients were given oral steroids before and after the operation but nasal steroid was used for four weeks before surgery. All cases were operated under general anesthesia by the same surgeon. Patients underwent FESS with conventional instruments.

#### **Surgical procedure**

Each nasal cavity was packed with a piece of gauze pack with adrenaline dissolved in saline in a concentration of 1:200,000 and removed after 15 minutes at the beginning of surgery.

We performed all surgeries under general anesthesia with oral endotracheal tube with the standard anterior to posterior approach for FESS (uncinectomy, middle meatus antrostomy, anterior and posterior ethmoidectomy, sphenoidotomy, skull base clearance, and/or frontal sinus clearance) was done in all the cases. All polypoidal tissue resected was sent for histopathological examination. Septoplasty and concha (inferior and/or middle) surgery was performed for 25 patients. The results of this patients group were not different. Intranasal packing was removed on the first morning after surgery. Postoperatively patients were discharged on the second day and started on normal saline nasal lavage solution. We prescribed postoperative antibiotics and analgesics. Cases were reviewed after one week and one month after surgery.

## Echocardiography

The standard M-mode, 2-D and color flow Doppler echocardiographic measurements of all patients were performed by 2.5 Mhz probe and GE Vingmed Vivid 7 (GE Ultrasound, Horten, Norway) echocardiography machine under ECG monitoring according to the American Society of Echocardiography guidelines.<sup>[7]</sup> Right ventricular transverse diameter, RV systolic and diastolic area were measured from apical four chamber images. Right ventricular systolic and diastolic area were formulized and right ventricular fractional change area (RVFAC) was calculated. The tricuspid annular plane systolic excursion (TAPSE), which is an indicator of RV systolic function, was measured in apical 4 chamber by placing M-mode on RV lateral tricuspid annulus and calculated as the difference between basal and apical systolic motion in millimeters (mm) (Figure 1). Pulmonary artery systolic pressure (PASP) was calculated by simplified Bernoulli equation using tricuspid flow velocity and addition of right atrial pressure (a mean of 5 mmHg) estimated according to the respiratory collapse of the inferior vena cava. The peak early diastolic flow velocity (E), peak late diastolic flow velocity (A) and the ratio of peak early and late flow velocities (E/A) were measured by pulsed-wave (PW Doppler) on tricuspid valve positioning the cursor parallel to the valve.<sup>[8]</sup>

### Statistical analysis

The numerical variables were presented as mean  $\pm$  standard deviation and categorical variables were given as percentages.

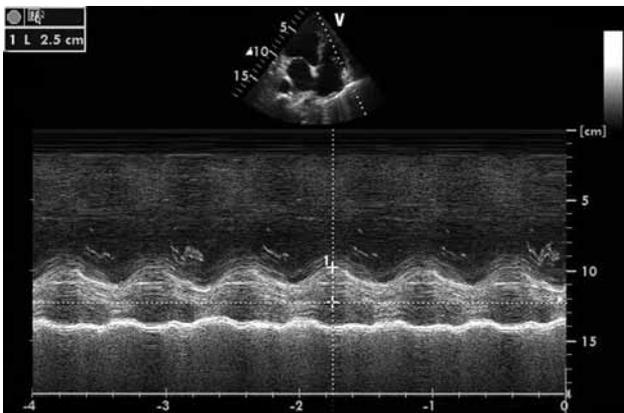


Figure 1. Right ventricular systolic function measuring in apical 4 chamber by placing M-mode.

Kolmogorov-Smirnov test was used for analysis of distribution of variables. All of the continuous variables had normal distribution. Independent-samples t test was used for comparison of pre- and postoperative parametric variables of NP patients. Statistical analysis was performed by IBM SPSS version 20.0 (IBM Corp., Armonk, NY, USA) software package.  $P < 0.05$  was assumed to be statistically significant.

## RESULTS

The basal characteristics of the patients are presented in Table 1. While 22 (39%) of patients had grade II NP, 34 (61%) of them had grade III NP. The mean paranasal sinus CT score was  $18.4 \pm 4.5$  (range 10 to 24).

The pre- and postoperative echocardiographic parameters and oxygen saturation of the patients were demonstrated in Table 2. The right ventricle end-systolic area ( $\text{mm}^2$ ) was found to be significantly decreased in the postoperative period ( $p = 0.042$ ). Similarly, RVFAC (%) increased significantly in the postoperative period ( $p = 0.005$ ). The TAPSE (mm) was detected to be increased significantly after surgery compared to the preoperative period ( $p = 0.009$ ). We found a very significant postoperative decrease in PASP (mmHg) ( $p = 0.003$ ). There was no statistically significant difference regarding other echocardiographic parameters. We found a significant postoperative increase in  $\text{SpO}_2$  measured at room temperature compared to the preoperative values ( $p = 0.005$ ).

## DISCUSSION

Our study showed that RV systolic functions recovered significantly after FESS in patients with NP. In previous studies, it was shown that

Table 1. Basal characteristics of patients with nasal polyposis (n=56)

	n	%	Mean $\pm$ SD
Age (years)			30 $\pm$ 10
Gender			
Male	36	64	
Female	20	36	
Body mass index ( $\text{kg}/\text{m}^2$ )			26.1 $\pm$ 3.2
Grade II nasal polyposis	22	39	
Grade III nasal polyposis	34	61	

SD: Standard deviation.

**Table 2.** Pre- and postoperative echocardiographic parameters and oxygen saturation data of the patients

	Preoperative	Postoperative	<i>p</i>
	Mean±SD	Mean±SD	
Peripheral arterial oxygen saturation	94.0±0.9	94.7±0.8	0.005
Right ventricle end-diastolic area (mm <sup>2</sup> )	16.0±3.2	15.0±2.8	0.042
Right ventricle fractional area change	47.4±4.2	50.6±3.9	0.005
Tricuspid annular plane systolic excursion (mm)	23.7±1.9	25.4±2.7	0.009
Pulmonary arterial systolic pressure (mmHg)	29.5±3.8	26.4±3.8	0.003
Tricuspid E (cm/s)	60.3±11.3	63.9±11.3	0.24
Tricuspid A (cm/s)	47.3±12.5	49.5±10	0.48
Tricuspid E/A	1.3±0.3	1.3±0.2	0.65
Right ventricular diameters (mm)	33±7	32.6±6	0.42

SD: Standard deviation; E: Early diastolic flow velocity; A: Late diastolic flow velocity.

RV functions recovered and pulmonary artery pressure decreased significantly after surgical correction of upper airway obstruction in patients with adenotonsillar hypertrophy, nasal septum deviation and similar pathologies.<sup>[9-12]</sup> To the best of our knowledge, this is the first study in the English literature in which patients operated on for severe NP were evaluated in terms of RV function in the postoperative period.

The cardiovascular complications in NP are due to upper airway obstruction which consequently results in PHT. The hypoxia and hypercapnia due to upper airway obstruction act synergistically and are the major factors leading to pulmonary vasoconstriction. Pulmonary hypertension increases RV pressure and causes RV hypertrophy, dilatation and finally, RV dysfunction.<sup>[12-14]</sup> There is usually a long asymptomatic period until RV dysfunction develops.<sup>[13]</sup> When the patient becomes symptomatic, the process is mostly irreversible. As a result, in patients with upper respiratory tract obstruction, the early assessment of RV functions remains crucial and in patients with signs of RV failure, early surgery can prevent potentially hazardous effects.

After the pathology leading to upper airway obstruction is relieved, chronic alveolar hypoxia, hypoxic pulmonary vasospasm and pulmonary vascular resistance decrease. In our study, we observed that SpO<sub>2</sub> levels increased significantly after nasal polypectomy. We also observed about 3 mmHg decrease in pulmonary artery pressure possibly due to the decrease in hypoxia. In two

similarly designed previous studies, it was shown that on postoperative third month evaluation, there was a mean decrease in pulmonary artery pressure of 4 and 6 mmHg, respectively.<sup>[16-17]</sup> In our study we evaluated the patients during the first month control after surgery. If the follow-up period were longer, we could possibly detect much more decrease in pulmonary artery pressure.

The RVFAC and TAPSE are simple, reproducible, effective and objective echocardiographic parameters in evaluation of RV systolic function in patients with pulmonary hypertension.<sup>[8-11,14-18]</sup> In our study, both TAPSE and RVFAC values were found to be recover significantly in proportion to the decrease in pulmonary artery pressure after FESS. We did not find any significant difference in tricuspid inflow parameters (E, A and E/A) which are the indicators of RV diastolic function.

There are some limitations in our study. The small sample size and relatively short evaluation time after surgery are major limitations. In our study, only the recovery period of the patients after treatment was evaluated. Acoustic rhinometry measurements can also provide more objective results, but this was not possible for technical reasons.

We can conclude that RV systolic functions recover and pulmonary artery pressure decreases after treatment of upper respiratory tract obstruction via FESS in adult patients with NP. However these results need to be confirmed by further studies with larger sample sizes.

### Declaration of conflicting interests

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