Evaluation of right ventricular functions in patients with nasal polyposis: an observational study

Nazal polipozisli hastalarda sağ ventrikül fonksiyonlarının değerlendirilmesi: Gözlemsel bir çalışma

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Abstract

Objective: The aim of this study was to assess the right ventricular functions in patients with nasal polyposis using the strain (S) and strain rate (SR) echocardiography.

Methods: A prospective, cross-sectional observational study was performed. The study included 40 patients with nasal polyposis (NP) (Group 1), and 25 healthy controls (Group 2). The study comprised patients with Stage 2 and Stage 3 nasal obstruction and no symptoms that could be associated with right ventricular heart failure. Longitudinal peak systolic strain (PSS) and peak systolic strain rate (PSSR) were measured from the basal-mid and apical segments of the right ventricle free wall. Student's t-test, Pearson's correlation analysis and Bland-Altman test were used for statistical analysis.

Results: Pulmonary arterial systolic pressure was significantly higher in group 1 than group 2 (31.2±5.8, 19.7±4.3, respectively, p<0.001). PSS and PSSR values at the basal, mid and apical segments of the right ventricular lateral wall of the group I were significantly lower compared to the control group (p<0.001, p=0.002 and p=0.002 for PSS, p=0.003, p<0.001 and p<0.001 for PSSR, respectively). The comparison of Stage 2 and Stage 3 NP patients revealed a significant difference only in the SR measurement of the right ventricular mid segment (p=0.002). There was a significant correlation between the systolic pulmonary arterial pressure (sPAP) and right ventricular S and SR values (p<0.001).

Conclusion: In this study, S/SR echocardiography showed a subclinical deficit of the right ventricular longitudinal functions in patients with NP who are considered to have normal right ventricular functions. *(Anadolu Kardiyol Derg 2013; 13: 251-6)*

Key words: Nasal polyposis, right ventricular functions, strain/strain rate

ÖZET

Amaç: Bu çalışmada amaç nazal polipozisi olan hastalarda sağ ventrikül fonksiyonlarını gerilme/gerilme hızı ekokardiyografi metodları ile değerlendirmektir.

Yöntemler: Çalışma enine kesitli gözlemsel prospektif olarak planlandı. Çalışmaya nazal polipozisli (NP) 40 hasta (Grup 1) ve sağlıklı 25 kontrol grubu (Grup 2) birey alındı. Hasta grubu nazal obstrüksiyonun seviyesi evre 2 ve evre 3 olan ve sağ kalp yetersizliğine bağlı olabilecek herhangi bir semptomu olmayan hastalardan oluşturuldu. Sağ ventrikül serbest duvarının bazal-mid ve apikal segmentlerinden longitüdinal pik sistolik strain (PSS) ve pik sistolik strain rate (PSSR) değerleri ölçüldü. İstatistiksel analizde Student-t test, Pearson korelasyon analizi ve Bland-Altman testi kullanıldı.

Bulgular: Pulmoner arter sistolik basınç Grup 1'de oldukça anlamlı düzeyde daha yüksek bulundu (31.2±5.8, 19.7±4.3, p<0.001). PSS ve PSSR değerleri NP grubunda sağ ventrikül lateral duvarının bazal, mid ve apikal tüm segmentlerinde kontrol grubuna göre oldukça anlamlı derecede düşük bulundu (PSS için sırasıyla; p<0.001, p=0.002 ve p=0.002, PSSR için sırasıyla; p=0.003, p<0.001 and p<0.001). Evre 2 ve evre 3 NP'li hastalar kendi aralarında karşılaştırıldığında ise; yalnızca sağ ventrikül mid-segmenti SR değerinde anlamlı farklılık gözlendi (p=0.02). Sistolik pulmoner arteriyal basınç (sPAP) yüksekliği ile sağ ventrikül S ve SR değerleri arasında oldukça anlamlı düzeyde bir korelasyon olduğu görüldü.

Sonuç: Çalışmamız, sağ ventrikül (SV) fonksiyonları normal olarak kabul edilen NP'li hastalarda S/SR ekokardiyografi ile SV longitüdinal fonksiyonlarında subklinik düzeyde bozulma olduğunu göstermiştir. *(Anadolu Kardiyol Derg 2013; 13: 251-6)*

Anahtar kelimeler: Nazal polipozis, sağ ventrikül fonksiyonları, gerilme/gerilme hızı

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Introduction

Nasal polyposis (NP) is a chronic inflammatory disorder of nasal and sinus mucosa with prominent nature of eosinophilia. This chronic inflammation results in a mass formation originating from mucosa of the sinus and prolapsing mostly through the lumen at the nasal mucosal surface (1). These mass formations leading to nasal obstruction are responsible from the clinical picture. This obstruction may also result in pulmonary hypertension (PH) and cor pulmonale (2). Nasopharyngeal muscles relax during sleep in patients with nasal obstruction. This relaxation increases the upper airway resistance during inspiration, leads to paralaryngeal collapse and hypoventilation, which end up with hypoxia and hypercapnia (3, 4). Chronic hypoxia and hypercapnia cause pulmonary arterial vasoconstriction and PH. If left untreated, this condition may lead to overloading, hypertrophy and dilatation of the right ventricle due to already increased pulmonary vascular resistance and pulmonary arterial pressure, which consequently causes right ventricular (RV) insufficiency and death (5, 6). Thus, early detection and treatment of myocardial disease are essential in such patients to prevent cardiopulmonary complications.

Tissue Doppler Imaging (TDI) is a technique, which is based on the demonstration of the movement of myocardial tissue with the low-frequency and high amplitude by filtering the movements of blood components with high-frequency (7). Strain (S) and strain rate (SR) echocardiography, which have been derived from myocardial colored TDI technique are clinically significant parameters and measure the global and regional myocardial functions rapidly and accurately (8). Studies on S/SR echocardiography techniques to investigate the RV functions have shown that these imaging techniques are convenient and effective in displaying the RV functions (9). They have suggested that S/SR echocardiography detects patients who are missed with conventional echocardiography, at an early subclinical stage.

We thought that, because of the hypoxia, hypoventilation and hypercapnia, right ventricular functions in patients with nasal polyposis could be affected in myocardial tissue level. To our knowledge, this hypothesis has not been confirmed before in the literature.

The aim of this study was to assess the right ventricular functions using S/SR echocardiography parameters in patients with nasal obstruction due to NP for at least one year.

Methods

Study design

A cross-sectional prospective observational trial was performed at Department of Ear, Nose and Throat, in Atatürk University, School of Medicine, Erzurum, Turkey between June 2009 and July 2010.

Patient selection

Consecutive 40 patients (Group 1) who presented with diagnosis of NP and 25 healthy controls (Group 2) were enrolled in the study. The patients younger than 18 years and older than 45 years, those with a nasal pathology obstructing the nasal passage, diabetes mellitus, hypertension, chronic obstructive lung disease, asthma and known coronary artery disease were excluded. Age-and gender-matched controls were recruited from among healthy patients attending the same hospital during the same study period.

Informed consent was received from all patients. The study protocol was approved by the Ethics Committee Atatürk University School of Medicine, Erzurum, Turkey.

Endoscopic examination

Nasal obstruction and NP diagnosis were based on history, symptoms, anterior rhinoscopy findings and endoscopic examination. NP was staged according to endoscopic findings (10) such as Stage 0: No polyps, Stage 1: Mild polyposis, Stage 2: Intermediate polyposis, and Stage 3: Severe polyposis.

For endoscopic examination, 4 mm rigid 0 and 30-degree endoscope (Karl-Storz® GmBH&Co. Tuttlingen, Germany) were used. The study group comprised patients with Stage 2 or 3 nasal obstructions and without any symptoms that could be attributed to right heart failure.

Echocardiography

Echocardiographic measurements of the patients were done in the left lateral position with Vingmed ultrasound system (Vingmed System 7, General Electric, Horten, Norway) using a 2.5 MHz transducer, under single lead electrocardiography monitorization. The measurements were performed, independently, by two cardiologists unaware of the groups. Parasternal long axis and apical four chamber images were recorded according to the recommendations of the American Society for Echocardiography. Parasternal long axis images were used for left ventricular end-diastolic diameter (LVED), left ventricular end systolic diameter (LVES) and left atrial diameter (LA) measurements. Following this left ventricular ejection fraction (LVEF) was calculated using the Teicholz method. Right atrial (RA) and right ventricular diastolic (RV) diameters were measured based on apical four chamber images (11). Systolic pulmonary arterial pressure (sPAP) was calculated with the simplified Bernoulli equation, by adding the right atrial pressure value (10 mmHg) to the value calculated using the tricuspid flow velocity, considering the diameter of vena cava inferior and the level of its collapse resultant from respiration. In the apical four -chamber imaging, pulse wave Doppler sampling volume was placed on the interception point of the right ventricle lateral wall with the tricuspid annulus and the peak systolic myocardial velocity (Sm), diastolic early (Em) and late (Am) wavelengths were recorded (Fig. 1).

Strain/Strain rate imaging

First, the RV free wall was visualized parallel to the transducer in 2-dimensional imaging and the tissue velocity imaging (TVI) function frame rate was considered >100/s. Images were obtained with the minimum possible angle and maximum frame rate, only including the RV free wall. Images including three consecutive sinus beats at end of the expiratory stage were digitally recorded. The colored Doppler myocardial images were analyzed offline using software (EchoPC, GE Vingmed, Horten, Norway). Longitudinal peak systolic strain (PSS) (Fig. 2) and peak systolic strain rate (PSSR) (Fig. 3) were measured at the RV free wall basal-mid and apical segments (12). Distance between the two measured points was chosen as 10 mm. Three segments were analyzed for each individual in both groups. Measurements were performed two times on separate days, and average values were taken. Weak images and segments with an angular difference >30 degrees were excluded from the study.

Statistical analyses

Data were analyzed with SPSS 11.0 (Statistical Package for Social Sciences, SPSS Inc., Chicago, IL, USA). The Kolmogorov-Smirnov test was used to evaluate whether the variables were normally distributed. The continuous variables were expressed as mean±standard deviation; categorical data were expressed as percent (%). Student's t-test was used to compare parametric variables between the patient and control groups, Chi-square test - categorical variables, and Pearson's correlation analysis was used to assess the correlation between pulmonary arterial systolic pressure and S and SR parameters. Inter-observer and intra-observer agreements were assessed by Bland-Altman analysis. A p value <0.05 was considered statistically significant.

Results

Age, gender, body mass index (BMI), and systolic and diastolic blood pressures were similar in both groups. In echocardiographic examination, LVED dimension, interventricular septum (IVS) thickness, LA, RA and RV diameters were similar in both groups. LVEF displayed no difference between the two groups whereas LVED dimension was significantly higher in Group 1 than Group 2; on the other hand, PAPs was significantly higher in Group 1 (p<0.001). The demographic and echocardiographic data for groups were listed in Table 1. TDI findings from the right ventricular lateral wall tricuspid annulus revealed that Sm, Em and Am velocities were similar in both groups (Table 2).

Assessment of strain rate and strain values

PSS and PSSR values from the RV lateral wall basal, mid and apical segments were significantly lower in the NP group compared to the control group. The total rate of segments that could not be examined in patient and control groups was 3% for S and 7% for SR. Moreover, intra-observer and inter-observer variables were computed 5% and 7.2%, respectively. PSS and PSSR values for all segments and their statistical comparisons were demonstrated in Table 3.

Comparison of Stage 2 and Stage 3 NP patients revealed that only the SR value for the RV mid-segment was significantly different (p=0.02); other segments did not show a significant difference in S and SR values (Table 4).

Table 1. Demographic and echocardiographic data of nasal polyposis patients and control subjects

Variables	Group 1 (n=40)	Group 2 (n=25)	*p
Age, years	36±9	38±6	0.41
Gender, M/F	25/15	16/9	0.91
BMI, kg/m^2	25.29±2.4	24.75±2.0	0.35
SBP, mmHg	116±12.9	112.6±11.2	0.28
DBP, mmHg	74.0±7.5	70.8±7.7	0.10
LVDD, mm	46.6±3.9	44.0±4.1	0.01
LVSD, mm	30.2±3.1	28.8±3.5	0.09
IVS, mm	9.43±1.4	9.40±1.3	0.94
LVEF, %	63.2±4.0	64.3±4.6	0.28
LA, mm	34.4±2.7	33.0±2.9	0.09
RA, mm	34.5±4.0	34.8±2.9	0.78
RV, mm	34.6±4.6	35.0±2.7	0.71
sPAP, mmHg	31.2±5.8	19.7±4.3	<0.001

Results are shown as mean±standard deviation and numbers
*Unpaired Students` t-test and Chi-square test
BMI - body mass index, DBP - diastolic blood pressure, F - female,, IVS - interventricular septum, LA - left atrium, LVDD - left ventricular diastolic diameter, LVEF - left ventricular ejection fraction, LVSD - left ventricular systolic diameter, M - male, RA - right atrium, RV - right ventricle, SBP - systolic blood pressure, sPAP - systolic pulmonary artery pressure

Table 2. Tissue Doppler findings of the RV lateral wall tricuspid annulus

Variables	Group 1 (n=40)	Group 2 (n=25)	*p
Sm, cm/s	13.1±1.6	13.2±1.6	0.98
Em, cm/s	12.9±3.4	13.1±3.0	0.77
Am, cm/s	12.3±2.5	13.2±2.1	0.05

Results are shown as mean±standard deviation
*Unpaired Students` t- test
Am - late diastolic myocardial velocity, Em - early diastolic myocardial velocity, RV - right ventricular, Sm - systolic myocardial velocity

Pulmonary arterial pressure level was inversely correlated with RV S and SR values in all segments (Table 5).

Discussion

This study showed a subclinical level of impairment on right ventricular functions with S/SR echocardiographic methods in patients with NP.

Cardiovascular complications of NP are attributed to the chronic upper airway obstruction. Chronic alveolar hypoxia may lead to hypoxemic pulmonary vasoconstriction within time, which may result in hypertension and right ventricular heart failure (6, 13, 14). Chronic upper airway obstruction will increase the pressure load of the right ventricle and this in turn will lead to hypertrophy and subendocardial ischemia by increasing the RV wall tension, which eventually ends up with RV dysfunction (15). Pulmonary hypertension may not be an early sign. Fuster et al. (16) reported that the mean time from initial symptoms to diagnosis was 1.9 years in patients with PH. Thus, early diagnosis is of utmost importance in such patients.

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Table 3. Peak systolic strain and strain rate values of the right ventricular lateral wall

	Peak systolic strain (%)			Peak systolic strain rate (/s)		
	Group 1 (n=40)	Group 2 (n=25)	*p	Group 1 (n=40)	Group 2 (n=25)	*p
Basal	-19.6±3.0	-22.9±2.60	<0.001	-2.16±0.32	-2.44±0.40	0.003
Mid	-22.0±2.90	-24.2±2.30	0.002	-2.12±0.33	-2.44±0.35	<0.001
Apical	-20.7±3.50	-23.4±2.80	0.002	-2.11±0.38	-2.51±0.32	<0.001

Results are shown as mean±standard deviation
*Unpaired Students` t-test

Table 4. Peak systolic strain and strain rate values of the right ventricular lateral wall in Stage 2 and Stage 3 nasal polyposis patients

	Peak systolic strain (%)			Peak systolic strain rate (/s)		
	Stage 2 (n=25)		*p	Stage 3 (n=15)		*p
Basal	-20.4±3.90	-18.9±2.0	0.12	-2.26±0.36	-2.09±0.27	0.1
Mid	-22.8±2.90	-21.3±2.70	0.1	-2.25±0.33	-2.09±0.27	0.019
Apical	-21.0±3.20	-20.4±3.80	0.58	-2.16±0.42	-2.07±0.36	0.46

Results are shown as mean±standard deviation
*Unpaired Students` t-test

Table 5. Correlation between pulmonary arterial pressure and right ventricular lateral wall peak systolic strain and peak systolic strain rate

Pulmonary arterial pressure	*R	*p
Basal RV PSS	-0.55	<0.001
Mid RV PSS	-0.45	<0.001
Apical RV PSS	-0.40	0.001
Basal RV PSSR	-0.49	<0.001
Mid RV PSSR	-0.55	<0.001
Apical RV PSSR	-0.49	<0.001

*Pearson's correlation analysis
PSS - peak systolic strain, PSSR - peak systolic strain rate, RV - right ventricle

Echocardiography is the method of choice to assess RV functions in daily practice. Studies assessing RV functions have shown that the TDI technique is practical and handy, and has potential value (17, 18). However, TDI has some limitations such as the negative effect on velocity of the increasing distance between the heart and the probe due to the elongation of the myocardium, transfer of active and passive deformation in neighboring segments and respiration (8). S and SR techniques have been developed from tissue Doppler velocities to overcome those problems. Recent studies have suggested that S/SR echocardiography methods are superior to tissue Doppler velocities in assessing myocardial functions (19-21). The assessment of RV longitudinal functions in our study revealed that while the Sm, Em and Am values did not display a significant difference between the patient and the control groups in the tissue Doppler arm, S/SR parameters revealed that the RV functions were significantly decreased in the patient group compared to the control patients.

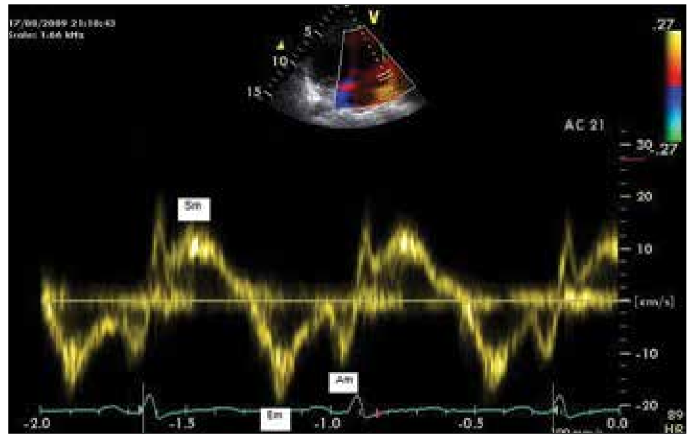

Figure 1. Tissue Doppler imaging of the right ventricular lateral wall tricuspid annulus in a patient with nasal polyposis
Am - late diastolic myocardial velocity. Em - early diastolic myocardial velocity, Sm - systolic myocardial velocity

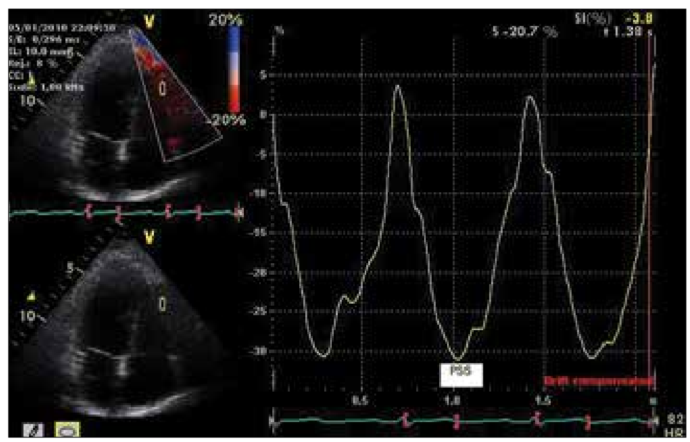

Figure 2. Peak systolic strain (PSS) measurement of the right ventricular lateral wall mid segment in a patient with nasal polyposis

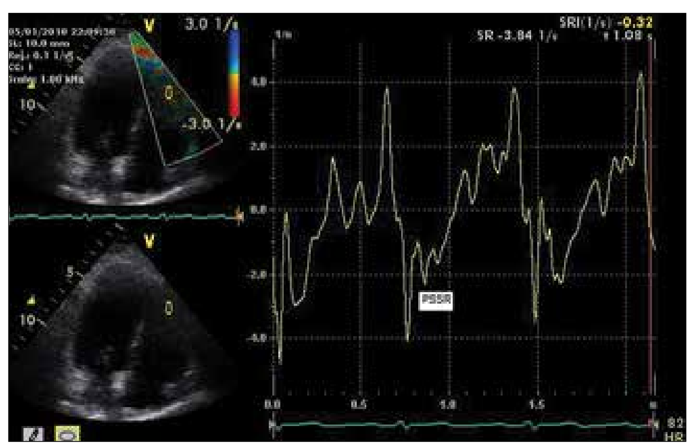

Figure 3. Peak systolic strain rate (PSSR) measurement of the right ventricular lateral wall mid segment in a patient with nasal polyposis

Although the PAPs values of the patients were intermediately increased (31.2±5.8) in our study group, they had no symptom attributable to RV insufficiency. Moreover, RA and RV diameters were within normal range in conventional echocardiography (34.6±4.6 mm and 34.5±4.0 mm respectively). Our patient and control groups had similar clinical and conventional echocardiographic findings. However, examination with S/SR echocardiography revealed a subclinical dysfunction in the patient group. Moreover, there was a significant negative correlation between the PAPs and S/SR values in the RV basal-mid and apical segments. In other words, S/SR values decreased as the PAPs increased. Early detection of such findings may be fundamental for the treatment of patients with NP.

Studies about the value of S/SR echocardiography techniques to assess RV functions have reported that these methods are practical and effective to show RV functions. Vitarelli et al. (22) categorized patients with obstructive lung disease and PH according to their PAPs values as Group 1 (<35 mmHg) and Group 2 (>35 mmHg) and compared them with healthy controls. They found that the decrease in RV S/SR values were correlated with the extent of PAPs and pulmonary function test results and they suggested that S/SR values might be clinical prognostic markers of RV insufficiency. Lopez-Candales et al. (23) reported that the RV longitudinal free wall S values were significantly decreased in patients with a high mean pulmonary arterial pressure (78±24 mmHg) compared to healthy individuals. A review by Gondi et al. (9) on the clinical usefulness of RV TDI suggested that all data obtained by comparing various patient populations revealed that TDI was an acceptable, reproducible and practical additional echocardiographic parameter in assessing RV systolic and diastolic functions. However, they suggested that such patients had subclinical conditions that could not be detected with conventional echocardiography.

Study limitations

Similar to previous studies, the major limitation in our study was angle dependence and artifacts. The angle difference increases from the basis to the apical part of the heart. The amount of deformation increases when the angle difference exceeds 30 degrees. We took care to keep the tissue direction less than 30 degrees and parallel to ultrasound waves. Besides, we tried to keep the frame rates high to decrease the margin of error. Lack of magnetic resonance imaging and/or invasive techniques, which are considered the gold standard in the assessment of RV functions, is another major limitation. However, studies have shown that S/SR parameters correlate well with invasive hemodynamic parameters. Other limitation is relatively small number of patients included in this study.

Conclusion

The results of our study suggest that NP patients who are clinically asymptomatic and have normal RV functions with conventional echocardiography have subclinical RV longitudinal dysfunction with S/SR echocardiography. S/SR echocardiography may be used as a reliable determinant of RV systolic functions in patients with no right heart failure findings.

Conflict of interest: None declared.

Peer-review: Externally peer-reviewed.

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Kalbi mecruha haber verme sakın yaresini
Koyuver çırpına dursun arasın çaresini
Bozma gel! hasta ile hastalığın aresini
Belki Allah yaratır çaresizin çaresini.

Na ümit etme tabip hastayı dermanından
İhtiraz üzre bulun his eyle iz'anından
Kesmez ümidini kul rabbinin ihsanından
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