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Research Article

The effect of nasal septum deviation on subclinical cardiac autonomic dysfunction

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ABSTRACT

Background: Nasal septum deviation is one of the most frequently encountered nasal pathology in otorhinolaryngology clinics. Disease with a high comorbidity such as obstructive sleep apnea syndrome (OSAS), among whose etiology septum deviation takes place, can cause subclinical pathologies like atrial fibrillation. The main objective of this study was to determine the effect of nasal septum deviation on subclinical cardiac pathologies.
Methods: The study included a total of 80 patients which were a group of 40 patients who admitted to the otorhinolaryngology department with a complaint of nasal obstruction and were diagnosed as having nasal septum deviation and a control group of 40 patients who admitted to the same department with complaints other than nasal obstruction and had no nasal septum deviation for the period of April 2015-August 2015. Initially, all patients were performed rhinomanometric measurement and then the patients were required to grade their symptoms of nasal obstruction using a 10-unit visual analog scale (VAS). Following that, patients were performed to transthoracic echocardiography by cardiology department and all the results were compared between two groups.
Results: In the patient group while the VAS and transnasal pressure were found meaningful higher, the transnasal flow was found meaningful lower than the control group. In the patient group PA septum, PA tricuspide, PA lateral-tricuspide, PA septum-tricuspide values were found meaningful higher than the control group. In the patient group left atrium width (LA), LA volume maximum, LA volume minimum and LA volume p values, which show the size of left atrium, were found meaningful high in comparison to the control group.
Conclusions: As a result of the data obtained from this study, the research demonstrates that nasal septum deviation can cause subclinical cardiac pathologies such as atrial fibrillation and these pathologies can be detected with noninvasive methods such as echocardiography.

Keywords: Nasal septum deviation, Atrial fibrillation, Echocardiography, Rhinomanometry

INTRODUCTION

Nasal obstruction is a common complaint in otorhinolaryngology practice, mostly caused by nasal septum deviation (NSD).[1] NSD is a deformity occurring in the rigid roof of the septum which includes the bone and cartilage that divides the nasal cavity in half, mostly leading to difficulty breathing induced by nasal obstruction.[1,2] Diagnostic methods including endoscopic nasal evaluation, nasal mucociliary transport time, computed tomography, magnetic resonance imaging, rhinomanometry, acoustic rhinometry, and rhinostereometry are also used in the evaluation of nasal obstruction.[3,4] Rhinomanometry allows the measurement of transnasal pressure and nasal air flow. Airflow occurs as a result of the pressure difference across the nose during inspiration and expiration. Nasal airflow increases with the increase in transnasal pressure. The amount of pressure required to enable airflow increases with the severity of nasal obstruction.[4,5]

NSD is one of the most common causes of upper respiratory tract obstructions.[2] Upper respiratory tract obstructions have been shown to be associated with cardiac rhythm and autonomic disorders.[6,7]

In this study, we aimed to evaluate nasal obstruction in NSD patients who have no systemic disease or additional health problems by using VAS and rhinomanometry and also to demonstrate the co-occurrence of NSD and tendency to atrial fibrillation, which is a major cardiac pathology, by using echocardiography and surface electrocardiography.

METHODS

The study was conducted after obtaining a formal approval from the Abant Izzet Baysal University medical school clinical and laboratory ethics committee, dated April 30, 2015 with the approval number 2015/22-39.

The study included a patient group of 40 patients (13 women and 27 men) aged between 18-50 years who presented to the Abant Izzet Baysal University Medical School Otorhinolaryngology Department with a complaint of nasal obstruction and were diagnosed as having nasal septum deviation and a control group of 40 patients (21 women and 19 men) who presented to the same department with complaints other than nasal obstruction and had no nasal septum deviation for the period of April 2015-August 2015. An informed written consent was obtained from each participant.

Initial otorhinolaryngological examination was performed and patient anamneses were recorded by the same otorhinolaryngologist. The exclusion criteria were as follows: history of cardiac and/or systemic disease at presentation, continuous drug use, and aged younger than 18 and older than 50 years. Moreover, the patients presenting with pathologies causing nasal obstruction in the initial examination and anamnesis such as chronic sinusitis, nasal polyposis, allergic rhinitis, adenoid vegetation, concha bullosa, and radiation-induced mucosal atrophy, or history of surgery were excluded from the study. Anterior rhinoscopy and endoscopic nasal evaluation were performed for the patients with a minimum of 3-months history of nasal obstruction.

Prior to the rhinomanometric measurement, the patients were required to grade their symptoms of nasal obstruction using a 10-unit visual analog scale (VAS). The patients were explained that the “0” in the scale indicates “a clear nose” and “10” indicates “complete nasal obstruction”. The VAS scores were recorded prior to rhinomanometry.

Objective evaluation of the nasal airway was performed using a rhinomanometry device (SRE2000 rhino metrics; interacoustics AS-DK-5610 Assens, Denmark) with the rhino stream software. All the measurements were performed in a quiet room with a constant temperature at 24°C. Prior to rhinomanometry, the patients stayed in the room for 30 minutes in order to adapt to the temperature and humidity in the room. The device was recalibrated before each measurement. The nasal probes were selected as appropriate for the nostrils of each patient. The patient was placed on a comfortable chair to achieve a sufficiently upright position, with the otorhinolaryngologist sitting opposite him /her. The nasal probe was inserted without impairing the anatomy of the nostrils. Afterwards, the patient was required to perform nasal breathing by keeping his/her mouth closed. At that time, multiple measurements were performed following the appearance of the green light on the computer screen which indicated the absence of conduction failure and the mean rates were calculated for the measurements. During the measurements, the airflows and pressures of the right and left nasal passages on expiration and inspiration were separately measured and the rates were recorded. The measurements were separately performed for each nasal passage.

Following the initial otorhinolaryngological examination, all the patients were transferred to the cardiology department for transthoracic echocardiography. In both groups, echocardiographic examination was performed by the same physician using a GE Vivid-S6 system (GE Vingmed, Horten, Norway) device with a 2-4 MHz probe. The echocardiographic examination was conducted using suitable echocardiographic windows with the patient in the supine position or on the left side. The time interval between the onset of P-wave on the electrocardiography (ECG) and the beginning of the late diastolic wave (Am wave) on tissue doppler trace, which is named PA, was obtained from the lateral mitral annulus (lateral PA), septal mitral annulus (septal PA), and right ventricular (RV) tricuspid annulus. The difference between lateral and tricuspid PA (lateral PA - tricuspid PA) was defined as inter-atrial electromechanical delay and the difference between septal PA and tricuspid PA (septal PA – tricuspid PA) was defined as intra-atrial electromechanical delay.

In the evaluation of the surface ECG, the left atrial (LA) end-systolic volume was defined as “maximum LA volume”, the LA end-diastolic volume was defined as “minimum LA volume”, and the LA volume at the P-wave that indicates the stimulation of the atrium was defined as “LA volume P-wave”. All the values were recorded and used for statistical analysis.

All the data in the study were analyzed using SPSS 17.0 for Windows (SPSS Inc., Chicago, IL, USA). Distribution of numerical data was assessed using the Kolmogorov-Smirnov test. Data were expressed as mean±standard deviation (SD). Differences between the repeated measurements obtained in the pre and post-treatment periods were assessed using the repeated measures analysis of variances (ANOVA). The study and control groups were compared using the Mann-Whitney U test. A p value less than 0.05 was considered significant in all measurements.

RESULTS

The 80 participants comprised two groups: (I) patient group (n=40) and control group (n=40). The patient group included13 (22.5%) women and 27 (67.5%) men with a mean age of 27.60±6.59 (range, 18-46) years and the control group included 21 (52.5%) women and 19 (47.5%) men with a mean age of 29.88±4.67 (range, 22-37) years. Mean Body Mass Index (BMI) was 23.61±4.22 in the patient group and 23.82±3.53 in the control group.

In the comparison of the groups, no significant difference was found between the groups in terms of age and BMI (p=0.079, p=0.810, respectively). Smoking and non-smoking rates were 42.5% (n=17) and 57.5% (n=23) in the patient group and 52.5 (n=21) and 47.5 (n=19) in the control group, respectively. In both groups, no significant correlation was found regarding the status of smoking (p=0.374). Nasal obstruction was on the right nasal passage in 15 (37.5%), on the left passage in 15 (37.5%), and on both passages in 10 (25%) patients.

The severity of nasal obstruction was assessed using a 10-unit VAS, in which “0” corresponds to “a clear nose” and “10” indicates “complete nasal obstruction”. Table 1 presents the mean VAS scores obtained for the right and left passages in both groups. The VAS scores were significantly higher in the patient group and the scores established a significant difference for both nasal passages (p=0.000).

Table 1: Mean VAS scores for the right and left passages in patient and control group.

Nasal passage	Right nasal passage	Left nasal passage
Mean VAS score patient group	6.80 ± 2.62	7.15 ± 2.65
Mean VAS score control group	2.00±1.03	1.55 ± 0.98
"p" value	<0.001	<0.001

The rhinomanometric evaluation included the measurement of the transnasal pressure and nasal airflow rates during expiration and inspiration for both nasal passages. The results are presented in Table 2. The transnasal pressure in both nasal passages was higher in the patient group compared to the control group and established a significant difference between the groups (p=0.000). Similarly, the nasal airflow in both nasal passages established a significant difference between the groups and was lower in the patient group compared to the control group (p=0.000).

Table 2: Mean transnasal pressure and nasal airflow rates during expiration and inspiration in the right and left nasal passages in the patient and control group.

	Right nasal passage			Left nasal passage		
	Patient group	Control group	"p" value	Patient group	Control group	"p" value
Transnasal pressure during inspiration (Pa s/cm^3)	1.48±0.83	0.60±0.17	<0.001	1.40± 0.70	0.59± 0.14	<0.001
Nasal airflow rates during inspiration (s/cm^3)	131.50±80.54	262.66±65.37	<0.001	139.74±92.49	266.19±58.39	<0.001
Transnasal pressure during expiration (Pa s/cm^3)	1.56±0.84	0.60±0.21	<0.001	1.46±0.81	0.60±0.17	<0.001
Nasal airflow rates during expiration (s/cm^3)	125.78±78.09	259.65±62.03	<0.001	144.29±90.26	263.05±5781	<0.001

Mean rates for left ventricular end-diastolic dimension (LVDD), left ventricular end-systolic dimension (LVSD), interventricular septum (IVS) thickness, posterior wall (PW) thickness, and left atrial (LA) volume measured by echocardiography are presented in Table 3. LVDD, LVSD, IVS, and PW established no significant difference between the patient and control groups (p=0.235, p=0.45, p=0.44, p=0.21, respectively), whereas LA volume was significantly higher in the patient group compared to the control group (p=0.025).

The mean rates for other echocardiographic parameters including PA lateral, PA septum, PA tricuspid, PA lateral-tricuspid, and PA septum-tricuspid in Table 4 and these are also shown in Figure 1 as graphical. Of these, PA lateral established no significant difference between the patient and control groups, whereas PA septum, PA tricuspid, PA lateral-tricuspid, and PA septum-tricuspid established a significant difference between the groups (p=0.021, p=0.033, p=0.007, p=0.021, respectively). These results suggest that both inter-atrial and intra-atrial conduction times were delayed in the patient group and this difference was significant compared to the control group.

Table 3: Mean rates for left ventricular end-diastolic dimension (LVDD), left ventricular end-systolic dimension (LVSD), interventricular septum (IVS) thickness, posterior wall (PW) thickness, and left atrial (LA) volume in the patient and control groups.

	Patient group	Control group	"p" value
LVDD	46.86±4.50	54.65±4.06	0.235
LVSD	29.35±4.27	28.43±6.59	0.45
IVS	8.53±1.24	8.30±1.36	0.44
PW	8.45±1.26	8.78±1.07	0.21
LA	33.43±3.28	31.63±3.76	0.025

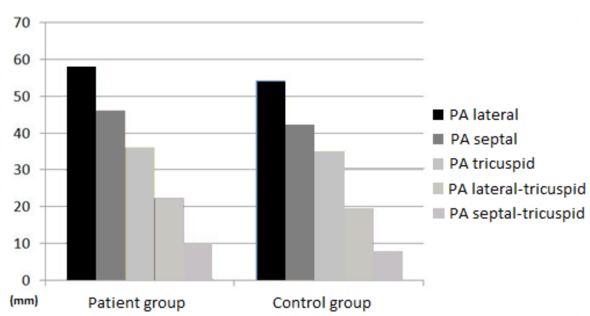

Figure 1: Graphical demonstration of PA lateral, PA septum, PA tricuspid, PA lateral-tricuspid and PA septum-tricuspid rates in the patient and control groups.

Table 4: Mean PA lateral, PA septum, PA tricuspid, PA lateral-tricuspid and PA septum-tricuspid rates in the patient and control groups.

	Patient group	Control group	"p" value
PA lateral	58.48±14.11	54.25±6.61	0.092
PA septum	46.15±8.86	42.53±3.85	0.021
PA tricuspid	36.25±6.53	35.00±4.84	0.033
PA lateral-tricuspid	22.40±8.53	19.25±6.66	0.007
PA septum-tricuspid	9.75±4.90	7.53±3.35	0.021

The rates for LA volume are presented in Table 5 and also shown in Figure 2 as graphical. Of these, maximum LA volume, minimum LA volume, and LA volume P-wave established a significant difference between the patient and control groups (p=0.00, p=0.00, p=0.00, respectively). These results indicate that the LA volume rates were significantly higher in the patient group compared to the control group.

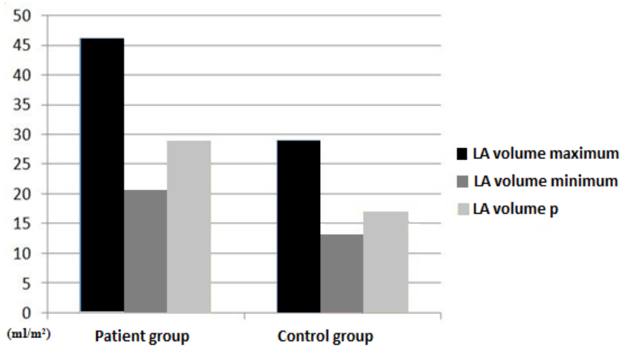

Figure 2: Graphical demonstration of maximum LA volume, minimum LA volume, and LA volume p-wave rates in the patient and control groups.

Table 5: Mean maximum LA volume, minimum LA volume, and LA volume p-wave rates in the patient and control groups.

	Patient group	Control group	"p" value
LA maximum	46.25±13.65	29.03±7.16	<0.001
LA minimum	20.68±6.75	13.08±3.39	<0.001
LA volume p	28.93±9.33	16.95±4.92	<0.001

DISCUSSION

Nasal septum deviation (NSD) is a common seen pathology in otorhinolaryngology practice. Patients with NSD commonly present with nasal obstruction and difficulty breathing induced by nasal obstruction.[2] The primary step in the evaluation of nasal obstruction is obtaining a detailed patient history followed by otorhinolaryngological examination. In addition, subjective and objective tests can also be used in the evaluation of nasal obstruction. Of the subjective tests, visual analog scale (VAS) is the most common used test. VAS has been used in the assessment of numerous subjective characteristics, primarily including nasal obstruction and nasal drainage, nasal pruritus, sneezing, and eye symptoms.[8,9] VAS is a self-report scale in which the patients are required to grade nasal obstruction from 0 to 10, where "0" indicates "a clear nose" and "10" indicates "complete nasal obstruction". VAS has been used in numerous studies for the evaluation of nasal obstruction.[8,9] In our study, the VAS scores were significantly higher in the patient group compared to the control group compatible with literature, suggesting that VAS can be a useful tool in the evaluation of nasal obstruction in clinical practice.

Rhinomanometry plays a key role in the objective evaluation of the patients presenting with the complaint of nasal obstruction; however, it is mostly used in clinical practice.[10] Rhinomanometry allows the assessment of transnasal pressure and transnasal airflow. Airflow occurs as a result of the pressure difference across the nose during inspiration and expiration. Nasal airflow increases with the increase in transnasal pressure. The amount of pressure required to enable airflow increases with the severity of nasal obstruction.[4,5] In addition, the curve gets closer to the pressure axis as the pressure/airflow ratio increases. Suzina et al investigated a clinical study on 112 patients with nasal pathology and 88 patients with no nasal pathology that rhinomanometry was a sensitive test for nasal obstructions and effective in assessing nasal airflow resistance but it failed to associate the abnormalities with the symptom of nasal obstruction.[4] Similarly, Szucs et al investigated the affectivity of acoustic rhinometry with that of rhinomanometry in a study group of 50 patients with NSD and a control group of 15 subjects and they divided 50 patients into three groups (anterior, middle, and posterior) according to the distance between the location of septal deviation and columella.[5] The study concluded that both acoustic rhinometry and rhinomanometry are useful diagnostic tools since they provide numerical description of nasal airway resistance and they were adequately sensitive to assess severe deviations in the anterior nasal cavity. However, the study revealed that acoustic rhinometry and rhinomanometry were less sensitive in patients with middle and posterior deviations and VAS established a better correlation with nasal airway resistance (NAR) than with minimal cross-sectional area (MCA). In our study, a significant difference was found between the patient and control groups in terms of the transnasal pressure for both nasal passages. Moreover, the pressure rates in the patient group were higher than those in the control group (p=0.000) and the transnasal airflow for both passages was significantly lower in the patient group compared to the control group (p=0.00). In line with the literature, our results suggest that the patients with NSD had higher transnasal pressure and lower transnasal airflow compared to the control group. Rhinomanometry provides detailed and objective data on the NSD patients that are unaware of the disease or remain asymptomatic. In rhinomanometric assessment, patients with NSD are detected with high transnasal pressure and low nasal air flow. Rhinomanometry, despite being costly and difficult to implement and requiring patient compliance, is a useful tool in clinical practice since it provides objective and reliable results.[4,5,8,11]

Nasal septum deviation (NSD) is one of the most common causes of upper respiratory tract obstructions.[12] Patients with NSD usually breathe through their mouth, especially during night. This condition may lead to poor oxygenation in the lungs and increased rate of breathing. As a result, the tidal volume with each breath is increased since the volume of the dead space is not changed.[13] Accordingly, increased rate of breathing leads to poor gas exchange, particularly during night. Ultimately, upper respiratory tract obstruction may lead to various disorders such as hypoxia, hypercapnia, increased intrathoracic pressure, and abnormal humoral, neuro-humoral and autonomic responses.[14,15] Therefore, patients with NSD have a tendency for severe pulmonary and cardiovascular disorders.[16] Upper respiratory tract obstruction has been shown to cause cardiac complications by the studies using electrocardiographic, echocardiographic, and scintigraphic methods.[16,17] NSD is a major cause of impaired breathing function, and the co-occurrence of NSD and upper respiratory tract obstructive diseases, particularly obstructive sleep apnea, has been shown in numerous studies.[18-20] Lavie and Zwillich conducted two studies in which they performed otorhinolaryngological evaluation on the mechanical occlusion of nasal passages in 10 healthy subjects.[18,19] The authors monitored the subjects by using polysomnography for a certain period of time and reported that the subjects had normal sleep throughout this period but after this period they had a marked increase in the number of central and obstructive apneas during sleep due to the obstruction of their nostrils. Nasal obstruction has been shown to cause significant increase in the number of apneas during sleep, in the incidence of nonapneic respiratory events, and in the period of vigilance while sleeping.[21] Olsen investigated respiratory and sleep disorders that occur secondary to nasal obstruction in 8 normal subjects by using an acute nasal obstruction method that did not stimulate the nasal receptors.[20] The author found significant increase in partial and total obstructive respiratory events and this result supports the view that the airflow dynamics are of prime importance for obstructive sleep apnea. These studies support the hypothesis that increased nasal resistance is a major cause of OSAS. Moreover, OSAS has been shown to be associated with diabetes, hypertension, coronary artery disease, myocardial infarction, congestive heart failure, right and left ventricular dysfunction, arrhythmia, and cerebrovascular diseases.[22,23] Atrial fibrillation (AF) is the most common form of arrhythmia encountered in clinical practice.[24] Studies have shown that the high rate of AF in OSAS patients indicates the co-occurrence of these two conditions.[24-27] However, the exact mechanism of AF predisposition in OSAS patients remains unknown. Prolonged intra- and inter-atrial conduction times and inhomogeneous propagation of sinus impulses are common electrophysiological features in AF cases.[28,29]

Yagmur et al investigated electromechanical delay and effective factors in OSAS patients by performing surface electrocardiography in 64 patients with moderate-to-severe OSAS (apnea-hypopnea index [AHI], $\geq$15) and 39 healthy volunteers (AHI, $\leq$5).[24] The study revealed that LA diameter, LA volume index, PA lateral, and PA septum were significantly higher in the OSAS group compared to the control group and also intra- and inter-atrial electromechanical delays were significantly higher in the OSAS group than in the control group. The authors also concluded that the OSAS patients with an AHI of 15 or greater are have a tendency for atrial fibrillation, which is a subclinical cardiac pathology.[25] The study performed by Can et al was the first clinical report on the effect of P-wave dispersion in OSAS patients and the study divided 67 patients based on their AHI scores following polysomnography: group I; patients with an AHI of <5 and diagnosed as OSAS, group II; patients with an AHI between 5-30; group III; patients with an AHI of >30.[26] All the patients underwent echocardiography and surface electrocardiography and the results indicated that P-wave dispersion was positively correlated with AHI, BMI and mitral early diastolic to late diastolic velocity (E/A) ratio. Moreover, P-wave dispersion was significantly higher in the patients with OSAS compared to patients without OSAS and the study also revealed that the P-wave dispersion for the patients with moderate and severe OSAS were 68.7±6.4 and 67.1±10.8, respectively. In addition to this, Yagmur et al reported that the P-wave value in the OSAS group was 46.09±13.40.[25] Interestingly, in both studies, the P-wave values of the study groups were significantly higher compared to the control groups. These results suggest that the patients in both studies have a tendency for atrial arrhythmia.[25,26] In our study, LVDD, LVSD, IVS thickness, and PW thickness were compared between patients with NSD and the control group with using echocardiography and electrocardiography and no significant difference was found between the groups. Nevertheless, the LA volume established a significant difference between the groups and was higher in the patient group compared to the control group. Moreover, PA septum, PA tricuspid, PA lateral-tricuspid, and PA septum-tricuspid established a significant difference between the groups (p=0.021, p=0.033, p=0.007, p=0.021, respectively), whereas no significant difference was found between the groups in terms of PA lateral (p=0.092). These results suggest that both inter-atrial and intra-atrial conduction times were delayed in the patient group and this difference was significant compared to the control group. The measurements of LA volume revealed that maximum LA volume, minimum LA volume, and LA volume P-wave established a significant difference between the patient and control groups (p=0.00, p=0.00, p=0.00, respectively). These results demonstrate that the LA volume rates were significantly higher in the patient group compared to the control group.

In this study, to contribute to the previous studies reporting on the tendency of OSAS patients for atrial fibrillation induced by intra- and inter-atrial delays, we performed a preliminary analysis with echocardiography and surface electrocardiography on the tendency of the NSD patients with no systemic diseases including OSAS and other health problems for atrial fibrillation which is a major subclinical cardiac pathology. In a subsequent study, we are planning to evaluate the echocardiography and surface electrocardiography results in NSD patients following the correction of nasal pathology by endonasal surgery, in order to compare these results with the results obtained in the initial study and to investigate the effectivity of endonasal surgery on the reduction of the risk of cardiac dysfunction.

CONCLUSION

In conclusion, the results revealed that nasal septum deviation may show tendency for important adverse cardiac effect in addition to airway symptoms and this tendency can be detected by noninvasive methods such as echocardiography.

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Ethical approval: The study was approved by Abant Izzet Baysal University Medical School Clinical and Laboratory Ethics Committee, dated April 30, 2015, 2015 with the approval number 2015/22-39

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