Eur Arch Otorhinolaryngol (2010) 267:73–76
DOI 10.1007/s00405-009-1055-z

RHINOLOGY

Parasympathetic overactivity in patients with nasal septum deformities

Baran Acar · Bunyamin Yavuz · Hayriye Karabulut · Emre Gunbey · Mehmet Ali Bababemez · Ahmet Arif Yalcin · Murat Karaşen

Received: 5 December 2008 / Accepted: 10 July 2009 / Published online: 24 July 2009

Abstract Nasal septum deformities (NSD) are one of the most frequent reasons for nasal obstruction presented with a reduction in nasal airflow and chronic mucosal irritation. Nasocardiac reflex which includes afferent stimulus with maxillary division of the trigeminal nerve and the efferent pathway of the heart via the vagus nerve is not a well-known part of autonomic nervous system (ANS). Heart rate variability (HRV) is a parameter reflecting the ANS activity on heart. The purpose of this study is to evaluate ANS functions in patients with NSD by HRV analysis. Twenty-nine patients with NSD and 26 control subjects were included in the study. The diagnosis of NSD was made with history, symptoms, anterior rhinoscopy, and nasal endoscopic examination. 24-h ambulatory electrocardiographic recording was performed by a 3-channel recorder. HRV parameters were obtained by analyzing these parameters. Baseline features were similar in patients and controls (mean age: 31 ± 8 in the patients, 32 ± 9 in control subjects; P = NS). Night-RMSSD (the square root of square of mean square differences of successive NN intervals) (47 ± 21, 34 ± 13; $P = 0.008$), night-PNN50 (the number of interval differences of successive NN intervals greater than 50 ms) (24 ± 16, 14 ± 10; $P = 0.007$), 24-h-RMSSD (39 ± 18, 27 ± 12; $P = 0.004$), and 24-h-PNN50 (16 ± 12, 9 ± 7; $P = 0.016$) were significantly higher in patients than controls. Other HRV parameters were not significantly different between two groups. Changes in these parameters demonstrated an increased parasympathetic tone and discordance in sympatho-vagal activity in NSD.

Keywords Nasal septum deformities · Heart rate variability · Sympatho-vagal activity

Introduction

Patients with nasal septum deformities (NSD) constitute a large group of patients with nasal obstruction. These deformities may cause reduction in nasal airflow, chronic mucosal irritation, and postnasal discharge. Nasal obstruction leads to sinusitis, epistaxis, snoring, upper airway infection, and various middle ear infections [1].

We hypothesized that reduction in nasal airflow and mucosal irritation resulting in vagal stimulation in patients with NSD may influence the autonomic nervous system (ANS) activities. To test this hypothesis we performed heart rate variability (HRV) analysis at patients with NSD.

Heart rate variability analysis has been extensively used to evaluate autonomic modulation of sinus node. It has been shown to reflect the sympatho-vagal balance in autonomic control of cardiovascular system and used previously to define the role of ANS activity in cardiovascular disorders [2].

The aim of this study was to evaluate sympatho-vagal activity as assessed by the HRV of 24-h ambulatory Holter recordings in patients with NSD.

B. Acar (✉) · H. Karabulut · E. Gunbey · M. A. Bababemez · M. Karaşen
Department of Otorhinolaryngology, Kecioren Training and Research Hospital, Pınarbaşı Mahallesi Sanatoryum Caddesi Ardahan Sok. No. 1, Keçiören, 06310 Ankara, Turkey
e-mail: drbaranacar@gmail.com

B. Yavuz · A. A. Yalcin
Department of Cardiology, Kecioren Training and Research Hospital, Ankara, Turkey

Methods

Study group

Twenty-nine consecutive patients (8 females and 21 males; mean age 31 ± 8 years) with a diagnosis of severe NSD and 26 age-matched healthy control subjects (10 females and 16 males; mean age 32 ± 9 years) without NSD were enrolled in the study. No subjects had obvious cardiac and autonomic neuropathic findings. They had no smoking, drug therapy, and alcohol. All subjects underwent detailed otorhinolaryngological examination, including flexible nasopharyngoscopy and the Müller maneuver. Patients with concomitant disease such as conchal pathology (hypertrophy and bullosa), allergic rhinitis, and infection were excluded from the study. Skin prick tests were performed by experienced allergologists for allergic rhinitis. We also excluded patients who have an obstruction in velum, tonsils, and tongue position (stage 2 and 3 in Dreher A classification).

Nasal septum deformities were evaluated by an otolaryngologist according to Dreher classification [3]. According to this classification, the relative degree of the septum deviation was estimated and classified into four categories: 0 no deviation, 1 slight deviation, 2 moderate deviation, and 3 severe deviation. The patients with third degree (severe) septum deviation had chronic mucosal contact; therefore, we just included third degree (severe) septum deviation in this study.

Twenty-four-hour Holter monitoring was performed to all subjects. Recordings were obtained using 3-channel analog recorders and analyzed using the DMS 300-7L Holter system (Nevada, USA). Cardioscan premier DM Holter software was used to calculate HRV parameters. The investigators who analyzed the ECG parameters were blinded to control/patient status. The protocol of this study was approved by the Local Ethics Committee, and informed consent was obtained from every subject participating in this study.

Analysis of heart rate variability parameters

For the HRV analyses, the definitions of evaluated parameters were made according to Task Force of European Society of Cardiology and the North American Society of Pacing and Electrophysiology on HRV [4].

All 24 hours, night- and day-time periods were used to investigate HRV parameters. For the time-domain analysis of HRV, each QRS complex resulting from sinus node depolarization is detected, and normal-to-normal (NN) intervals are determined.

The following standard parameters were calculated from the time series:

1-SDNN Standard deviation of intervals between two normal R-waves. SDNN gives an impression of the overall circulatory dynamics.

2-RMSSD The square root of square of mean square differences of successive NN intervals. Higher values indicate higher vagal activity.

3-pNN50 The proportion derived by dividing NN50 (the number of interval differences of successive NN intervals greater than 50 ms) by the total number of NN intervals. Again higher values indicate higher vagal activity.

Spectral analysis of HRV included total power, high-frequency (HF) component (0.15–0.40 Hz), low-frequency (LF) component (0.04–0.15 Hz), and very low-frequency (VLF) component (0–0.04 Hz). LF/HF ratio = low-frequency power/high-frequency power was calculated to give the relative changes in HRV in the frequency domain.

Statistical analyses

Distribution of the continuos variables was determined by the Kolmogorov–Smirnov test. Continuos variables with normal distribution were expressed as mean ± SD; variables with skew distribution are expressed as median (minimum-maximum); categorical variables are expressed as percentage. Means were compared by ANOVA or Mann–Whitney *U* test. For all statistics, a two-sided *P* value <0.05 was considered statistically significant. All analyses were performed with SPSS 10.0 for Windows.

Results

Twenty-nine patients with NSD and 26 control subjects were examined. Demographic data of the NSD [mean age: 31 ± 8; 21 (72%) males] and control groups [mean age: 32 ± 9 years; 16 (62%) male] were similar (P = NS). No subjects had hypertension, diabetes mellitus, heart failure, coronary artery disease, and valvular heart disease.

According to the Holter analysis results, all subjects were detected to be in sinus rhythm, without episodes of sustained atrial or ventricular arrhythmias. Night-RMSSD (47 ± 21, 34 ± 13; $P = 0.008$), night-PNN50 (24 ± 16, 14 ± 10; $P = 0.007$), 24-h-RMSSD (39 ± 18, 27 ± 12; $P = 0.004$), 24-h-PNN50 (16 ± 12, 9 ± 7; $P = 0.016$) were significantly higher in patients than controls. Distributions are demonstrated in Fig. 1. Other HRV parameters were not significantly different between two groups (Table 1). Changes in these parameters demonstrated an increased parasympathetic tone and discordance in sympatho-vagal activity in NSD.

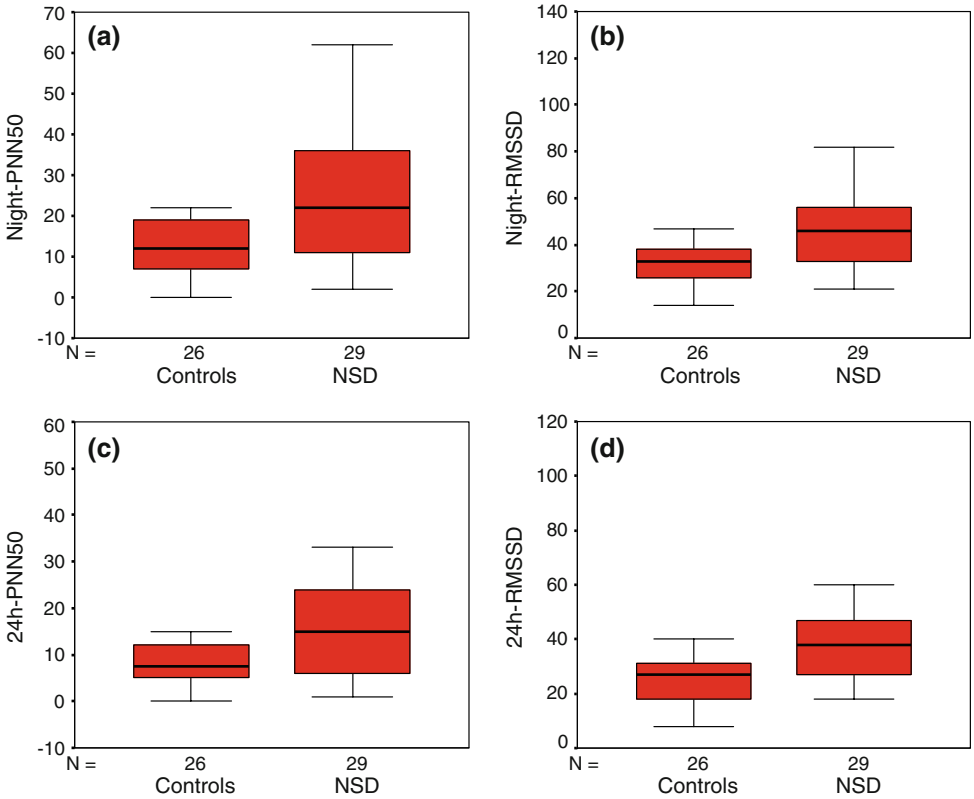

Fig. 1 Box-plot graphics of Night-PNN50, Night-RMSSD, 24-h-PNN50, 24-h-RMSSD, respectively. The *black lines* within the *boxes* indicate the median, the *edges* of the *boxes* are the 25th and 75th percentiles, and the *lines* extend to the maximum and minimum values

Table 1 HRV parameters in NSD and controls

	NSD	Control	*P* value
24 hour			
SDNN (ms)	158	149	0.315
RMSSD (ms)	39.4	27	0.004
PNN50 (%)	16	9	0.016
24-h LF	971	836	0.174
24-h HF	417	323	0.207
LF/HF ratio	3.15	3.46	0.540
Day time			
SDNN (ms)	136	125	0.182
RMSSD (ms)	35	31	0.208
PNN50 (%)	13	9	0.143
24-h LF	926	787	0.189
24-h HF	327	234	0.159
LF/HF ratio	3.92	4.34	0.453
Night time			
SDNN (ms)	129	125	0.681
RMSSD (ms)	47	34	0.008
PNN50 (%)	24	14	0.007
24-h LF	1047	923	0.282
24-h HF	575	484	0.386
LF/HF ratio	2.62	2.73	0.832

Discussion

This study showed that patients with NSD had increased parasympathetic tone and discordance in sympatho-vagal activity. To the best of our knowledge, this is the first study to examine the relationship between NSD and ANS activity.

Nasal septum deviation is a common disorders causing nasal obstruction. The most common etiologies are irregular development of the nasomaxillary complex and nasal injury. These deformities may cause nasal obstruction and chronic mucosal irritation; therefore, NSD can lead to postnasal discharge, aggravate sinusitis, upper airway infection, and various middle ear infections.

The sensory nerve supply of the nose arises from the maxillary branch of the trigeminal nerve. Sympathetic and parasympathetic (vagal) fibers enter the sphenopalatine ganglion from the deep petrosal nerve. Thus, every branch from the sphenopalatine ganglion carries a mixture of three kinds of fibers: sensory, secretomotor (parasympathetic), and sympathetic. The afferent stimulus of the nasocardiac reflex travels in the maxillary division of the trigeminal nerve, and the efferent pathway to the heart is via the vagus nerve [5]. Betlejewski et al. [6] investigated nasocardiac reflex in 80 healthy volunteers. After stimulation of the nasal mucosa on the media turbinates by means of 25%

ammonia, almost all subjects revealed a significant decrease in the heart rate [6].

In NSD, mucosal irritation is occurring by stimulation of afferent neurons of trigeminal nerve. It may be a direct result of nerve fibers interacting with the chemical or an indirect result of locally produced mediators [7]. Stimulation of branches of the trigeminal nerve or peripheral fields they innervate induces a complex physiological response consisting of apnea, bradycardia, vasoconstriction, and inhibition of respiratory drive, which involves the integration of afferent impulses, carried on fibers innervating somatic receptors, chemoreceptors, and baroreceptors [8].

Previous studies showed that head immersion in water depresses baroreflex sensitivity in ducks and face immersion cold water augments baroreflex bradycardia in humans [9]. Also cigarette smoking or irritant gases such as ammonia provokes reflex responses that include apnea, hypertension, and bradycardia. Panneton et al. [8] showed controlled bradycardia induced by nasal stimulation in the muskrat with water or various concentrations of ammonia vapors. Baxandall et al. [10] notice a profound bradycardia due to the nasocardiac reflex when the surgeon introduced a nasal speculum into nares under anesthesia. Kobayashi et al. [9] showed inhibition of baroreflex vagal bradycardia by nasal stimulation in rats with nasal application of smoke and fluids. All of these studies determine mainly the acute effects of nasal stimulation on heart; but to our knowledge, there is no study on long-term effects of chronic nasal irritation on heart such as severe deviation of nasal septum.

Conclusion

Our study showed parasympathetic overactivity in the patients with NSD due to the same reflex pathway mechanisms. Further studies are needed to evaluate the significance of HRV parameters and to clarify the mechanism of increased parasympathetic activity in patients with NSD.

References

1. Takahashi R (1971) Malformations of the nasal septum. In: Takahashi R (ed) A collection of ear, nose and throat studies. Kyoya Co. Ltd, Tokyo, pp 1–87
2. Pumprla J, Howorka K, Groves D et al (2002) Functional assessment of heart rate variability: physiological basis and practical applications. Int J Cardiol 84:1–14
3. Dreher A, de la Chaux R, Klemens C et al (2005) Correlation between otorhinolaryngologic evaluation and severity of obstructive sleep apnea syndrome in snorers. Arch Otolaryngol Head Neck Surg 131(2):95–98
4. Malik M, Bigger JT, Camm AJ et al (1996) Heart rate variability. Standards of measurement, physiological interpretation, and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Eur Heart J 17(3):354–381
5. Last RJ (1984) Anatomy: regional and applied. Churchill Livingstone, Edinburgh, p 403
6. Betlejewski S, Betlejewski A, Burduk D, Owczarek A (2003) Nasal-cardiac reflex. Otolaryngol Pol 57(5):613–618
7. Cain WS (1974) Contribution of the trigeminal nerve to perceived odor magnitude. Ann N Y Acad Sci 237:28–34
8. Panneton WM (1990) Controlled bradycardia induced by nasal stimulation in the muskrat, *Ondatra zibethicus*. J Auton Nerv Syst 30:253–264
9. Kobayashi M, Cheng ZB, Nosaka S (1999) Inhibition of baroreflex vagal bradycardia by nasal stimulation in rats. Am J Physiol Heart Circ Physiol 276:176–184
10. Baxandall ML, Thorn JL (1988) The nasocardiac reflex. Anaesthesia 43:480–481