Correlation between subjective and objective nasal breathing assessments in examinees with nasal septum deformities

Povezanost subjektivne i objektivne procene disajne funkcije nosa kod ispitanika sa deformitetom nosne pregrade

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Abstract

Background/Aim. Nasal obstruction is one of the most frequent disorders because of which patients see their Ear, Nose and Throat (ENT) doctors. Impaired nose breathing is a subjective symptom and it often does not coincide with clinical nose findings and functional tests of breathing function. Therefore, the aim of this study was to establish if there is an accordance between a subjective nose breathing assessment and objective methods (rhinomanometry and acoustic rhinometry) in assessing nose breathing function in patients with diverse nasal septum deformity degrees, as well as to establish an accordance between these two objective methods. Methods. This study involved the total of 90 examinees divided into three groups. The group I consisted of examinees with nasal septum deformities less than 10º. The group II consisted of examinees with nasal septum deformities ranged from 10º to 15º. The group III involved examinees with nasal septum deformities over 15º. Each examinee had subjectively graded his/her nasal breathing on the side of the nose septum deformity from 0 to 10, and afterwards the whole noses. Rhinomanometry and acoustic rhinometry were done on the side of the nasal septum deformities and after that on the other side of the nose using the Interacoustics SRE 2000 device. Results. In the groups II and III there was a positive correlation between a subjective nose breathing assessment and rhinomanometric values both on the side of the nasal septum deformities and the nose as a whole, (p < 0.05), and no correlation between these traits in the group I (p > 0.05). In none of the examined groups correlation was found between a subjective nose breathing assessment and rhinometric values, both minimum cross-sectional area (MCA) and volume (VOL), both on the side of the nasal septum deformities and the nose as a whole (p > 0.05). There was no correlation found between rhinomanometric and rhinometric MCA and VOL values in either on the sides of nasal septum deformities or the nose as a whole in any of the examined groups (p > 0.05). Conclusion. Rhinomanometry significantly correlates with the subjective nose breathing assessment and it can be used as a reliable and objective indicator of nose breathing in everyday clinical practice. Acoustic rhinometry, on the other hand, which does not correlate with a subjective nose breathing assessment could have a greater significance in a scientific sense than in clinical applying.

Key words: nose; respiration disorders; nasal septum; rhinomanometry; rhinometry, acoustic.

Apstrakt

Uvod/Cilj. Nosna opstrukcija je jedna od najčešćih tegoba zbog koje se bolesnici javljaju otorinolaringologu. Otežano disanje na nos je subjektivan simptom i često se ne poklapa sa kliničkim nalazom u nosu i funkcionalnim testovima disajne funkcije. Upravo zbog toga cilj ovoga rada bio je da se utvrdi da li postoji podudarnost između subjektivne procene disanja na nos i objektivnih metoda (rinomanometrije i akustičke rinometrije) u proceni disajne funkcije nosa kod bolesnika sa različitim stepenom deformiteta nosne pregrade, kao i da li postoji podudarnost između ove dve objektivne metode međusobno. Metode. Istraživanje je obuhvatio ukupno 90 ispitanika podeljenih u tri grupe. Grupu I činili su ispitanici sa deformitetom nosne pregrade manjim od 10º, a grupu II deformitet nosne pregrade manjim od 15º. U grupi III bili su ispitanici sa deformitetom nosne pregrade većim od 15º. Rabinomometrija, na drugi strani, nije korisna za procenu subjektivnog disanja nosa, a ona je korisna za procenu disanja nosa u kontekstu istraživanja.
Nasal obstruction is one of the most common disorders because of which patients are referred to otorhinolaryngologists. There are numerous factors causing it, but they can be divided into two basic groups: the first one being anatomic factor group leading to nasal obstruction, whereas the second one is the group characterized by changes in the mucus.

Nasal breathing is a subjective symptom and frequently does not coincide with clinical nasal findings. This is the reason why the need for an objective assessment of breathing function arose, which could enable more precise diagnoses and indications for conservative, i.e. surgical treatment, as well as a more successful follow-up.

Rhinomanometry and acoustic rhinometry are most commonly used objective methods for assessment of nose breathing function. As rhinomanometry gives a dynamic nasal function assessment, acoustic rhinometry enables a static (anatomic) assessment of the nasal cavity condition.

Although these two objective methods to assess nasal breathing function have been clinically applied for a relatively long time, rhinomanometry since the 50s of the twentieth century and acoustic rhinometry since the late 80s, contemporary authors still have opposite attitudes on their clinical applications. These opposite attitudes on the validity of clinical rhinomanometry and acoustic rhinometry derive from the reason why different authors have obtained different results on correspondence of subjective and objective nasal breathing function assessment by rhinomanometry and acoustic rhinometry. Also, certain authors have completely different results when nasal breathing function assessments are obtained by rhinomanometry and rhinometry.

The aim of this study was to establish whether there is a correspondence between a subjective nasal breathing function assessment and objective methods (rhinomanometry and acoustic rhinometry) in assessing nasal breathing functions in patients with different nasal septum deformity degrees as well as whether there is a correspondence between the two objective methods in nasal breathing function assessment.

Methods

The study involved a total of 90 examinees out of whom there were 26 female patients and 64 male patients. The average age of the examinees was 31.12 years. This study included otorhinolaryngological patients with a rhinoscopically visual nasal septum deformities and no other otorhinolaryngological conditions and no lower respiratory tract ailments that could lead to a subjective assessment of breathing difficulties.

On the basis of nasal septum deformity degree, the examinees were divided into three groups (30 patients in each): the group I with nasal septum deformities less than 10°; the group II, with nasal septum deformity from 10° to 15°; the group III with nasal septum deformity degrees more than 15°. The degree of nasal septum deformity was diagnosed by computed tomography (CT) nasal findings as an angle made of a line from *cristae gali* to *spinae nasalis anterior inferior* and a line drawn from *cristae gali* to the point where the most striking deformity of nasal septum was. The values of deformity degree were expressed in full numbers.

Every examinee subjectively assessed their nasal breathing on the deformity side and afterwards on the nose as a whole. Their marks ranged from 0 to 10 on the visual analogue scales (VAS), with 0 marking no breathing troubles at all, whereas 10 meant nasal total nasal breathing disability. Rhinomanometry and acoustic rhinometry was performed on the side of nasal septum deformity as well as on the other sides of the nose using an Interacoustics SRE 2000 device.

Rhinomanometry is a method based on indirect resistance determination (*r*) in the nasal air flow. The differences in air pressure are measured directly (ΔP) at the nose entrance as well as in the nasopharynx, along with the proportion of the air flown in the time unit (V/s). On the basis of these data, nasal air flow resistance (*r*) is worked out by a computer using the *r* = ΔP / V/s formula, and it is expressed in Pas/cm³ for each side of the nose, respectively. The total nose air flow resistance is calculated according to a formula *R(t) = R(t) x R(r) / R(t) + R(r)*. In this paper, anterior active rhinomanometry was used with nose adaptors.

Acoustic rhinometry is a method based on the time of functional nasal septum sound wave reflection analysis. It makes possible obtaining data on the size of decussated in-
tersections of various nasal septum cavity as well as air volumes in the previously examined nasal septum regions. Even the MCA has been marked and expressed in cm². The values of VOL were measured in the nose at the distance between 2 and 5 centimeters and they were expressed in cm³. For rhinometric measurements the measuring tube with the nose adaptor was used. It was shown that the deformation of the vestibulum by the anatomical nose adaptor is less than by the conical nosepiece inserted into the nostril.

For this study we provided the consent of the Ethical Committees of Vojvodina Clinical Center and Medical Faculty in Novi Sad.

For the measured parameters, the following was calculated and shown: arithmetic mean, median and standard deviation. To examine linking of the two traits the Pearson’s correlation coefficient was used.

**Results**

Table 1 shows the average values of subjective nose breathing assessment on the nasal septum deformity side and the nose as a whole in all the groups, as well as standard deviations and median. In the group I there was no statistically significant difference in the subjective nose breathing assessment between the side with nasal septum deformity and the nose as a whole ($p > 0.05$), while in the groups II and III this difference was statistically significant ($p < 0.05$).

Table 2 shows the average rhinometric VOL and MCA values in the groups as well as their standard deviations and median on the nasal septum deformity side and the nose as a whole.

Tables 3 and 4 show the average rhinometric VOL and MCA values in the groups as well as their standard deviations and median on the nasal septum deformity side and the nose as a whole.

In the groups II and III there was a positive correlation between a subjective nose breathing assessment and rhinometric values both on the nasal septum deformity side and the nose as a whole, ($p < 0.05$), while in the group I there was no correlation between these traits ($p > 0.05$), (Table 5).

None of the examined groups had any correlation between a subjective nose breathing assessment and rhinometric values, both MCA and VOL values either on the nasal septum deformity side or the nose as a whole ($p > 0.05$), (Tables 6 and 7).

**Table 1**

| The group of patients | The nasal septum deformity side | The nose as a whole |
|-----------------------|--------------------------------|--------------------|
| I                     | Mean 1.80 SD 1.13 Median 2.00   | Mean 1.70 SD 1.05 Median 2.00 |
| II                    | Mean 3.67 SD 1.06 Median 4.00   | Mean 1.86 SD 1.22 Median 2.00 |
| III                   | Mean 6.73 SD 0.98 Median 7.00   | Mean 3.70 SD 1.54 Median 3.00 |

*see section Methods

**Table 2**

| The group of patients | The nasal septum deformity side | The nose as a whole |
|-----------------------|--------------------------------|--------------------|
| I                     | Mean 0.71 SD 0.19 Median 0.63  | Mean 0.23 SD 0.05 Median 0.23 |
| II                    | Mean 0.73 SD 0.16 Median 0.72  | Mean 0.26 SD 0.07 Median 0.25 |
| III                   | Mean 1.60 SD 0.86 Median 1.26  | Mean 0.34 SD 0.13 Median 0.32 |

*see section Methods

**Table 3**

| The group of patients | The nasal septum deformity side | The nose as a whole |
|-----------------------|--------------------------------|--------------------|
| I                     | Mean 0.39 SD 0.05 Median 0.39  | Mean 0.98 SD 0.15 Median 0.96 |
| II                    | Mean 0.34 SD 0.06 Median 0.35  | Mean 0.88 SD 0.09 Median 0.87 |
| III                   | Mean 0.26 SD 0.10 Median 0.25  | Mean 0.77 SD 0.10 Median 0.76 |

*see section Methods

**Table 4**

| The group of patients | The nasal septum deformity side | The nose as a whole |
|-----------------------|--------------------------------|--------------------|
| I                     | Mean 3.12 SD 0.48 Median 3.10  | Mean 6.80 SD 0.85 Median 6.72 |
| II                    | Mean 2.81 SD 0.42 Median 2.83  | Mean 6.33 SD 0.82 Median 6.39 |
| III                   | Mean 2.33 SD 0.39 Median 2.33  | Mean 5.86 SD 0.92 Median 6.05 |

*see section Methods
No correlation was found between rhinomanometric and rhinometric MCA and VOL values both on the nasal septum deformity side and the nose as a whole in any of the examined groups, \((p > 0.05)\), (Tables 8 and 9).

### Table 5

Correlation between subjective nose breathing assessment and rhinomanometric values on the nasal septum deformity side and the nose as a whole

| The group of patients* | The nasal septum deformity side | The nose as a whole |
|-----------------------|----------------------------------|---------------------|
|                       | \(r\) | \(p\) | \(r\) | \(p\) |
| I                     | 0.227 | 0.229 | 0.213 | 0.257 |
| II                    | 0.485 | 0.077 | 0.471 | 0.009 |
| III                   | 0.420 | 0.021 | 0.504 | 0.005 |

*see section Methods; \(r\) – coefficient of correlation

### Table 6

Correlation between subjective nose breathing and rhinometric minimal cross-sectional area (MCA) values (cm\(^2\)) on the nasal septum deformity side and the nose as a whole

| The group of patients* | The nasal septum deformity side | The nose as a whole |
|-----------------------|----------------------------------|---------------------|
|                       | \(r\) | \(p\) | \(r\) | \(p\) |
| I                     | 0.146 | 0.442 | 0.037 | 0.848 |
| II                    | - 0.066 | 0.728 | - 0.062 | 0.745 |
| III                   | 0.340 | 0.066 | - 0.188 | 0.320 |

*see section Methods; \(r\) – coefficient of correlation

### Table 7

Correlation between subjective nose breathing and rhinometric volume (VOL) values (cm\(^3\)) on the nasal septum deformity side and the nose as a whole

| The group of patients* | The nasal septum deformity side | The nose as a whole |
|-----------------------|----------------------------------|---------------------|
|                       | \(r\) | \(p\) | \(r\) | \(p\) |
| I                     | - 0.069 | 0.716 | 0.034 | 0.589 |
| II                    | 0.033 | 0.862 | 0.008 | 0.962 |
| III                   | - 0.049 | 0.798 | 0.001 | 0.994 |

*see section Methods; \(r\) – coefficient of correlation

### Table 8

Correlation between rhinomanometric and rhinometric minimal cross-sectional area (MCA) values (cm\(^2\)) on the nasal septum deformity side and the nose as a whole

| The group of patients* | The nasal septum deformity side | The nose as a whole |
|-----------------------|----------------------------------|---------------------|
|                       | \(r\) | \(p\) | \(r\) | \(p\) |
| I                     | - 0.146 | 0.440 | 0.028 | 0.885 |
| II                    | - 0.178 | 0.346 | 0.124 | 0.513 |
| III                   | - 0.100 | 0.599 | 0.096 | 0.615 |

*see section Methods; \(r\) – coefficient of correlation

### Table 9

Correlation between rhinomanometric and rhinometric volume (VOL) values (cm\(^3\)) on the nasal septum deformity side and the nose as a whole

| The group of patients* | The nasal septum deformity side | The nose as a whole |
|-----------------------|----------------------------------|---------------------|
|                       | \(r\) | \(p\) | \(r\) | \(p\) |
| I                     | 0.013 | 0.947 | 0.129 | 0.495 |
| II                    | 0.155 | 0.413 | 0.012 | 0.950 |
| III                   | 0.064 | 0.738 | 0.060 | 0.754 |

*see section Methods; \(r\) – coefficient of correlation

### Discussion

An objective assessment of nose breathing function is one of the most frequent problems in everyday ENT routine\(^7\). The need for its objectiveness is especially important in making a difference between mucous and mechanical causes of difficult breathing as well as establishing the proper indication for a surgical treatment of nasal septum deformity. Although anterior rhinoscopy is a routine method in diagnosing every patient complaining about impaired nose breathing, this clinical finding is often not in accordance with the degree of the subjective suffering of the patients\(^9\). The subjective feeling of obstruction of the nose is a complex phenomenon and depends on more than anatomical and

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functional details and airflow characteristics\textsuperscript{11}. It is known that a slight septal deviation in the nasal valve region can cause clear symptoms, whereas a much larger deviation in the back of the nasal cavity may result in far fewer symptoms\textsuperscript{8}. Anterior rhinoscopy by means of nasal speculum risks masking abnormalities by distortion of nasal lumen in the valve area\textsuperscript{12}. Until today, there has been no ideal clinical test of nasal patency giving the dynamic nature of the nose\textsuperscript{13}, that can translate that patient’s evaluation of nasal obstruction into a specific figure, as it is the case with the audiogram for hearing, the vision test for sight, and spirometry for lung function\textsuperscript{14}. The results of our study suggest a correspondence with a subjective nose breathing assessment and rhinometric findings in the examinees in the groups II and III, regardless nasal septum deformity side or the nose as a whole. Also, the examinees of these two groups experienced a significantly impaired breathing function on the side of the nasal septum deformity in relation to the nose as a whole, while the examinees of the group I did not experience it at all. These results correspond with those obtained by Sipilä et al.\textsuperscript{15} showing the difficulties in assessing their noses breathing in case the difference in rhinometric findings between the nose side is less than 60–70%. McCaffrey and Kern\textsuperscript{16} as well as Roithmann et al.\textsuperscript{12} have also found a correspondence between these traits. On the other hand, Kim et al.\textsuperscript{17}, Tomkinson and Eccles\textsuperscript{11} as well as Naito et al.\textsuperscript{17} Thulesius et al.\textsuperscript{18} do not find any correspondence between a subjective nose breathing assessment and rhinometric findings. Mygind\textsuperscript{19} is of the opinion that rhinomanometry has only a scientific importance, whilst its clinical significance is very little.

We found no correspondence in any of the examined groups between a subjective nose breathing assessment and rhinometric values (either MCA or VOL) regardless the nasal septum deformity side or the nose as a whole. Similar results were reported by the majority of other authors\textsuperscript{1,11,17}. Contrary to them, Roithmann et al.\textsuperscript{12} found a correspondence between a subjective nose breathing function assessment and rhinometric MCA values. Thulesius et al.\textsuperscript{18} found that older age significantly lowers rhinometric values and are of the opinion that this is a consequence of nasal mucus atrophy and nose bones growth which lead to nasal cavity enlargement. Also, Kalmovich et al.\textsuperscript{20} have found, endonasal volumes and minimal cross sectional areas increase in elderly people as measured with acoustic rhinometry. There was no correspondence between rhinometric and rhinometric (MCA and VOL) values in any of the examined groups regardless the nasal septum deformity side or the nose as a whole. Our results coincide with the ones obtained by Warren et al.\textsuperscript{21} and Naito et al.\textsuperscript{17}. Nevertheless, Yaniv et al.\textsuperscript{22} as well as Tomkinson et Eccles\textsuperscript{11} do find correspondence between these traits.

Conclusion

Rhinomanometry which, notably in greater nasal septum deformities, significantly correlates with a subjective nose breathing function assessment, can be an objective indicator of nasal breathing function in everyday clinical practice. Acoustic rhinometry that does not correlate with a subjective nose breathing function assessment, might have a greater scientific significance than clinical application.

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