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ARTYKUŁ ORYGINALNY / ORIGINAL ARTICLE

The correlation of the results of the survey SNOT-20 of objective studies of nasal obstruction and the geometry of the nasal cavities

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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ABSTRACT:

Introduction: In this paper were verified the correlation between the results of the survey SNOT-20 and the results of the objective tests of nasal obstruction which are rhinomanometry and acoustic rhinometry before and after surgical treatment, such as septoplasty, septoconchoplasty, ethmoidectomy and septoethmoidectomy.

Material and methods: The material used in this study was 233 patients diagnosed routinely in the Rhinomanometry Laboratory of the Department of Otolaryngology at the Medical University of Warsaw, reporting rhinological problems. Data were obtained from 70 women (31,4%) ranging in ages from 18 to 81 years of age and 153 men (68,6%) ranging in ages from 16 to 81 years of age. The researches presented in the study were made using the device RhinoMetrics SRE 2100 which combines the Rhinomanometer (RhinoStream) and Acoustic Rhinometer (RhinoScan) Interacoustics AS (Denmark). Survey SNOT-20 (Sino-Nasal Outcome Test-20) in Polish was completed by patients before surgery and during the postoperative control visits.

Results: The calculated correlations between the objective parameter, which was the resistance to the flow of air through the nasal cavity , and the subjective feelings of respondents expressed in the survey SNOT-20 were generally weak, and statistical significance was achieved with respect to the first question survey (the severity of the nose obstruction) for all components of resistance flow.

Discussion: The feeling of nasal obstruction is the most reproducible and reliable complaint reported by the patient with rhinological problems.

KEYWORDS: acoustic rhinometry, rhinomanometry, rhinosurgery, nasal patency, subjective assessment, treatment results

LIST OF ABBREVIATIONS:

AR Acoustic rhinometry
CSA Nasal cross sectional area
RMM Rhinomanometry
MCA Minimum nasal cross sectional area
MCA1 Cross sectional area within the 0.0-2.2 cm section
MCA2 Cross sectional area within the 2.2-5.4 cm section
VOL1 Nasal cavity volume [0.0-2.2 cm] (cm^3)
VOL2 Nasal cavity volume [2.2-5.4 cm] (cm^3)
R-ex Air flow resistance upon exhalation at 75 Pa pressure difference
R-in flow resistance upon inhalation at 75 Pa pressure difference
R-res Mean air flow resistance R-res = (R-in + R-ex)/2
n Population number
$\bar{x}$ Arithmetic mean
SD Standard deviation

INTRODUCTION

Reduction or obstruction of nasal patency is a common cause of complaints reported by patients presenting at ENT practices. The impression is caused by reduced cross sectional area or by simple change in the geometry of nasal cavities. Most

commonly, both causes are present simultaneously. They result from progressive deformation of nasal septum and/or progressing proliferative lesions within the bony framework and the mucosal membranes of the nose.

Objective evaluation of the nasal cavity may be achieved by two techniques including acoustic rhinometry and rhinomanometry.

Acoustic rhinometry (AR) is currently the most common method for assessing the geometry of nasal cavities [1]. It is a non-invasive, quick and inexpensive examination that measures the cross-sectional area (CSA) of nasal cavity as a function of distance from the nasal cavity. The value is used to calculate the volume of nasal cavity and the result is of value for patients experiencing congestion due to nasal polyps or deviated septum [2,3,4]. AR requires minimum patient cooperation and may be performed during normal sleep or under general anesthesia, ensuring that the measurements of nasal airways are carried out in natural conditions. Usually, AR does not require administration of analgesics or sedatives and may be carried out in both children and adult patients.

Another objective method for evaluation of nasal patency is rhinomanometry (RMM). The method consists of simultaneous measurement of the pressures and air flows in frontal nostrils. The flow of air is possible only due to a pressure difference. Nasopharyngeal pressure is the only pressure parameter that changes upon inhalation and exhalation and is responsible for the pressure within the entire nasal cavity. Nasal air flow is affected by numerous factors, including the length of the nose, the cross-sectional area, the pressure in nasal cavities and the laminar vs. turbulent status of flow [5]. However, the main factor affecting the flow of air within the nose is the cross-sectional area of nasal cavities. RMM is an excellent research tool. It may be used for the measurement of nasal air flow resistance before and after decongestion.

Both acoustic rhinometry and rhinomanometry are widely used in nasal challenge tests [6,7]. Many researchers demonstrated that objective examination of nasal patency may be used to prove the efficacy of intranasal use of steroids or antihistamines [8,9] and may be used for the detection of correlations between nasal air flow resistance and sleep apnea as well as for the assessments of the efficacy of nasal septum or concha surgeries [10].

Quite commonly, symptoms experienced by patients with significant disturbances as evidenced by rhinomanometric or rhinometric examinations are less intense than those experienced by patients with better results of objective assessments. Therefore, a decision was made to compare the results of subjective assessment using the SNOT-20 survey with the objective evaluations of nasal patency before and after the surgery.

OBJECTIVE

The objective of the study was to determine the strength of correlations between individual questions of the SNOT-20 survey and the parameters determined by acoustic rhinometry and rhinomanometry as well as to determine whether good subjective outcomes of surgical treatment could be reflected in objective assessments.

MATERIAL AND METHODS

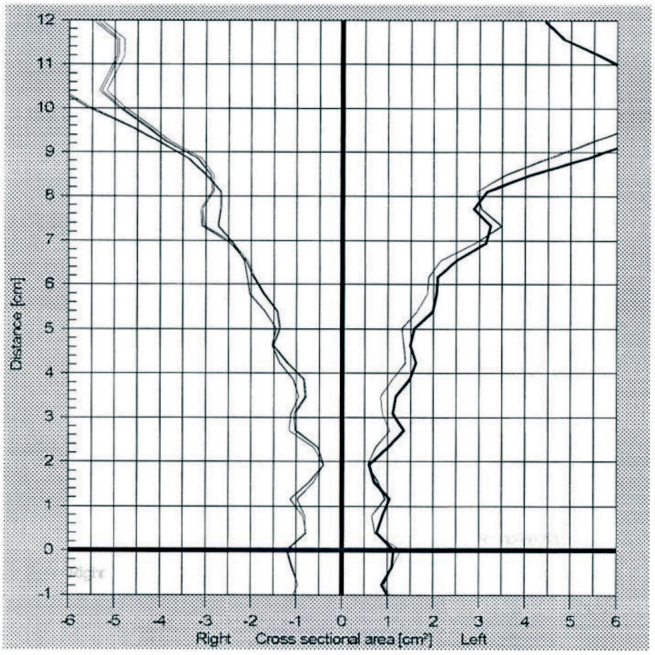
The study material consisted of the results of acoustic rhinometry (Fig. 1), rhinomanometry (Fig. 2), and SNOT-20 survey (Fig. 3) obtained from 233 patients reporting rhinological problems and routinely diagnosed at the Rhinomanometry Laboratory of the Department of Otolaryngology of the Medical University of Warsaw. Data were obtained from 70 women (31.4%) in the age range of 18 to 81 years and 153 men (68.6%) in the age range of 16 to 81 years. Examinations were made using an Interacoustics AS (Denmark) RhinoMetrics SRE 2100 device combining the functionalities of a rhinomanometer (RhinoStream) and an acoustic rhinometer (RhinoScan). SNOT-20 (Sino-Nasal Outcome Test-20) was delivered in Polish (Fig. 3) and completed by patients before the surgery as well as 6 months after the surgery. Although the survey was initially designed for nasal sinusitis, research studies [11] showed that it is also a useful tool when assessing the efficacy of septal surgeries. The survey combines both detailed questions regarding nasal complaints and overall health questions that may be analyzed either separately or jointly.

Patients were subjected to one of four types of surgeries depending on the reported complaints. The populations of individual subgroups within the study material identified on the basis of surgery type and patient gender are presented in table (Tab. I) and the figure (Fig. 4) below.

The analysis of variance revealed that the age of patients was significantly different for different types of surgeries ($P<0.001$). The Newman-Keulus test allowed for identification of two homogeneous subgroups. The first subgroup (younger patients) consisted of patients subjected to the first and the second type of surgery while the second subgroup (older patients) consisted of patients subjected to the third or the fourth type of the surgery. The type of the surgery was also correlated with patient's

test - Examination - RhinoScan

Patient journal		Examination journal	
Patient name:	test	Title:	Examination
Social security no.:		Created date:	21-04-2015 08:31:59
Personal journal no.:		Type:	RhinoScan
Born:		Examiner:	
Sex:		Software ver.:	4.2.0.0, v 3.00.Xj/v 3.0b
Diagnosis:		Probe:	



Date and time	Side	Title	Dist	MCA1	VOL1	Dist	MCA2	VOL2	Nose Piece
Distance ranges:			[0.00;2.20] cm			[2.20;5.40] cm			
Units:			[cm]	[cm²]	[cm³]	[cm]	[cm²]	[cm³]	
21-04-2015 08:18:38	L	L 15-04-21 08:18:38	1.93	0.56	1.72	2.20	0.68	3.59	
21-04-2015 08:18:38	L	L 15-04-21 08:18:38	1.93	0.56	1.72	2.20	0.68	3.59	
21-04-2015 08:18:38	L	L 15-04-21 08:18:38	1.93	0.56	1.74	2.20	0.68	3.60	
21-04-2015 08:31:07	L	L 15-04-21 08:31:07	1.93	0.60	1.85	2.20	0.89	4.47	
21-04-2015 08:31:07	L	L 15-04-21 08:31:07	1.93	0.60	1.85	2.20	0.88	4.46	
21-04-2015 08:31:07	L	L 15-04-21 08:31:07	1.93	0.60	1.85	2.20	0.89	4.47	
21-04-2015 08:18:11	R	R 15-04-21 08:18:11	1.93	0.41	1.77	2.20	0.50	3.47	
21-04-2015 08:18:11	R	R 15-04-21 08:18:11	1.93	0.41	1.78	2.20	0.50	3.46	
21-04-2015 08:18:13	R	R 15-04-21 08:18:13	1.93	0.40	1.77	2.20	0.49	3.38	
21-04-2015 08:30:00	R	R 15-04-21 08:30:00	1.93	0.41	1.69	2.20	0.57	3.86	
21-04-2015 08:30:00	R	R 15-04-21 08:30:00	1.93	0.41	1.68	2.20	0.57	3.85	
21-04-2015 08:30:01	R	R 15-04-21 08:30:01	1.93	0.41	1.69	2.20	0.57	3.86	

Fig. 1. A result of acoustic rhinometry examination. X axis – distance from the nasal orifice (nostril position – 0 cm), Y axis – nasal cross-sectional area

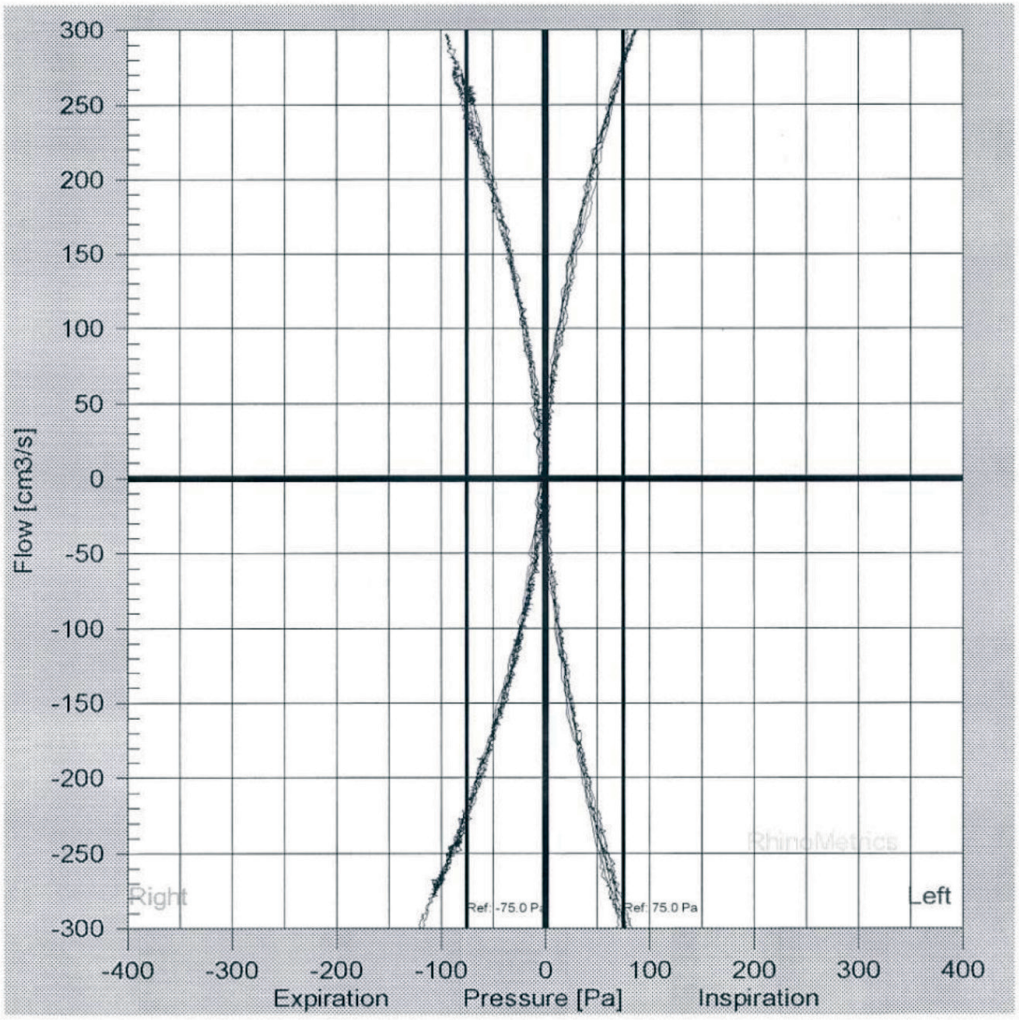
test - Examination - RhinoStream

Patient journal

Patient name: test
Social security no.:
Personal journal no.:
Born:
Sex:
Diagnosis:

Examination journal

Title: Examination
Created date: 21-04-2015 08:10:32
Type: RhinoStream
Examiner:
Software ver.: 4.2.0.0, v 3.01.Xf/v 3.0b



Date and time	Side	Title	Resistance at Reference ±75.0 Pa					
			Expiration	CV	Flow	Inspiration	CV	Flow
		Units:	[Pa s/cm3]	[%]	[cm3/s]	[Pa s/cm3]	[%]	[cm3/s]
21-04-2015 08:09:19	L	L 15-04-21 08:09:58	0.30	3.91	252.89	0.25	3.33	294.29
21-04-2015 08:08:41	R	R 15-04-21 08:09:18	0.34	2.61	219.72	0.27	1.15	277.81

Fig. 2. A result of rhinomanometry examination. X axis – pressure difference, Y axis – air flow

Tab. I. Surgery type vs. patient age

	WOMEN			MEN			OVERALL		
Surgery type	n	mean	SD.	n	mean	SD.	n	mean	SD
1	18	38,6	17,8	72	39,1	13,3	90	39,0	14,2
2	20	35,5	14,1	35	38,9	15,0	55	37,6	14,6
3	16	42,3	13,7	35	47,5	17,8	51	45,9	16,6
4	16	51,0	13,6	11	52,3	14,2	27	51,5	13,6

1 – septoplasty, 2 – septoconchoplasty, 3 – septoethmoidectomy, 4 – ethmoidectomy

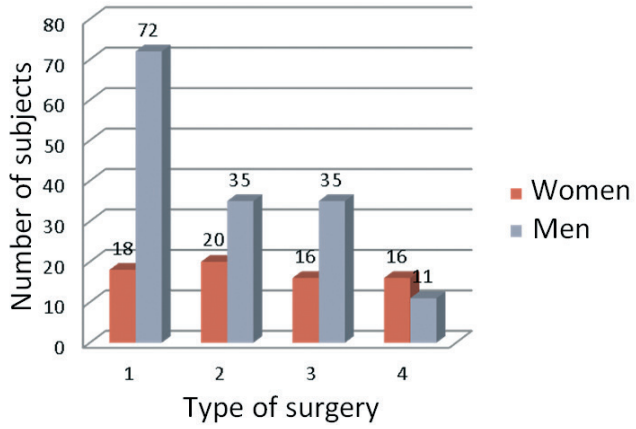


Fig. 4. Distribution of population in individual subgroups including the gender of patients

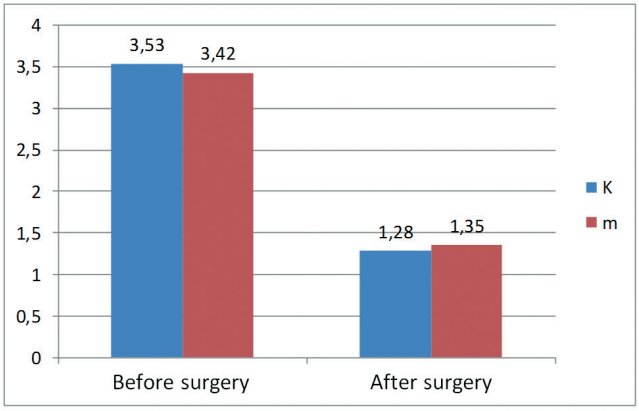


Fig. 5. Distribution of answers to the first SNOT-20 question depending on gender, before and after the surgery.

Ankieta określająca stopień dolegliwości ze strony jamy nosowej i zatok przynosowych - SNOT 20

Proszę określić stopień nasilenia dolegliwości poprzez zakreślenie kółkiem odpowiedniej cyfry na zamieszczonej skali.

Objaśnienie skali: 0 - dolegliwości nie występują
1 - dolegliwości nieznacznie nasilone
2 - dolegliwości nieznacznie lub średnio nasilone
3 - dolegliwości umiarkowane
4 - dolegliwości poważne
5 - dolegliwości bardzo nasilone

DOLEGLIWOŚCI

Upośledzenie drożności nosa	0	1	2	3	4	5	☐
Kichanie	0	1	2	3	4	5	☐
Wycieki wodniste z nosa	0	1	2	3	4	5	☐
Kaszel	0	1	2	3	4	5	☐
Spływanie wydzieliny po tylnej ścianie gardła	0	1	2	3	4	5	☐
Wycieki śluzowe lub śluzowo-ropne z nosa	0	1	2	3	4	5	☐
Zatykanie uszu lub uczucie pełności w uszach	0	1	2	3	4	5	☐
Zaburzenia równowagi	0	1	2	3	4	5	☐
Ból ucha	0	1	2	3	4	5	☐
Ból lub rozpieranie twarzy	0	1	2	3	4	5	☐
Trudności w zasypianiu	0	1	2	3	4	5	☐
Wstawanie w nocy	0	1	2	3	4	5	☐
Brak wysypiania się	0	1	2	3	4	5	☐
Uczucie zmęczenia po przebudzeniu	0	1	2	3	4	5	☐
Męczliwość	0	1	2	3	4	5	☐
Zaburzenia produktywności	0	1	2	3	4	5	☐
Zaburzenia koncentracji	0	1	2	3	4	5	☐
Frustracja/zmęczenie/rozdrażnienie	0	1	2	3	4	5	☐
Smutek	0	1	2	3	4	5	☐
Zakłopotanie	0	1	2	3	4	5	☐

Proszę zakreślić pięć najbardziej dokuczliwych dolegliwości.

Inne - proszę o wymienienie: .....

Podpis pacjenta..... podpis lekarza.....

Fig. 3. SNOT-20 survey in Polish

gender (chi-square test for independence: P=0.001). Male patients were significantly more often subjected to septoplasty while female patients were significantly more often subjected to endoscopic ethmoidectomy.

Answers to individual questions of the SNOT-20 survey were analyzed according to patients' gender. The questions were blocked depending on the type of complaints. The survey was completed before and after surgical treatment.

The results of the SNOT-20 survey (before and after the surgery) depending on gender (Fig. 5) suggest no statistically significant differences between male and female patients with the exception of total1 value. This, however, might be random in nature.

The strength of correlations between the subjective assessments and the results of AR and RMM examinations was analyzed.

The analysis of AR data revealed no statistically significant correlations with SNOT-20 scores as obtained either before or after the surgery In the face of the above, further analyses focused on the results of RMM measurements. The results are presented in Tables 3, 4, and 5. In contrast to previous assumptions, only low strength or very low strength correlations were demonstrated between the tested variables, with statistical significance being obtained in selected cases only.

In general, the strength of the correlations between the objective parameter of nasal air flow and the subjective impressions of subjects as expressed in SNOT-20 surveys was low (Tab. III, IV, V), and the statistical significance was obtained only with regard to the first question of the survey (the intensity of nasal patency impairment) for all the flow components. With regard to the block of questions regarding RNT disorders, the strength of the correlations was very low and correlations themselves were detected in an inconsistent manner. Thus, it must be concluded that the feeling of impaired nasal patency is the most repeatable and reliable complaint reported by patients with rhinological problems. After the surgery (Tab. IV), the strength of the respective correlations was much lower and, in the case of certain parameters, insignificant. The assessment carried out 6 month (Tab. V) after the surgery again pointed to an increase in the strength of correlation between the feeling of impaired nasal patency and the objective air flow resistance measurements. This might be due to the fact that patients reporting for follow-up visits 6 months after the surgery consisted mainly of those experi-

Tab. II. SNOT-20 results (before and after the surgery) vs. gender. Arithmetic means and standard deviations

PARAMETER	BEFORE SURGERY		AFTER SURGERY	
	F	M	F	M
01-SNOT	3,53 (1,07)	3,42 (1,31)	1,28 (1,25)	1,35 (1,32)
total1	14,91 (8,05)1	12,01 (8,06)1	7,23 (7,25)	5,95 (5,67)
total2	9,03 (6,55)	8,97 (6,44)	4,64 (5,63)	4,57 (5,65)
total3	6,23 (5,75)	6,46 (5,69)	3,62 (6,08)	3,76 (4,87)
TOTAL	33,70 (17,98)	30,86 (17,17)	16,77 (18,23)	15,63 (15,11)

Population numbers: F before = 70, F after = 47, M before = 153, M after = 97

01-SNOT – the score provided by the answer to the SNOT-20 question regarding impaired nasal patency

total1 – the total score provided by the answers to the group of SNOT-20 questions regarding the ENT complaints (sneezing, running nose, coughing, discharge dripping down the posterior pharyngeal wall, mucous or mucopurulent nasal discharge, congestion or fullness of ears, balance disorders, ear pains, facial pain or pressure)

total2 – the total score provided by the answers to the group of SNOT-20 questions regarding the functional complaints (difficulties with falling asleep, nocturnal awakenings, inability to get enough sleep, feeling tired after waking up, fatigue)

total3 – the total score provided by the answers to the group of SNOT-20 questions regarding the psychiatric complaints (disturbed productivity, concentration disorders, frustration/fatigue/irritability, depression, confusion

TOTAL – the total score provided by the answer to all SNOT-20 questions.

Tab. III. Kendall's tau coefficient for the correlation between nasal air flow resistance and pre-surgery SNOT-20 score.

PARAMETER	BEFORE DECONGESTION					AFTER DECONGESTION				
	R-EXL	R-EXR	R-INL	R-INR	R-RES	R-EXL	R-EXR	R-INL	R-INR	R-RES
01-SNOT	0,06	**0,18**	0,05	**0,18**	**0,24**	-0,01	**0,13**	-0,01	**0,12**	**0,13**
total1	-0,06	0,03	-0,05	0,02	-0,06	-0,03	-0,07	-0,04	-0,07	-0,07
total2	-0,07	-0,01	-0,06	-0,01	-0,06	-0,05	-0,05	-0,05	-0,06	-0,05
total3	-0,05	-0,05	-0,04	-0,05	-0,06	-0,03	-0,08	-0,04	-0,08	-0,06
TOTAL	-0,07	-0,01	-0,06	-0,01	-0,06	-0,05	-0,07	-0,05	-0,08	-0,07

The correlation coefficients determined in the examination are significant; P<0.05 (n=217).

Pre-surgery air flow resistance.

R-exL – air flow resistance upon exhalation on the left

R-exR – air flow resistance upon exhalation on the right

R-inL – air flow resistance upon inhalation on the left

R-inR – air flow resistance upon inhalation on the right

R-res – mean resistance

Tab. IV. Kendall's tau coefficient for the correlation between nasal air flow resistance and SNOT-20 score obtained 6 weeks after the surgery

PARAMETR	BEFORE DECONGESTION					AFTER DECONGESTION				
	R-EXL	R-EXR	R-INL	R-INR	R-RES	R-EXL	R-EXR	R-INL	R-INR	R-RES
01-SNOT	0,15	0,11	0,16	0,10	0,22	0,18	0,04	0,18	0,07	0,17
total1	0,04	0,02	0,04	0,01	0,04	0,01	-0,03	0,00	0,00	-0,03
total2	-0,06	-0,04	-0,05	-0,04	-0,04	-0,03	-0,07	-0,02	-0,04	-0,07
total3	-0,04	-0,06	-0,04	-0,07	-0,06	0,01	-0,07	0,02	-0,03	-0,03
TOTAL	0,00	-0,02	0,01	-0,03	0,01	0,01	-0,05	0,00	-0,01	-0,02

The correlation coefficients determined in the examination are significant; P<0.05 (n=137).

Tab. V. Kendall's tau coefficient for the correlation between nasal air flow resistance and SNOT-20 score obtained 6 months after the surgery

PARAMETR	BEFORE DECONGESTION					AFTER DECONGESTION				
	R-EXL	R-EXR	R-INL	R-INR	R-RES	R-EXL	R-EXR	R-INL	R-INR	R-RES
01-SNOT	0,19	0,21	0,19	0,18	0,34	0,19	0,15	0,18	0,13	0,24
total1	0,02	0,16	-0,01	0,13	0,13	0,00	0,13	-0,01	0,11	0,06
total2	-0,04	0,03	-0,05	0,03	0,05	-0,05	-0,04	-0,05	-0,04	-0,03
total3	-0,04	0,02	-0,04	0,02	0,05	-0,05	-0,03	-0,04	-0,02	-0,01
TOTAL	0,00	0,12	-0,02	0,10	0,12	-0,01	0,06	-0,01	0,05	0,04

The correlation coefficients determined in the examination are significant; P<0.05 (n=123).

encing higher resistance who perhaps had not achieved a satisfactory result after the procedure. The analysis of the results obtained for the remaining blocks of questions is suggestive of low repeatability and therefore, the results obtained in this part of the survey should be treated with caution.

The analysis of data provided in Table VI including the comparison of scores obtained for individual blocks of survey questions before and after the surgery demonstrated an improvement in the intensity of individual complaints (a reduction in the mean intensity of complaints).

The high level of correlation between the survey scores obtained before and after the surgery (Tab. VII) is the proof of patient's consistent compliance when completing the survey. Patients provided coherent and consistent responses to the survey questions.

As shown in Table VIII, patients with mild or medium discomfort with regard to nasal patency before the surgery (score range 0-3) stood by their subjective assessment of "medium" discomfort after the surgery as well. Vast majority of patients who had experienced extremely strong discomfort (5) reported reduction of discomfort after the surgery. High intensity of discomfort (score range 4-5) was reported by as little as 14% of responders.

Tab. VI. Porównanie wyników odpowiedzi udzielonych w ankiecie SNOT-20 przed i po operacją.

PARAMETER	BEFORE SURGERY	AFTER SURGERY	P
01SNOT	3,42 (1,31)	1,33 (1,29)	<0,0001
total1	12,17 (7,74)	6,37 (6,23)	<0,0001
total2	8,53 (6,44)	4,59 (5,63)	<0,0001
total3	6,20 (5,71)	3,72 (5,28)	<0,0001
TOTAL	30,33 (17,62)	16,00 (16,14)	<0,0001

Descriptive statistics (arithmetic means and standard deviations) Student's t-tests for dependent samples (n=144).

Symbol definitions as in Table II.

Tab.VII. Correlation of SNOT-20 results obtained before and after the surgery

PARAMETER		AFTER SURGERY				
		01SNOT	TOTAL1	TOTAL2	TOTAL3	TOTAL
before surgery	01SNOT	0,10	0,01	0,02	0,01	0,03
	total1	0,12	0,32	0,25	0,23	0,29
	total2	0,14	0,24	0,43	0,33	0,36
	total3	0,15	0,24	0,40	0,42	0,38
	TOTAL	0,16	0,29	0,39	0,36	0,39

Kendall's tau-correlations

Tab. VIII. Changes in the answers to the first SNOT-20 question in the same patients before and after the surgery

		0	1	2	3	4	5	
	01SNOT-0	01SNOT-1	01SNOT-1	01SNOT-1	01SNOT-1	01SNOT-1	01SNOT-1	N
Number	0	5	2	1	0	0	0	8
% of the column		10,87%	4,35%	4,17%	0,00%	0,00%	0,00%	
% of the row		62,50%	25,00%	12,50%	0,00%	0,00%	0,00%	
Number	1	3	1	0	1	0	1	6
% of the column		6,52%	2,17%	0,00%	5,56%	0,00%	33,33%	
% of the row		50,00%	16,67%	0,00%	16,67%	0,00%	16,67%	
Number	2	3	4	2	1	0	0	10
% of the column		6,52%	8,70%	8,33%	5,56%	0,00%	0,00%	
% of the row		30,00%	40,00%	20,00%	10,00%	0,00%	0,00%	
Number	3	12	16	4	6	4	0	42
% of the column		26,09%	34,78%	16,67%	33,33%	57,14%	0,00%	
% of the row		28,57%	38,10%	9,52%	14,29%	9,52%	0,00%	
Number	4	14	16	12	6	1	0	49
% of the column		30,43%	34,78%	50,00%	33,33%	14,29%	0,00%	
% of the row		28,57%	32,65%	24,49%	12,24%	2,04%	0,00%	
Number	5	9	7	5	4	2	2	29
% of the column		19,57%	15,22%	20,83%	22,22%	28,57%	66,67%	
% of the row		31,03%	24,14%	17,24%	13,79%	6,90%	6,90%	
Number	Overall	46	46	24	18	7	3	144

DISCUSSION

The correlations between the air flow resistance parameters assessed in RMM measurements and patients' self assessment scores as observed in the study were of low strength with only some of them meeting the significance criteria. Similar results had been obtained by other researchers.

In 2006, Zhao et al. [12] attempted to determine the importance of AR and RMM in the assessment of the outcomes of surgical treatment of patients with hypertrophy of inferior nasal concha by means of conchoplasty and septoconchoplasty. Both methods turned out to be suitable in terms of surgical outcomes; however, the authors stated that correlations between subjective symptoms and objective results of AR and RMM measurements requires further studies. Similar conclusions were drawn by Magnusson A. et al. [13] who carried out a study to assess the changes in minimum cross-sectional area and air flow resistance following surgical removal of conchal hypertrophy. Also in this case, no correlation between the objective and the subjective outcomes could be observed.

In the studies conducted to date by Piril et al. [14], the researchers observed a clear correlation between the objective pre-operative measurements and the post-operative satisfaction of patients. Low MCA values or low air flows on the side of septum deviation, large difference in flows between both nasal cavities (air flow ratio) or bilaterally low MCA values before the surgery were significant predictors of high satisfaction following the surgical treatment.

Suonpaa et al. [15] examined a group of 88 using active anterior rhinomanometry 6 months after a septoplasty procedure and assessed patients' satisfaction using special questionnaires 3 to 5 years after the surgery. A slight yet statistically insignificant reduction in patients' satisfaction several year after septal surgery was observed in the patient. The results showed that patients with high pre-surgery air flow resistance values as well as patients with normal pre-surgery air flow resistance values

were the most satisfied with the surgical outcomes. Therefore, it was concluded than rhinomanometric examination prior to a rhinological surgery facilitates the selection of patients that would achieve the best postoperative effects.

Numerous authors [16,17] carried out studies to assess the satisfaction of patients subjected to rhinological procedures on the basis of rhinomanometry and acoustic rhinometry results. Some studies showed that high air flow resistance values measured by RMM before the surgery were correlated with high satisfaction after the surgery. The satisfaction with the surgery outcomes was declared as high or very high by 84.7 % of patients with high air flow resistance (90 Pa/(1/s) and 200 Pa/(1/s) were accepted as reference values for total and unilateral air flow resistance following decongestion, respectively). In these cases, RMM results allowed to categorize patients according to the severity of their symptoms (the size of mucosal swelling and its uni-/bilateral status). This facilitates earlier surgeries in patients most intensely suffering from nasal congestion [16].

Balcerzak et al. [18] demonstrated than nasal air flow resistance as measured by rhinomanometry were reduced following septal surgery despite the lack of statistical significance of results. It was also demonstrated that simultaneous septoplasty and conchoplasty significantly improves the subjective impression of nasal patency disorders as measured by SNOT-20.

In this study, the results of acoustic rhinometry turned out to be completely inconsistent with patients' self-assessment of nasal patency. This was in contrast with the reports by other authors who claimed that AR is very useful for the assessment of nasal cavity in cases when septoplasty with conchoplasty is being considered [19]. It is however, consistent with the conclusions drawn by Reber et al. [20] who assessed the outcomes of septoplasty 6 months after the procedure on the basis of visual analog scale assessments and acoustic rhinometry measurements before and after decongestion. The authors were unable to demonstrate any correlation between MCA or nasal cavity volume and the subjective impression of nasal patency and concluded that acoustic rhinometry is not a valuable tool to indicate the need for patency-restoring procedures or to assess the outcomes of such procedures.

CONCLUSIONS

The conclusions from the study are as follows:

1. There is a statistically significant correlation between the subjective impression of nasal patency and the results of rhinomanometric measurements.

2. The SNOT-20 question regarding nasal patency is the only survey question with significant correlation to the results of air flow resistance measurements. Patients reporting the maximum discomfort (the score of 5) with that respect were shown to differ significantly from the remaining patients, as they nearly always experienced satisfaction following the procedures to restore nasal patency.

3. Patients reporting extreme discomfort with regard to nasal patency were characterized by air flow resistance values several times larger than those measured in the remaining patients.

4. Acoustic rhinometry is not significantly reflected in subjective impressions of patients as expressed by SNOT-20 survey outcomes.List of tables

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