ORIGINAL ARTICLE

Evaluation With Acoustic Rhinometry of Patients Undergoing Sinonasal Surgery

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Summary

The purpose of this study is to evaluate the use of Acoustic Rhinometry in assessing surgical outcomes in sinonasal surgery. This prospective study was carried out from January till December 2001. A group of 44 patients who presented with nasal obstruction due to various rhinologic abnormality were examined with acoustic rhinometry pre and post-operatively. They were examined with acoustic rhinometry pre and post decongestion with cocaine and adrenaline. A highly significant correlation existed between minimal cross sectional area (MCA) and the subjective feeling of nasal problem, pre and post surgery. Thus MCA is a valuable parameter to express objectively the nasal patency. The mucovascular component of the nasal cavity plays a major role in the nasal patency as determined in the pre and post-decongestion acoustic rhinometry measurement. Acoustic rhinometry is a good tool to evaluate the nasal patency in cases where sinonasal surgery is considered in correcting the abnormality as well as for the post-operative evaluation.

Key Words: Acoustic rhinometry, Minimal cross sectional area, Sino-nasal surgery

Introduction

Nasal obstruction as felt by the patient is a subjective symptom with many possible origin, either anatomical or structural obstruction with impairment of nasal patency such as septal deviation, septal spur, conchal hypertrophy, concha bullosa or nasal polyp. Another group of nasal obstruction is caused by functional component with no structural abnormalities. Anterior rhinoscopy of subjects with and without nasal complaints reveals varying severity and location of septal and turbinate deformities which do not always correlate with the symptoms. Since symptoms are commonly inconsistent with the appearances, objective criteria are required for accurate diagnosis, appropriate therapy and assessment of results.

Endoscopic and imaging technology have enabled great advances to be made in rhinologic evaluation and knowledge with an exact anatomic display of the nasal cavities, paranasal sinuses, nasopharynx and the neighbouring structures. But these modality do not quantify the nasal obstruction even though they can project the structural abnormality.

An objective test is a valuable tool for clinical assessment and patient care. Objective testing can help in the diagnosis, provide a guide and monitor the therapy, may help to avoid inappropriate treatment, assist in the outcome studies and finally it may help to furnish in medicolegal documentation. The assessment of the nasal airway consist of a complete history, physical examination and objective testing.

Currently there are two methods available to assess the nasal patency objectively. These assessment are performed widely in both practice and research. There

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are two methods of evaluation in current use 1) a dynamic technique (for measurement of both respiratory airflow and differential pressures between proximal and distal extremities of the nasal airway) and 2) a static technique (for measurement of lumen dimensions of designated airway segment independently of respiratory airflow). The application of the dynamic technique to the assessment of the nasal patency is termed acoustic rhinomanometry and the static technique of the assessment of the nasal patency is termed acoustic rhinometry.

Materials and Methods

This is a prospective study where all patients who fulfilled the inclusion criteria with informed consent and underwent sinonasal surgery namely functional endoscopic sinus surgery, intranasal polypectomy, septoplasty or turbinate surgery from January 2001 till September 2001 were included in this study. The purpose of this study is to evaluate the use of acoustic rhinometry (AR) in assessing surgical outcomes in sinonasal surgery. Patient who underwent previous nasal surgery or sinonasal surgery for tumor of the nasal cavity or paranasal sinuses, septal perforation, foreign bodies etc were excluded from the study.

The Rhinometric's rhinoscan from Denmark was utilised in this study and the results were calculated and produced in diagram by Rhinometric 98 software. The nasal pathology was documented using rigid nasal endoscopy. Prior to the AR measurement an informed consent was obtained from patients willing to participate in the study. A day prior to surgery the patient was subjected for acoustic rhinometry measurement before and after the nasal decongestion using cocaine and adrenaline topical nasal spray. Prior to performing AR, the subject was asked to blow his / her nose to remove any nasal discharge or crusts from the nasal cavities. The AR measurement were made with the patient in the sitting position. A nose piece was attached to fit into the nostril to maintain the proper angle of 45° between the wave tube and nasal floor. The subject was instructed not to breathe via the nose during the test. The AR measurement was conducted by a same operator.

The patients were also given questionnaires (appendix 1) concerning nasal passage and related symptoms (sinonasal outcome questionnaires - SNOQ) to record the degree of nasal impairment pre- and post-operatively. The questions ranged from nasal blockage, sneezing, running nose, postnasal discharge and headache. These symptoms were chosen because they are common in rhinitis presentation. The score of each complaints ranged from 0 (no problem), 1 (mild or slight problem), 2 (moderately problem) to 3 (severe problem). The raw scores may range from 0 which is no nasal complaint to a maximum of 15 which indicate severe nasal complaint.

The subjects were then assessed post-operatively in 4 to 6 weeks with acoustic rhinometry measurement and sinonasal outcome test's questionnaires were provided to assess subjectively the nasal symptoms.

The data was analysed using SPSS statistical program. Paired t-test was used in the analysis comparing pre-operative and pre-decongestion with post-operative and post-decongestion respectively. Correlation between subjective nasal patency and measurement by AR were calculated by Pearson correlation statistical analysis. Other non-parametric tests were used where P value less than 0.05 (two-tailed) were considered significant.

Results

Twenty-seven male and seventeen female patients were enrolled in this study with a mean age of 33.20 (sd +/- 13.40). Eighteen patients were diagnosed to have deviated nasal septum with bilateral hypertrophied inferior turbinate, 15 had deviated nasal septum, 6 had bilateral hypertrophied inferior turbinates and 5 had intra-nasal polyps. These patients were subjected to septoplasty and bilateral turbinectomy, septoplasty, intranasal polypectomy or bilateral turbinectomy respectively. All patients showed a subjective improvement of nasal patency by comparing the sinonasal outcome questionnaires pre (pre-SNOQ) and post-operatively (post-SNOQ) as shown in Table I. The sinonasal outcome questionnaires raw scores pre-operatively were found to have mean of 10.32 (sd +/- 1.58), which decreased to 5.30 (sd +/- 1.49).

The results of pre and post-operative measurement of the minimal cross sectional area - 1 (MCA1) as shown in the Table II revealed a significant change when measured bilaterally even though the results on the left showed P value of 0.06 compared to the right (P value of 0.00). However the results of pre and post-operative measurement of the minimal cross sectional area - 2 (MCA2) (Table III) revealed a significant change in measurement of the nose either unilaterally or bilaterally. The right post-operative measurement of both MCA1 and MCA2 was increased from 0.4093 cm^2 and 0.4200cm^2 to 0.5900 cm^2 and 0.5955cm^2 ($p < 0.05$). The right post-operative measurement of MCA1 was increased from 0.4093cm^2 to 0.5900cm^2, ($p < 0.05$). The right post-operative measurement of MCA2 also showed an increasing trend from 0.4200cm^2 to 0.5955cm^2, ($p < 0.05$). The left post-operative measurement of MCA1 was increased from 0.4457cm^2 to 0.5482cm^2, ($p > 0.05$). The left post-operative measurement of MCA2 was increased from 0.5109cm^2 to 0.6580cm^2, ($p < 0.05$).

The results of pre and post-decongestion with cocaine and adrenaline nasal spray showed a significant change in both MCA1 and MCA2 of the acoustic rhinometry measurement with the P value less than 0.05, (Table IV and Table V). The right pre-decongestion assessment of the MCA1 was 0.4093cm^2, which increased with post-decongestion to 0.5216cm^2 ($p < 0.05$). The left pre-decongestion assessment of MCA1 was 0.4457 cm^2, which increased to 0.5425cm^2 on post-decongestion ($p < 0.05$). The right pre-decongestion assessment of MCA2 was 0.4200cm^2 which increased to 0.6173cm^2 ($p < 0.05$).

Correlation exist between subjective nasal patency from the post-operative sino-nasal outcome questionnaires and the post-operative acoustic rhinometry measurement of both MCA1 and MCA2 with the p value less than 0.05 (Table VI). This study also revealed that after the surgery the distance area of MCA 2 had moved forward from 2.56cm to 2.31cm which statistically was significant (Table VII).

Table I: Subjective sinonasal outcome questionnaires on score ranging from 0 (no complaint) to 15 (severe complaint)

	MEAN	+/- SD
Pre-operative SNOQ (pre-SNOQ)	10.32	+/-1.58
Post-operative SNOQ (post-SNOQ)	5.30	+/-1.49
Difference	5.02	+/-2.40

Table II: Pre and post-operative minimal cross sectional 1 (MCA 1) measurement with significant P value (P < 0.05)

	Pre-operative (+/-SD cm^2)	Post-operative (+/-SD cm^2)	P value
Right	0.41 (+/-0.22)	0.59 (+/-0.12)	0.00
Left	0.45 (+/-0.25)	0.55(+/-0.13)	0.04
Bilateral	**0.43 (+/-0.16)**	**0.57 (+/-0.11)**	**0.00**

Table III: Pre and post-operative minimal cross sectional area 2 (MCA 2) with the significant P value (P < 0.05)

	Pre-operative (+/- SD cm^2)	Post-operative (+/- SD cm^2)	P value
Right	0.42 (+/-0.34)	0.59 (+/-0.14)	0.04
Left	0.51 (+/-0.33)	0.66 (+/-0.25)	0.01
Bilateral	**0.46 (+/-0.27)**	**0.63 (+/-0.14)**	**0.00**

Table IV: Pre and post decongestion MCA 1 measurement with significant P value ($P < 0.05$)

	Pre-decongestion (+/- SD cm^2)	Post-decongestion (+/- SD cm^2)	P value
Right	0.41 (+/-0.22)	0.52 (+/-0.24)	0.00
Left	0.44 (+/-0.25)	0.54 (+/-0.21)	0.02
Bilateral	**0.43 (+/-0.16)**	**0.53 (+/-0.16)**	**0.00**

Table V: Pre and post-decongestion MCA 2 measurement with significant P value ($p < 0.05$).

	Pre-decongestion (+/- SD cm^2)	Post-decongestion (+/- SD cm^2)	P value
Right	0.42 (+/-0.34)	0.62 (+/-0.40)	0.00
Left	0.51 (+/-0.33)	0.72 (+/-0.38)	0.00
Bilateral	**0.46 (+/-0.27)**	**0.67 (+/-0.27)**	**0.00**

Table VI: Correlation between SNOQ (pre and post-operatively) and acoustic measurement and post-operatively) using Pearson correlation, which was significant ($P < 0.05$)

	MCA 1	MCA 2
Pre-operative SNOQ	0.01	0.00
Post-operative SNOQ	0.01	0.03

Table VII: The distance of minimum cross sectional area (MCA 1 & MCA 2) between pre and post-operative

	Pre-operative (cm)	Post-operative (cm)	P Value
MCA 1	1.74 (+/- 0.44)	1.64 (+/- 0.48)	0.29
MCA 2	2.56 (+/- 0.57)	2.31 (+/- 0.21)	0.00

Discussion

The impact on the nasal patency by the abnormalities of the nasal cavity were mostly located on the anterior half of the nasal cavity. Septoplasty, turbinate reduction procedure and endoscopic sinus surgery are the common surgical procedures performed on patients presenting with either nasal polyposis, septal deviation or enlarged turbinate. The two most common symptoms presented by patient which need surgical intervention are nasal obstruction and nasal congestion, and these symptoms are reported as being improved subjectively after undergoing the above named surgical procedure[1].

Acoustic rhinometry is a valuable tool in the objective assessment of nasal patency, where it can provide the assessment of nasal cross-sectional area and volume. The method provides values before and after decongestion which allows to evaluate the cause of the nasal obstruction as mainly structural or functional. From a clinical point of view, the area-distance function curve helps the researcher to differentiate objectively and quantify the mucosal and the structural component of nasal obstruction and to assess results of the surgical procedure or even the medical treatment outcome.

As seen in this present study the minimal cross sectional area moved anteriorly especially after nasal decongestion with the topical nasal spray. The effect of the decongestion was obviously seen as shown in the Tables IV and V. This results strongly indicate that the vascular network within the submucosal region of the anterior segment provide a major contribution to the dimension of the minimal cross sectional area. Therefore it is an important parameter to be considered in determining the true anatomical abnormality to be corrected in surgery for nasal obstruction. These was supported by the studies done by Shemen and Hamburg 1997[2], Grymer et al 1989[3] and Gospath et al 2000[4]. The mucosa of the inferior turbinate is considered the main contributing factor in physiological cause of nasal obstruction by majority of the authors[5,6].

The area dimension of the MCA is a valuable parameter in the evaluation of the severity of obstruction and is correlated with the subjective nasal patency as calculated in this study.. Intra-operative direct measurement from collumella to the anterior edge of the inferior turbinate and to the anatomical abnormality which cause the obstruction present a valuable parameter in increasing the specificity of the MCA for acoustic rhinometry measurement.

Both nostrils and the bilateral cross sectional areas of both MCA 1 and MCA 2 were both increased post-operatively (Table II and III) which was statistically significant. The post-operative acoustic rhinometry measurement should be performed within 4 to 6 weeks after the surgery to allow normal mucosal healing to take place. In our opinion the acoustic rhinometry measurement can also be used as part of objective assessment of the process of post-operative mucosal recovery and this is a subject that need to be studied in the future to widen the usage of acoustic rhinometry.

The subjective sensation of the nasal patency from the SNOQ were significantly improved post-operatively ($P = 0.00$) and this was consistent with the study by Reber et al 1998[7].

This study also revealed a positive association between the subjective assessment in the SNOQ and the objective data results from the acoustic rhinometry measurement. This finding was consistent with the studies by Reber et al 1998[7], Gosepath et al 2000[4] and grymer et al 1989[3]. These results indicated that the surgery was successful and the indications of these surgical procedure seems to eradicate the cause of the nasal problem in the patients reviewed. This also suggested that the MCA is a valuable parameter to express the nasal patency in rhinological practice. In Table VII revealed the distance area of MCA 2 which had moved anteriorly indicating that the influence of the structural abnormality is mainly in the functional valve.

There are few factors that to be considered in order to get a good and reliable results of acoustic rhinometry measurement which are of crucial importance such as the positioning and design of the nose piece and stability of the head during measurement. Cole et al 1997[8] have suggested that the head of the seated patient is comfortably stabilized in a standardized position by means of a firm stand with adjustable chin and forehead rests. Great attention must be paid to avoid distortion of the vestibule and at the same time get a good seal at the interphase between nostril and nosepiece. Using a paraffin gel is one method to get a good seal. During the measurement the patient must clearly be instructed that he or she must not breath through the nostril for this may cause distortion of the transmission of the acoustic wave within the nasal cavity. The limitation of this acoustic rhinometry technique which have been suggested by Hilberg et al 1989[6] and Roithmann et al 1995[9] is that it could not measure the cross sectional area beyond very narrowed segments because the acoustic energy is lost beyond a severe constriction.

Conclusion

Acoustic rhinometry is a good research tool for rhinology namely as part of evidence based medicine where the results can be shown to the patient as an objective indicator of the cause of the reduction of the nasal patency hence the indication for the surgical procedure. It is also helpful in decision making especially in those who manifest very minimal findings on physical examination. Finally acoustic rhinometry can be used as part of medicolegal documentation of surgical outcomes and success. Thus acoustic rhinometry is a quick, painless, non-invasive and inexpensive technique to objectively evaluate the nasal cavity which can be rapidly performed and highly reproducible.

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Appendix I

SINONASAL OUTCOME TEST QUESTIONNAIRES:

SCORE :-

NO PROBLEM	-	0
MILD / SLIGHT	-	1
MODERATE	-	2
SEVERE	-	3

ITEM :-

NASAL BLOCKAGE	:
SNEEZING	:
RUNNY NOSE	:
POSTNASAL DISCHARGE	:
HEADACHE	:
TOTAL SCORES	:-

RAW SCORES :

0	:	NO COMPLAINT
1-5	:	MILD COMPLAINT
6-10	:	MODERATE COMPLAINT
11-15	:	SEVERE COMPLAINT