# Rhinomanometry evaluation in Septoplasty

**Saad Shammas** FICMS (ENT.)
**Ammar H. Khammas** FICMS (ENT.)
**Ali I. ALbayati** FICMS (ENT.)

**Abstract**

**Objective:** Subjective (Rhinomanometry) assessment and correlation before and after septal surgery.
**Methods:** A prospective study on 100 patients undergoing septoplasty with pre and postoperative assessment of subjective nasal obstruction, clinical rhinoscopic findings and subjective rhinomanometric measures.
**Results:** The mean nasal airway resistance (NAR) has decreased from 0.63 Pa/cm$^3$/s preoperatively to 0.24 postoperatively with a drop of 62%, while the nasal airflow has increased from 262 to 743cm$^3$/s. There was a marked correlation between the objective and subjective results, 68-80% (preoperative) and 80-87% (postoperative).
**Conclusion:** It is recommended to use rhinomanometry in patient selection for septoplasty.

**Key words:** Rhinomanometry, septoplasty.

## Introduction

The objective assessment of nasal patency is a common challenge in the everyday clinical ENT.practice. Since the observation of condensation spots after breathing on the mirror (Zwaardemaker 1889, Glatzel 1901), several methods have been described to evaluate nasal patency[1].

With the development of more sensitive devices such as the pressure transducer and the pneumatograph and with the use of more sophisticated recoding equipments, it became possible to register simultaneously the pressure gradient and the airflow during breathing. These technical achievements allowed the development of the actual rhinomanometric techniques which started in the 1960s [2].

The subjective sensation of nasal obstruction is very difficult to quantify in clinical practice unless the obstruction is nearly complete. Furthermore, perception of nasal obstruction varies considerably, often bearing no direct relation to the actual resistance to airflow in the nose [3].

One of the commonly used methods of objective assessment of the nasal airway is the simultaneous recording of transnasal pressure and airflow. Rhinorheomanometry, rhinomanometry, rhinometry and rhinomanography are names that have been applied to these measurements [4].

The International Standards Committee suggested in the meeting held in Brussels in 1983 that the term rhinomanometry (RMM) is more appropriate because it is restricted in meaning to that of measurement of nasal respiratory function [2].

RMM represents a dynamic assessment of nasal patency based on the measurement of transnasal pressure and flow during breathing [1].

Nasal airway resistance (NAR) is calculated from the following equation:

$R = \Delta P/v$

R= Resistance to airflow in Pa/cm$^3$/s

Δ= Transnasal pressure in Pascal (Pa)

V= Nasal airflow in cm$^3$/s

A plot of the dynamic relations of transnasal pressure and flow on an X/Y plotter shows a curvilinear relationship.

The right and left nasal airflows (NAF) are normally asymmetrical due to the nasal cycle and therefore a single pressure value may relate to two different airflows. It is therefore sensible to standardize nasal airway resistance (NAR) by measuring both nasal airflows at the same sample pressure points rather than by measuring transnasal pressures at the same sample flow point [5]. Unilateral nasal airflow measured at a sample pressure point of 150 Pa and bilateral nasal airflow measured at 75 Pa has been recommended as universal standard [2].

Active anterior RMM is a convenient technique because it requires very little patient cooperation. In this method, NAR is measured on one side of the nasal cavity only, because the airflow on the contralateral side of the nose must be obstructed to monitor the nasopharyngeal pressure. Pressure-flow curves in the nasal cavity being assessed can be measured by sealing a small tube into one nostril to measure nasopharyngeal pressure, i.e., transnasal pressure, and measuring airflow through the other nares by means of a closely fitted face mask [3].

The P/V curves and NAR are determined separately for each nasal passage and the total R is then calculated by summing the values [5]:

$1/R\ (Total) = 1/r\ (left) + 1/r\ (right)$

On the basis of statistical analysis, active anterior RMM has proven its value in the differentiation between normal and pathological

values and in the evaluation of the postoperative results [2, 6].

**Advantages of the active anterior RMM:**

1-Practically no deformation of the ostium.

2-Little chance of leakage at the level of the nostril.

3-No nozzles needed.

4-Simultaneous recording of pressure gradient (ΔP) and flow V on a two-channel recorder.

5-Most accurate method for clinical use.

**Disadvantages:**

1-More time consuming.

2-Chance of leakage between face and mask.

3-Cannot be performed in the presence of septal perforation [2].

Anterior rhinoscopy of subjects with and without nasal complaints reveals varying severity and location of septal and turbinate deformities. Prescription of surgical treatment for a nose with impaired nasal passage should be based on objective criteria[7].

The relevance of objective assessment of nasal resistance and patency has been documented in many rhinological situations [8]:

1-It can be used to differentiate if the nasal obstruction is structural or mucosal in nature by conducting the test before and after topical decongestion.

2-Objective testing is useful in the quantitative assessment of the benefit of therapy. It can be used to assess the effectiveness of septoplasty and turbinoplasty in alleviating nasal obstruction.

3-In the research of nasal physiology, it provides quantitative information on the response of nasal mucosa to intranasal challenges with allergens and other types of physical and chemical stimuli.

4-Objective data on the nature of the nasal airway can be used for medico-legal documentation.

**Patients & Methods**

One hundred patients were studied prospectively during 2001-2005. All were presented with variable degrees of troublesome nasal obstruction, in addition to other symptoms of nasal septal deviation. Full history, clinical examination and investigations were performed including fiberoptic naso-endoscopy for better assessment of the degree and the site of of the septal deviation, valve area, in addition to the state of inferior turbinates, and the mucosa as well.

Preoperative subjective nasal symptoms were assessed depending on the patient description including nasal obstruction, facial pain, allergic rhinitis features (sneezing, rhinorrhoea and postnasal drip) and epistaxis.

Active anterior RMM was the applied method using rhinomanometry (300 ATMOS) to measure the transnasal airway resistance and nasal airflow (NAF). Before starting the measurement, all patients were allowed to acclimatize for 15-20 minutes (rest period). The nasal adaptor is inserted to one nostril which measures the transnasal pressure, i.e., nasal airway resistance(NAR)of one side, and a face mask is applied and the patient is asked to make a deep quiet breath (inspiratory and expiratory) with the mouth closed to measure the nasal airflow on the contralateral side. The same step is applied but to the other nostril. The rhinomanometer will give recordings of the right, left and total nasal resistance ($Pa/cm^3/s$) in addition to nasal airflow ($cm^3/s$) under P of 75,150 and 300 Pa. It is the 150 Pa recordings which are chosen for this study. The same procedure was applied 10 minutes after instillation of 0.05% oxymetazoline nasal drops to eliminate the mucosal factors. All the documented readings are on the decongested nose.

All the patients were subjected to septoplasty and/or partial inferior turbinectomy. This procedure was performed one day before and four weeks after the operation.

Pre and postoperative comparison was achieved between subjective sensation of nasal obstruction, clinical rhinoscopic findings and rhinomanometric results of NAR and nasal airflow.

It has been reported that the mean total resistance is $0.23 Pa/cm^3/s$ with a range of 0.15-0.39[9]. In other series [10], the mean NAR was 0.36 $Pa/cm^3/s \pm 0.05$ ($p=0.22$, $n=20$).

Data collected were analyzed using the available statistical packages of SPSS-11.5 (Statistical packages for Social Sciences-Version 11.5). Data were presented in simple measures of frequency, percentage, mean, standard deviation, and range. Paired-t-test was used to test the significance of difference of NAR, NAF both pre and post-operatively, while chi-square test ($\chi^2$-test) was used to test the significance of association between different percentages (assessment for the correlation between subjective sensation, rhinomanometry, and rhinoscopy). P value of $\leq 0.05$ was used as the level of significance.

**Results**

One hundred patients were evaluated, most of whom were males (59) with a male: female ratio 1.4:1. All of the patients were 18 years old and above with a mean of 27 and ranging between 18-43 years. The majority (60%) belong to the group (20-29 years) followed by the 30-39 years group (20%). (Table 1)

Objective sensation of nasal obstruction was the main complaint (100%), followed by facial pain (65%). (Table 2)

**Table 1: The age and sex distribution of patients included in the study.**

| Age (years) | Sex | | | | Total | |
|---|---|---|---|---|---|---|
| | Female | | Male | | | |
| | No. | % | No. | % | No. | % |
| 10-19 | 5 | 33.3 | 10 | 66.7 | 15 | 15 |
| 20-29 | 29 | 48.3 | 31 | 51.7 | 60 | 60 |
| 30-39 | 6 | 30.0 | 14 | 70.0 | 20 | 20 |
| 40-49 | - | - | 5 | 100 | 5 | 5 |
| Total | 40 | 40.0 | 60 | 60.0 | 100 | 100 |
| Mean+SD | 24.85±5.03 | | 27.50±7.23 | | 26.44±6.54 | |
| Range | 18-39 | | 18-43 | | 18-43 | |

*P>0.05 (Not significant). This means that we select comparable age and sex patients

**Table 2: The preoperative symptoms presented by patients included in the study.**

| Symptoms | No. | % |
|---|---|---|
| **Nasal obstruction** | 100 | 100 |
| **Facial pain** | 65 | 65 |
| **Allergic rhinitis features** | 20 | 20 |
| **Epistaxis** | 9 | 9 |

Active anterior RMM was performed to all the patients before and after nasal decongestion, the second recording was considered to exclude mucosal effects as mentioned before. The mean preoperative total nasal airway resistance (NAR) has declined from 0.63 $Pa/cm^3/s$ to 0.24 postoperatively with a mean drop of 0.39(62%). Meanwhile, the mean preoperative total nasal airflow at 150 Pa has increased from 262 $cm^3/s$ to 743. (Table 3) Table 4 illustrates the pre and postoperative correlation between the subjective sensation of nasal obstruction, rhinomanometric results and the clinical rhinoscopic findings. There was a clear pre and postoperative correlation between rhinomanometric recordings, (80%) and (84%) respectively.

On the other hand, the preoperative correlation between the clinical rhinoscopic findings and the subjective symptoms has increased from 70% to 86% postoperatively.

There was another change of correlation between rhinomanometric results, clinical rhinoscopic findings and the subjective symptoms from 68% into 80%.

Finally, the correlation between the preoperative rhinomanometric results and the rhinoscopic findings has changed from 72% into 87% postoperatively.

**Table 3: The pre and postoperative measurements of nasal airway resistance (NAR) and the nasal airflow (NAF)**

| NAR (mean+SD) Pa/cm$^3$/s | | NAF (mean) cm$^3$/s | |
|---|---|---|---|
| **Pre op.** | **Post op.** | **Pre op.** | **Post op.** |
| 0.632±0.155 (0.41-0.95) | 0.244±0.046 (0.18-0.32) | 263.95±35.46 (190-360) | 742.70±28.99 (680-790) |
| **P<0.0001 (Highly significant)** | | **P<0.0001 (Highly significant)** | |

**Table 4: The pre and postoperative correlations for different methods of assessment of patients included in the study*.**

| | Pre op. | | Post op. | |
|---|---|---|---|---|
| | **Correlated** | **Not correlated** | **Correlated** | **Not correlated** |
| **RMM+Subjective sensation** | 80 (80%) | 20 (20%) | 84 (84%) | 16 (16%) |
| **Rhinoscopic +Subjective sensation** | 70 (70%) | 30 (30%) | 86 (86%) | 14 (14%) |
| **RMM+Rhinoscopic+Subjective sensation** | 68 (68%) | 32 (32%) | 80 (80%) | 20 (20%) |
| **RMM+Rhinoscopic** | 72 (72%) | 28 (28%) | 87 (87%) | 13 (13%) |

RMM= Rhinomanometry
RMM= Rhinomanometry
Subjective sensation= Subjective sensation of nasal obstruction
Rhinoscopic= Rhinoscopic clinical findings
*P<0.05 (significant association) between correlated and not correlated for each one pre and post-operatively.

## Discussion

This is a prospective analysis of 100 patients, all of whom had nasal septal deviations with a variety of clinical features and presentations. All had septoplasty and/or partial inferior turbinectomy or out fracture. We only chose patients of 18 years of age and above who are fully mature to avoid future problems like the recurrence of the deviation. Their mean age was27 years. Other studies have near by age means, Kumlien J 1988[11] (29 years) Broms P 1982[6] (31 years) and Elwany etal 1996[12] (31 years).

The subjective sensation of nasal obstruction is difficult to quantify in clinical practice unless the obstruction is nearly complete. Nasal patency is a complex phenomenon that is determined by different characteristics of the nasal cavity. Rhinomanometry assesses nasal patency via establishing aerodynamic parameters, such as transnasal pressure and airflow. It is believed that not every septal deviation causes problems to the patient. However, we might find mild septal deviation with relevant signs and symptoms.

Rhinomanometry can help to predict the patients who need surgery in correlation with the subjective sensation of nasal obstruction and the rhinoscopic clinical findings as well.

One hundred percent (100%) of the patients suffered from nasal obstruction, in addition to facial pain and headache (70%). Harraldsson etal 1987[13] had nasal obstruction in 100% and headache in 58% of their patients. These represent the major presenting features anywhere which bring the patients to the ENT office.

There was a significant drop of the mean NAR from preoperative 0.63 to 0.24 Pa/cm$^3$/s postoperatively, i.e. 0.39 mean drop (62%). Elwany etal 1996[12] had a mean drop from 0.31 to 0.23 Pa/cm$^3$/s after surgery (23%).

Nasal airflow has been improved significantly from a preoperative mean of 262 to 743 cm$^3$/s, i.e. a mean increase of 481. This correlates with the results of others. Robert etal 1983[14] had a mean increase of nasal airflow from 253 to 630 cm$^3$/s. Elwany etal 1996[12] had a change from 579.5 into 727 cm$^3$/s postoperatively.

These measures help the pre and postoperative assessment of patients with nasal septal deviations that need corrective surgery depending not only on the subjective sensation of airflow but on the objective rhinomanometric measures, however, these measures were again proved by the same procedures after surgery.

There is some debate about the correlation between subjective symptoms, rhinomanometry(objective test) and the rhinoscopic findings. It was found here that there is a significant correlation between the above criteria in different combinations ranging between 72-80% preoperatively and 80-87% postoperatively. These results ultimately show their importance for surgical decision and its outcome.

Other series show a considerable correlation between the subjective and objective rhinomanometric results ranging between 75-85% [15, 16, 17].

Malm 1992[18] suggested that it is possible to select patients for surgery on the basis of rhinomanometric results, while Bachmann 1990[9] has outlined rhinomanometric indications for and against surgery and noted that when constant stenosis exists and the total flow is below 700 $cm^3/s$, then there exists a clear indication for surgery.

A significant correlation has been found between rhinoscopy and the results of rhinomanometry[20]. This adds another support to this study and to the fact that objective tests ate valuable in pre and postoperative selection, judgment and assessment.

There are few other researches which do not support these correlations. Li etal 1997[21] mentioned that there was no correlation between the subjective sensation of nasal airflow and objective assessment of nasal airflow and resistance. The same was true with Yaniv etal 1997[22]. Hardcastle etal 1988[23] found that the results of rhinomanometry correlated with the degree of obstruction, whereas rhinoscopy did not.

In conclusion, this study has proved that there is a significant correlation between the subjective sensation of nasal obstruction, clinical rhinoscopic findings and the objective rhinomanometric measurements of NAR and nasal airflow. Hence, it is recommended to use rhinomanometry in patient selection who need septal surgical correction, knowing that the severity of nasal septal deformity does not always correlate with the severity of the clinical features. In addition, the postoperative rhinomanometric results give a prognostic value to the outcome of surgery.

**References**

1-Szucs E, Clement PAR: Acoustic Rhinomanometry and rhinomanometry in the evaluation of nasal patency of patients with nasal septal deviation. Am-J-Rhinol, 1998, Sep-Oct 12(5):345-352.

2-Clement PAR, Hirsch C: Rhinomanometry-A Review. ORL, 1984, 46:173-191.

3-Micheal J, Schumacher M: Rhinomanometry. The Journal of Allergy and Clinical Immunology, 1989, 83(4):711-719.

4-Pallanch JF, McCaffrey TV, Kern EB: Evaluation of nasal breathing function with objective airway testing. Otolaryngology-Head &Neck Surgery, 3rd ed, Ed. Cummings CW etal,Mosby –Year Book Inc1998, Ch.42:799-832.

5-Rccles E: Evaluation of the nasal airway and nasal challenge. Scott Brown's Otolaryngology (Rhinology), 6thed, Mackay IS, Bull TR, ED: Butterworth-Heinemann, 1997,Ch.4:4/1-4/4/12.

6-Broms P: A pre-and postoperative evaluation in functional septoplasty. Acta Otolaryngol, 1982, 94:523-529.

7-Grymer LF, Hilberg O, Elbrond O, Pederson OF: Acoustic rhinomanometry: Evaluation of the nasal cavity with septal deviations, before and after septoplasty. Laryngoscope, 1989, Nov, 99(11):1180-1187.

8-Wang DY, Pang YT, Yeoh KH: What you need to know- Objective assessment of nasal patency- Why is it important. Singapore Med J, 1999, 40(03):186-7.

9-Bachmann W: Differential diagnosis in patients with nasal obstruction: Rhinomanometric indications for surgery. Facial Plastic Surg, 1990, 7:274.

10-Eccles R, Reilly M, Eccles KS: Changes in the amplitude of the nasal cycle associated with symptoms of acute upper respiratory tract infection. Acta- Otolaryngol, 1996, Jan, 116(1):77-81.

11-Kumlien J: A clinical follow- up of septal surgery. Clin. Otolaryngol, 1988, 13:115-120.

12-Elwany S, Thabet H: Obstruction of the nasal valve. The Journal of Laryngology and Otology, 1996, 110:221-224.

13-Harraldsson PO, Anggard A: Long term results after septal surgery. ORL, 1987, 49(4):218-222.

14-Robert M, Goldwyn E: The effects of nasal surgery on airflow. Plast. And Reconstructive Surg, 1983, 72(1).

15-Sipila J: Correlation between subjective sensation of nasal patency and rhinomanometry. ORL, 1995, 157:260-263.
16-Sipila J: Sensation of nasal obstruction compared to rhinomanometry in patients referred for septoplasty. Am.J. Rhinology, 1994, 8:113-116.
17-Hirschberg A, Rezek O: Correlation between objective and subjective measurements of nasal patency. ORL-J-Otorhinolaryngol-Related-spec., 1998, Jul-Aug, 60(4):206-11.
18-Malm L: Rhinomanometric assessment for rhinologic surgery. Ear Nose Throat J, 1992, 17:11.
19- Hardcastle PF, White A, Prescott RJ: Clinical and rhinometric assessment of the nasal airway- do they measure the same entity. Clinic. Otolaryngol, 1988, 13:185-191.
20-Li X, Du B, Guo X,: Relationship between nasal airflow sensation and nasal patency. Zhonghua-Er-Bi-Yan-Hou-Ke-Za-Zhi, 1997, Apr, 32(2): 109-11.
21-Yaniv E, Hadar T, Shvero J, Raveh E: Objective and subjective nasal airflow. Am-J-Otolaryngol, 1997, Jan-Feb, 18(1):29-32.
22- Hardcastle PF, White A, Prescott RJ: Clinical or rhinomanometric assessment of the nasal airway- Which is better? Clin-Otolaryngol, 1988, Oct, 13(5):185-91.

*Dept. Of Surgery College Of MedicineAl-Mustansiriyah University
**Dept. Of Surgerycollege Of Medicine
Al-Mustansiriyah University