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The use of objective measures in selecting patients for septal surgery*

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SUMMARY

To improve results in septal surgery, patient selection is the mainstay of a successful outcome. Patient history is the basis as well as clinical examination but both are subjective and must be considered towards a background with a high frequency of septal deviation in the population and a lack of good correlation between function and status. Rhinomanometry and acoustic rhinometry as well as nasal peak inspiratory flow are tests of different nasal parameters as resistance to breathing, nasal dimensions and flow. This article illuminates the use of these more objective tests in selection of patients for septoplasty. Objective tests have in several studies shown to predict postoperative satisfaction while normal values can be a marker for a poor surgical outcome. Pros and cons with objective tests are discussed and the conclusion is: operate when there is a good correlation between the patient´s status, history and the results of rhinometry!

Key words: septal surgery, rhinomanometry, acoustic rhinometry, nasal peak inspiratory flow, objective measures

INTRODUCTION

The continuous evaluation of surgical indications and outcomes is necessary nowadays, when objective evidence is more important than the opinions of experienced surgeons. Quality registers are also more common and are available to the general population. In Sweden, there is an open register (http://kvalitet.onh.nu/) with septoplasty results from all surgical centres in the country. National health authorities encourage prospective patients to look at these results, and for obvious reasons they are followed carefully by the profession. As seen in Figure 1, results during the past two years regarding patients who are cured or improved six months after septoplasty range from 55% to 92%. The mean figure for all departments in the country, based on 2183 operations, is 76%. This figure is comparable to other reports of septoplasty outcome showing 70-90 % satisfied patients [(1-5)].

Clinical data suggests that patient selection is the mainstay of a successful outcome. It is crucial to select patients for whom there is a reasonable expectation regarding outcome, and whose disease is suitable for the procedure. Since nasal obstruction can be due to skeletal as well as mucosal causes, the patient's history is the basis for selection and this must include questions about hyper-reactivity and allergy. We know from the literature that the outcome of septoplasty is worse when there is a mucosal problem [(6)] and if there is no history of trauma [(7)]. A further consideration before nasal surgery is performed is the high frequency of septal deviation in the population, with figures of 40% in teenagers [(8)] and over 50% in the general population [(9)].

After history, the next measure is an evaluation by the surgeon/physician. This is also a subjective measure as it is based on the frame of reference of the examiner. This paper focuses on tests for measuring nasal patency before septal surgery that are regarded as objective. However, all tests involving patient co-operation can be criticized for not being fully objective. Furthermore, it must be admitted that there are no ideal tests for nasal breathing that can translate the patient's evaluation of nasal obstruction into a specific figure, as is the case with the audiogram for hearing, the vision test for sight, and spirometry for lung function.

Rhinometry has been used in other surgical procedures to follow surgical effects, such as in turbinoplasty [(10)] and endoscopic sinus surgery [(11)]. This review will focus on the benefit of rhinometry in septoplasty.

AVAILABLE METHODS AND CORRELATION TO SUBJECTIVE OBSTRUCTION

Since the nose is available for direct inspection by anterior rhinoscopy, some advocate that no other measures of its function are needed. However, there is no direct correlation between function and status. Further, in many studies the subjective feeling of nasal obstruction has been difficult to correlate to patency of the nasal passages [(12)]. However, in the

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majority of studies a significant correlation has been found between subjective scoring and test methods [13,14]. Significant correlations ($p < 0.001$) have been reported in large groups between objective and subjective assessments of nasal patency, but with low r-values (0.3). The implication has been that on an individual level these measures are of little significance [15], but the value of nasal tests depends on how tests are interpreted. This must be done actively, with good knowledge of the technique being used, the pitfalls, and correlation to normal values. Several methods can be used for objective assessment of nasal function.

Rhinomanometry (RM), which is most often performed today using the active anterior technique, is the most frequently used method for research and clinical evaluation of nasal airway resistance (NAR) to breathing. There is not a direct correlation to the subjective evaluation of stuffiness, probably because the location of NAR is in the valve region while the sensation of nasal obstruction can also be related to congestion in other areas. However, several studies of both skeletal and mucosal obstruction show a fair correlation [16-21]. In the study by Hirschberg and Rezek [15], the correlation between subjective obstruction and airway resistance on the narrow side reached a higher level of significance compared to this correlation on the wide side. Similar results were reported by Clarke et al. [22] and Sipilä et al. [23] who found that RM was better than patients' subjective sensations in detecting subtle side differences in resistance. In another study, the same authors found that VAS results correlated better to RM when evaluating unilateral obstruction as compared to total nasal evaluation [24]. It is important to take this into account, and measures should always be done on each side separately. There is a variation coefficient of 15% unilaterally and this figure is 8% for the total nose [25]. A drawback is that RM requires trained staff.

Acoustic rhinometry (AR) is easier to perform but it has several pitfalls concerning technique and also requires trained staff [26]. Due to the wide variation in nasal mucosal swelling, the test corresponds better, on an individual level, to the subjective feeling of obstruction after, rather than before, decongestion [27]. On a group level, however, the VAS or subjective patient evaluation regarding nasal obstruction has a good correlation to AR-measures [16,28,29] and there is a significant correlation between AR and the doctor's evaluation of septal deviation [30]. There is a 5% variation coefficient and reproducibility is 5-10% [25].

Nasal peak inspiratory flow (NPIF) is easy to perform, cheap, quick and does not require trained staff. It is suitable for serial measures and for home use, and thus for following up an intervention. NPIF is only performed bilaterally, with both sides tested at the same time, which is why it is not useful in selecting patients for surgery. However, it can be used for follow-up [31]. Peak flow can also be measured expiratorily, but for hygienic reasons this is seldomly done, and it does not correlate better to subjective values of obstruction than inspiratory flow [32]. The variation coefficient is 6-18%, and valve collapse might give false low values during a forced inspiration manoeuvre. Several reports have shown good correlation to a subjective feeling of obstruction [29,31,33] but others have not [34].

Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are also objective methods for surveying the nasal passages in chronic rhinosinusitis, but correlation to function is poor. MRI is useful for soft tissue pathologies and has fair correlation to AR [35]. For septoplasty, CT is only indicated in malformation surgery.

Quality of Life questionnaires can give additional information about the impact of disease on the welfare of a subject, thereby quantifying an aspect of the disease that is not detected by objective testing [36]. There are no specific questionnaires for skeletal nasal diseases, but SNOT-22 for rhinosinusitis contains questions about nasal obstruction and has recently also been recommended for use in assessing surgical outcome [37,38]. General questionnaires like SF-36 can also be used, but not for selection of surgical cases since they are not illness-specific. All QoL questionnaires are subjective, but can be useful for follow-up of an intervention and should be used more extensively today to obtain better insight concerning the patient's wellbeing. SNOT-22 seems to be a suitable instrument for follow-up of rhinosinusitis as well as functional surgery.

WHAT IS MEASURED?

It is important to remember that the described methods do not measure the same parameters of nasal function. Rhinomanometry measures the resistance to nasal breathing by registering flow and pressure fall from the anterior to the posterior nasal cavity ($Pa/cm^3/sec$). Acoustic rhinometry is a static measure of nasal dimensions like volume (cm^3) and cross sectional areas (cm^2), while nasal peak inspiratory flow is a measure of maximal inspiratory nasal air flow (litres/min). These methods complement one another, and it would seem appropriate to perform RM and AR at the same time in the same individual for preoperative evaluation, as has also been recommended by other authors [16,39,40]. In a paper by Spronsen and coworkers using the GRADE approach, RM, AR and NPIF were strongly recommended, based on high quality evidence (1A), for follow-up in assessing treatment of nasal congestion [34].

To correlate measures of nasal function to surgical success, the measures must be carried out after decongestion to overcome the effect and variation of mucous swelling on nasal patency. Since surgery is performed on skeletal structures, measures that include the mucosal component are not reliable or relevant. On the other hand, with a high degree of mucosal swelling a mucosal disease can be suspected, and in normal cases a 40% reduction of NAR after decongestion is regarded as normal swelling [41]. Since the nose is very sensitive to physiological changes [42] it is important to let the nose rest for at least 15 minutes before rhinometry, especially if mucosal swelling is to be evaluated.

It is also important to measure both sides separately and not focus on the total nasal value. The most common reason for septal surgery is one-sided deviation, and in measures of "total" nose this can be hidden in a normal value. This is of course also the reason that peak flow measures are not suitable as a selection test for septal surgery.

NORMAL VALUES

When assessing nasal patency, the fact that validated normal values are still lacking, is a major problem. The international consensus document regarding RM and AR [43] has not dealt with this problem, probably due to the wide range of manufacturers of equipment and the lack of consensus concerning methodology. The wide variability of the nasal mucosa, which is influenced by several external and internal factors, makes it unlikely that we will ever have "normal values" for nasal patency before decongestion. After decongestion, however, the situation is different. With standardized decongestants like sympathicomimetic sprays (xylomethazoline, oxymethazoline), or cocaine, or physical exercise, the decongested nasal passage can be evaluated based on the influence of the skeleton (nasal cartilage and bone structures). It is important to keep in mind that a subjective feeling of nasal patency is not solely dependent on flow, resistance and nasal dimensions. Another complicating factor regarding experienced patency is the importance of the sensorium of the nasal cavity. A system of sensory nerve endings in the nose reacts to different triggers. We know that patency is influenced by odours like menthol and that a subjective feeling of patency can be provoked without visible changes in objective parameters [44]. Rhinometry values are also dependent on race [45,46], age, as the nasal passage grows until adolescence [47], sex [47], body mass index [48], and height, as suggested by Broms [49]. In elderly people, endonasal volumes and minimal cross sectional areas increase as measured with acoustic rhinometry [50], but this can be counterbalanced by increasing destabilization of the valves in the elderly. Despite these considerations, there are still cases where correlations between objective and subjective measures are poor.

Rhinomanometry is the most widely used method for preoperative evaluation. Sipilä and Suonpää in Finland (personal communication) reported their normal baseline values to be 0.4-1.0 Pa s/cm^3 before decongestion and 0.15-0.5 Pa s/cm^3 after decongestion using the Broms technique [49]. Broms published his normal material back in 1982 [49] and since then other authors have presented their normal materials [51-54]. Zapletal and Chalupova [55] reported normal values in healthy Caucasian children. They found a significant relation to height and age but not to sex. If reference values are not available for the technique that is used, the department must establish their own references depending on age (distinguishing between children, adolescents and adults), sex and height. In our department, we use the RhinoStream (Interacoustics, Assens, Denmark), and we seldomly perform septal surgery if the resistance value is below 1.0 Pa s/cm^3 on the narrow side.

Acoustic rhinometry has been reported on in several papers with reference values similar to those reported by Scucs and Clement for a limited number of cases [30]. Straszek et al. [56] reported values in school children and adults indicating that posterior volume (2-5 cm) was the most sensitive measure for detecting change in nasal patency. Corey et al. [57] presented normal values in relation to sex, race, height and weight, and Millqvist and Bende [58] reported reference values based on 334 individuals without nasal symptoms. Later the same group [59] reported undecongested values for children aged 4-16 years who were followed for two years, and they found correlations to height but not to age, probably due to huge variations in undecongested noses. We still await a large series of measures, preferably population based and stratified according to age, sex, height and weight. In a study by Warren et al. [60], a minimal cross sectional area of less than 0.4 cm^2 was the threshold for nasal airway impairment. In our department, we seldomly perform septal surgery when MCA values obtained with RhinoScan (Interacoustics) are higher than 0.4 cm^2.

Recently, Nasal Peak Inspiratory Flow values were described in 137 healthy subjects in relation to height, age and sex [61] and in correlation to VAS [62]. However, the value of these data in septal surgery is very limited.

OBJECTIVE MEASURES BEFORE AND AFTER NASAL SURGERY

Several papers have shown that an objective method can be used to demonstrate that nasal surgery improves the nasal passage. Using RM after surgery, decreased resistance was reported by several authors compared to preoperative values [2,7,51,63-66], and improved nasal dimensions with AR were shown by others [3,31,65,67]. Peak flow measures were also significantly increased after septal surgery [31] and there was a good correlation between peak flow values after surgery and self assessed nasal patency [68]. In one study where patients were selected for septoplasty based on RM values, there was a highly significant improvement both three months and 10 years after surgery [4] based on RM. Correlation to subjective evaluation was also good, and 10 years after surgery only 2/37 (5%) were dissatisfied. In Grymer's study [3], a highly significant correlation was seen between minimal cross sectional area and the subjective feeling of nasal patency before and after surgery. In dissatisfied subjects, a significantly smaller MCA was seen postoperatively compared to satisfied patients (0.45 and 0.74 cm^2, respectively). A significant correlation between improved values after septoplasty measured with RM and AR was also demonstrated by Pirilä and Tikanto [65]. They also found significant correlations before surgery between subjective scoring and objective measures of nasal patency, as well as after surgery where significant correlations were seen between subjective nasal obstruction and rhinomanometry and acoustic rhinometry, except for MCA 2 on the narrow or deviated side. Nasal spirometry has also proved to be of value to measure nasal airflow before and after septal surgery [69].

WHAT EVIDENCE IS THERE THAT OBJECTIVE EVALUATION IS OF USE IN SELECTING PATIENTS FOR NASAL SURGERY?

As early as 1982, Broms and co-workers [49] reported a better outcome from septal surgery in patients with high NAR in RM preoperatively. They also found that patients who were dissatisfied postoperatively had high NAR after surgery, while NAR was significantly lower in patients who were satisfied postoperatively. Jessen and Malm [7] also reported a large number of satisfied patients after septal surgery (81%) when one of the inclusion criteria for the decision to perform surgery was based on a pathological NAR preoperatively. An even larger number were improved according to RM (94%). In a non-operated control group of 100 patients, a larger number had bilateral stuffiness and no history of nasal trauma.

Nasal obstruction documented with rhinometry is the main indication for septal surgery, and if NAR is high preoperatively the patient is more likely to benefit from surgery, as shown by Sipilä et al. [51]. In another Finnish study, 432 patients were on the waiting list for septal surgery based on symptoms and clinical findings. All of them had RM performed. The patients were then analysed based on preoperative RM results. In a group of patients where preoperative RM was normal the success rate was 69%, while in the group with pathological NAR 85% were satisfied with the outcome[70]. The experience from my own department is similar to that of Sipilä and Suonpää. In the National Quality Register, our success rate was 64% in 2000. After introducing AR and RM and using reference levels in combination with clinical examination and patient history, our success rate has increased to 84%. When considering patients who are dissatisfied with their surgery, there is an over representation of patients with near normal values on rhinometry tests.

In a long-term follow-up, Suonpää et al.[71] found that patients who had high NAR preoperatively were most satisfied at follow-up, and there was a smaller number of symptom free patients among those who had normal NAR preoperatively. Their conclusion was “preoperative rhinomanometry helps in selecting patients who benefit most from surgery and thus saves operative resources”.

In another study by Holmström and Kumlien [2], patients were selected for septoplasty based on their history and status. The day before surgery an anterior RM was performed and surgery was thus performed irrespective of RM values. Based on RM, 52/57 improved; however, 11/57 were not satisfied with the result and among these 8/11 had normal NAR before surgery. Thus, in this study, >90% would have been satisfied if pathological NAR had been used as a selection criterion for septal surgery. However, a few cases were satisfied with the operation although preoperative NAR was in the normal range, and with stricter criteria based on pathological RM values, these patients would not have been operated on.

In a recently published study, Piril and Tikanto[72] showed that preoperative AR and RM had a statistically significant impact in predicting postoperative satisfaction. In their study the decision to operate was based on clinical judgement without the aid of RM or AR, and these tests were performed after the decision for surgery was taken. An MCA after decongestion of 0.40 m3 on the narrow side was estimated as an optimal cut-off for predicting postoperative satisfaction. For AR as well as for RM, both sensitivity and specificity were higher regarding the prediction of postoperative satisfaction than was the case for anterior rhinoscopy. The authors concluded that rhinoscopy was sufficient in severe deviation but in milder deviations rhinometry predicted postoperative satisfaction to a statistically significant degree.

In Bohlin’s study [4], where junior staff had performed the operations, 84% of patients were satisfied after 10 years. The surgical outcome was explained by strict inclusion criteria based on pathological RM values preoperatively. In contrast, in the study by Dinis and Haider [73] it could not be shown that a preoperative RM influenced surgical outcome as measured by patient satisfaction. However, this was a retrospective study without randomization. There were no preoperative inclusion criteria based on RM results, and we do not know anything about RM in the control group. The fact that RM is available does not equate with a positive effect. The crucial points are an active use of the method and correlation of measured data to normal values.

There are thus several studies indicating that a normal NAR value before surgery is a marker for a poor surgical outcome [2,51,70,74]. However, even some patients with normal rhinometry values will improve after surgery. Thus, with stricter criteria for surgery we would risk losing these potential successes. On the other hand, some studies indicate a positive outcome in cases with normal rhinometry values, even with a wait and see policy. Jessen and Malm [75] presented a series of 67 patients who were candidates for septal surgery but were taken off the waiting list since rhinomanometry showed normal values. After five years, 20% were free from daily nasal obstruction, and this was also the case for another 21% in the next seven years. A majority of patients were regarded as having idiopathic rhinitis with septal deviation. The wait and see policy was also advocated by Sipilä et al.[70]. They found that 10% of patients

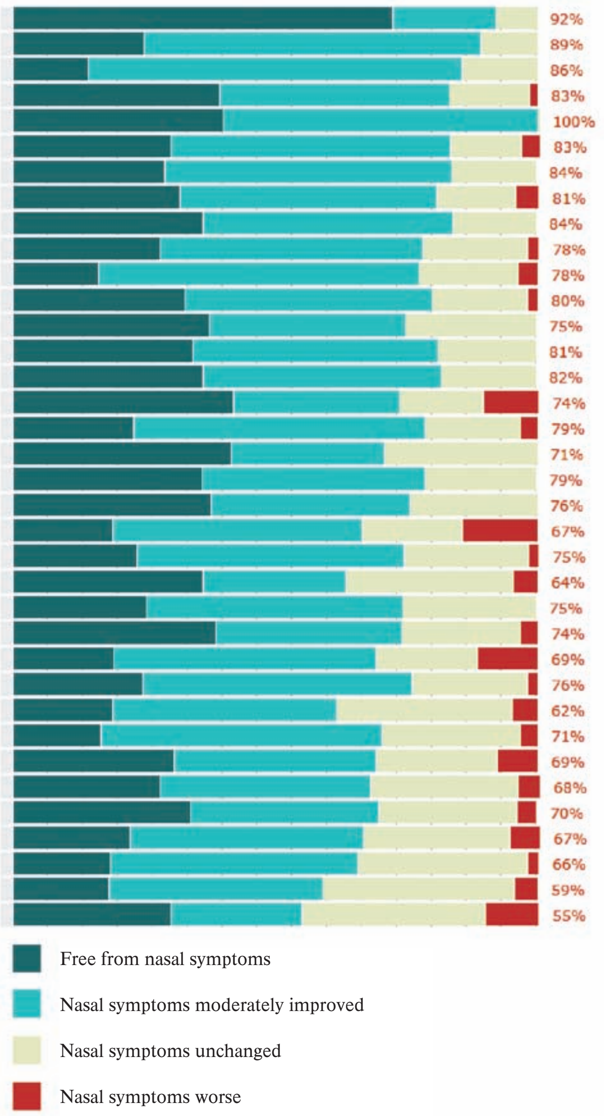

Figure 1. Results of septal surgery in Sweden in 2007 and 2008 as judged by the patients six months after surgery. The results of different departments are listed. The percentages (%) represent the total number of patients who were completely or moderately improved.

referred for septal surgery were symptom-free after three to five years if no RM was performed, and if RM was normal and patients were not operated on, 40% were symptom-free with or without medical treatment and only 26% were dissatisfied with the decision not to be operated on. Even when NAR is high, the same conclusions were recently drawn by Thulesius et al. [76] who followed 44 patients with high NAR values and nasal stuffiness for eight years without performing surgery. Over time NAR values decreased on both the wide and the narrow side; 36% of patients were symptomatically improved and a logistic regression showed that increasing age and allergy prevalence were significantly associated with reduced nasal stuffiness at follow-up. The authors also speculated as to whether age-related, decreased nasal mucosal sensitivity was a contributing factor, and they recommended a wait and see policy, at least for elderly patients.

CONCLUDING RECOMMENDATIONS FOR SEPTAL SURGERY

The value both of objective techniques for following up surgical results and quality assessments have been clearly elucidated in several studies. It also seems as if rhinometry is more sensitive in detecting minor anatomical changes, while in other cases one method can miss an abnormality; for example, a posterior deviation is often missed with AR if there is a more prominent anterior deviation. This is also why two complementary tests are recommended [16,39,40]. RM appears to be preferable for selecting suitable candidates for septal surgery if only one test is used. In this era of objective measures, when evidence based medicine is the norm, the comment “in my hands” is not appropriate.

- Investigate and be very careful to obtain sufficient information before surgery, eg if there is a history of mucosal disease (hyperreactivity/allergy).
- If there is uncertainty about mucosal disease, try medical treatment first.
- If there is uncertainty, wait and see!
- Obtain unilateral instead of total measurements with rhinometry.
- Rhinometry is also useful in medical-legal cases to demonstrate skeletal deviation and to verify corrections after surgery.
- In surgical studies rhinometry should be used.
- Operate when there is good correlation between the patient’s status, history and the results of rhinometry!

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