

RHINOLOGY

Septoplasty: is it possible to identify potential “predictors” of surgical success?

Settoplastica: è possibile identificare potenziali “predittori” di successo chirurgico?

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SUMMARY

Septoplasty is one of the most frequent surgical procedures performed by otolaryngologists. Despite successful surgical correction, many patients are not satisfied with their outcomes. So far, in clinical practice there is no consensus of opinion about the reliability of objective measurements of nasal patency and the correlation between objective measurements and subjective nasal patency symptoms. This study aims to assess the reasons for patient dissatisfaction after septoplasty and optimise pre-operative diagnostic management to predict surgical outcomes. We analysed 494 patients undergoing septoplasties with turbinoplasty by subjective Nasal Obstruction Symptom Evaluation questionnaire (NOSE) and objective active anterior rhinomanometric measurements before surgery and after 6 months. In our series, 17% had postoperative septal re-displacement; all patients had an anterior deviation at baseline. We found that the type of septal deviation, anterior vs posterior, was a significant predictor of postoperative functional improvement, whereas demographic characteristics as age, gender and smoke habit were not. Our data suggest that the anterior segment of the nasal septum was the most critical area for nasal airway resistance and more difficult to manage because it is likely to re-displace vs the posterior one and for this reason it represents a negative predictor of postoperative satisfaction.

KEY WORDS: Septoplasty • Nasal obstruction • Rhinomanometry • Outcomes • Septal deviation

RIASSUNTO

La settoplastica è una delle procedure chirurgiche più frequentemente eseguite in otorinolaringoiatria. In molti casi nonostante la correzione sia tecnicamente corretta, i pazienti non sono soddisfatti dei risultati ottenuti. Finora, nella pratica clinica non vi è consenso sull'affidabilità della diagnostica funzionale oggettiva, né sulla correlazione tra la misura oggettiva della pervietà nasale e i sintomi soggettivi riferiti dal paziente. Questo studio si propone di valutare le ragioni dell'insoddisfazione del paziente dopo settoplastica e di ottimizzare la gestione diagnostica pre-operatoria al fine di prevedere i risultati chirurgici. Abbiamo valutato 494 pazienti sottoposti a settoplastica con turbinoplastica con il questionario sulla valutazione dell'ostruzione nasale, NOSE, e rinomanometria attiva anteriore. Le misurazioni sono state effettuate prima dell'intervento chirurgico e 6 mesi dopo. Nel 17% dei casi abbiamo osservato una re-dislocazione del setto, tutti i casi di redislocazione presentavano una deviazione anteriore preoperatoria. I nostri risultati suggeriscono che il tipo di deviazione del setto, anteriore vs posteriore, rappresenta un predittore statisticamente significativo del miglioramento funzionale postoperatorio, mentre le caratteristiche demografiche come età, sesso e abitudine al fumo, non lo sono. I dati ottenuti hanno, inoltre, dimostrato che relativamente alle resistenze nasali, l'area più critica e difficile da trattare è il segmento anteriore del setto poiché più a rischio di re-dislocazione rispetto al segmento posteriore, e per questo rappresenta un fattore predittivo negativo di soddisfazione post-operatoria.

PAROLE CHIAVE: *Settoplastica • Ostruzione nasale • Rinomanometria • Risultati • Deviazione settale*

Cite this article as: Acta Otorhinolaryngol Ital 2018;38:528-535. <https://doi.org/10.14639/0392-100X-2072>

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Introduction

Nasal obstruction is one the most common symptoms observed in rhinological practice ¹ and septoplasty is one of the most frequent surgical procedures performed by otolaryngologists ². Despite successful surgical correction,

many patients are not satisfied with their postoperative outcomes, which may lead to medicolegal problems ².

So far, to avoid postoperative dissatisfaction, surgeons have developed a variety of techniques, but sometimes, regardless of the surgical technique, nasal obstruction can persist ³.

On the other hand, inadequate surgical procedures lead patients to re-consult an otolaryngologist. This happens because there are often many underestimated causes for nasal obstruction, such as allergy, nasal valve collapse or lateral wall insufficiency, which may alter the physiological dynamics of nasal airflow ¹.

In addition to persistent septal deviation, septal perforation, synechiae, loss of nasal dorsum and tip support are the main reasons for persistent postoperative nasal obstruction and represent the most frequent complications after septoplasty ^{2,4}.

In clinical practice there is still no consensus of opinion about the reliability of objective measurements of nasal patency and the correlation between objective measurements and subjective symptoms reported by patients ⁵. Indeed, there is no diagnostic tool to predict postoperative outcomes, objectively evaluate the geometry of the nose and measure nasal resistances and degree of obstruction. For instance, several studies have shown no correlation between objective measurements and patient satisfaction, whereas other studies did not use validated questionnaires to assess postoperative outcomes after septoplasty ⁵.

To the best of our knowledge, this is the first prospective study examining, in a large sample size, the medium-term outcomes of septoplasty in terms of both objective and subjective assessment, with the use of active anterior rhinomanometry (AAR) and a validated questionnaire specifically designed for nasal obstruction, the Nasal Obstruction Symptoms Evaluation (NOSE).

Materials and methods

This is a prospective cohort study including 537 consecutive patients who underwent septoplasties with turbino-plasty performed at the ear nose and throat (ENT) Departments of the “Federico II” University and Cardarelli Hospital in Naples. Patients were enrolled between 2010 and 2017. We analysed 494 septoplasties that completed the study with at least 6 months follow-up; there were 284 females and 210 males, 18 to 50 years old (Table I). Enrolled subjects gave informed consent to the study, which was approved by the local Board of Medical Ethics. The study was carried out according to the Declaration of Helsinki.

Inclusion criteria were: patients complaining of nasal obstruction due to septal deviation and inferior turbinate hypertrophy who underwent septoplasty and turbino-plasty; nasal endoscopy confirming septal deviation and negative for chronic rhinosinusitis; previous maxillofacial computed tomography scan (CT) confirming septal nasal deviation and negative for chronic rhinosinusitis.

Table I. Patient characteristics. Study population at baseline.

Population (N = 494)	
Sex	284 F; 210 M
Age	39.6 ± 3.2
Allergy	321 (65%)
Smoking habit	142 (28%)
Septal deviation:	
anterior deviations	312 (63%)
posterior deviations	182 (37%)

Exclusion criteria were: age < 18 years, previous nasal surgery, patients requiring rhinoseptoplasty, malformative and neuropsychiatric diseases, previous diagnosis of chronic rhinosinusitis (cystic fibrosis, immotile cilia syndrome etc.), uncontrolled rhinitis and asthma (to prevent interference of medical therapy with surgical and functional outcomes). Furthermore, we excluded patients with serious pathologies such as previous head or neck radiotherapy, immunologic disorders, diabetes, heart disease, neoplasms etc.

Before surgery (T₀) enrolled subjects underwent:

- Nasal endoscopy with a 4 mm 30° rigid endoscope (Storz, Tuttlingen, Germany).
- Skin prick test (SPT) using a standard allergen extract panel [(Stallergenes Company, Anthony, France). Positive (histamine) and negative (distilled water) controls were also performed. Aeroallergens included house dust mite, pollens, alternaria, aspergillus, cladosporium, grasses, weeds, wheat, cockroach] ⁶.
- The Italian version of the NOSE questionnaire to evaluate the subjective sensation of nasal obstruction, usually used in the literature to evaluate the success of septoplasty and related quality of life (QoL). The NOSE consists of 5 questions (nasal congestion or stuffiness, nasal blockage or obstruction, trouble breathing through nose, trouble sleeping, and unable to get enough air through the nose during exercise or exertion), each with a score ranging from 0 to 4. The range of raw scores is from 0 to 20. The final sum is then scaled to a total score of 0 to 100 by multiplying the raw score by 5. A score of 0 means no problems with nasal obstruction and a score of 100 means the worst possible problems with nasal obstruction ^{7,8}.
- Active anterior rhinomanometry (AAR) [Diagnostic cube, Rhino 31 Atmos Medizintechnik, Lenzkirch, Germany] to calculate nasal resistance (NAR). All measurements were performed without decongestion by the same two experienced consultants (EC, FR) and under the same standard conditions, in accordance with the recommendations of the International Standardization Committee for Rhinomanometry ⁹.

We distinguished anterior and posterior septal deviation in relation to the nasal valve (Table I). In particular, we considered anterior the deviations corresponding to the dorso-caudal septal cartilage as previously described^{10,11}. Enrolled subjects underwent septoplasty and turbinoplasty as described by Cottle and later by Sul senti^{12,13} under general anaesthesia by the same three experienced consultants (MI, EC, FR). The maxilla-premaxilla approach combining mobilisation and/or removal of any deranged portion of the bony and/or cartilaginous septum, followed by reconstruction of the septum support and the submucous inferior turbinoplasty (without bony resection) with lateral out-fracture of inferior turbinates were performed¹³. The septum was fixed through trans-septal sutures and the septal caudal incision was closed. Nasal packing was used and removed 48 hours after surgery. After removal of nasal packing, all patients subjectively recovered normal nasal flow; they were treated with intranasal saline irrigation alone, twice a day for 20 days. At 6 months' post-operative evaluation (T₆), patients repeated endoscopy to assess septal displacement and rhinomanometric evaluation, and were asked to fill out the Nose Scale questionnaire. As reported in the literature, we considered surgical success as a significant decrease in the postoperative NOSE score⁸.

Statistical analysis

Statistical analyses were performed using the SPSS-PC program (version 16; SPSS Inc., Chicago, IL). Three dependent AAR variables were considered: nasal resistance in the wider nasal cavity (WNR), nasal resistance in the narrower nasal cavity (NNR), and total nasal resistance (TNR), each recorded at sample pressures of 150 Pa¹⁴. A Student's t test was used to evaluate differences in nasal obstruction metrics at T₀ and T₆. To evaluate the relationship between nasal obstruction metrics and patient characteristics using linear regression we created a multivariable model. Pearson's correlation was used to determine the correlation between two numerical variables (Wessa P. Free Statistics Software, Office for Research Development and Education, version 1.1.23-r7, 2017L; www.wessa.net).

For data analysis, we used the Δ, i.e. the difference in values detected at baseline and at T₆ (Δ = T₀-T₆). A p-value was considered statistically significant if < 0.05.

Results

At 6 months' post-operative evaluation, we observed septal re-displacement (R) in 84 of (17%) 494 enrolled patients. According to the type of septal deviation, we observed septal re-displacement in 84 out of 312 anterior septal deviation patients; whereas we observed no displacement in patients with posterior septal deviation at baseline. Furthermore, we observed the following complications: 3 (0.6%) infections, 6 (1.2%) haemorrhage, 12 (2.5%) valvular and 82 (16.5%) intra-nasal synechias, 6 (1.2%) perforations and 13 (2.6%) haematomas.

The analysis demonstrated that the type of deviation (D) anterior (a) vs posterior (p) and the occurrence of a re-displacement (R) at T₆ represented significant (p < 0.01) predictors of the change (= Δ, i.e. differences between parameters at T₀ and T₆) in subjective, ΔNOSE (T₀NOSE-T₆NOSE) and objective, ΔTNR (T₀TNR-T₆TNR), ΔWNR (T₀WNR-T₆WNR), ΔNNR (T₀NNR-T₆NNR) measures. Only for ΔNNR did the presence of allergy represent an additional significant predictor (Table II).

By applying Pearson's test, we found no correlation between ΔNOSE, ΔTNR, ΔWNR, ΔNNR and age, (respectively r = 0.021; r = -0.026; r = -0.013; r = 0.041. p > 0.05). To evaluate whether the patients' starting point impacted postoperative functional outcomes, we used a t-test for paired samples comparing T₀ and T₆ values of NOSE, TNR, WNR, NNR. We found that parameters (mean ± SD) improved (p < 0.01) in all subjects (T₆NOSE 24.06 ± 19 vs T₀NOSE 49.60 ± 20; T₆TNR 0.25 ± 0.15 vs T₀TNR 0.50 ± 0.23; T₆WNR 0.39 ± 0.14 vs T₀WNR 0.57 ± 0.14; T₆NNR 0.44 ± 0.16 vs T₀NNR 0.76 ± 0.22).

To evaluate whether the type of deviation (D), anterior (a) vs posterior (p), the occurrence of displacement (R), allergy status (A) and smoking (s) habit (independent variables) influenced the improvement (Δ) of each outcome measure (dependent variable), we used a t test.

Table II. Multivariate linear regression between nasal obstruction metrics and patient characteristics.

Obstruction metrics	R ²	F (ANOVA)	Independent variables	P
ΔNOSE	0.298	103.9	D and R'	0.001
ΔTNR	0.441	139.4	D and R'	0.001
ΔWNR	0.601	369.7	D and R'	0.001
ΔNNR	0.355	89.7	D, R' and A	0.001

The table shows the model that explains most of the statistically significant variance. Subjective, ΔNOSE (T₀NOSE-T₆NOSE) and objective, ΔTNR (T₀TNR-T₆TNR), ΔWNR (T₀WNR-T₆WNR), ΔNNR (T₀NNR-T₆NNR) measures. D: type of dislocation, anterior-posterior; R': re-displacement at T₆; A: allergy.

All obstruction metrics improved ($p < 0.01$) after surgery in both anterior and posterior deviations, although the change (Δ) was more relevant ($p < 0.01$) in the anterior-a- (a Δ NOSE: 28.16 ± 24.7 ; a Δ TNR: 0.35 ± 0.28 ; a Δ WNR: 0.27 ± 0.19 ; a Δ NNR: 0.39 ± 0.28) than in the posterior-p- ones (p Δ NOSE: 21.07 ± 12.5 ; p Δ TNR: 0.08 ± 0.16 ; p Δ WNR: 0.02 ± 0.1 ; p Δ NNR: 0.17 ± 0.20).

Our data demonstrated that allergic (A) subjects presented a more statistically relevant change (Δ) ($p < 0.05$) only for A Δ WNR (0.16 ± 0.19) and A Δ NNR (0.28 ± 0.26) than non-allergic (NA) ones (NA Δ NNR: 0.36 ± 0.28 ; NA Δ WNR: 0.20 ± 0.22).

In addition, we found no differences ($p > 0.05$) between smokers – s – (s Δ NOSE: 27.48 ± 19.8 ; s Δ TNR: 0.27 ± 0.28 ; s Δ WNR: 0.19 ± 0.20 ; s Δ NNR: 0.30 ± 0.27) and non-smokers – ns – (ns Δ NOSE: 24.77 ± 21.91 ; ns Δ TNR: 0.24 ± 0.27 ; ns Δ WNR: 0.17 ± 0.20 ; ns Δ NNR: 0.31 ± 0.27).

We found a positive significant ($p < 0.05$) correlation between NOSE and AAR measures. For instance, in all sample populations we found a positive significant ($p < 0.05$) correlation between T₀NOSE and T₀TNR ($r: 0,58$), T₀WNR ($r: 0,51$), and T₀NNR ($r: 0,57$), and between T₆NOSE and T₆TNR ($r: 0,43$), T₆WNR ($r: 0,27$), and T₆NNR ($r: 0,40$) (Figs. 1, 2). In the posterior deviations we also found a positive significant ($p < 0.05$) correlation between T₀NOSE and T₀TNR ($r: 0,59$) (Fig. 3), T₀WNR ($r: 0,27$), and T₀NNR ($r: 0,53$), and between T₆NOSE and T₆TNR ($r: 0,18$). Conversely, we found no correlation between T₆NOSE and T₆WNR ($r: 0,06$), and T₆NNR ($r: -0,03$).

In anterior deviations, we found a significant positive correlation ($p < 0.05$) between T₀NOSE and T₀TNR ($r: ,38$), T₀WNR ($r: 0,44$) and T₀NNR ($r: 0,45$), and between T₆NOSE and T₆TNR ($r: 0,55$), T₆WNR ($r: 0,61$), T₆NNR ($r: 0,53$) (Fig. 4). In the re-displaced septoplasties, we found no correlation between T₆NOSE and T₆TNR ($r: 0,012$), T₆WNR ($r: 0,09$), and T₆NNR ($r: 0,12$) (Fig. 5).

Discussion

Comfortable nasal breathing is a condition that is directly related to QoL. Currently, there is evidence that the patient's perspective on treatment outcomes is a crucial element for improving high-quality care and patient-rated therapeutic outcomes in terms of symptoms, and that it can provide a much more realistic picture of the effectiveness of a treatment than those of objective outcomes¹⁵.

For instance, symptoms score questionnaires provide valuable information about how patients perceive the severity of their nasal obstruction and, consequently, about the degree of postoperative satisfaction¹⁵.

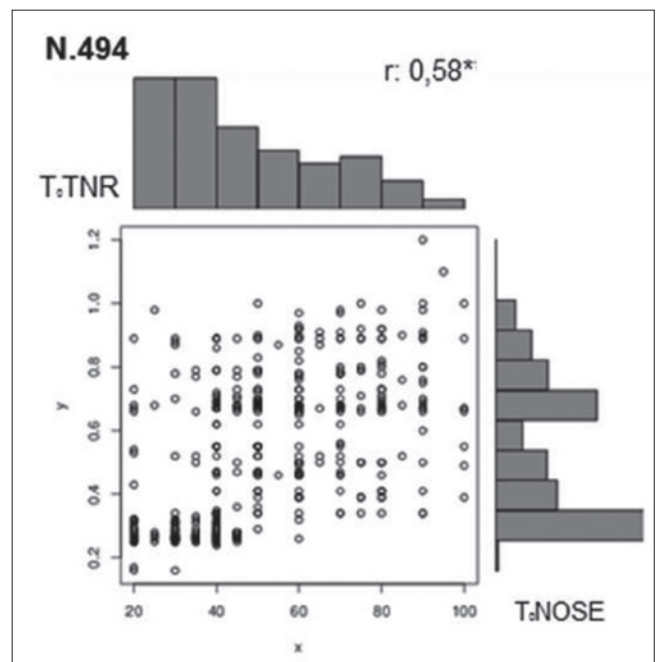


Fig. 1. Correlation between T₀NOSE and T₀TNR, T₀WNR and T₀NNR in all subjects, *correlation 0.01.

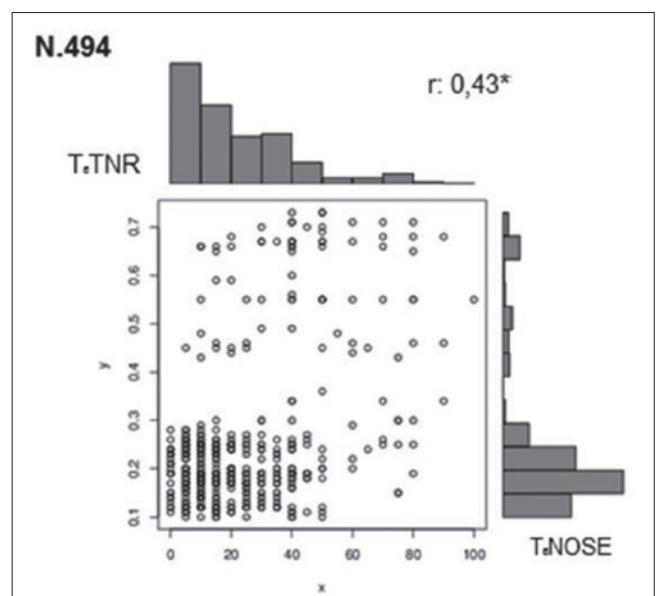


Fig. 2. Correlation between T₆NOSE and T₆TNR, T₆WNR and T₆NNR in all subjects, *correlation 0.01.

Sometimes, after surgery nasal obstruction can persist with consequent dissatisfaction and poor QoL²; other times persistent septal deviations are associated with good patient satisfaction, whereas completely corrected deviations are not. According to the literature, the risk of relapse or re-displacement after septoplasty is a common condition. Very

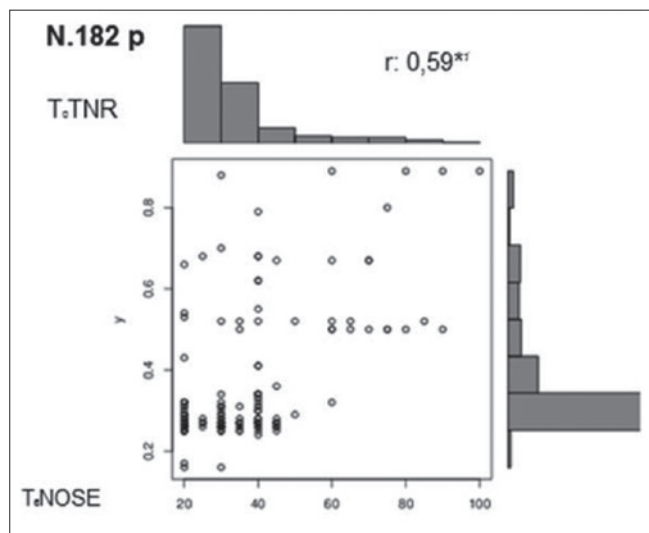


Fig. 3. Correlation between T_0 NOSE and T_0 TNR, T_0 WNR and T_0 NNR in the posterior deviations (p), *correlation 0.01.

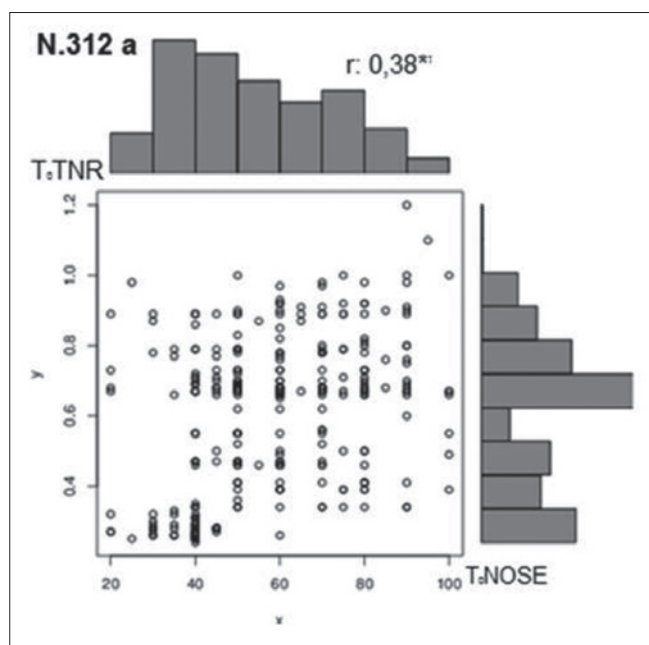


Fig. 4. Correlation between T_0 NOSE and T_0 TNR, T_0 WNR and T_0 NNR in the anterior deviations (a), *correlation 0.01.

often, an excellent postoperative result immediately after surgery evolves in a partial or total failure a few months later on the reappearance of deviation to some degree. This mostly depends on septal cartilaginous structures, which tend to retain the “memory” of the deviation due to their elasticity and so, over time, tend to curve again¹⁶. This phenomenon is the result of two, extrinsic and intrinsic, forces acting on the cartilaginous nasal septum and

causing, if they are not released during surgery, relapse. The extrinsic forces are exerted on by deviated nasal bony structures, whereas the intrinsic forces are due to the impaired growth of septal cartilage or to trauma deforming tissue ultrastructure¹⁶. Another common cause of septal displacement is the difficult repositioning of the caudal margin of the quadrangular cartilage along its bony rail¹³. Thus, despite structural differences, all relapsed patients will predictably share certain features: surgically distorted native anatomy, disrupted tissue planes, altered micro-circulation and potentially postsurgical mucosal dysfunction¹⁷.

At baseline anterior deformities not only prevailed (Table I) in our surgical population, but also showed higher NOSE and ARR scores suggesting the prevalence of anterior deviations in candidates for septoplasty and a higher impact on symptom severity and nasal resistances than posterior ones.

Furthermore, our data demonstrated that the type of deviation, anterior vs posterior, represented significant predictors of the change (Δ) both in subjective and objective measures. According to the literature, these findings suggest a role of the type of deviation as a potential predictor for surgical success in terms of symptoms score improvement¹⁸. The study of Shiryayeva et al. using only subjective scores demonstrated that the type of septal deviation, unilateral vs bilateral, and preoperative obstruction scores, may aid in predicting outcomes of nasal surgery. However, they did not evaluate the anterior vs posterior septal deviation and did not use objective measurements¹⁸.

In our population, the presence of allergy represented an additional significant predictor; our findings demonstrated that allergic subjects presented a more relevant change (Δ) in ARR (Δ WNR and Δ NNR) scores than non-allergic (NA) ones, probably for worse starting scores.

In allergic subjects, the hypertrophy of turbinates plays a primary role in the genesis of nasal obstruction, but while septoplasty corrects the septal deviation, literature data has shown that it is unclear whether turbinoplasty is beneficial in the long term for treatment of nasal obstruction. Recent studies reported improvement in symptoms and subjective evaluation at early post treatment evaluation and decreased benefits at the long term observation¹⁹. As allergy is a chronic inflammatory disease, in the long-term it tends to cause turbinate hypertrophy even after surgery²⁰. Our data showed worse baseline AAR subscores in allergic individuals, although they did not clarify the impact of the allergy on septoplasty outcomes.

In any case, these data pointed out the utility of studying preoperative allergic status as an additional putative predictive factor for surgical outcomes¹⁹.

Based on our results, smoking status, as well as age and gender, were not crucial as predictors of postoperative results. In particular, our findings confirmed recent research demonstrating that both smokers and non-smokers benefit from septoplasty²¹.

At T_6 we found that all parameters improved ($p = 0.01$) in the overall population, in agreement with the literature (satisfactory outcomes in 65% to 80% of patients)¹⁷.

So far, the correlation between subjective nasal patency symptoms and objective nasal measurements is still debated in the literature. For instance, some authors reported the presence of correlation, whereas others did not^{22,23}.

Hong et al. pointed out that only the preoperative NOSE scale, reflects post-septoplasty outcomes. Although the study by Hong provided useful information, it included a non-homogeneous (43 males and 6 females), small sample of patients undergoing septoplasty with or without turbinoplasty treated with different surgical techniques and different follow-up times (1, 3 or 6 months). Furthermore, the authors used acoustic rhinometry as an objective measurement that produces detailed evaluation of the geometry of nasal cavities, but it does not evaluate the flow field or provide any information on the physiology of nasal pressure¹.

In our study population, we found a significant correlation between subjective and objective measures (Figs. 1-5), whereas among re-displaced anterior deviations, we did not find any correlation at T_6 (Fig. 5).

This lack of correlation, again in accordance with the literature, pointed out that the AAR provides only a global assessment and does not consider the local details of the nasal air flow (i.e. the anterior regions of inferior meatus or nasal valve) that are often extremely significant from clinical and QoL standpoints^{22,25}.

From a merely speculative point of view, we can hypothesise that re-displacement occurs almost exclusively in the nasal valve region, where the ARR presents some limitations in the evaluation of nasal air flow^{22,23}; in such cases a dilation test could be useful²⁶.

On the basis of these observations, in our opinion surgeons should always perform both objective and subjective nasal measurements before and after septoplasty, even if the predictive value of these methods is still controversial^{22,23}. In our clinical setting we always administer the subjective NOSE questionnaire and the objective ARR. This assessment helps us to evaluate the nasal airways and to select patients who would benefit most from septoplasty.

Literature data have also demonstrated that patients with significant nasal obstruction may have a small septal deviation, whereas other patients with severe anatomical deformity may have mild symptoms²⁷.

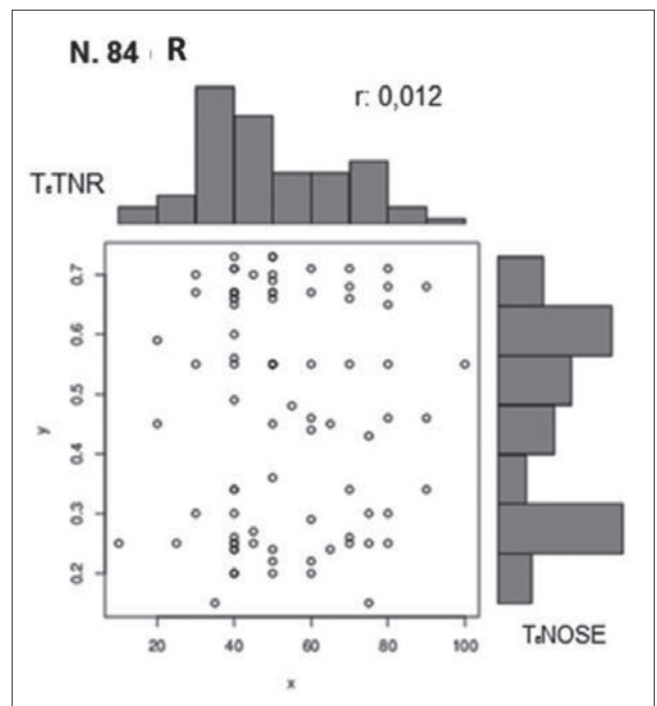


Fig. 5. Lack of correlation between T_6 NOSE and T_6 TNR, T_6 WNR and T_6 NNR in the re-displaced septoplasty (R).

Therefore, the goal of septoplasty should not be to obtain a perfectly midline aligned septum, but to improve breathing, making the nasal cavities pervious¹³.

Consequently, in clinical practice the presence at nasal endoscopy and/or imaging as CT of non-perfectly aligned portions of the septum or the presence of septal spurs in different nasal subsites that do not impact nasal airflow (posterior regions of nasal cavities, high regions of the septal cartilage) should not be considered a surgical failure, especially in association with improvement in objective and subjective measures. Although preoperative CT scan can be used for further examination of nasal anatomy and can be helpful in identifying ancillary sinonasal pathologies, there is little correlation between septal deviation findings on CT scan and symptoms of nasal obstruction as demonstrated by previous studies that did not support a role for CT as a clinically meaningful or necessary test to investigate residual postoperative nasal obstruction^{28,29}. Since patients generally tend to rate the results of their septal surgery less positively as the postoperative period gets longer, it should be mandatory to evaluate surgical outcomes in the long term; although the most literature data on septoplasty outcomes reports postoperative results after 6 months^{27,30,31}.

Another limitation of this study is the lack of nasal decongestion, but given the large sample size reported in

the study the decongestion test was not available for all patients. However, in our opinion this limitation does not affect the validity of the study. Indeed, some authors reported a mean nasal airway resistance reduction after decongestion only of 33%³² and many others do not perform decongestion in nasal assessment^{33,34}.

Conclusions

In conclusion, our data suggest that anterior septal deviations significantly impact the QoL, they are more difficult to manage and disposed to re-dislocate than posterior ones. In particular, the nasal valve is the hardest site to evaluate with objective measures like AAR².

Surgeons should always perform both objective and subjective nasal measurements before and after septoplasty, although their predictive value is still controversial. Furthermore, as previously demonstrated, CT does not correlate with septal deviation findings, and is not recommended as a postoperative diagnostic tool.

Conflict of interest statement

None declared.

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Received: January 17, 2018 - Accepted: March 27, 2018

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