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Aesthetic Rhinoplasty and Nasal Obstruction: Presentation of Results of a 100-Patient Study by Using NOSE Inventory

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Abstract

Objective The current prospective study is evaluating the nasal symptoms of patients who underwent aesthetic rhinoplasty with the intranasal approach, in a long-term setting.

Setting There is a large amount of the literature about the technique, the possible comorbidities, the aesthetic result, the patient's psychosocial background, but it is very limited regarding the effect of the operation on nasal function and physiology and this is the setting that this study is focusing on.

Materials and Method The validated NOSE questionnaire (Nasal Obstruction Symptoms Evaluation) was used in 100 patients operated on by surgeons in both the public and private sectors during the period of 2009 and 2016. The results were analyzed statistically by using SPSS.

Results Classical aesthetic rhinoplasty, without functional interventions (septum or conchas reduction), was found to improve nasal obstruction symptoms postoperatively in various grades: 77% of patients improved, 10% were found unchanged, and 13% reported worsening of their symptoms. Statistical analysis revealed that, in general, the functional outcome is stable with a slight tendency to deteriorate in the following years after operation. Although both genders had improvement in their symptomatology postoperatively, females had a greater improvement than males. Smoking and allergic rhinitis did not appear to be important determinants of the outcome.

Conclusion Classical aesthetic rhinoplasty appears to improve nasal obstruction symptoms, and this is stable through time. However, limitations apply.

Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Rhinoplasty · Classical aesthetic rhinoplasty · Endonasal approach · NOSE · Functional outcome

Introduction

Classical aesthetic rhinoplasty is one of the most popular facial aesthetic operations. It already counts about 3000 years of history, from the 16th Egyptian dynasty (1650B.C.) when the first report on an ancient papyrus was found by Edwin Smith [1] and Susruta from India (600 BC) [2] to modern techniques of the twenty-first century developed by Roe, Trendeleburg, Jacques Joseph and W. Goldman [3–5].

There is always the question concerning the effect of this operation on nasal function and physiology. The latter is very important as it can affect either positively or negatively the outcome of the operation regarding patient's quality of life. A recent study of our group, Kotzampasakis et al. [6] that used GBI (Glasgow Benefit Inventory), reported that rhinoplasty improves dramatically the patients' quality of life in all three sectors: quality of life,

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social support and physical health. However, because there is a general sense that rhinoplasty without functional intervention deteriorates substantially nasal breathing, and there was a need to focus on this aspect and investigate the outcomes of purely aesthetic rhinoplasties, especially in the long-term setting.

There are several studies assessing the outcome of the rhinoplasty with septoplasty or exclusively septoplasty [7–9], others dealing with special points of interest such as nasal valve [10–14] and others dealing with the open technique [15]. Unfortunately, the existing studies evaluating the nasal symptoms of classical aesthetic rhinoplasty (endonasal approach) are few. These studies use various questionnaires/methods, sometimes extracting conclusions from general questionnaires of aesthetic results such as the ROE (Rhinoplasty Outcome Evaluation).

Therefore, the aim of the present prospective study is to assess the long-term functional outcome, from the patient's point of view, of classical aesthetic rhinoplasty (endonasal approach) without any functional intervention by using a validated and specific questionnaire.

Materials and Method

All patients were operated on by two well-experienced plastic surgeons in the period between 2009 and 2016 (8-year sample). The first was Director of the Plastic Surgery Department at the "KAT" General Trauma Hospital of Athens until 2010 and then continued to work in the private sector. The other surgeon is operating exclusively in the private sector.

The study was performed with 100 operated patients composed of 34 males and 66 females. The ages were ranging between 23 and 57 years with a mean of 36.4 years and mean time elapsed between their operation and observation point 4.9 years. The initial pool of operated patients was 247. From them, 119 patients could be reached. The reasons for not finding the remaining patients were various (changed telephone numbers, changed emails, etc.). Out of 119 patients, 14 were excluded because they had additional minor interventions to improve nasal function or minor septoplasty. In more detail, they had lateralization and cauterization of lower nasal conchas or had minor septoplasty such as anteroinferior portion of septum only or repositioning of quadrangular cartilage due to extended obstruction. Furthermore, cases with extended reshaping of the nasal framework with grafts (L-shaped, columela grafts) were also excluded from the current population as the receipt of autologous grafts could be considered as septoplasty. It is widely common for nasal surgeons to use grafts from septal areas that protrude toward the lower nasal cavity to assist nasal breathing in parallel with rhinoplasty interventions. This is the reason why only the closed technique was chosen to be studied. Lastly, any rhinological obstructing condition such as nasal polyps, concha bullosa, hypertrophic adenoids, chronic sinusitis were by definition excluded. Moreover, five patients refused to participate due to "lack of time to deal with a survey," although we insisted that their answers, even if they were very disappointed, were more than welcome and would help to get unbiased results.

All patients were assured that their personal information will be used only by the authors, keeping their answers strictly confidential and that their surgeon will never be informed of their response. There was a consent form according to medical ethics that was read to every patient, and if they were accepting the terms, the process could move on. The study was approved by the ethical committee of University of Athens–Attikon University Hospital (protocol number 2443).

We constructed two settings: one for preoperative answers and one for postoperative ones. All of their answers were collected and registered electronically to perform statistical analysis. Patients answered the questionnaire preoperatively and once more during re-examination. The later observation point of patients was after 2 years $\pm$ 2 months due to varying availability of patients.

All operations were done on the basis of the Joseph technique with modifications by Aufricht [16–18]: in detail, an intercartilaginous incision (with or without delivery of lower cartilages), transfixion incision, lowering of upper lateral cartilage, hump removal—open roof, medial osteotomies and lateral osteotomies (either external or internal). Immediately after the operation, nasal decongestants or ointments were prescribed as a short course, without any effect in the results of this long-term study (minimum follow-up, 2 years).

The current study used the NOSE questionnaire (Nasal Obstruction Symptoms Evaluation) (Appendix). This questionnaire was the result of a multicenter study by Steward et al. [19] in 2003 and has been used in numerous studies concerning nasal symptoms. The questionnaire has been proven valid and reliable [19]. In addition, Lachanas et al. [20], Thiago et al. [21] and Magali et al. [22] translated the NOSE questionnaire into the Greek, Portuguese and French languages, respectively, and performed reliability tests. They concluded that the NOSE questionnaire is valid, reliable and reproducible, with internal consistency and responsiveness. In addition, there are numerous studies that have been performed during the last years with the use of NOSE [23–29].

The scoring of NOSE according to its authors is 0–4 with 0 indicating no symptoms and 4 severe obstruction. The sum of answers ranged between 0 and 20, and it was multiplied by 5 to get a total score in percentile (%). As a

result, we collected two total scores: one for preoperative symptoms and one for postoperative symptoms. Scores closer to 0 are symptom-free, and those closer to 100 are heavily symptomatic. The greater the score, the greater the nasal symptoms. At the end, the postoperative result was subtracted from the preoperative score and the total score (Δ_{score}) was extracted. Positive scores indicate improvement, while negative scores indicate worsening of symptoms as a final conclusion.

Results

The results are presented in three different aspects:

- Total scores of NOSE questionnaire (Δ_{Score}): By adding up all scores/question, there were one preoperative total score and one postoperative one. Δ_{score} = preoperative score − postoperative score.
- Scores per question and
- Statistical analysis correlating the outcomes with basic parameters such as smoking, age, time from the operation and history of allergic rhinitis.

Total Scores (Δ_{scores})

Results revealed that patients did notice an overall improvement in their symptoms (Fig. 1). In more detail, patients had a mean total score of 49.1% preoperatively, whereas this was reduced substantially to 24.6% postoperatively and that difference was found statistically significant ($p < 0.001$), suggesting that classical aesthetic rhinoplasty does improve the overall functional symptomatology of the patients.

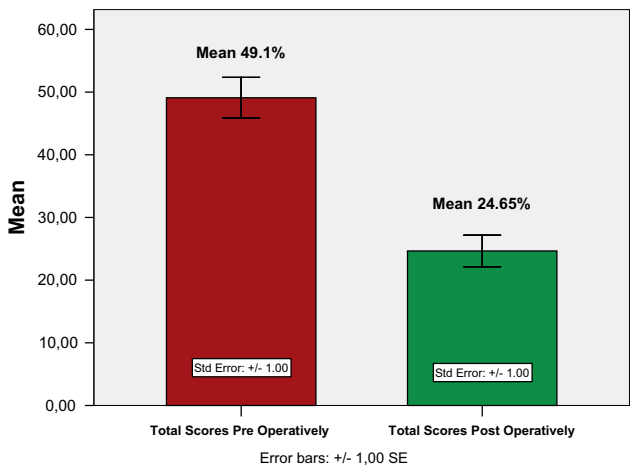

Fig. 1 The difference of the mean values of preoperative and postoperative total scores ($p < 0.001$)

In further analysis, the difference between the total score preoperatively and postoperatively Δ (total scores) was negative for patients with worsening of symptoms, 0 for patients with no overall difference and positive for patients with improvement in their symptoms; only 13 patients (13%) had negative scores, ten patients had no overall change in their symptoms, and 77 patients (77%) had positive scores (Table 1).

NOSE Mean Values Per Question

As shown in the chart (Fig. 2), the mean values of postoperative scores per question are much lower than the respective preoperative ones. In the question of nasal congestion or stuffiness, the mean score preoperatively was 10.0, whereas postoperatively 6.9 ($p < 0.001$), in the question of nasal obstruction or blockade the mean score preoperatively was 11.2 and postoperatively 6.0 ($p < 0.001$) and in the question of trouble breathing through nose the mean score preoperatively was 10.8 and postoperatively 5 ($p < 0.001$). Lastly, in the question of trouble during sleep there was a mean score of 8.7 preoperatively, whereas postoperatively it was 3.6 ($p < 0.001$) and in the question of exercise or exertion preoperatively was 8.2 and postoperatively 3.1 ($p < 0.001$).

Results showed that more than 50% of patients had improvement in every nasal symptom (Fig. 3).

1. Year of operation and mean total scores

Data analysis revealed a constant positive effect (improvement) between 17.8 and 51 along years elapsed. The

Table 1 The difference between preoperative and postoperative symptoms total scores ($\Delta_{total\ scores}$)

Change Total score pre-op (–) Total score post-op per patient	No of patients	Final result
$\Delta_{total\ score}$ from − 100 to − 81	1	Worsening
$\Delta_{total\ score}$ from − 80 to − 61	1	13 patients
$\Delta_{total\ score}$ from − 60 to − 41	5	
$\Delta_{total\ score}$ from − 40 to − 21	4	
$\Delta_{total\ score}$ from − 20 to − 1	2	
$\Delta_{total\ score}$ 0	10	Unchanged 10 patients
$\Delta_{total\ score}$ from 1 to 20	29	Improvement
$\Delta_{total\ score}$ from 21 to 40	18	77 patients
$\Delta_{total\ score}$ from 41 to 60	11	
$\Delta_{total\ score}$ from 61 to 80	12	
$\Delta_{total\ score}$ from 81 to 100	7	

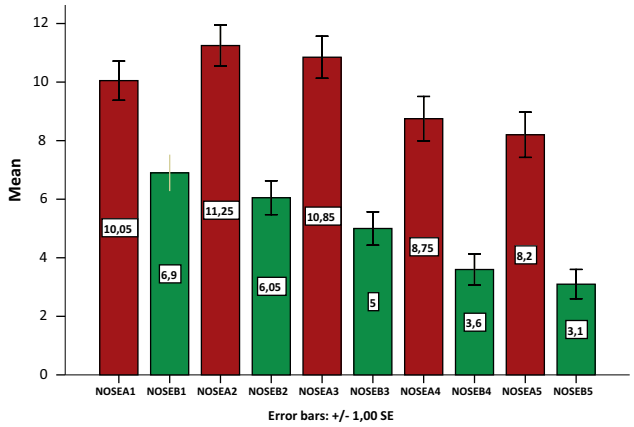

Fig. 2 Mean values per question of the studied patients—preoperatively (in red) and postoperatively (in green). Nasal congestion or stuffiness A1: preoperatively B1: postoperatively, nasal obstruction or blockade A2: preoperatively B2: postoperatively, trouble breathing through my nose A3: preoperatively B3: postoperatively, trouble sleeping A4: preoperatively B4: postoperatively, unable to get enough air through my nose during exercise or exertion A5: preoperatively B5: postoperatively

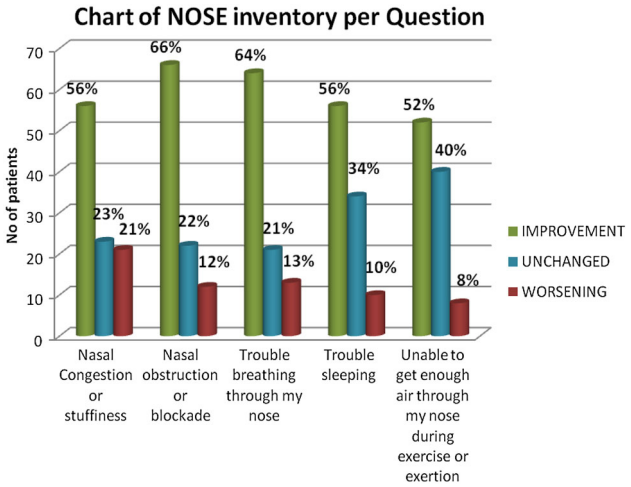

Fig. 3 Analysis of each NOSE question

difference between preoperative and postoperative scores was statistically significant for every year (all p values < 0.05). The exponential mean value shows on the graph that there is a decline of the positive effect while years pass. A possible explanation will be given in Discussion.

2. Gender and mean value of total scores

Both genders had improvement in their symptomatology postoperatively (Fig. 4). The study included 34 males and 66 females. As can be seen from the results, there was an improvement by 22.9% postoperatively ($p = 0.001$) for males and 25.7% ($p < 0.001$) for females. However,

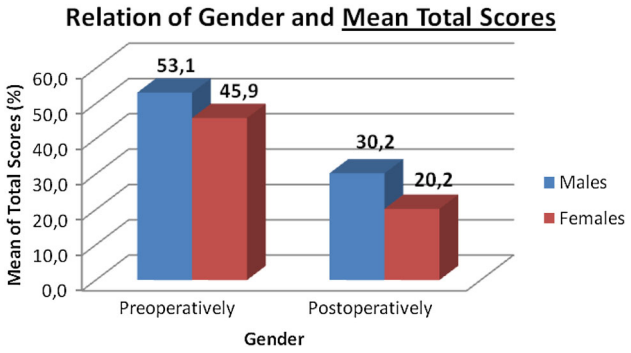

Fig. 4 Relation between gender and total scores. Preoperative and postoperative results

females appear to have greater improvement than males and this difference is statistically significant ($p = 0.02$).

3. Relation between smoking and total scores

From the whole population, 59 patients were smokers. Both smokers and nonsmokers improved their nasal breathing after rhinoplasty (Fig. 5). Smokers reduced their symptomatology by 25% ($p < 0.001$) and nonsmokers by 23.8% ($p < 0.001$). Although smokers had greater improvement in their nasal symptoms postoperatively, they still have more symptoms in comparison with nonsmokers. The difference, though, between smokers and nonsmokers postoperatively is not statistically significant ($p = 0.19$).

4. Allergic rhinitis and mean total scores of NOSE

Of the total examined population, 25 patients declared suffering from allergic rhinitis. Both allergic and nonallergic patients had improvement in their nasal symptomatology (Fig. 6). In detail, patients with allergic rhinitis had less nasal symptoms (Δmean) by 28.6% ($p < 0.001$) and patients with no allergic rhinitis by 23% ($p < 0.001$). In contrast of what could be expected, it appears that allergic patients had greater improvement from nonallergic rhinitis.

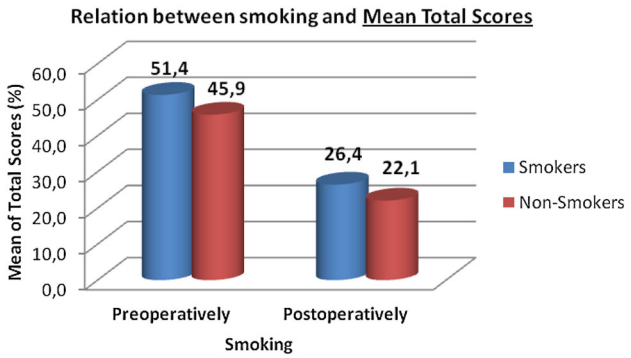

Fig. 5 Relation between smoking and mean total scores. Preoperative and postoperative results

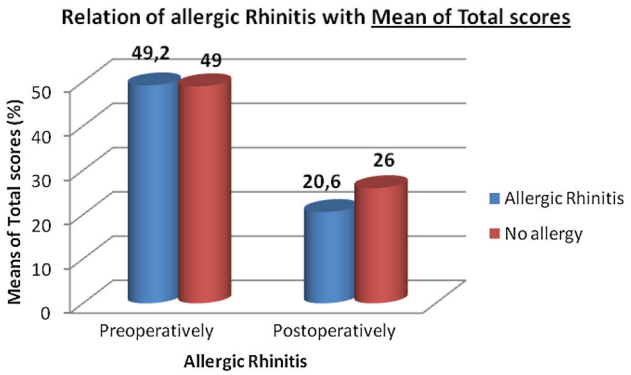

Fig. 6 Relation between allergic rhinitis and mean total scores. Preoperative and postoperative results

However, the above difference is not statistically significant ($p = 0.17$).

Discussion

It is of great importance to stress that the aim of the current study is to assess the average rhinoplasty patient who has not had major septal deviation or other nasal obstruction. It is well known by experience and the literature that no patient has a totally straight nasal septum or completely normal lower nasal conchas. In addition, there are also physiological effects involved in nasal breathing such as the nasal cycle, environmental factors, etc. The study is placed in purpose, over the average nasal anatomy of common population, seeking rhinoplasty. For that reason, all patients were examined preoperatively for extensive anatomical deformities. There are several classifications concerning grading of anatomical deformities, and none of them can describe accurately the deformity due to great variability of deviations. However, it was chosen to basically assess every patient according to the Vidigal et al. scale [30]. Major deformities that are in touch with the lateral nasal wall are described as grade III, lesser deformities that touch the lower nasal concha are described as grade II, and minor deformities that do not touch the aforementioned anatomical structures are described as grade I. Grades II and III were excluded, whereas minor deformities of grade I participated in the study as part of the average population seeking rhinoplasty. Thus, after excluding that patients did not have any major septal deviations or substantially hypertrophied conchas, they were asked to subjectively evaluate existing nasal obstruction in the physiological context of stuffiness or air blockade due to nasal cycle, environmental factors, working environment (dust, chemicals, air-conditioned areas), etc., with the current questionnaire.

The questionnaire that was used in the current study is a subjective inventory and measures the patient's opinion about their breathing. As such, there may also be a percentage of patients who slightly overestimated their functional results due to an excellent or very good aesthetic result, although all patients were instructed to separate the two surgical outcomes. Nevertheless, this is a weakness of most relative studies, taking into account that all objective methods (e.g., rhinomanometry) have their own inherit problems. Even if this is the case, it cannot be received as distraction of their actual opinion but as an important parallel positive impact of rhinoplasty as an outcome in general.

The NOSE questionnaire outcomes can be analyzed in two different ways: one by looking at the overall scores that patients achieved and one by looking at each question separately. In terms of the overall score, the majority of patients (77%) had improvement in their nasal symptoms after their operation, 10 patients (10%) remained unchanged, and only 13 patients (13%) had worsening of their symptoms. This means that the operation has a positive impact on patient's nasal symptoms and can improve nasal breathing in various grades. So the overall score can provide a more general view of the effect of rhinoplasty (by normalizing the fluctuating results between the questions) in nasal breathing, and maybe this is the most important conclusion of the present study. However, limitations apply. Extended nasal size reductions or other difficult cases as well as minor septal deviations could deteriorate the nasal breathing. This is something that has been proven by experience and relative scientific studies.

Among the very few research studies that have assessed nasal symptoms of aesthetic rhinoplasty (without other functional operations) is the study of Saleh et al. [31]. Their results showed that patients had improvement in their nasal symptoms, and the difference of the mean values of total scores preoperatively and postoperatively was 29.2% ($p < 0.001$). These results are aligned with the respective difference found in the current study (24.45%). Another study of Islam et al. [32] examined 50 patients who underwent endonasal rhinoplasty by also using the NOSE inventory. Results showed that preoperatively these patients had a mean score of 67.60% $\pm$ 12.26 and postoperatively 14.70 $\pm$ 8.04 ($p < 0.05$) with a mean difference of 52.9%. These results also suggest that classical aesthetic rhinoplasty does improve nasal symptoms.

Other studies assessing functional outcomes have used various assessment tools/methods. The study of Xavier [33] evaluated the nasal patency of 23 patients who underwent rhinoplasty with the use of PNIF (Peak Nasal Inspiratory Flow). The mean preoperative PNIF was 86.5 L/min and the mean postoperative was 123 L/min indicating that rhinoplasty improves nasal patency. There is also another similar study by Celebi et al. [34] who examined 50 patients of aesthetic rhinoplasty

preoperatively and postoperatively. The preoperative PNIF was 115.10 ± 17.45 and postoperative PNIF was 115.30 ± 16.7, concluding that rhinoplasty is not affecting nasal patency. Another study of Faidiga et al. [35] used the ROE questionnaire for evaluating 69 patients who underwent classical aesthetic rhinoplasty. Their results showed that the mean value of Question 2 (Can you breathe through your nose? 0–4 0: absolutely not and 4: absolutely yes) was 2.8, concluding that rhinoplasty is not affecting nasal patency negatively.

Another study of Guyron et al. [36] used a self-constructed questionnaire to examine the aesthetic and functional results of rhinoplasty. They administered the questionnaire into three groups: In all three groups, functional outcome was between 48.9% and 51.1%. They concluded that rhinoplasty improves nasal breathing in 49.7% of patients, does not cause any difference in a quite large percentage (38.8%) of patients and causes deterioration of nasal breathing in only 11.4% of patients. These results are also in agreement with the results of the present study. However, it is worth mentioning at this point that still after almost 20 years when this study was published, the percentage of worsening patients remains at the same level. This is still a percentage, high enough to be further studied by the scientific community [37]. There is a need to focus on factors playing an important deteriorating role in nasal breathing after rhinoplasty. It is worth to say that there are no major changes in techniques of rhinoplasty. There are minor changes in tools or different techniques in nasal tip surgery or the lateral osteotomies, but the basic technique remains same. As a consequence, the late effects (negative or positive) remain also same. Some other possible explanations concerning deteriorating factors, while years elapse, are given in the text below.

Xavier, Celebi and Faidiga [33–35] found that rhinoplasty does not deteriorate nasal breathing if not improving it by using objective measurements. Saleh et al. [31] described well why rhinoplasty can alter positively the nasal patency and improve nasal symptoms. They mentioned that most aesthetic deformities such as tension nose, long nose, weak upper cartilage, internal nasal valve collapse, pinched tip or inverted V deformities are associated with a high dorsum, narrow nostrils and softer upper cartilage creating breathing obstruction. They concluded that form and function go hand and hand. An interesting old study of Berry [38] explained why rhinoplasty can improve nasal breathing. By using an anesthetic type mask and a sophisticated model, Berry measured the postnasal airflow and pressure against the external mask's standard pressure. By using nasal physiology, he described that when air or liquid passes through wide openings, it becomes turbulent and flow reduces (Bernoulli's law). Thus, reduction of nostrils and nasal cavity's cross-sectional area makes air particles traveling in a more linear manner offsetting any increased resistance within the nasal cavity. In addition, reducing the height of the nose converts wide nostrils susceptible to collapse into a narrower and more rigid framework with greater stability. Lastly, he mentioned that inward displacement of lateral nasal bones is insufficient to significantly alter the cross-sectional area.

Concerning the statistical analysis, it appears that years elapsed after rhinoplasty do not affect substantially the functional result. The outcome remains positive throughout years according to the results of the present study, and this is very important for the steady wellbeing of the operated patients. However, we must stress that the exponential moving average in Fig. 7 shows a slight decline, meaning that the positive effect on breathing has a small tendency to decrease with years. This can be explained by developing secondary nasal symptoms such as postoperative scaring, hypertrophy of nasal conchas, changes in nasal physiology or the aging nose. However, the above results are in agreement with the study of Arima et al. [39] who examined 28 patients and came to the same conclusion. One could say that the mean value of time elapsed is large (4.9 years). The NOSE questionnaire has been used in studies assessing the post-op "quality of life" [31, 40] as nasal breathing plays an important role in it and sustains through the years. Bensoussan et al. [41] performed a literature review of questionnaires measuring the QoL in patients who had aesthetic operations in which facial operations/rhinoplasty were included. Their results showed that the initial effect of an aesthetic operation raises between the first 2 months (Sarwer et al. [42]) and reaches a maximum plateau phase between 2 and 5 years which is maintained through the following years [43, 44]. In addition, the aforementioned study of Saleh et al. [31] by using the NOSE questionnaire on 113 patients who underwent rhinoplasty concluded that the positive effects on respiratory function remain after 3 years of follow-up.

Regarding gender, both had improvement in their symptomatology postoperatively. The above results are

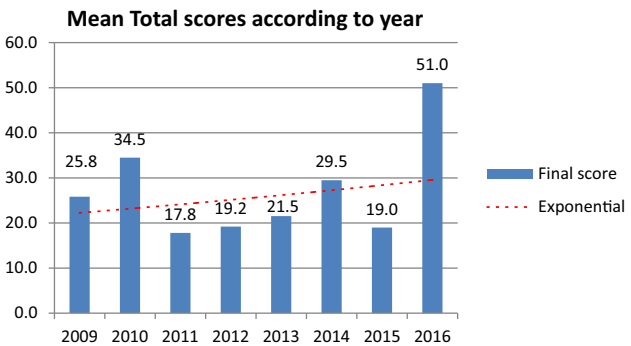

Fig. 7 Distribution of mean total scores according to years elapsed since their operation

aligned with the aforementioned study of Guyron [36]. Of 86 males, 54.7% had improvement in nasal breathing, and of 372 females, 48.1%.

It seems that both smokers and nonsmokers had improvement in their symptomatology postoperatively. Surprisingly, smokers had slightly greater improvement than nonsmokers. Searching the literature on this topic, only one study attempted to relate rhinoplasty and smoking with the use of the NOSE questionnaire. Lindsay [45] studied 60 patients who underwent rhinoplasty with simultaneous correction of nasal valve disease or turbinectomy. He concluded that smokers had no worse functional results after rhinoplasty.

In the current study, allergic rhinitis patients had improvement in their nasal symptoms. It is an observation made by the results of the NOSE and needs further scientific support as the difference between preoperative and postoperative results was not statistically important. The possible explanations could be the alteration of turbulent airflow within nostrils and changes in local circulation. In the same study of Lindsay [45] that is mentioned above, it is also supported that allergic rhinitis patients had also improvement in nasal congestion but less than nonallergic patients.

Conclusions

The study concludes that classical aesthetic rhinoplasty, without functional intervention, improves nasal obstruction symptoms postoperatively; 77% improved, 10% unchanged, and 13% reported worsening. Statistical analysis showed that, in general, the functional outcome is stable and independent of the time elapsed from the operation. Although both genders had improvement in their symptomatology postoperatively, females had a greater improvement than males. Smoking and allergic rhinitis did not appear to be important determinants of the outcome.

Authors Contribution DK, main author, was involved in literature review, and designed and performed the study. TD, co-author was involved in literature review. SK was involved in guidance and contribution with patients who underwent rhinoplasty. PM was involved in guidance and contribution with patients who underwent rhinoplasty.

Compliance with Ethical Standards

Conflict of interest There is no conflict of interest with other colleagues, researchers or other third party. The study did not have any commercial interests.

Ethical Approval The study was approved by the ethical committee of University of Athens–Attikon University Hospital (protocol number 2443).

Informed Consent There was a written consent form in Greek language.

Appendix: NOSE Questionnaire

ID# _____ Date _____

Nasal Obstruction Symptoms Evaluation Scale

➔ To the Patient: Please help us to better understand the impact of nasal obstruction on your quality of life by completing the following survey. Thank you!

Over the past 1 month, how much of a problem were the following conditions for you?
Please Circle the Most Correct Response

	Not a Problem	Very Mild Problem	Moderate Problem	Fairly Bad Problem	Severe Problem
1. Nasal congestion or stuffiness	0	1	2	3	4
2. Nasal blockage or obstruction	0	1	2	3	4
3. Trouble breathing through my nose	0	1	2	3	4
4. Trouble sleeping	0	1	2	3	4
5. Unable to get enough air through my nose during exercise or exertion	0	1	2	3	4

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