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Predictive factors of patients' general quality of life after nasal septoplasty

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Abstract

Purpose Although septoplasty is considered to be the definitive treatment of septal deviation and is associated with an increase of nasal patency, patients are not always satisfied with the surgical outcome as assessed by its effect on their general Quality of Life (QOL).The aim of this study was to identify the predictive factors that influence the patients' QOL after surgery.

Methods 60 patients with nasal obstruction and septal deviation were enrolled in this prospective study, and they all completed the follow-up survey of 6 postoperative months. Symptom severity (Nasal Obstruction Symptom Evaluation—NOSE, Sino nasal outcome test 22—SNOT-22), sleep quality (Epworth Sleepiness Scale—ESS), olfactory function (Threshold Discrimination Identification—TDI score), voice quality (Nasalance score and Voice Handicap Index—VHI), stress (SQ test) and emotional status (Beck Depression Index—BDI) were evaluated as predictive factors of patients' QOL (Glasgow Benefit Inventory—GBI) postoperatively. We also analyzed age, gender, smoking, socioeconomic status, type of septal deviation and changes of nasal patency (with the use of rhinomanometry, acoustic rhinometry, and peak nasal inspiratory flow).

Results From all the analyzed parameters, the nasal obstruction symptom severity, the sleep quality, and stress levels were only significantly associated with patients' overall QOL ($p < 0.05$; univariate analysis). However, on multiple regression, positive changes in NOSE score (OR 15.09, 95% CI 1.47–22.64, $p < 0.05$) and SQ test (OR 4, 95% CI 1.12–14.3, $p < 0.05$) were only related with higher likelihood of participants' QOL improvement after surgery.

Conclusions Thorough preoperative evaluation of the symptom severity and stress levels is critical as these two factors are predictive of patient's satisfaction after septoplasty.

Keywords Septoplasty · Nasal obstruction · Quality of life · Predictive factors · Symptom severity · Stress

Introduction

Nasal obstruction is the most common complaint in rhinological practice [1]. One of its main causes is nasal septal deviation and septoplasty, which is considered the definitive treatment for septal deviation [2], is the third most common ear/nose/throat (ENT) operation [3]. Nasal obstruction attributed to nasal septal deviation has been demonstrated to be responsible for several symptoms that affect patients' quality of life (QOL) [2].

Additionally, the nasal obstruction may be accompanied by snoring caused via two mechanisms [4]. First, the increase of nasal resistance during inspiration due to narrowing of the nasal passages provokes an increase of the negative pressure which is essential to maintain adequate airflow. This effect increases airspeed as well as induce oscillation

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of the soft palate. Second, nasal obstruction during sleep typically causes the route of breathing to switch from nasal to oral, which can produce palatal flutter due to the oral airflow during the inspiration. Therefore, patients with nasal obstruction due to septal deviation may suffer from sleep-disordered breathing (SDB), daytime somnolence and fatigue, which tend to have significant physical and social consequences on patients' QOL [5].

Although nasal obstruction is the leading symptom in those patients with nasal septal deviation, they may also complain of olfactory impairment. Studies focusing on the association between the intranasal airflow and olfactory function have shown that the structure of nasal cavity which determines the pattern of nasal airflow, is affecting the magnitude of odorant molecules that reach the olfactory epithelium. Thus, higher olfactory thresholds, as well as reduced olfactory identification, have been documented in patients with septal deviation [6, 7].

Furthermore, the nose and paranasal cavities are part of the vocal tract and act as resonators to alter the original sound produced by the vocal folds. As a result, the nasal obstruction can promote the minimization or elimination of the nasal feature during the production of a nasal sound (hyponasality) [8]. Studies have shown that patients with voice disorders are often stereotyped as less pleasant, less intelligent, and less attractive than people with normal speech. Such perceptions may have a severe impact on the social life and self-esteem of those patients [9, 10]. Although septal surgery can potentially affect the nasal resonance and acoustic features of the voice by altering the volumes of the nasal cavity [11], there has been little interest in the role of this intervention on the acoustic features of the voice and its impact on patients' QOL.

In recent years, health-related quality of life (HRQL) research is gaining increasing importance in the clinical assessment. QOL can be defined as 'the extent to which an individual's usual or expected physical, emotional, and social well-being are affected by a medical condition or its treatment' [12]. Clinicians rely mainly on the subjective measures of satisfaction after septoplasty, since there is no reliable objective test for nasal obstruction quantification [13]. Despite successful correction, some patients are not satisfied with the outcome after septoplasty, and that is why some investigators criticize the number of unnecessary surgeries performed each year [14]. Indeed, the findings of our previous study [15], showed that nasal septoplasty results in a significant increase in nasal patency as well as in an improvement of the nasal obstruction symptoms. However, patients' QOL evaluation did not reflect an important change in their health status (low GBI score) postoperatively. Additionally, it was indicated that the patients' positive evaluation of the septal surgery outcome tended to decrease with time (at 3-year postoperatively).

Furthermore, according to the results of a recent systematic review and the current body of evidence the effect of septoplasty on patients' QOL remains controversial [16]. So, if the surgeon was able to identify which patients will have the higher QOL improvement and satisfaction after surgery, it would enable the selection of the most appropriate patients to benefit by the surgical intervention. Since nasal obstruction is a highly subjective sensation, patients' emotions such as stress and other psychological factors may also contribute to their subjective satisfaction after septal surgery. Interestingly this was reported in previous studies, which investigated the effect of the psychological status on the postoperative QOL in patients who suffered from chronic rhinosinusitis and underwent endoscopic sinus surgery [17].

Therefore, the aim of the present study was to investigate all the potential prognostic factors contributing to QOL improvement after septoplasty, with a focus on symptom severity, sleep disorders, olfactory function, voice performance, and emotional factors, utilizing both subjective and objective methods. Few prior studies have attempted to identify such predictors of patients' subjective satisfaction after septoplasty [18–21]. However, none of them have investigated the possible relationship between the severity of nasal obstruction symptoms along with psychological factors and patients' overall QOL.

Methods

We performed a prospective observational study which enrolled 60 consecutive patients (between March 2016 and March 1017) who presented in the outpatient clinic complaining of nasal obstruction, and were diagnosed with septal deviation after clinical and endoscopic examination. Following a power sample size calculation, the study required 60 patients and 25 individuals for the control group to have a two-tailed significance test, a significance level of 0.05 and a power > 85% to detect a difference as small as 0.05 among the means of the compared groups, for a standard deviation of 0.1. The institutional Review Board approved the study protocol (decision No 3525/10.02.2016). All patients included in the study were followed-up for 6 months and were available for statistical analysis. According to the inclusion criteria, we enrolled patients aged ≥ 18 years with chronic nasal obstruction (lasting for at least 6 months) and nasal septal deviation upon clinical examination. The symptom of nasal obstruction should be persistent after a 4-week trial of medical management that included topical nasal steroids, topical decongestants, or a combination of oral antihistamine and topical nasal steroid or decongestant. We excluded from the study patients with clinical evidence or history of allergic rhinitis, sinonasal malignancy, chronic sinusitis, sinonasal polyposis, cleft lip, cleft palate,

or submucosal cleft palate, radiation therapy to the head and neck, acute nasal trauma or fracture in the past 3 months, septal perforation, craniofacial syndrome, nasal valve collapse, adenoid hypertrophy, cardiopulmonary disease (coronary artery disease, chronic obstructive pulmonary disease, or uncontrolled asthma), laryngeal diseases or speech disorders, neuromuscular disease, age greater than 65 years, or morbid obesity [body mass index (BMI) ≥ 40 kg/m^2], Wegener granulomatosis, sarcoidosis, pregnancy, and those who had undergone other ENT procedures such as rhinoplasty and sinus surgery concomitant to septal surgery, tonsillectomy, or uvulopharyngopalatoplasty or a combination of these.

25 volunteers who had similar age and sex distribution and no nasal obstruction nor septal deviation, were also included as a control group. Patients who met the inclusion criteria and agreed to participate, signed a consent form and completed a brief questionnaire with their demographic and general medical data. The participants were preoperatively subjected to a detailed ENT examination (including flexible fiberoptic nasopharyngeal endoscopy to exclude the presence of associated velopharyngeal incompetence: Müller's maneuver) and when medically justified computed tomography (CT) scan for the nose and paranasal sinuses. To assess patients' symptoms and disease-specific QOL, we utilized previously published, translated, and validated into the Greek language questionnaires. Patients were asked to complete these questionnaires preoperatively and postoperatively at 6 months. At the same time, we performed objective methods for the evaluation of nasal patency, olfaction, and voice analysis. Healthy volunteers completed the same questionnaires and underwent the same diagnostic procedures with the patient group. We consequently compared the preoperative and postoperative results of the patients' group to each other, each separately with the control group, and separately for each subgroup of the patients' group. Informed consent was obtained from all individual participants included in the study.

Nasal measures

All participants underwent active anterior rhinomanometry—RM (for the measurement of nasal resistance—NR). 10 min before RM, decongestion of each nostril was performed with two puffs of 0.1% xylometazoline spray to diminish the potential effect of the nasal cycle. Total NR was calculated by the standard formula total NR = (right NR · left NR)/(right NR + left NR) [22]. We utilized acoustic rhinometry (ARM) to measure minimal cross-sectional area (MCSA) on both the right and left sides of the nose. In this study, MCSA was calculated by averaging the right and left nasal measurements to minimize the effect of the nasal cycle. We also measured peak nasal inspiratory flow (PNIF) for the evaluation of nasal patency.

Disease-specific and overall QOL questionnaires

All participants completed the Nasal Obstruction and Septoplasty Effectiveness Scale (NOSE) and the Sino Nasal Outcome Test 22 (SNOT-22). NOSE is a five-item, disease-specific QOL questionnaire for measurement of nasal obstruction. For each item the patient scores from zero to four, and then the sum of the items is multiplied by five, resulting in a final score which ranges from zero (no symptoms) to 100 (severe nasal obstruction) [2]. In the SNOT-22 questionnaire, patients rate 22 different symptoms related to both nasal and general health on a score from 0 to 5 [18].

The Glasgow Benefit Inventory is a validated measure of patient's benefit, developed especially for surgical interventions. It is not disease-specific, but measures change in the overall health status. It is an 18-item post-intervention questionnaire and gives a total score as well as profile scores for the general benefit, social support, and physical health categories. The scores range from + 100 (maximum positive change) to − 100 (maximum negative change) [23].

Daytime sleepiness, olfaction and voice analysis

Daytime somnolence was measured using the Epworth Sleepiness Scale (ESS) [22]. Olfactory function was assessed using the Sniffin' Sticks test package with specific tests for odor threshold (OT), odor discrimination (OD), and odor identification (OI). Results are aggregated to odor threshold, discrimination, and identification (TDI) score [24]. The TDI scores range from 0 to 48, and values of 15 or less represent anosmia, values between 16 and 34.5 represent hyposmia, and values over 34.5 represent normosmia. A clinically significant change of olfactory function was assumed when the TDI score differed by six points [25]. To assess daily life problems due to olfactory dysfunction, we used a short modified version of a 25-item olfactory-specific questionnaire (Questionnaire of Olfactory Disorders—QOD). High scores indicate a potent impairment in QoL [26].

Additionally, all participants underwent nasometry for the assessment of nasality in their speech. Nasometry (with the use of Nasometer II 6400), provides a nasalance score that corresponds to the ratio of the nasal acoustic energy to the sum of nasal and oral acoustic energy expressed as a percentage. The value for nasality can theoretically vary from 0% (no sound from the nose) to 100% (all sound from the nose). For this measurement, all subjects were asked to repeat a Greek oronasal text, which contained both nasal and oral consonants in representative ratios for spoken Greek (8.6% nasals and 91.3% oral sounds) [27]. Participants also completed the Voice Handicap Index (VHI) which is a

30-item questionnaire regarding the effect of patients' voice on their lives. Every item is scored on a 5-point scale (0–4), and the total score is between 0 and 120. A higher score is indicative of a more severe subjective voice disorder [28].

Emotional factors

The Stress Questionnaire (SQ) which is a 20-item (graded from 0 to 3) questionnaire, was used to evaluate the stress levels of the participants. Higher scores are representative of higher levels of stress [29]. Beck Depression Index (BDI) was used for assessing participants' psychological profile. It consists of 21 self-reporting items graded from 0 to 3, and a higher score indicates a higher level of depression [30].

Other possible predictive factors

Age, gender, smoking habits and socioeconomic status were also analyzed. All patients underwent skin-prick testing to exclude a diagnosis of allergic rhinitis. A nasal endoscopic examination was performed in all patients to evaluate the severity of their septal deviation. The patients were then classified into three groups: (a) grade I: mild deviation—less than half the total distance to the lateral nasal wall; (b) grade II: moderate deviation—more than half the distance but not touching the lateral nasal wall; and (c) grade III: severe deviation—deviation touching the lateral nasal wall [31].

Operation

The surgical technique was standardized and included a hemitransfixion incision followed by an elevation of the septal mucoperichondrium in both sides, addressing all areas of deviation and reshaping or removing the deviated part of the cartilage. All patients also underwent cauterization of the inferior nasal turbinates to reduce their size. The anterior nasal packings placed at the end of the operation, were removed after 48 h. None of the patients suffered major complications. All operations were performed by the same consultant surgeon, who was blinded to the patients' scores both before and after the treatment and did not participate in the collection of the questionnaires and analysis of data.

Statistical analysis

Statistical analyses were performed using the IBM SPSS Statistics for Windows software (IBM SPSS, IBM, Armonk, NY, USA), version 23.0. The variables studied are presented as group means with standard deviations. Normality of the data was assessed with the Kolmogorov–Smirnov test, and the independent sample t test and the paired sample t test were used for the group comparison of the data with normal distribution. When the data were not normally distributed, the Mann–Whitney U test and the Wilcoxon t test were used. Spearman's (ρ) correlation coefficients were calculated to check the correlations between predictive factors and patients' QOL (GBI score). Univariate analysis was used to perform simple regressions to evaluate the predictive factors of septoplasty outcomes related to patients' QOL, and multiple regression analysis was performed to explore the independent effect of each factor on patients' QOL. Odds ratios (OR) and 95% confidence intervals (CI) were estimated as the measure of association between QOL improvement and all potential predictors. A p value of less than 0.05 was accepted as the statistical significance level.

Results

60 patients [34 males (56%); mean age: 32.98 ± 11.98 years] and 25 healthy subjects [13 males (52%); mean age: 29 ± 8.87 years] met the eligibility criteria and participated in the study. Demographics of all patients and controls are shown in detail in Table 1. There were no statistically significant differences related to gender ($p = 0.151$), age ($p = 0.176$), socio-economic status ($p = 0.942$), and smoking habits ($p = 0.143$) between patients and controls. All patients completed the 6-month follow-up survey.

There was a significant difference in the preoperative nasal objective measurements (RM, ARM, PNIF, Nasality) between the control and study groups ($p < 0.001$ for RM, ARM and PNIF measurements and < 0.05 for Nasality). Patients had significantly higher nasal resistance (TNR value) and hyponasality (Nasalance score) as well as lower nasal patency (MCSA, PNIF value) compared

Table 1 Demographics of the 60 patients and 25 healthy controls that were enrolled in the study

Demographics [no (%)]	Patient group ($n = 60$)	Control group ($n = 25$)	p*
Gender			0.151
Male	34 (56%)	13 (52%)	
Female	26 (44%)	12 (48%)	
Age [years; mean (SD)]	32.98 (11.98)	29 (8.87)	0.176[a]
Smoking	20 (33.33%)	10 (40%)	0.143
Socioeconomic Status			0.942
Low	14 (23%)	6 (25%)	
Medium	24 (40%)	9 (35%)	
High	22 (37%)	10 (40%)	

Values represent number of patients and percentages (in brackets) unless stated

S.D. standard deviation

*Chi-square test

[a]Mann–Whitney U test for independent samples

to the controls. Additionally, the patient group had more severe nasal obstruction symptoms (higher NOSE and SNOT22 scores), worse olfaction (lower TDI and higher QOD scores), more stress (higher SQ) and suffered more from daytime somnolence (higher ESS) compared to the control group. All these differences reached statistical significance (Table 2). Postoperative evaluations showed that there was a statistically significant improvement in TNR, MCSA, and PNIF values (nasal resistance decrease, better nasal patency; $p < 0.001$), but not in Nasalance scores (no significant improvement; $p = 0.41$). Patients had statistically significant improvement in their NOSE and SNOT22 scores (improvement of nasal obstruction symptoms), TDI scores (improved olfaction), SQ test (less stress), and ESS scores (less daytime sleepiness) 6 months after surgery (p values are presented in Table 2).

Table 2 shows that postoperatively, there were no statistically significant differences in all nasal objective measurements and some subjective parameters (ESS, BDI, VHI scores) between the patient and control groups. However, NOSE, SNOT22, TDI, QOD, and SQ scores maintained their statistically significant difference between the two groups ($p < 0.001$ for all the examined parameters).

Spearman's correlation coefficient showed no statistically significant correlation between the baseline as well as the postoperative nasal objective measurements and patients' QOL improvement (GBI scores) (Table 3).

Univariate statistical analysis revealed that improvements in NOSE, SNOT22, ESS, and SQ scores were the only independent predictors significantly associated with patients' QOL improvement (GBI scores) (Table 4).

Multivariate logistic regression analysis revealed that significant improvement in NOSE score (nasal obstruction

Table 2 Comparison of pre and postoperative (at 6 months after surgery) nasal measurements and patients scores (third column) and comparison with the control group (first and second columns, respectively)

Variable	Preop mean	Control mean	p^a	Postop mean	Control mean	p^a	Preop mean	Postop mean	p^a
TNR (Pa/cm^3/s)	0.81 (0.47)	0.37 (0.09)	0.000	0.41 (0.23)	0.37 (0.09)	0.258	0.81 (0.47)	0.41 (0.23)	0.000
MCSA (cm^2)	0.61 (0.16)	0.85 (0.2)	0.000	0.74 (0.26)	0.85 (0.2)	0.079	0.61 (0.16)	0.74 (0.26)	0.001
PNIF (L/min)	51.4 (20.52)	88 (12.18)	0.000	85.61 (30.77)	88 (12.18)	0.622	51.4 (20.52)	85.61 (30.77)	0.000
Nasalance score	34.85 (9.33)	31 (9.2)	0.035	36.4 (10)	31 (9.2)	0.113	34.85 (9.33)	36.4 (10)	0.41
NOSE	76.1 (20)	7 (5.7)	0.000	27.73 (27)	7 (5.7)	0.000	76.1 (20)	27.73 (27)	0.000
SNOT22	42.93 (19.57)	12.9 (8.86)	0.000	26.7 (18.9)	12.9 (8.86)	0.000	42.93 (19.57)	26.7 (18.9)	0.000
ESS	13.15 (4.89)	9.1 (4.68)	0.002	9.93 (6.7)	9.1 (4.68)	0.544	13.15 (4.89)	9.93 (6.7)	0.007
SQ	21.63 (7.94)	11.7 (6.39)	0.000	19.5 (10.4)	11.7 (6.39)	0.000	21.63 (7.94)	19.5 (10.4)	0.05
BDI	7 (5.36)	6.85 (3.43)	0.887	7.53 (5.76)	6.85 (3.43)	0.224	7 (5.36)	7.53 (5.76)	0.08
VHI	8.46 (3.62)	7.7 (3.52)	0.754	8.95 (8.79)	7.7 (3.52)	0.614	8.46 (3.62)	8.95 (8.79)	0.89
TDI	23.89 (5.16)	35.67 (4.57)	0.000	26.42 (6.21)	35.67 (4.57)	0.000	23.89 (5.16)	26.42 (6.21)	0.03
QOD	14.76 (8.36)	6.9 (2.35)	0.000	12.96 (7.84)	6.9 (2.35)	0.000	14.76 (8.36)	12.96 (7.84)	0.102

Values represent mean scores and standard deviation (in brackets)

TNR total nasal resistance, *MCSA* minimal cross-sectional area, *PNIF* peak nasal inspiratory flow, *NOSE* Nasal Obstruction Symptom Evaluation, *SNOT22* Sinonasal Outcome Test-22, *ESS* Epworth Sleepiness Scale, *SQ* Stress Questionnaire, *BDI* Beck Depression Inventory, *VHI* Voice Handicap Index, *TDI* Threshold Discrimination Identification Test, *QOD* Questionnaire of Olfactory Disorders, *Preop* preoperatively, *Postop* 6-month postoperatively

[a]Mann–Whitney *U* test for independent samples

Table 3 Correlation between nasal objective measurements and the Glasgow Benefit Inventory (GBI) scores (patients' Quality of Life) pre- and postoperatively

Variable	TNR (preop)	MCSA (preop)	PNIF (preop)	Nasalance score (preop)	TNR (postop)	MCSA (postop)	PNIF (postop)	Nasalance score (postop)
GBI								
r value[a]	−0.169	0.144	0.089	−0.263	−0.193	0.206	0.043	−0.103
p value	0.196	0.273	0.497	0.43	0.14	0.115	0.747	0.434

GBI Glasgow Benefit Inventory, *TNR* total nasal resistance, *MCSA* minimal cross-sectional area, *PNIF* peak nasal inspiratory flow, *Preop* preoperatively, *Postop* 6-month postoperatively

[a]Spearman's p (rho) correlation

Table 4 Univariate analysis of the Glasgow Benefit Inventory (GBI) score (patients' Quality of Life) postoperatively

Variable	Mean (S.D.)	Regression coefficient	p[a]
Age, years	32.98 (11.98)	− 0.084	0.522
Gender		0.214	0.101
Smoking		− 0.195	0.323
Socioeconomic status		− 0.057	0.665
Severity of septal deviation		0.201	0.123
NOSE difference[b]	48.4 (40.4)	− 0.413	0.001
SNOT22 difference	16.2 (27.9)	− 0.375	0.003
SQ difference	2.1 (7.3)	− 0.475	0.000
BDI difference	1.5 (8.89)	0.136	0.3
VHI difference	0.48 (3.8)	0.141	0.283
TDI difference	2.5 (8.3)	− 0.073	0.577
QOD difference	2.1 (7.9)	− 0.189	0.149
ESS difference	3.2 (8.9)	− 0.439	0.000

GBI Glasgow Benefit Inventory, *NOSE* Nasal Obstruction Symptom Evaluation, *SNOT22* Sinonasal Outcome Test-22, *ESS* Epworth Sleepiness Scale, *SQ* Stress Questionnaire, *BDI* Beck Depression Inventory, *VHI* Voice Handicap Index, *TDI* Threshold Discrimination Identification Test, *QOD* Questionnaire of Olfactory Disorders, *S.D.* standard deviation

[a]Univariate logistic regression

[b]Difference (between pre- and postoperative values) represents clinically significant improvement

symptom severity) and SQ test (stress) were the sole predictive factors statistically significantly associated with higher likelihood of patients' QOL improvement (GBI scores) (Table 5).

In agreement with other studies, we used as criteria to measure the differences in QOL improvement, the median preoperative NOSE score, and SQ test values. The patients were divided into two groups (above the criterion group—patients with more severe obstruction symptoms and higher stress levels—and below group—patients with milder obstruction symptoms and lower stress levels). The analysis of the GBI scores was based on the comparison of these two groups. Patients with preoperative milder nasal obstruction symptoms severity (lower NOSE scores) and those with lower stress levels (lower SQ scores) had statistically significantly higher improvement in QOL after septoplasty (higher GBI results) (Table 6). The same results were also found when the comparisons were done postoperatively. Additionally, QOL improvement was statistically significantly higher in patients with more significant postoperative change (improvement) in symptom severity (NOSE and SNOT-22 scores) and stress levels (SQ test) (above groups; Table 6).

Table 5 Results of multivariate logistic regression analysis between predictor variables and clinically significant improvement of the Glasgow Benefit Inventory (GBI) in patient group, expressed as odds ratios with their 95% confidence intervals

Variable	OR	95% CI	p
GBI			
NOSE improvement	15.09	1.47–22.64	0.022
SNOT22 improvement	2.07	0.38–11.27	0.4
ESS improvement	0.25	0.02–3.06	0.28
SQ improvement	4	1.12–14.3	0.033

OR odds ratios, *95% CI* 95% confidence intervals, *GBI* Glasgow Benefit Inventory, *NOSE* Nasal Obstruction Symptom Evaluation, *SNOT22* Sinonasal Outcome Test-22, *ESS* Epworth Sleepiness Scale, *SQ* Stress Questionnaire

Discussion

Nasal septoplasty is one of the most frequently performed otorhinolaryngologic operations. The commonest indication for this surgical intervention is persistent nasal obstruction due to substantial septal deviation and despite trials of appropriate medical therapies. In recent years, provision

Table 6 Comparison of postoperative (6 months after surgery) total Glasgow Benefit Inventory (GBI) scores between above–below criterion A (median value of preoperative NOSE score), criterion B (median value of preoperative SQ test), criterion C (median value of postoperative NOSE score), criterion D (median value of postoperative SQ test), criterion E (median value of NOSE score change), criterion F (median value of SNOT 22 score change) and criterion G (median value of SQ test change) groups

Variable	Above ($N=28$) Mean (S.D.)	Below ($N=32$) Mean (S.D.)	p[a]
Criterion A			
GBItotal	5 (15.04)	13.89 (14.34)	0.032
Criterion B			
GBItotal	6.57 (13.51)	12.31 (16.53)	0.027
Criterion C			
GBItotal	4.08 (14)	15.57 (14.42)	0.003
Criterion D			
GBItotal	2.08 (14.14)	17.85 (11.86)	0.000
Criterion E			
GBItotal	15.18 (14.11)	3.7 (14.33)	0.003
Criterion F			
GBItotal	13.49 (14.03)	3.77 (15.33)	0.022
Criterion G			
GBItotal	15.9 (11.61)	2.58 (15.85)	0.002

Change is defined as the difference between the pre- and postoperative value of each variable

GBI Glasgow Benefit Inventory, *NOSE* Nasal Obstruction Symptom Evaluation, *SNOT22* Sinonasal Outcome Test-22, *SQ* Stress Questionnaire, *S.D.* standard deviation

[a]Mann–Whitney *U* test for independent samples

of health care has become increasingly influenced by the patient's needs and preferences. Thus, there has been a shift in emphasis towards patient-oriented measures of outcome. The present study showed that nasal septoplasty leads to a significant improvement of all nasal obstruction symptoms and a better disease-specific Qol, looking closer at the symptom scores provided by the NOSE and SNOT 22 questionnaires. Similarly, prospective studies on patient satisfaction have reported high-satisfaction levels after septoplasty [18, 32].

However, only a few studies have been performed to assess the impact of nasal septal surgery on the patient's general quality of life [23, 33]. In the current study, the total mean GBI score was 9.44 which although positive score suggesting that patients perceived benefit from the surgical procedure, at the same time, this did not reflect a significant change in their overall health status following septoplasty. The low mean GBI score obtained is similar to the results of previous studies, where researchers have found that the majority of patients undergoing nasal septoplasty did not report a significant subjective benefit in their general QOL following the surgical intervention [14, 23, 34]. The important addition to existing knowledge is the finding of the present study that the QOL improvement is mainly attributed to the general health status changes (GBI scores) in the patient subgroups who suffered from severe nasal obstruction and higher stress levels preoperatively. To be more specific, patients with higher NOSE and SQ scores compared to those with mild nasal obstruction symptoms and lower stress levels preoperatively had statistically significant higher GBI scores (better QOL improvement) after surgery. Additionally, patients with more significant change (improvement) in nasal symptoms' severity and stress levels had significantly higher QOL improvement postoperatively.

The possible explanation for the low GBI score is that the indications for septal surgery were incorrect. In patients with false indications, the outcomes of surgical intervention are not expected to be as good as in those with the correct indications, even if the operation is successfully performed. This demonstrates the clear need for improved patient selection and identification of the reliable prognostic factors to minimize the number of unnecessary surgical procedures. The gold standard in establishing the indications for septoplasty has been the clinical assessment via history and physical exam, but the clinical examination findings are highly subjective and vulnerable to examination bias. So, although it is clear that clinicians are very accurate in assessing the anatomical variations of the patient's nose, there are other factors also affecting the patient's QOL perception. Thus, it is necessary to ascertain which preoperative features are highly predictive of both the subjectively and objectively perceived positive septoplasty outcomes.

Standardized selection criteria to identify the patients with the greater probability of postoperative benefit are still lacking. In the present study, age, gender, smoking, socioeconomic status, and type of septal deviation were evaluated as possible predictive factors of the postoperative QOL improvement. Similar to previous studies which have examined age [18, 21, 35, 36], gender [18, 21, 36], smoking habits [18, 21, 36], allergy [18–20], and the type of septal deviation [36, 37], none of these parameters was significantly associated with the subjective surgical outcome. However, there are previous studies reporting that female gender [38], younger age [35] and allergic rhinitis, are predictors of poor septoplasty outcomes [20, 21, 38]. In the current study, patients with allergic rhinitis were excluded because allergy was considered a confounding factor.

Undoubtedly, septoplasty is accompanied by nasal patency increase and nasal resistance decrease. This was also found in the present study where the objective methods of nasal airway evaluation including RM, ARM, and PNIF were used for investigating the effect of septoplasty on nasal obstruction. Similarly, a systematic review of the literature indicated that septoplasty improves nasal patency and the objective rhinometric outcomes [39]. Therefore, these objective methods are valuable tools not only for clinical research, but also as a complementary examination to the continuous clinical evaluation of patients before and after their operation. However, these methods do not always correlate consistently with the patients' reports of nasal obstruction. According to the results of a methodical systematic review, there was no correlation between the subjective sensations of nasal obstruction and the objective measurements by RM or ARM [40]. Likewise, in the present study, patients' QOL did not correlate with the improvement in all the nasal measurements. Due to these inconsistencies in the existing evidence, the value of these objective measurements in the routine selection of those patients who are more likely to be satisfied by the surgical outcome on their QOL remains questionable, particularly given the added time and cost of these tests.

Another important finding is that septoplasty significantly improves daytime somnolence (significant reduction in the subjective ESS score), indicating that this kind of surgery has a beneficial effect on the subjective quality of sleep in selected patients with nasal obstruction due to septal deviation. Various studies investigating the relationship between nasal pathology and sleep-disordered breathing reported that the nasal airflow resistance is significantly higher in patients with snoring. This is because the decrease of nasal patency can promote more negative intraluminal pressure within the upper airway and thus provoke an increased tendency for airway collapse at the level of oropharynx or hypopharynx [4]. Interestingly a meta-analysis of 13 studies [41] concluded that surgical correction of nasal obstruction

ameliorates daytime sleepiness and sleep quality of patients with habitual snoring.

An additional parameter which we investigated was the effect of septoplasty on patients' olfactory function. We concluded that this type of surgery seems to be beneficial to the patients' olfactory ability (improvement in TDI score), through nasal airflow improvement. Only a few studies have quantitatively investigated correlations between septal surgery and its outcome regarding olfaction and have reached to similar results [6, 42].

Until now, the effect of septoplasty on voice performance has received far less attention [43, 44]. Our results demonstrated that surgical treatment of nasal obstruction increases nasal patency and decreases the nasal airflow resistance, leading to an increase in the nasal acoustic energy (increase in nasalance scores) and improved speech quality (VHI score improvement; hyponasality decrease), although not statistically significant. These results were also similar to previous research which reported that postoperative nasalance values (6 months after surgery) did not differ significantly from the preoperative scores [44].

To the best of our knowledge, this is the first study to address such a wide variety of possible predictive factors for clinically significant overall health-related QOL improvement in patients undergoing septoplasty for nasal obstruction. There was a primary focus on the impact of symptom severity, sleep quality, olfactory function, voice performance, and psychological factors on the QOL results, using specific questionnaires as well as quantitative tests. After univariate analysis of all possible demographic and clinical predictors we found that clinical improvement of (1) nasal obstruction symptom severity (NOSE and SNOT22 scores), (2) sleep quality (ESS score), and (3) stress (SQ test) was significantly associated with QOL improvement (GBI scores) 6 months after septoplasty. However, multivariate logistic regression analysis revealed that clinical improvement of nasal obstruction symptom severity (NOSE score) and stress (SQ test) were the only independent predictors associated with higher likelihood of clinically significant improvement on patients' QOL.

According to our study's results, the severity of nasal obstruction symptoms (NOSE score) is a predictive factor of the postoperative patients' QOL improvement. In particular, we found that the patient subgroup with the more severe preoperative nasal obstruction symptoms and the more significant improvement of their symptoms severity tended to have significantly greater QOL improvement after surgery. This is likely because their disease had a more significant impact on their health status preoperatively, and therefore, they had more potential for improvement after surgery. Other QOL studies have also found that patients, who were more severely affected by the obstruction symptoms, had greater improvement postoperatively [2, 23, 36, 45]. However, all these studies, except for one [23] investigated the correlation between symptom severity and patients' disease-specific QOL. In the present study, there was a focus on the association between the significant clinical improvement of the nasal obstruction symptoms and the likelihood of patients' better postoperative overall health-related QOL.

It is a fact that patients' perception of their overall QOL is complex and may be affected by psychological factors too. Thus, the present study explored the stress levels (SQ test) and emotional status (BDI score) as prognostic factors for patients' overall QOL improvement after surgery. Previously, only one study had investigated these two factors and found that they did not predict subjective symptom improvement after septoplasty [36]. On the contrary, the present study results indicated that stress levels were a predictive factor of the postoperative general QOL status. Furthermore, subgroup analysis revealed that, postoperatively, patients with significant clinical improvement of their psychological status (lower stress levels) had better QOL (higher GBI scores).

Considering all the above-mentioned findings, it becomes evident that is valuable to obtain a detailed evaluation of the severity of the nasal symptoms as well as the stress levels both before and after nasal septoplasty to aim/achieve better results regarding patients' general health status and degree of satisfaction (related to the surgical outcome). In other words, should our patient group consist mainly or exclusively of patients with severe symptoms of nasal obstruction and also significant symptom-related stress levels (anticipating significant improvement postoperatively), the GBI scores found would have been considerably higher. In the clinical setting, the preoperative evaluation of the symptom severity and stress levels could enable the surgeon to identify in which patients higher overall QOL improvement and patients' satisfaction is anticipated and thus to select the most appropriate patients that will benefit by the surgical intervention.

Strengths of this study are its prospective design, the combined use of subjective research tools and objective measurements, and the 100% follow-up response rate. In addition to this, validated instruments were used to achieve a patient-based outcome assessment, to eliminate the examination bias due to the subjective clinical examination. Furthermore, the possibility of bias was prevented and minimized, as the surgeon was not involved in retrieving the patients' follow-up outcome data. However, larger scale randomized controlled trials could be beneficial for the definite establishment of valid selection criteria for appropriate candidate selection for nasal septoplasty, to reduce the number of unnecessary surgical interventions.

Conclusion

In patients with septal deviation, nasal septoplasty results in significant improvement in nasal obstruction symptoms, sleep quality, olfaction, and stress levels as well as an increase in nasal patency. However, patients report a minimal change in their overall health-related quality of life. Surgeons should thoroughly evaluate preoperatively the symptom severity as well as the psychological status (stress levels) of those patients since these prognostic factors seem to better predict overall QOL improvement postoperatively.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. Tsang CLapN, Nguyen T, Sivesind T, Cervin A (2018) Long-term patient-related outcome measures of septoplasty: a systematic review. Eur Arch Otorhinolaryngol. https://doi.org/10.1007/s00405-018-4874-y
2. Stewart MG et al (2004) Development and validation of the Nasal Obstruction Symptom Evaluation (NOSE) scale. Otolaryngol Head Neck Surg 130(2):157–163
3. Manoukian PD, Wyatt JR, Leopold DA, Bass EB (1997) Recent trends in utilization of procedures in otolaryngology-head and neck surgery. Laryngoscope 107:472–477
4. Kohler M, Bloch KE, Stradling JR (2007) The role of the nose in the pathogenesis of obstructive sleep apnoea and snoring. Eur Respir J 30:1208–1215
5. Li H-Y, Lee LA, Wang PC, Chen NH, Lin Y, Fang TJ (2008) Nasal surgery for snoring in patients with obstructive sleep apnea. Laryngoscope 118:354–359
6. Damm M, Vent J, Schmidt M et al (2002) Intranasal volume and olfactory function. Chem Senses 27(9):831–839
7. Zhao K, Scherer PW, Hajiloo SA, Dalton P (2004) Effect of anatomy on human nasal air flow and odorant transport patterns: implications for olfaction. Chem Senses 29(5):365–379
8. Lee GS, Yang CC, Wang CP, Kuo TB (2005) Effect of nasal decongestion on voice spectrum of a nasal consonant-vowel. J Voice 19:71–77
9. Behlau M, Hogikyan ND, Gasparini G (2007) Quality of life and voice: study of a Brazilian population using the voice-related quality of life measure. Folia Phoniatr Logop 59:286–296
10. Markiewicz K, Pąchalska M (2007) Diagnosis of severe developmental disorders in children under three years of age. Med Sci Monit 13(2):89–99
11. Behrman A, Shikowitz MJ, Dailey S (2002) The effect of upper airway surgery on voice. Otolaryngol Head Neck Surg 127:36–42
12. Schwentner I, Dejakum K, Schmutzhard J, Deibl M, Sprinzl GM. Sprinzl (2006) Does nasal septal surgery improve quality of life? Acta Otolaryngol 126:7, 752–757
13. Sedaghat AR, Busaba NY, Cunningham MJ, Kieff DA (2013) Clinical assessment is an accurate predictor of which patients will need septoplasty. Laryngoscope 123:48–52
14. Konstantinidis I, Triaridis S, Triaridis A et al. (20050 Long term results following nasal septal surgery. Focus on patients' satisfaction. Auris Nasus Larynx32:369–374
15. Valsamidis K, Titelis K, Rachovitsas D, Konstantinidis I, Markou K, Triaridis S (2018) Long-term evaluation of nasal septoplasty followed by inferior turbinate cauterization for the treatment of nasal obstruction using objective and subjective methods. Int Arch Otorhinolaryngol 22:284–290
16. Tsang CLN, Nguyen T, Sivesind T, Cervin A (2018) Long-term patient-related outcome measures of septoplasty: a systematic review. Eur Arch Otorhinolaryngol 275(5):1039–1048
17. Katotomichelakis M, Simopoulos E, Tripsianis G, Balatsouras D, Danielides G, Kourousis C, Livaditis M, Danielides V (2014) Predictors of quality of life outcomes in chronic rhinosinusitis after sinus surgery. Eur Arch Otorhinolaryngol 271(4):733–741
18. Stewart MG, Smith TL, Weaver EM et al (2004) Outcomes after nasal septoplasty: results from the Nasal Obstruction Septoplasty Effectiveness (NOSE) study. Otolaryngol Head Neck Surg 130:283–290
19. Kahveci OK, Miman MC, Yucel A et al (2012) The efficiency of Nose Obstruction Symptom Evaluation (NOSE) scale on patients with nasal septal deviation. Auris Nasus Larynx 39:275–279
20. Karatzanis AD, Fragiadakis G, Moshandrea J et al (2009) Septoplasty outcome in patients with and without allergic rhinitis. Rhinology 47:444–449
21. Mondina M, Marro M, Maurice S et al (2012) Assessment of nasal septoplasty using NOSE and RhinoQoL questionnaires. Eur Arch Otorhinolaryngol 269:2189–2195
22. Li HY, Wang PC, Hsu CY, Cheng ML, Liou CC, Chen NH (2005) Nasal resistance in patients with obstructive sleep apnea. ORL 67:70–74
23. Uppal S, Mistry H, Nadiq S, Back G, Coatesworth A (2005) Evaluation of patient benefit from nasal septal surgery for nasal obstruction. Auris Nasus Larynx 32:129–137
24. Hummel T, Sekinger B, Wolf SR, Pauli E, Kobal (1997))'Sniffin' sticks': olfactory performance assessed by the combined testing of odor identification, odor discrimination and olfactory threshold. Chem Senses 22:39–52
25. Katotomichelakis M, Balatsouras D, Tripsianis G, Tsaroucha A, Homsioglou E, Danielides V (2007) Normative values of olfactory function testing using the 'Sniffin' sticks'. Laryngoscope 117:114–120
26. Simopoulos E, Katotomichelakis M, Gouveris H, Tripsianis G, Livaditis M, Danielides V (2012) Olfaction-associated quality of life in chronic rhinosinusitis: adaptation and validation of an olfaction-specific questionnaire. Laryngoscope 122:1450–1454
27. Okalidou A, Karathanasi A, Grigoraki E (2011) Nasalance norms in Greek adults. Clin Linguist Phon 25(8):671–688
28. Liapi A, Hirani S, Rubin J (2015) Changes in nasal resonance following septoplasty in adults: acoustic and perceptual characteristics. Logoped Phoniatr Vocol 6:1–8
29. Grammatikopoulos IA, Sinoff G, Alegakis A, Kounalakis D, Antonopoulou M, Lionis C. The short anxiety screening test in Greek: translation and validation. Ann Gen Psychiatry 9(1):1. https://doi.org/10.1186/1744-859X-9-1

30. Beck AT, Steer RA, Ball R, Ranieri W (1996) Comparison of beck depression inventories -IA and -II in psychiatric outpatients. J Pers Assess 67:588–597
31. Jin HR, Lee JY, Jung WJ (2007) New description method and classification system for septal deviation. J Rhinol 14(01):27–31
32. Bugten V, Nilsen AH, Thorstensen WM, Moxness MH, Amundsen MF, Nordgård S (2016) Quality of life and symptoms before and after nasal septoplasty compared with healthy individuals. BMC Ear Nose Throat Disorders 16:13DOI. https://doi.org/10.1186/s12901-016-0031-7
33. Calder NJ, Swan IRC (2007) Outcomes of septal surgery. J Laryngol Otol 121:1060–1063
34. Arunachalam PS, Kitcher E, Gray J, Wilson JA (2001) Nasal septal surgery: evaluation of symptomatic and general health outcomes. Clin Otolaryngol 26:367–370
35. Shiryaeva O, Tarangen M, Gay C, Døsen LK, Haye R (2017) Preoperative signs and symptoms as prognostic markers in nasal septoplasty. Int J Otolaryngol. https://doi.org/10.1155/2017/4718108
36. Hong SD, Lee N-J, Cho H-J et al (2015) Predictive factors of subjective outcomes after septoplasty with and without turbinoplasty: can individual perceptual differences of the air passage be a main factor? Int Forum Allergy Rhinol 5(7):616–621
37. Verhoeven S, Schmelzer B (2016) Type and severity of septal deviation are not related with the degree of subjective nasal obstruction. Rhinology 54(4):355–360
38. Siegel NS, Gliklich RE, Taghizadeh F, Chang Y (2000) Outcomes of septoplasty. Otolaryngol Head Neck Surg 122(2):228–232
39. Moore M, Eccles R (2011) Objective evidence for the efficacy of surgical management of the deviated septum as a treatment for chronic nasal obstruction: a systematic review. Clin Otolaryngol 36:106–113
40. Andre RF et al (2009) Correlation between subjective and objective evaluation of the nasal airway. A systematic review of the highest level of evidence. Clin Otolaryngol 34(6):518–525
41. Li HY, Wang PC, Chen YP, Lee LA, Fang TJ, Lin HC (2011) Critical appraisal and meta-analysis of nasal surgery for obstructive sleep apnea. Am J Rhinol Allergy 25(1):45–49
42. Damm M, Eckel HE, Jungehulsing M, Hummel T (2003) Olfactory changes at threshold and suprathreshold levels following septoplasty with partial inferior turbinectomy. Ann Otolrhinolaryngol 112:91–97
43. Mora R, Jankowska B, Dellepiane M, Mora F, Crippa B, Salami A (2009) Acoustic features of voice after septoplasty. Med Sci Monit 15:269–273
44. Kim YH, Lee SH, Park CW, Cho JH (2013) Nasalance change after sinonasal surgery: analysis of voice after septoturbinoplasty and endoscopic sinus surgery. Am J Rhinol Allergy 27:67–70
45. Hytönen ML, Lilja M, Mäkitie AA, Sintonen H, Roine RP (2012) Does septoplasty enhance the quality of life in patients? Eur Arch Otorhinolaryngol 269:2497–2503