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Impact of septal deviation and turbinate hypertrophy on nasal airway obstruction: insights from imaging and the NOSE scale: a retrospective study

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Abstract

Background The aim of this study was to evaluate the effects of nasal septum deviation and inferior turbinate hypertrophy on nasal obstruction by utilizing the Nose Obstruction Symptom Evaluation (NOSE) values and paranasal sinus computed tomography (PSCT) findings for correct preoperative evaluation.

Methods Ninety-six patients (57 males and 39 females) aged between 18 and 54 years (mean age, 30.3 ± 9.7 years) participated in this study. Among them, 56 patients underwent septoplasty combined with inferior turbinate outfracture, while 40 patients underwent septoplasty alone. Preoperative nasal examinations were performed on all patients. The direction, location, nasal septum deviation classification, and inferior turbinate hypertrophy size classification were carefully evaluated and compared with the NOSE survey results. PSCT of 56 patients were evaluated and classified by calculating the coronal location of septum deviation, the axial location of septum deviation, the coronal angle of septum deviation, and the axial angle of septum deviation.

Results A positive correlation was found between the coronal location of the septal deviation and the preoperative NOSE 2, and the NOSE total, and the difference of postoperative and preoperative NOSE ($p = 0.032$, $p = 0.007$, $p = 0.021$, respectively). There was a statistically significant relationship between the coronal location of the septal deviation classification and the NOSE preoperative total values ($p = 0.26$). A negative statistically significant correlation was found between inferior turbinate hypertrophy and preoperative NOSE 5 values ($p = 0.029$).

Conclusion We conclude that the combination of PSCT and the NOSE scale is helpful in determining the severity of nasal obstruction prior to surgery. Specifically, we found that nasal septum deviations located in the anterior and coronal planes have a greater impact on nasal obstruction compared to deviations in the axial plane. Inferior turbinate fracture does not provide more benefit than septoplasty alone in treating patients' nasal obstruction. These findings emphasize the importance of a comprehensive approach in addressing nasal obstruction for optimal patient outcomes.

Keywords Septoplasty, Septorhinoplasty, Inferior turbinate outfracture, NOSE scale, Classification, Computed tomography

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Background

Nasal obstruction stands as the predominant complaint among individuals with rhinological problems [21]. Chronic nasal obstruction often arises from two primary factors: septal deviation and inferior turbinate hypertrophy [3]. The prevalence of nasal septum deviation can vary significantly, with reported rates ranging from 19 to 65% in various populations [4]. Several procedures are available to improve nasal airflow, including nasal septoplasty and inferior turbinate reduction [12]. Surgery may fail because of inferior turbinate hypertrophy that is not treated properly during septoplasty [20].

The inferior turbinate has the potential to become hypertrophied and cause nasal obstruction. The nasal turbinates play a critical role in normal breathing, and their position in the nasal valve area makes them particularly influential in nasal airflow and obstruction [6, 16]. Various techniques are available to reduce the size of nasal turbinates, including total or partial turbinate resection, submucous resection, as well as procedures aimed at preserving the turbinates, such as outfracture. Additionally, there are non-surgical methods such as radiofrequency application, electrocautery, cryosurgery, and argon plasma treatment that can help alleviate turbinate hypertrophy and improve nasal airflow [3, 8]. Studies have suggested that outfracture is effective in the treatment of nasal congestion [21]. In the outfracture technique, the turbinate is first manipulated by breaking it upwards and inwards towards the septum. Subsequently, it is further fractured outwards laterally towards the medial wall of the maxilla [11]. This technique is a minimal destructive procedure with minimal risk of surgical bleeding, is easy to perform, and does not cause crusting, infection, or necrosis [5].

The establishment of a reliable method is crucial for confirming the properness of indications for nasal septum surgery. The Nose Obstruction Symptom Evaluation (NOSE) scale is an appropriate and reliable method for evaluating nasal septum surgery [14]. Stewart et al. [24] developed and approved the NOSE scale for use in nasal congestion. It consists of five nasal congestion-related substances that provide a patient with an easy way to determine the severity of his complaints in the last month. All the items are scored using a five-point Likert scale, ranging from 0 to 100 points. Higher scores on the scale indicate a higher degree of nasal airway obstruction [15].

The aim of this study was to evaluate the effects of nasal septum deviation and inferior turbinate hypertrophy on nasal obstruction by utilizing the NOSE values and paranasal sinus computed tomography (PSCT) findings for correct preoperative evaluation.

Methods

Ethical considerations

This retrospective study was conducted in accordance with the Declaration of Helsinki and received approval from the ethics committee under the number 2011-KAEK-25 2019/02–14. The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Subjects

Ninety-six patients (57 males and 39 females) aged between 18 and 54 years (mean age, 30.3 ± 9.7 years) participated in this study. Among them, 56 patients underwent septoplasty combined with inferior turbinate outfracture, while 40 patients underwent septoplasty alone. The septoplasty procedure was performed using either an open technique or endonasal approach. The inclusion criteria for the study were as follows: documented septal deviation causing nasal obstruction for at least 3 months, age of at least 18 years, and persistence of symptoms following a 4-week trial of medical management. Previous surgery for the inferior turbinates and nasal septum, nasal polyposis, chronic sinusitis, and anatomical deformity were accepted as exclusion criteria. PSCT sections were examined in the bone window routinely before surgery.

Deviation side and place; Mladina's classification; inferior turbinate hypertrophy

All patients underwent preoperative evaluation to determine the side and location of the nasal septum deviation. The place of the deviation was classified as anteroposterior, anterior, or posterior. The septal deviation was further categorized into seven types based on the Mladina classification [18].

NOSE survey

All patients answered the questions on the "NOSE" [24] survey about their congestion, before surgery and 3 months after the surgery. Sums of the answers were multiplied by five.

PSCT evaluation

PSCT of 56 patients in the inferior turbinate outfracture group were evaluated and classified by calculating the coronal location of septum deviation, the axial location of septum deviation, the coronal angle of septum deviation, and the axial angle of septum deviation.

In the coronal section of PSCT where the septum was most deviated, the coronal location of septal deviation was measured. The coronal location of septal deviation is defined as the length between the maximum point of the septum deviation and the top of septum/the length between the top and the lowest point of the septum × 100. This was categorized into four different classes according to the percentage of deviation. Class 1 was for 0–24% rate; class 2 was for 25–49% rate; class 3 was for 50–74% rate; and class 4 was for 75–100% rate.

In coronal section of PSCT where the septum was most deviated, the angle between line (between the top and the lowest point of the nasal septum) and septal deviation was measured and was called the coronal angle of septal deviation. Angle measurements was categorized as class 1, 0 to 19°; class 2, between 20 and 39°; class 3, between 40 and 59°; and class 4, between 60 and 80° (Fig. 1).

In the axial section of PSCT where the septum was most deviated, the axial location of septal deviation was measured. The axial location of septal deviation is defined as the length between the maximum point of the septum deviation and the anterior of septum/the length between the anterior and the posterior point of the septum × 100. There are four classifications for this. Class 1 was for 0–24% rate; class 2 was for 25–49% rate; class 3 was for 50–74% rate; and class 4 was for 75–100% rate.

In axial section of PSCT where the septum was most deviated, the angle between line (between the anterior and the posterior point of the nasal septum) and septal deviation was measured and was named the axial angle of septal deviation. Angle measurements was classified as class 1, 0 to 12.4°; class 2, between 12.5 and 24.9°; class 3, between 25 and 37.4°; and class 4, between 37.5 and 50° (Fig. 2).

The thickness of the inferior turbinates was measured in the coronal section of the PSCT, where the nasolacrimal ducts of the patients were opened to the inferior meatus. Inferior turbinate thickness was classified as 1st class, 2.5–5.6 mm; 2nd class, 6–9.4 mm; 3rd class, 9.5–12.9 mm; and 4th class, 13–16.5 mm. The widest part of the inferior meatus was measured as transverse [9, 10], (Fig. 1).

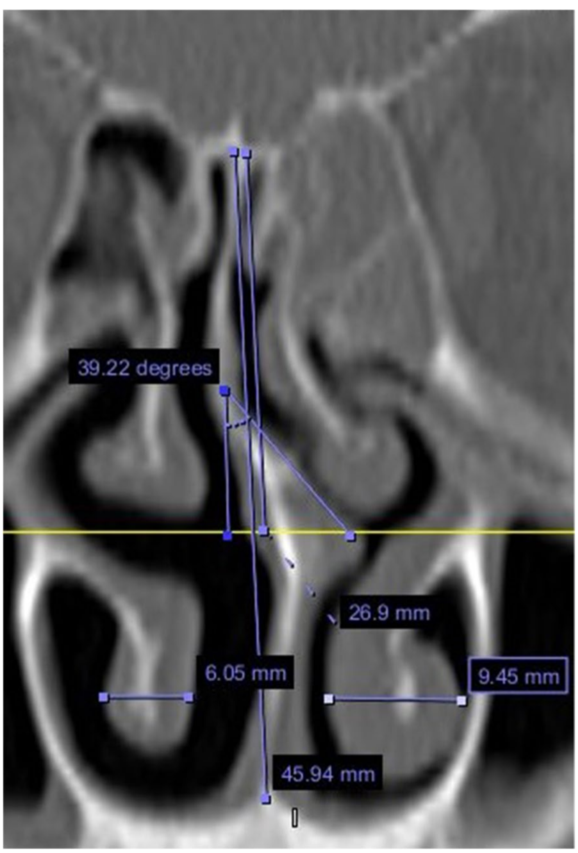

Fig. 1 A coronal section of the PSCT, measurement of the coronal location and angle of septal deviation and the inferior turbinate thickness

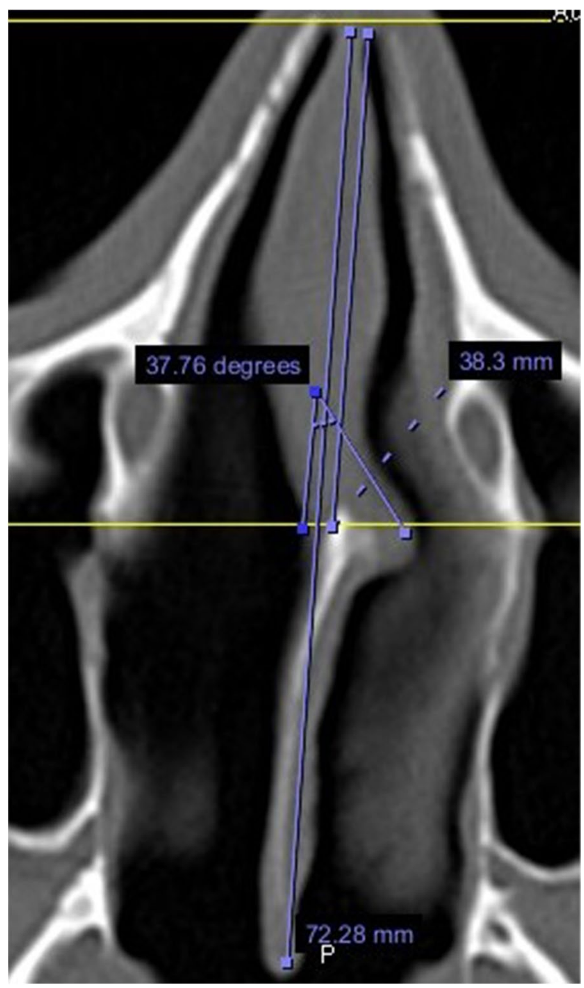

Fig. 2 An axial section of the PSCT, measurement of the axial location and angle of septal deviation

Surgical procedure

All patients had undergone septoplasty. Fifty-six patients also underwent bilateral inferior turbinate outfracture.

Statistical analysis

Statistical analyses were performed using SPSS software (version 23.0). The Wilcoxon signed-rank test, Mann–Whitney *U* test, Kruskal–Wallis test, and Spearman correlation test were utilized. A *p* value of less than 0.05 was considered statistically significant.

Results

In the Mladina classification results, type 1 in 16 (16.3%) patients, type 2 in 19 (19.4%) patients, and type 3 in 15 (15.3%) patients were seen mostly, in inferior turbinate outfracture group. Type 1 in 14 (35.0%) patients and type 3 in 13 (32.5%) patients were seen mostly, in inferior turbinate non-outfracture group (see Table 1). The deviation place was in the anteroposterior part in 58 (59.2%) patients, the anterior part in 27 (27.6%) patients, and the posterior part in 11 (11.2%) patients. There was the left side deviation in 57 (58.2%) patients and the right side deviation in 39 (39.8%) patients.

Table 1 Distribution table of patients according to Mladina classification

Mladina's class	Group 1 (inferior turbinate outfracture) ($n=56$)		Group 2 (inferior turbinate non-outfracture) ($n=40$)	
	Frequency	Percent	Frequency	Percent
1	14	14.6	14	35.0
2	17	17.7	3	7.5
3	10	10.4	13	32.5
4	2	2.1	1	2.5
5	8	8.3	4	10.0
6	5	5.2	1	2.5
7	0	0	4	10.0
Total	56	100.0	40	100

The coronal location of septal deviation classification was mostly class 3 with 41 (41.7%) patients. The axial location of septal deviation classification was mostly class 3 with 44 (45.8%) patients. The coronal angle of septal deviation classification was mostly class 2 with 34 (35.4%) patients. The axial angle of septal deviation classification was mostly class 2 in 29 (30.2%) patients (Table 2).

There was a positive statistically significant relationship between age and coronal angle of septal deviation classification ($p=0.049$). There was a positive correlation between Mladina type and deviation place, inferior turbinate hypertrophy ($p=0.020$, $p=0.031$, respectively). There was a significant positive correlation between deviation place and the coronal location of septal deviation classification ($p=0.039$). In the inferior turbinate outfracture group (mean rank: 33.69), the Mladina type was lower and in the other group (mean rank: 46.36) it was in the higher class significantly ($p=0.029$) (see Table 3).

NOSE survey results

Preoperative total NOSE values were 70.00 ± 17.50, and postoperative total NOSE values were 10.35 ± 11.23 in the inferior turbinate outfracture group. Preoperative total NOSE values were 79.62 ± 12.57, and postoperative total NOSE values were 14.87 ± 13.42 in the group without inferior turbinate outfracture. Preoperative total NOSE values were significantly lower in the inferior turbinate outfracture group ($p=0.007$). However, postoperative total NOSE values were lower in the inferior turbinate outfracture group, although not statistically significant ($p>0.05$).

Preoperative NOSE 1, 2, 5, and total values were lower in the inferior turbinate outfracture group than the inferior turbinate non-outfracture group ($p<0.05$). All NOSE 1–6 scores decreased significantly in the postoperative period compared with the preoperative period in both groups ($p<0.05$) (Table 4). There was a positive correlation between the coronal location of septal deviation classification and preoperative NOSE 2 and NOSE total and

Table 2 Patient distribution table according to the coronal location of septum deviation, the axial location of septum deviation, the coronal angle of septum deviation, and the axial angle of septum deviation classification

Class	The coronal location of septum deviation		The axial location of septum deviation		The coronal angle of septum deviation		The axial angle of septum deviation	
	n	%	*n*	%	*n*	%	*n*	%
1	0	0	0	0	14	14.6	14	14.6
2	2	2.1	9	9.4	34	35.4	29	30.2
3	41	42.7	44	45.8	8	8.3	9	9.4
4	13	13.5	3	3.1	0	0	4	4.2
Total	56	58.3	56	58.3	56	58.3	56	58.3

Table 3 Spearman correlation test results

		Age	Deviation place	NOSE1	NOSE2	NOSE3	NOSE4	NOSE5	NOSE total	NOSE difference
Age	**Spearman's rho**	1	0.027	0.167	0.037	0.075	−0.042	0.072	0.085	0.051
	p	0	0.796	0.103	0.723	0.47	0.687	0.483	0.411	0.619
Mladina's class	**Spearman's rho**	−0.161	0.273	0.095	0.224	0.143	0.015	0.009	0.098	0.035
	p	0.178	0.02	0.426	0.059	0.232	0.9	0.94	0.413	0.767
Deviation place	**Spearman's rho**	0.027	1	0.01	0.043	0.002	−0.057	−0.033	0.014	0.022
	p	0.796	0	0.925	0.675	0.987	0.583	0.753	0.89	0.832
Inferior turbinate hypertrophy	**Spearman's rho**	−0.109	0.035	−0.106	−0.091	0.113	0.024	−0.223	−0.05	−0.103
	p	0.292	0.734	0.304	0.38	0.271	0.819	0.029	0.629	0.317
Inferior turbinate hypertrophy left	**Spearman's rho**	0.008	−0.273	−0.075	−0.112	−0.084	0.022	−0.008	−0.048	−0.035
	p	0.955	0.042	0.582	0.41	0.538	0.872	0.954	0.727	0.797
Inferior turbinate hypertrophy right	**Spearman's rho**	−0.012	0.075	0.177	0.049	0.139	−0.081	0.012	0.102	0.186
	p	0.93	0.58	0.193	0.722	0.309	0.554	0.933	0.452	0.17
The coronal location of septum deviation	**Spearman's rho**	−0.154	−0.108	0.14	0.287	0.158	0.146	0.214	0.356	0.307
	p	0.258	0.429	0.303	0.032	0.246	0.283	0.113	0.007	0.021
The axial location of septum deviation	**Spearman's rho**	−0.088	0.106	−0.018	−0.079	−0.072	−0.025	−0.155	−0.131	−0.208
	p	0.519	0.439	0.896	0.562	0.599	0.854	0.254	0.336	0.124
The coronal angle of septum deviation	**Spearman's rho**	0.264	0.276	0.098	−0.078	0.038	−0.114	−0.027	−0.068	−0.043
	p	0.049	0.039	0.474	0.566	0.783	0.402	0.846	0.618	0.754
The axial angle of septum deviation	**Spearman's rho**	0.236	−0.075	0.142	0.198	0.148	0.262	0.139	0.223	0.162
	p	0.079	0.58	0.297	0.144	0.277	0.051	0.307	0.098	0.232

p value shows the results of Spearman correlation test $p > 0.05$

Table 4 NOSE survey results of the inferior turbinate outfracture and non-outfracture groups

NOSE survey		Group 1 (inferior turbinate outfracture) ($n=56$)			Group 2 (inferior turbinate non-outfracture) ($n=40$)			p^*
		Median	Min	Max	Median	Min	Max	
NOSE 1	Preop	2.8	0	4	3.2	2	4	0.014
	Postop	0.5	0	4	0.6	0	2	0.366
	p^{**}	0.000			0.000			
NOSE 2	Preop	2.8	1	4	3.2	1	4	0.013
	Postop	0.4	0	2	0.6	0	2	0.157
	p^{**}	0.000			0.000			
NOSE 3	Preop	3.1	0	4	3.3	2	4	0.348
	Postop	0.3	0	3	0.5	0	2	0.043
	p^{**}	0.000			0.000			
NOSE 4	Preop	2.7	0	4	2.8	1	4	0.741
	Postop	0.3	0	4	0.5	0	3	0.178
	p^{**}	0.000			0.000			
NOSE 5	Preop	2.7	0	4	3.3	1	4	0.020
	Postop	0.3	0	3	0.6	0	2	0.020
	p^{**}	0.000			0.000			
NOSE total	Preop	70.0	15	100	79.6	50	100	0.007
	Postop	10.3	0	40	17.87	0	30	0.092
	p^{**}	0.000			0.000			

[*] *p* value shows the results of Mann–Whitney *U* test

[**] *p* value shows the results of Wilcoxon signed-rank test

NOSE difference ($p=0.032$, $p=0.007$, $p=0.021$, respectively). A statistically significant relationship was found between the coronal location of the septal deviation and NOSE preoperative total values ($p=0.260$) (mean rank 2:10.25, mean rank 3:26.49, mean rank 4:37.65, respectively). A negative statistically significant correlation was found between inferior turbinate hypertrophy and preoperative NOSE 5 values ($p=0.020$, $p=0.029$, respectively). No significant relationship was found between NOSE and the right and left sides of the inferior turbinate classification ($p>0.05$).

Discussion

The etiology of nasal obstruction should be determined carefully, and unnecessary surgery should be avoided as much as possible. Various methods, including acoustic rhinometry, rhinomanometry, and PSCT, are used for the objective evaluation of nasal obstruction [23, 24]. Computed tomography is an effective method that objectively demonstrates nasal septum deviation [14].

NOSE scores after septoplasty decrease significantly and septal surgery alone is a very effective technique for overcoming the symptoms of nasal obstruction in appropriate cases [14]. Septal deviation and inferior turbinate hypertrophy are frequently seen together. Septoplasty and inferior turbinate surgery have been shown to be more successful than septoplasty surgery alone. It was also found that the location of the septal deviation affects the success of septoplasty [17, 23].

The turbinoplasty method leads to a greater reduction in turbine volume than does inferior turbinate outfracture and bipolar cauterization (Bozan et al. 2018). Successful lower turbinate surgical treatment is achieved by preserving mucociliary function and sufficiently reducing tissue volume. Nasal congestion will continue when the inferior turbinate volume is reduced inadequately. Crusting occurs in mucociliary dysfunction [8]. Outfracture does not damage mucociliary function by protecting the nasal epithelium. Inferior turbinate outfracture does not result in crusting, bleeding, or edema [5].

Devseren et al. [7] found that patients who underwent septoplasty and turbinoplasty reported more subjective improvement in nasal obstruction when compared with patients who had undergone only septoplasty [12]. Kılıç et al. [16] showed that nasal functional capacity increased after inferior turbinate surgery with septorhinoplasty. Stewart et al. [24] reported that patients in the septoplasty and turbinate reduction group showed more improvement than did those in the septoplasty alone group. Similarly, many studies have reported that septoplasty and turbinate surgery are more effective [14]. The presence of allergy or sinonasal disease with septal deviation is related to the continuation of nasal obstruction after surgery [13]. The degree of turbinate hypertrophy causing nasal obstruction did not differ between patients with and without allergic rhinitis [1].

Kahveci et al. [14] stated that the NOSE scale is a very effective method for evaluating septoplasty results. They found a significant decrease in VAS scores in postoperative evaluations. NOSE scores have been found correlated with the degree of septal deviation graded by the surgeon [14]. In the septoplasty study group, NOSE baseline scores were reported as 67.5 ± 19.5 by Stewart et al. [24] and as 57.9 ± 25 by Mondina et al. [19]. Postoperative scores were 26.6 ± 23.8 and 22.7 ± 24.1, respectively [19]. Lajdan et al. [2] concluded that unilateral reduction of the hypertrophic contralateral inferior turbinate during septoplasty gives better results than septoplasty alone in the subjective relief of nasal obstruction in adults with nasal septal deviation. Seden et al. [22] concluded that inferior turbinate ablation does not benefit patients' nasal obstruction more than septoplasty alone.

In our study, we observed improvements in nasal obstruction symptoms of both groups. The preoperative total NOSE values in the outfracture group were 70.00 ± 17.50, which significantly decreased to 10.35 ± 11.23 postoperatively. In contrast, the non-outfracture group exhibited higher preoperative total NOSE values of 79.62 ± 12.57, which decreased to 14.87 ± 13.42 after surgery. Notably, the preoperative total NOSE values were significantly lower in the inferior turbinate outfracture group compared to the non-outfracture group. Furthermore, the outfracture group demonstrated lower preoperative NOSE 1, 2, 5, and total values compared to the non-outfracture group. Although postoperative total NOSE values were lower in the outfracture group, the difference did not reach statistical significance. These findings underscore the lower effectiveness of inferior turbinate outfracture in alleviating nasal obstruction symptoms.

Postoperative NOSE values demonstrated a significant reduction in both groups, indicating improved nasal obstruction symptoms following surgery. Interestingly, we observed a positive correlation between the coronal location of septal deviation classification and preoperative NOSE 2, NOSE total, and NOSE difference. Furthermore, a statistically significant relationship was found between the coronal location of septal deviation and preoperative NOSE total values. On the other hand, there was a negative and statistically significant correlation between the classification of inferior turbinate thickness and preoperative NOSE 5 values. These findings suggest that deviations located closer to the base of the nasal septum have a greater impact on nasal obstruction. Moreover, the negative correlation between the classification of inferior turbinate thickness and preoperative NOSE 5 values indicates that inferior turbinate thickness decreases due to an adrenergic effect. To accurately assess inferior turbinate hypertrophy, it is crucial to carefully evaluate the turbinates with the administration of a decongestant preoperatively. These results highlight the importance of considering septal deviation and inferior turbinate thickness when evaluating and addressing nasal obstruction.

The localization of septal deviations may be predictive of the severity of nasal obstruction. A good assessment of deviation localization before surgical treatment is important in planning surgery and ensuring postoperative success. The mean postoperative NOSE score of cases with anterior septal deviation was significantly lower than that of cases with posterior and anteroposterior septal deviations. The mean postoperative NOSE score of patients with posterior septal deviation was significantly lower than those of patients with anteroposterior septal deviation [23]. In our study, we observed a trend where preoperative NOSE scores of patients with anterior and anteroposterior deviation tended to be higher than those with posterior deviation, although the difference was not statistically significant. Additionally, a noteworthy finding was the significant increase in deviation angles with advancing age, suggesting a potential correlation between age and increased nasal obstruction. Notably, deviations located in the posterior plane exhibited a larger coronal angle, indicating a more pronounced and sharper deviation. These findings shed light on the potential influence of deviation location and age-related changes on the severity of nasal obstruction.

In the group undergoing inferior turbinate outfracture, we noted that the septal deviation primarily affected the base of the septum. Conversely, in non-outfracture deviations, the deviation tended to be higher and closer to the middle turbinate, impacting the nasal valve area. Furthermore, there was a positive association between increasing classification of inferior turbinate thickness and higher NOSE scores. Consequently, for cases of inferior turbinate hypertrophy, we recommend preoperative assessment with a decongestant and comprehensive evaluation of turbinate status using PSCT. These measures will provide valuable insights for surgical planning and management of nasal obstruction related to inferior turbinate hypertrophy.

Conclusion

The combined utilization of PSCT and the NOSE scale represents a helpful approach in assessing the severity of nasal obstruction prior to surgery. A meticulous preoperative evaluation of PSCT holds the potential to aid in the selection of the most suitable surgical intervention. Notably, the anterior and coronal locations of nasal septum deviation exert a more substantial impact on nasal obstruction compared to the axial location. By incorporating a nasal decongestant during clinical examination and conducting preoperative PSCT evaluation, the assessment of inferior turbinate hypertrophy can be enhanced, facilitating the determination of the optimal surgical procedure. In our opinion, inferior turbinate outfracture does not provide more benefit than septoplasty alone in treating patients' nasal congestion. These findings underscore the significance of employing a comprehensive and tailored approach to surgical management, ensuring the successful resolution of nasal obstruction.

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Authors' contributions
OgD was involved in the literature survey, design, planning, and data collection. OgD and OsD were involved in the intellectual review of the results, writing, and approving the final manuscript. All authors read and approved the final manuscript.

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Availability of data and materials
The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by the Ethics Committee of Bursa Yüksek Ihtisas Training and Research Hospital on 27.02.2019, no: 2011-KAEK-25 2019/02–14.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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