Is Computed Tomography Imaging of Deviated Nasal Septum Justified for Obstruction Confirmation?

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Abstract

Third-party payers request objective confirmation of the nasal septum deviation (NSD) severity by computed tomography (CT) before authorizing financial support for septoplasty. Previous studies have provided contradictory results related to the link between obstruction severity and CT-measured angle of the NSD. The aim of this study was to investigate whether the diverse CT morphology of NSDs (including previously neglected types and shapes) could predict obstruction severity. The study included 225 patients with NSD. The CT morphology of the septum was analyzed using 5 different classifications of NSD that are commonly used in the clinical practice and research. The angle of NSD was also measured. Nasal obstruction was assessed by the Nasal Obstruction Symptom Evaluation (NOSE) questionnaire. A relationship between CT morphology and the angle of the NSD and NOSE scores was analyzed using appropriate regression models. Patients with NSDs located in the anterior part of the septum always have some degree of nasal obstruction, while those with posterior NSDs did not necessarily report obstruction symptoms no matter how complicated NSD they have. Regression analysis did not reveal any causal relationship between NOSE scores and CT morphology and the angle of NSD. The presence of spurs and whether they divide nasal passages have no statistically significant predictive effect on the obstruction severity. The CT morphology and the angle of the NSD could not predict severity of the nasal obstruction. Requesting CT examination just to objectively confirm nasal obstruction is not justified.

Keywords

nasal septal deviation, computed tomography, nasal obstruction, NOSE scale

Introduction

Septoplasty is the most frequent operation in adults performed by otorhinolaryngologist.1-3 Annually 10 000 to 95 000 septoplasties are performed in European countries1,4 and 260 000 in the United States.5,6 The total cost per operation is even up to $10 559 in the United States.5 Despite the fact that this procedure is frequently performed all around the globe, ear, nose & throat (ENT) societies emphasized that one of the greatest unfamiliarity in the modern otorhinolaryngology is the lack of objective evidence for septoplasty.1 Namely, the lack of the obvious connection between subjective sensation of nasal obstruction and objective findings of the nasal septal deviation (NSD) may mislead in assessment which patient should be treated surgically. Moreover, ENT clinicians from the United Kingdom expressed suspicion that some hospitals’ administration consider to abolish or strictly limit septal surgery because of uncertainties over its benefit.7

In the era of evidence-based medicine, third-party payers usually request objective confirmation of the NSD severity on computed tomography (CT) before authorizing financial support for septoplasty.8,9 However, there are contradictory opinions in the literature related to the necessity for CT examination of every patient who is a candidate for septal surgery. Some authors explicitly say that CT findings do not correlate well with subjective perception of nasal obstruction symptoms.10 By contrast, others recommend CT for NSD evaluation because of a good correlation between NSD and subjectively assessed nasal obstruction.11,12 Lee and his team recommend CT examination of NSD before septoplasty, especially for deviations in the middle and posterior parts of the nasal septum.11

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In addition, there is no standard way of grading NSD on CT images. There are various classification systems of NSD in the literature, but none is generally accepted. Recent CT studies mainly considered the angle of deviation,\textsuperscript{10-12} whereas other anatomical parameters of NSD such as single or double curve, presence of the spur, and which septal structure is affected by deviation (bone or cartilage) were not examined at all in the context of the nasal obstruction severity. Currently, there is no CT study that comprehensively evaluated different morphological modalities of NSD and connected them with the subjective perception of nasal obstruction.

In order to answer the question whether CT imaging is justified in patients with NSD, we applied 5 different NSD classifications on CT images. Our aim was to find out which of these 5 classifications commonly used in the literature could predict nasal obstruction severity and thus should be recommended for CT characterization of NSD.

**Patients and Methods**

The study was carried out at the department of diagnostic radiology. A total of 225 participants were consecutively selected among patients who were referred to the CT examination of the head and neck. The following inclusion criteria were applied: (1) age older than 18 years, (2) required CT examination includes the entire nasal cavity in the field of view, and (3) CT confirmation of the NSD. Patients with a history of any disease that may interfere with the nasal obstruction, nasal surgery, facial bone trauma, facial developmental anomalies, and sinonasal malignancy were considered not eligible for the study. All participants fulfilled the Nasal Obstruction Symptom Evaluation (NOSE) questionnaire\textsuperscript{13} and estimated severity of the nasal obstruction symptoms experienced in the last month. Written informed consent was obtained from all patients included in the study. The study was approved by the Ethic Committee of the Faculty of Medicine, No. 29/V-1.

All patients were scanned with the same CT device (Siemens Somatom Sensation 16; Siemen, Munich, Germany) in a series of axial slices with a thickness of 3 mm. For the purpose of the current study, raw CT data of each patient were further reconstructed in a bone window into 0.75-mm-thick sections parallel to the hard palate. These axial images of the nasal septum were reformatted in the frontal plane in which the nasal septal region between the nasal valve region was analyzed. All analysis and angle measurements were performed directly on the Siemens CT workstation by an experienced head and neck radiologist.

A total of 225 NSDs were classified according to the 5 different classifications. These classifications were selected from the literature due to their frequent use in clinical researches and easy applicability on the CT. Table 1 summarizes applied classifications and their criteria for categorization of NSD. Since these classifications consider NSD from different aspects, various anatomical details of deviated nasal septum that potentially could cause nasal obstruction symptoms were incorporated in the analysis. Guyuron et al’s **Table 1. Classifications of NSD Used in the Study.**

| Classification of NSD | Categories | Abbreviation Used in Text |
|-----------------------|------------|---------------------------|
| Septoplasty-oriented NSD classification\textsuperscript{15} | I type: Septal tilt deformity of nasal septum | C1 |
| | II type: Deviation in a form of letter “C” in anteroposterior direction | |
| | III type: Deviation in a form of letter “C” in cephalocaudal direction | |
| | IV type: Deviation in a form of letter “S” in anteroposterior direction | |
| | V type: Deviation in a form of letter “S” in cephalocaudal direction | |
| | VI type: Nasal septum with localized deviations or large spurs | |
| Classification according to morphology of NSD\textsuperscript{16} | I type: Vertical deviation in the nasal valve region that does not change physiologic valve angle (15°) | C2 |
| | II type: Vertical deviation in the nasal valve region that change physiologic valve angle (<15°) | |
| | III type: Deviation inside nasal cavity at the level of the head of middle turbinate | |
| | IV type: Bilateral deviation with anterior curve in the region of the nasal valve and posterior curve more inside in the nasal cavity. | |
| | V type: Is characterized by the bony spur with plane opposite side of the septum | |
| | VI type: Deviation parallel to horizontal plate with basal septal crest and “gutter” in opposite side | |
| | VII type: Combination of previous types | |
| Classification based on location of the most prominent point of NSD\textsuperscript{17} | I type: Caudal deviation is placed in the nasal septal region in front the head of inferior turbinate | C3 |
| | II type: Anterior deviation is located in the nasal septal region between anterior edges of inferior turbinate and middle turbinate | |
| | III type: Media deviation occur in the nasal septal region between anterior and posterior edge of the middle turbinate | |
| Classification of NSD based on septal structure | I type: Deviation of the cartilaginous part of the nasal septum | C4 |
| | II type: Deviation of cartilaginous and bony part of the nasal septum | |
| | III type: Deviation of the bony part of the nasal septum | |
| Classification according to the maximal NSD degree\textsuperscript{13,18} | I type: Mild deviation with maximal angle from 0° to 9.99° | C5 |
| | II type: Moderate deviation with maximal angle from 10° to 14.99° | |
| | III type: Severe deviation with maximal angle >15° | |

Abbreviation: NSD, nasal septum deviation.
classification (C1) consists of 6 different types of NSD that require diverse surgical approaches.\textsuperscript{14} Mladina et al’s classification (C2) precisely describes morphology of NSD and divides deviations into 7 categories.\textsuperscript{15} Classification of Liu et al (C3) contains 3 groups of deviation (caudal, anterior, and media) based on location of the most prominent point of the NSD.\textsuperscript{16} Another classification (C4) is based on deformed septal structure and categorize deviation into 3 types: cartilaginous, bony, and combined cartilaginous–bony. Classification according to the maximal NSD angle (C5) grades deviation into mild, moderate, and severe.\textsuperscript{12,17} The maximal NSD angle measurement was carried out like in the previous studies (an angle between the line that connects the crista galli and the nasal crest and the second line that joins the crista galli with the maximal deviation point).\textsuperscript{10,12,18} For the S-shaped NSDs, a greater angle was taken into account.

Statistical analysis was performed in SPSS for Windows, version 20.0 (SPSS, Inc, Chicago, Illinois). Data related to the NOSE scores were analyzed using descriptive methods (mean, standard deviation, median, minimum, and maximum). Linear regression analysis was used to explore the relationship between the total NOSE scores and 5 NSD classifications. In order to investigate whether some NSD types are more likely characterized by particular nasal obstruction symptoms (single NOSE scale items), binomial logistic regression analysis was applied. For the necessity of this analysis, Likert grading of NOSE scale items was simplified and observed in a light of experience (1) or does not experience (0) symptom. Afterward, every item was analyzed with each type of NSD according to classification systems applied in the study. The association between spur-induced nasal passage partitioning and nasal obstruction (total NOSE score and single items) was also analyzed by the same regression models. The statistical significance was set at a level of 0.05.

### Results

Descriptive statistical data of the NOSE scores for each NSD type within 5 classifications are displayed in Table 2. Considering C1 to C4 classifications, the highest NOSE scores were recorded in the NSD types located in the anterior segment of the septum. These NSD types were always accompanied with some degree of nasal obstruction (minimum NOSE score from 5 to 25). By contrast, other NSD types of C1 to C4 classifications were not necessarily accompanied by obstruction symptoms (minimum NOSE score = 0). Interestingly, in C5 classification (angle related), patients with smaller NSD angle (type 1) had higher NOSE scores, whereas patients with greater NSD angle (type 3) reported less severe nasal obstruction (Table 2).

The results of the linear regression analysis showed that there was no statistically significant influence of any of the NSD classification type on total NOSE scores (Table 3). Table 4 presents results of the binomial regression analysis. Similar to total NOSE score, NSD classifications were not significantly associated with single NOSE items. Additionally, spurs partitioning of the nasal passages did not show a statistically significant effect on the nasal obstruction severity expressed by total NOSE scores and single NOSE items (Tables 3 and 4). Statistical significance was only noticed between single NOSE items and total NOSE scores (Table 4).

### Discussion

Although septoplasties are performed for thousands of years (first recorded on Ebers Papyrus, 3500 bc, Egypt),\textsuperscript{19} nowadays still exists a knowledge gap in this field of surgery.\textsuperscript{1} The major problem is the lack of a diagnostic tool that objectively measures level of obstruction and is compatible with symptomatic burden that patients are experiencing.\textsuperscript{20} Anterior rhinoscopy and nasal endoscopy are considered as gold standards for evaluation of NSD\textsuperscript{8,9}; however, these methods depend on clinicians’ experience. These are not measuring techniques, and interobserver variability may exist in a context of determining the precise location of NSD, the angle of deviation, and evaluation of the NSD clinical impact on patients.\textsuperscript{21,22} Besides, anterior rhinoscopy cannot visualize posterior parts of the septum,\textsuperscript{15} while nasal endoscopy has a tendency to underestimate posterior deviations.\textsuperscript{23} Furthermore, nasal endoscopic findings may also be affected by the angle of an endoscope.\textsuperscript{11,22} Application of more expensive equipment such as rhinomanometry and acoustic rhinometry showed high sensitivity in assessing...
### Table 3. Linear Regression Analysis of Total NOSE Scores and NSD Classifications Including Spurs.

| Nasal Obstruction Symptoms | CI | C2 | C3 | C4 | C5 | Spur Touch/or Not Lateral Nasal Wall |
|-----------------------------|----|----|----|----|----|-------------------------------------|
|                             | β  (95% CI for β) | Sig. | β  (95% CI for β) | Sig. | β  (95% CI for β) | Sig. | β  (95% CI for β) | Sig. | β  (95% CI for β) | Sig.|
| Total NOSE score            | 0.081 (–1.339 to 1.501) | 0.911 | 0.837 (–0.628 to 2.301) | 0.261 | –0.366 (–3.111 to 2.580) | 0.807 | 1.132 (–3.094 to 5.358) | 0.598 | –1.053 (–5.486 to 3.380) | 0.640 | 3.680 (–2.262 to 9.623) | 0.224 |

Abbreviation: CI, confidence interval; NSD, nasal septum deviation; NOSE, Nasal Obstruction Symptom Evaluation; Sig., Significance. 

\( ^{\text{a}}\) unstandardized coefficient.

### Table 4. Binomial Logistic Regression Analysis of Single NOSE Items and NSD Classifications Including Spurs.

| Nasal Obstruction Symptoms | C1 | C2 | C3 | C4 | C5 | Spur Touch/or Not Lateral Nasal Wall |
|-----------------------------|----|----|----|----|----|-------------------------------------|
|                             | Exp (B) (95% CI for Exp (B)) | Sig. | Exp (B) (95% CI for Exp (B)) | Sig. | Exp (B) (95% CI for Exp (B)) | Sig. | Exp (B) (95% CI for Exp (B)) | Sig. | Exp (B) (95% CI for Exp (B)) | Sig.|
| NOSE question 1 (nasal congestion or stuffiness) | 0.982 (0.844-1.142) | 0.810 | 1.073 (0.918-1.255) | 0.376 | 1.078 (0.877-1.275) | 0.641 | 1.130 (0.720-1.773) | 0.959 | 0.889 (0.555-1.424) | 0.624 | 1.780 (0.936-3.385) | 0.078 | 1.141 (1.102-1.181) | 0.000\(^{a}\) |
| NOSE question 2 (nasal blockage or obstruction) | 0.940 (0.807-1.095) | 0.427 | 1.003 (0.856-1.176) | 0.966 | 0.908 (0.662-1.247) | 0.551 | 1.021 (0.647-1.611) | 0.928 | 0.822 (0.505-1.336) | 0.428 | 1.489 (0.788-2.814) | 0.221 | 1.119 (1.087-1.153) | 0.000\(^{a}\) |
| NOSE question 3 (trouble breathing through my nose) | 1.063 (0.908-1.244) | 0.447 | 1.178 (0.999-1.389) | 0.052 | 1.154 (0.829-1.605) | 0.396 | 1.410 (0.878-2.264) | 0.155 | 0.861 (0.525-1.411) | 0.552 | 1.668 (0.878-3.167) | 0.118 | 1.196 (1.142-1.252) | 0.000\(^{a}\) |
| NOSE question 4 (trouble sleeping) | 1.039 (0.821-1.316) | 0.748 | 1.019 (0.801-1.297) | 0.875 | 0.818 (0.518-1.292) | 0.389 | 0.791 (0.400-1.562) | 0.499 | 1.494 (0.789-2.831) | 0.218 | 0.795 (0.285-2.222) | 0.662 | 1.094 (1.062-1.127) | 0.000\(^{a}\) |
| NOSE question 5 (trouble breathing during exercise) | 1.006 (0.864-1.170) | 0.942 | 0.992 (0.848-1.160) | 0.919 | 0.914 (0.666-1.254) | 0.577 | 0.912 (0.580-1.432) | 0.688 | 0.866 (0.541-1.386) | 0.548 | 0.829 (0.440-1.563) | 0.562 | 1.174 (1.124-1.226) | 0.000\(^{a}\) |

Abbreviations: CI, confidence interval; NSD, nasal septum deviation; NOSE, Nasal Obstruction Symptom Evaluation. 

\( ^{\text{a}}\) significance at the 0.01 level.
anterior NSD, whereas estimation of the deep septal deviations appeared to be less accurate.\(^\text{21}\) Generally, precise diagnosis of anterior NSD is routinely achieved by simpler and cheaper procedure such as anterior rhinoscopy, while rhinomanometry and acoustic rhinometry turned out as not so useful diagnostic tools for septal surgery patient selection.\(^\text{21,24,25}\)

Lack of strong evidence base for septoplasty,\(^\text{1,21}\) frequent recurrent surgeries,\(^\text{7,26}\) and patient dissatisfaction with surgery outcomes (even up to 35%)\(^\text{7,21}\) cast a shadow on this procedure. Therefore, third-party payers mandate CT examination for objective confirmation of the nasal obstruction severity before authorizing septoplasty.\(^\text{10,9}\) However, the justification of such demand has been under question.

In up-to-date literature, only a few studies investigated the connection between CT images of NSD and subjective perception of nasal obstruction. These studies expressed opposite attitudes about the need of CT for the evaluation of noncomplicated NSD. Lee et al strongly recommend CT for the assessment of the middle and posterior NSD prior to septoplasty.\(^\text{11}\) They found that angle of deviation significantly correlated with NOSE scores at the ostiomeatal unit level.\(^\text{11}\) Similarly, cross-sectional areas correlated well with nasal obstruction symptoms at the ostiomeatal unit level and at the choana level.\(^\text{11}\) However, in the same study, it was not detected any connection between observed anatomical parameters at the nasal valve area and NOSE scores. Conversely, Ardeshirpour et al\(^\text{10}\) pointed out that CT examination of patients with nasal obstruction caused solely by NSD is generally unnecessary. They did not find a correlation between nasal obstruction (expressed through the NOSE scores) and the angle of deviation measured at the anterior, middle, and posterior part of the nasal septum. Moreover, the maximal NSD angle poorly correlated with nasal obstruction symptoms.

Despite contradictory results, it can be perceived that these studies primarily observed NSD through the angle of deviation. However, there are many NSD classification systems described in the literature, each focusing on some different characteristics of NSD. Unfortunately, none of the classification is widely accepted and routinely used in everyday ENT practice. Additionally, it has not been determined yet which components of septal deviation are responsible for the onset of nasal obstruction symptoms and as such are the most relevant for inspection and measurement.

In the current study, we applied 5 different classification systems in order to detect any specific morphology of NSD and/or angle threshold that could predict nasal obstruction severity. We consider that selection of these classifications is adequate because they observe NSD from different points of view (Table 1). Furthermore, the sample selected from general population provided great morphological variability in the nasal septum and wide range of NOSE scores. This allowed meticulous and unbiased evaluation of the relationship between NSD types and nasal obstruction severity.

After thorough analysis of the morphological aspects of septal deviations, our results (Tables 3 and 4) indicate that choosing septal surgery candidates only by relying on a radiological report can lead into misjudgment trap. Namely, any particular NSD type (within any classification system) that was more likely prone to cause some specific nasal obstruction symptoms was not identified. Similarly, the presence of spurs as well as whether they divide nasal passages or not did not show a predictive effect on NOSE score. Although this feature of NSD had not been investigated in previous studies, it seems that spurs have no clinically significant impact on nasal obstruction. Besides, any characteristic morphological feature of NSD as predictive factor for severe nasal obstruction was not isolated.

We have to emphasize that frequently used statement in radiological reports “mild (or moderate, or severe) deviation of the nasal septum” does not necessarily have the same reflection on the nasal obstruction symptom severity. A burdensome of NSD is generally evaluated by notifying how complicated the nasal septum shape looks like and how much the septum is deflected from the midline. However, it is a well-known fact that not all people with NSD have severe nasal obstruction symptoms. Moreover, some septal deviations are not symptomatic at all, and radiological diagnosis of NSD is usually an incidental finding. Our results pointed out that complicated shapes of NSD, for example, type 7 of the C2 classification system, do not correlate with severe nasal obstruction. Some patients with this type of deviation did not have any trouble with breathing through the nose, as it is shown in Table 2. Likewise, some patients with mild degree of deviation (type 1 of C5 classification) had severe obstruction symptoms, whereas patients with greater angles of deviation (type 3 of C5 classification) experienced less severe nasal obstruction (Table 2). Therefore, results of this study indicate that observing an anatomical aspect of NSD solely cannot be the criterion in objective estimation of the nasal obstruction severity.

On the other hand, it seems that NOSE scale gives more valuable information concerning the quantification of the nasal obstruction severity although it is a subjective measure. The NOSE scale in the current study detected that all patients with anterior NSD experienced some trouble with nose breathing (Table 2). This can indicate that the nasal valve is a crucial zone for the emergence of nasal obstruction symptoms. However, it was not confirmed statistically that these particular types of NSD are more likely prone to cause severe nasal obstruction symptoms than other NSD types (Tables 3 and 4).

This study demonstrated that any CT grading of NSD could not objectively confirm nasal obstruction severity. Hence, we could not recommend CT as a diagnostic tool of choice for an objective selection of septal surgery candidates. This indicates that the current attitude of third-party payers to mandate CT examination prior to septoplasty just for an objective confirmation that nasal obstruction severity is not justified at all. Moreover, unnecessary exposure to radiation, the extra cost of examination, and unjustified spending of patient’s health insurance money could be considered as medical equipment overuse. We suggest that physical examination together with correct anamnesis and NOSE scale grading can satisfactorily identify patients for septal surgery.
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References

1. Van Egmond MM, Rovers MM, Hendriks CT, van Heerbeek N. Effectiveness of septoplasty versus non-surgical management for nasal obstruction due to a deviated nasal septum in adults: study protocol for a randomized controlled trial. Trials. 2015;16:500.
2. Moor M, Eccles R. Objective evidence for the efficacy of surgical management of the deviated septum as a treatment for chronic nasal obstruction: a systematic review. Clin Otalaryngol. 2011;36(2):106-113.
3. Gandomi B, Bayat A, Kazemei T. Outcomes of septoplasty in young adults: the nasal obstruction septoplasty effectiveness study. Am J Otalaryngol. 2010;31(3):189-192.
4. Bauman I. Quality of life before and after septoplasty and rhinoplasty [in German]. Laryngorhinootologie. 2010;89(suppl 1):S35-S45.
5. Thomas A, Alt J, Gale C, et al. Surgeon and hospital cost variability for septoplasty and inferior turbinate reduction. Int Forum Allergy Rhinol. 2016;6(10):1069-1074.
6. Bhattacharyya N. Ambulatory sinus and nasal surgery in the United States: demographic and perioperative outcomes. Laryngoscope. 2010;120:635-638.
7. Nasal Septal Surgery. EN'TUK position paper 2010. ENT UK (the British Academic Conference in Otolaryngology (BACO) and the British Association of Oturhinolaryngology–Head and Neck Surgery (BAO-HNS)). Nasal Septal Surgeryth ed. London, United Kingdom: Aesculapius Publishing Co; 1971:1-3.
8. Sedaghat AR, Kieff DA, Bergmark RW, Cunnane ME, Busaba NY. Radiographic evaluation of nasal septal deviation from computed tomography correlates poorly with physical exam findings. Int Forum Allergy Rhinol. 2014;5:258-262.
9. Wotman M, Kacker A. What are the indications for the use of computed tomography before septoplasty? Laryngoscope. 2016;126(6):1268-1270.
10. Ardeshirpour F, McCann KE, McKinney AM, Odland RM, Yueh B, Hilger PA. Computed tomography scan does not correlate with patient experience of nasal obstruction. Laryngoscope. 2016;126(4):820-825.
11. Lee DC, Shin JH, Kim SW, et al. Anatomical analysis of nasal obstruction: nasal cavity of patients complaining of stuffy nose. Laryngoscope. 2013;123(6):1381-1384.
12. Savovic S, Kljaic V, Buljajic Cupic M, Jovanvecij LJ. The influence of nasal septum deformity degree on subjective nasal breathing assessment. Med Pregl. 2014;67(suppl 1):61-64.
13. Janovic N, Marie G, Dusanovic M, Janovic A, Pekmezovic T, Djuric M. Introducing Nasal Obstruction Symptom Evaluation (NOSE) scale in clinical practice in Serbia: validation and cross-cultural adaptation. Vojnosanit Pregl. 2018. doi.org/10.2298/VSP180619130 J.
14. Guyuron B, Uzzo CD, Scull H. A practical classification of septo-nasal deviation and an effective guide to septomucocutaneous surgery. Plast Reconstr Surg. 1999;104(7):2202-2209.
15. Mladina R, Cujic E, Subaric M, Vukovic K. Nasal septal deformities in ear, nose, and throat patients: an international study. Am J Otalaryngol. 2008;29(2):75-82.
16. Liu T, Han D, Wang J, et al. Effects of septal deviation on the airflow characteristics: using computational fluid dynamics models. Acta Otalaryngol. 2012;132(3):290-298.
17. Serifoglu I, Ilker I, Damar M, Buyukusyal MC, Tosun A, Tokgoz O. Relationship between the degree and direction of nasal septum deviation and nasal bone morphology. Head Face Med. 2017;13(1):3.
18. Kim YM, Rha KS, Weissman JD, Hwang PH, Most SP. Correlation of asymmetric facial growth deviated nasal septum. Laryngoscope. 2011;121(6):1144-1148.
19. Hinderer KH. Fundamentals of Anatomy and Surgery of the Nose. London, United Kingdom: Aesculapius Publishing Co; 1971:1-3.
20. Andre RF, Vuyk HD, Ahmed A, Graamans K, Nolst Trenite GJ. Correlation between subjective and objective evaluation of the nasal airway. A systematic review of the highest level of evidence. Clin Otalaryngol. 2009;34(6):518-525.
21. Aziz T, Biron VL, Ansari K, Flores-Mir C. Measurement tools for the diagnosis of nasal septal deviation: a systematic review. J Otalaryngol Head Neck Surg. 2014;43:11.
22. Suh MW, Jin HR, Kim JH. Computed tomography versus nasal endoscopy for the measurement of the internal nasal valve angle in Asians. Acta Otalaryngol. 2008;128(6):675-679.
23. Lebowitz RA, DoudCalli SK, Holliday RA, Jacobs JB. Nasal septal deviation: a comparison of clinical and radiological evaluation. Oper Tech Otalaryngol Head Neck Surg. 2001;12(2):104-106.
24. Kim CS, Moon BK, Jung DH, Min YG, Correlation between nasal obstruction symptoms and objective parameters of acoustic rhinometry and rhinomanometry. Auris Nasus Larynx. 1999;25(1):45-48.
25. Dinis PB, Haider H. Septoplasty: long-term evaluation of results. Am J Otalaryngol. 2002;23(2):85-90.
26. Becker SS, Dobratz EJ, Stowell N, Barker D, Park SS. Revision septoplasty: review of sources of persistent nasal obstruction. Am J Rhinol. 2008;22(2):440-444.
27. Delaney SW. Evolution of the septoplasty: maximizing functional and aesthetic outcomes in nasal surgery. Mathews J Otol. 2018;1(1):004.