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Comparison of different nasal septal areas between patients with and without nasal obstruction

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Abstract

Introduction: We intended to investigate the deviation of septal swell body, perpendicular plate, septal spur and vomer in patients with and without nasal obstruction.

Methods: We compared the deviation of these septal areas in computed tomography scans of patients scheduled for nasal surgical procedures (cases) and of patients without clinically relevant nasal obstruction (controls).

Results: Septal swell body was similarly deviated between 56 cases (median value: 6.5 mm) and 56 controls (6.4 mm; p>0.2). Septal spur was more deviated in cases (5.6 mm) than in controls (4.7 mm; p<0.001). The deviation of perpendicular plate (found in 28/112 subjects) did not differ significantly between cases (3.0 mm) and controls (2.2 mm; p>0.2). The deviation of vomer (found in 71/112 subjects) was larger in cases (7.1 mm) than in controls (4.3 mm; p=0.001).

Conclusion: Septal spur, vomer and perpendicular plate were more frequent causes of nasal obstruction compared to septal swell body.

Keywords

Nasal obstruction; tomography; nasal septum; septal deviation; nasal septal swell body; perpendicular plate; inferior turbinate

Introduction

Nasal obstruction is a common presenting symptom to physicians. Several factors contribute to its etiology. Septal deviation is a frequent anatomic cause.[1] Several methods have been utilized to investigate and quantify the role of the nasal septum on nasal obstruction. Computed tomography (CT) is the standard imaging method for evaluation of the nasal cavity and paranasal sinuses. However, several studies suggested that CT may offer only little to the preoperative assessment of septal deviation compared to the classic anterior rhinoscopy.[2-5]

Nevertheless, CT offers significant advantages due to the availability of hospital-based control subjects. Several studies have utilized CT to compare nasal characteristics between subjects with and without clinically-relevant nasal obstruction. Among others, these have been the piriform aperture width and height, nasal septal width, nasal floor asymmetry,[6] as well as cross-sectional areas located anterior[7] and posterior to the piriform aperture.[8]

This setting allows for the investigation of several nasal septal areas and their deviations, caused at least partially by the developmental interactions among them. Nasal septal areas of special interest are the anterosuperior nasal septal swell body, the anteroinferior cartilaginous-osseus septum, the posterosuperior perpendicular plate and the posteroinferior vomer.

The nasal septal swell body, alternatively named septal turbinate or intumescentia septi anterior, is a mucosal bulging on each side of the nasal septum anterior to the head of the middle turbinate.[9, 10] Despite its importance on nasal surgery as part of the so called high septal deviation,[9] there is a paucity of case-control studies that investigate its role on nasal obstruction. Similarly, there is a lack of data that compare the perpendicular plate, the posterior part of the high septal deviation, between patients with and without nasal obstruction.

With this study, we aimed to investigate the anterosuperior nasal septal swell body, the anteroinferior cartilaginous-osseus septum, the posterosuperior perpendicular plate and the posteroinferior vomer in patients with and without nasal obstruction. For this reason, we measured the deviation of these nasal septal areas in CT of subjects with known clinically-relevant nasal obstruction scheduled for nasal surgical procedures, and in CT of subjects with trauma unrelated to the head and face, without known clinically-relevant nasal obstruction, which served as controls. Moreover, we investigated the correlation of the deviation of these areas with active anterior rhinomanometry (AAR).

Materials and Methods

Design and study population

In a retrospective hospital-based cross-sectional study, adult subjects with a preoperative cone beam CT-scan who underwent septoplasty or functional septorhinoplasty for chronic nasal obstruction at the University Department of Otorhinolaryngology, Head and Neck Surgery, between January 2017 and December 2020, were eligible (cases). Of these, the SPSS random sample routine was utilized to find a sex-balanced random sample. As controls, we recruited adult subjects presenting to the Department of Orthopaedics and Traumatology for evaluation and management of serious trauma unrelated to the head and face in the same time period. Here, multi-slice CT of the whole body was already available due to routine workup. Subjects were excluded, if nasal cavity or sinus opacification, facial or cephalic dysmorphic syndromes, or facial bone trauma were present. In cases where AAR was available, we investigated the relationship of AAR with the deviations of the several nasal septal areas.

Data collection

Measurements were carried out in the software Syngo-share-view (Siemens Healthcare Diagnostics GmbH, Vienna, Austria) with DICOM (Digital Imaging and Communications in Medicine) images derived either with the cone beam CT protocol (KaVo 3D eXam, KaVo, Biberach, Germany) or the multi-slice CT protocol (Discovery CT750 HD, GE Healthcare, Vienna, Austria).[6-8] For AAR, the Otopront Rhino-Sys system for AAR (Otopront, Hohenstein, Germany) was used.[7, 8, 11] Here, only values before decongestion were used, since CT-scans and AAR were usually performed on different days. The study protocol was approved by the ethics committee of the Medical University (1261/2019).

We measured distance from the midline in millimetres (mm). We drew a line from the basis of the nasal septum to its most cranial part. A perpendicular line was then drawn from the most prominent lateral border of the septal mucosa of each septal area to the midline. The distance from the midline was automatically displayed by the software. The distance was documented for the right and left nasal side, for each septal area separately.

Septal areas

The anterosuperior nasal septal swell body and the anteroinferior cartilaginous-osseous septum were examined in the coronal plane at the level of the incisive canal. The axial plane was set by the anterior and posterior nasal spine. The superior deviation was assigned to the nasal septal swell body, while the inferior deviation was assigned to the anteroinferior septum, titled septal spur for simplicity (Figure 1).

The posterosuperior perpendicular plate and the posteroinferior vomer were examined in the coronal plane at the level of the dorsal edge of the crista galli. The dorsal edge of the crista galli was set on the sagittal plane. The axial plane was set by the anterior and posterior nasal spine. The superior deviation was assigned to the perpendicular plate, while the inferior deviation was assigned to the vomer (Figure 2).

Inferior turbinates

The area at the plane of the incisive canal is in direct vicinity with the area of the internal nasal valve. In order to examine this area comprehensively, we measured also the size of the inferior turbinates. In the same plane that was used for the anterior septal areas, the inferior turbinate appearing grey on CT was outlined with the mouse using the drawing polygon function exactly on the border between the grey area of the inferior turbinate and the black space of the nasal airway or the white space of the lateral bone (Figure 3a). The middle, inferior and lateral border of the inferior turbinate was easy to define in contrast to the superior border. The superior border was defined as the imaginary line, where the curvature of the turbinate mucosa stopped and the mucosa continued cranially perpendicularly to the axial plane (Figure 3a).

Data analysis

Data were analyzed using the SPSS 26.0 statistic package (SPSS Inc., Illinois, USA). Count data were tabulated, for metric data means, standard deviations and 95% confidence intervals (CI) were calculated. Normality of distribution of variables was tested with the Shapiro-Wilk test. Comparison between cases and controls or between parameters was performed by independent samples T-test, paired-samples T-test, Mann-Whitney-U test or Wilcoxon signed ranks test, where appropriate. Correlations for continuous parameters were examined with Pearson's correlation coefficient. Correlations were categorized as strong, if $r>|0.8|$, moderate, if $|0.8|>r>|0.6|$ and weak, if $r<|0.6|$.

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Comparison of septal areas between cases and controls

To compare the deviations regardless of the right and left nasal side and in a way more relevant to the nasal airflow, comparison was based on "large" and "small" deviations. Therefore, the large distances of the nasal septal swell body, septal spur, perpendicular plate and vomer were compared between cases and controls.

Relation of septal areas and active anterior rhinomanometry

We examined the correlations of right and left distances of each septal area with right and left flow as well as with right and left resistance, respectively.

Relation of the variable distances with the variable angle

In order to compare two different methods of nasal septal deviation assessment, we also measured the angles from the midline in the anterosuperior nasal septal swell body and anteroinferior cartilaginous-osseous septum. Here, after choosing the function "angle", a line was drawn from the basis of the nasal septum to its most cranial part, and from there to the right or left most prominent lateral border of the septal mucosa of each septal area (Figure 3b, 3c). The angle of the nasal septal swell body was automatically displayed by the software in degrees. The angle was documented for the right and left nasal side, for each septal area separately. We examined the correlations of distances with angles of the same nasal side, i.e., right and left, as well as of the same septal area, i.e., nasal septal swell body and septal spur.

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Results and analysis

Study population

During the study period, 1005 patients underwent septoplasty or functional septorhinoplasty. Of them, a sex-balanced random sample of 60 subjects was drawn. Fifty-six subjects fulfilled the study criteria and were included. Septoplasty and functional septorhinoplasty were carried out by 30 and 26 subjects, respectively. The median age was 31 years (range: 18-60 years). Twentynine were women. The Departments of Orthopaedics and Traumatology and of Radiology provided an equal sized sample with balanced gender distribution. These 56 trauma-subjects were used as controls. Of these, 30 were men. In cases, the median age was 31 years (24.25 to 48 years), and in controls, it was 27 years (lower to upper quartile: 20.25 to 41 years; Mann-Whitney U test; p=0.071).

Nasal septal swell body

The distance of nasal septal swell body from the midline was not normally distributed (Shapiro-Wilk test; p<0.044). A deviation of the nasal septal swell body was found in all 112 subjects. The deviation of the nasal septal swell body ranged from 1.8 to 9.7 mm (median: 6.5 mm; Table 1) and did not differ significantly between cases and controls (Mann-Whitney U test; p>0.2).

Septal spur

The distance of septal spur from the midline was not normally distributed (Shapiro-Wilk test; p<0.001). A deviation of the septal spur was found in all 112 subjects. The deviation of

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the septal spur was significantly larger in men (median: 5.3 mm; lower to upper quartile: 4.5 to 6.6 mm) than in women (4.8 mm; 3.7 to 6.0 mm; Mann-Whitney U test: $p=0.044$). The deviation of the septal spur ranged from 1.6 to 10.4 mm (median: 5.0 mm; Table 1). The deviation of the septal spur was significantly larger in cases (median: 5.6 mm; lower to upper quartile: 4.7 to 7.4 mm) than in controls (4.7 mm; 3.5-5.4 mm; $p<0.001$; p Bonferroni corrected and adjusted for age and gender).

Perpendicular plate

The distance of the perpendicular plate from the midline was not normally distributed (Shapiro-Wilk test; $p<0.001$). A deviation of the perpendicular plate was found in 28 subjects only (15 cases). It ranged from 0.7 to 4.8 mm (median: 2.0 mm; Table 2). The deviation of the perpendicular plate was slightly larger in cases (median: 3.0 mm; lower to upper quartile: 2.1 to 3.7 mm) than in controls (2.2 mm; 1.6-2.6 mm; Mann-Whitney U test; $p>0.2$).

Vomer

The distance of the vomer from the midline was not normally distributed (Shapiro-Wilk test; $p<0.001$). A deviation of the vomer was found in 71 subjects (36 cases). The deviation of the vomer ranged from 0.7 to 12.2 mm (median: 5.3 mm; lower to upper quartile: 3.5 to 8.0 mm; Table 2). The deviation of the vomer was significantly larger in cases (7.1 mm; 3.9-9.0 mm) than in controls (4.3 mm; 2.6-6.1 mm; Mann-Whitney U test: $p=0.001$).

Inferior turbinates

The size of the inferior turbinates was normally distributed (Shapiro-Wilk test; $p>0.2$). It ranged from 14 mm^2 to 246 mm^2 (mean value: 121 mm^2; Table 1). It did not differ significantly between men and women (independent-samples t-test; $p>0.2$) and it did not correlate significantly with age ($p>0.2$).

$Turb_{LARGE}$ ranged from 56 mm^2 to 230 mm^2 (mean: 128 mm^2; Table 1) and did not differ significantly between cases (mean: 124 mm^2) and controls (132 mm^2; independent-samples t-test; $p>0.2$). Similarly, $Turb_{SMALL}$ ranged from 14 mm^2 to 246 mm^2 (mean: 115 mm^2; Table 1) and did not differ significantly between cases (114 mm^2) and controls (117 mm^2; independent-samples t-test; $p>0.2$). $Turb_{LARGE}$ was significantly larger than $Turb_{SMALL}$ (paired-samples t-test; $p=0.017$).

Correlation of septal areas with active anterior rhinomanometry

AAR was available in 33 subjects with nasal obstruction. The distances of the septal areas from the midline did not correlate significantly neither with flow nor with resistance of AAR ($p>0.2$).

Correlation of distances with angles

The correlations of distances with angles, in the area of nasal septal swell body and septal spur on the right and left noses, were moderate ($r=0.63$-0.80; $p<0.001$; Figure 4).

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Discussion

Several studies reported that size reduction of the nasal septal swell body was effective for the treatment of nasal obstruction in patients with associated hypertrophy.[12-15] Moreover, Moss and coauthors concluded, that surgeons should evaluate the nasal septal swell body and consider addressing it surgically in patients with nasal obstruction.[16] However, this structure still receives little attention in the clinical setting.[17] Meng and Zhu concluded that despite its potential contribution to nasal obstruction, more evidence is needed to elucidate its effects.[18] Furthermore, the posteriorly-based deviated perpendicular plate might cause narrowing of the nasal valve. Veit and coauthors suggested the deviated perpendicular plate as a frequent cause of persistent or recurrent nasal obstruction after septoplasty.[19] Similarly, there is a lack of data that examine the latter in patients with nasal obstruction and controls.

In this hospital-based, CT-morphometric cross-sectional study, we intended to investigate the superiorly-based nasal septal swell body and perpendicular plate, as well as the inferiorly-based cartilaginous-osseous septum and vomer, in patients with and without nasal obstruction. For this reason, we measured and compared the deviation of these four septal areas from the midline, in a patient group with clinically-relevant nasal obstruction and in a patient group without it.

There is a paucity of case-control studies in the literature that investigated this issue. Gelera and coauthors assessed CT scans of patients who suffered under allergic rhinitis and chronic rhinosinusitis, of patients with brain tumours without sinonasal diseases, and of patients with malocclusion, dental problem and facial pain without sinonasal diseases.[20] However, despite the very interesting insight this study offered, this case-control setting did not include patients with nasal obstruction due to septal deviation.

Our results revealed that the deviation of the superiorly-based nasal septal swell body and perpendicular plate was similarly large in patients with nasal obstruction and in patients without it (Table 1 and 2). However, the deviation of the inferiorly-based septal spur and vomer was significantly larger in patients with nasal obstruction (Table 1 and 2). These results implied that the inferiorly-based septal spur and vomer are a much more frequent cause of nasal obstruction than the superiorly-based nasal septal swell body and perpendicular plate.

Moreover, these results may further indicate that septal spur and vomer contribute to a greater extent than nasal septal swell body and perpendicular plate to nasal obstruction. However, if examined carefully, this might be misleading. Our data revealed no significant difference of the deviation of the perpendicular plate between patients with and without nasal obstruction. The reason might be the relatively small number of subjects with an actually deviated perpendicular plate. Despite the non-significant difference, the perpendicular plate was more deviated in the deviated side of subjects with nasal obstruction (median value of 3.0 mm) compared to that of controls (2.2 mm; Table 1). On the contrary, the nasal septal swell body did not differ between subjects with and without nasal obstruction (median values of 6.5 vs 6.4 mm, respectively). This implied that the perpendicular plate could be indeed a significant, still less often, cause of nasal obstruction.

The case-control setting of the current study highlighted a significant advantage of the CT scan, i.e., the availability of hospital-based controls. This was also exploited by Gelera and coauthors,[20] and has allowed for significant observations in the recent past.[6-8] Cases were patients scheduled for nasal surgical procedures, i.e., septoplasty or septorhinoplasty with or without turbinate surgery. Thus, they were considered patients with clinically relevant nasal obstruction. On the contrary, controls were patients with trauma unrelated to the head and face. These patients may be considered a suitable control group, if nasal obstruction does not generally alter the risk of injury.[6, 7] However, we cannot exclude with certainty, that some patients in the control group did not suffer from clinically relevant nasal obstruction.

Several studies have also evaluated the nasal septal swell body at the same coronal plane, i.e., at the plane of the incisive canal.[21-23] Other studies chose a more anterior or a more posterior plane.[10, 14, 16, 20, 24] This is justified, since the nasal septal swell body is a 3-dimensional structure. We chose the plane of the incisive canal in all subjects, since bony structures increase reproducibility. Similar studies have quantified nasal septal swell body by measuring total horizontal width.[10, 14, 22, 24] Despite the paucity of studies that examine distance from the midline, we chose this unit to quantify the several septal areas. However, it would be interesting to investigate the total horizontal width as well.

An additional method to quantify the nasal septal deviation could be the measurement of the angle of the nasal septum from the midline. Comparison of the variable distance with the variable angle revealed a moderate significant positive correlation between them. This implied that the angle of the nasal septum from the midline increased as the distance of the septal area from the midline increased. This was a logical finding. However, both variables did not change equally, otherwise the correlation would have been perfect. This suggested some caution in the selection of the appropriate parameter to examine nasal septal deviation.

We recommend the deviation as the more appropriate parameter, since we found it more accurate compared to the angle. The line which defined the angle originated cranially from the midline and reached the most lateral part of the nasal septal swell body mucosa almost parallel. Therefore, some degree of variability of the "true" angle was unavoidable. We noticed the same to a lower extent in the inferiorly-based septal spur. These observations were supported by the better correlations between distances and angles in the inferior septal spur (>0.7) compared to those of the nasal septal swell body (<0.7). Nevertheless, significant (septal spur) or not significant (nasal septal swell body) differences were found by both methods between patients with and without nasal obstruction.

Further results of this study revealed that the inferior turbinates on the side of the smaller septal spur were significantly larger than those on the side of the larger septal spur. This is common knowledge and pointed towards the pathology known as compensatory inferior turbinate hypertrophy contralateral to the side of the septal deviation. However, this does not exclude large inferior turbinates on the side of the larger septal spur. This observation is supported by the largest inferior turbinate (246 mm^2) found on the side of the larger septal spur (Table 1). The setting of this study allowed for these observations.

Furthermore, neither the deviation of the several septal areas from the midline nor the size of the inferior turbinates did correlate significantly with flow or resistance of the AAR. These observations applied for the right and left nasal sides, as well as for the sides of the larger and smaller several septal areas. This did not imply that nasal septal deviation or the inferior turbinate do not contribute to nasal obstruction. It simply indicated that these variables at the plane of the incisive canal and the dorsal end of the crista galli, if examined separately, did not correlate with flow or resistance of AAR in the current study.

Several reasons can explain this. The nasal septum cannot be easily objectified in simple CT-scans. It is a structure with possible curvatures among its whole cartilaginous and bony length and height, each of which may separately contribute to nasal obstruction. Moreover, its effect on air humidification, air heating, facilitation of the airflow and nasal obstruction depends highly on the total width of the nose and the nearby structures, e.g., nasal turbinates and lateral nasal wall. The latter explains why the cross-sectional area of the nasal airway combines all the above-mentioned nasal structures and may correlate with AAR, while the other nasal structures separately might not.

The study's subject sample was based on samples of previous similar studies.[6-8] These studies managed to reveal significant differences with approximately 30 to 60 subjects in each group. Therefore, 56 subjects in each group were empirically chosen as a study sample with an acceptable effect size, without a previous statistical assessment. Notably, 55 subjects per group were considered sufficient to obtain a significant result with an independent-samples t-test ($\alpha=0.05$), and with a moderate effect size ($d=0.54$) and a power of 0.8.

The results of this study should be addressed with caution. No subjective evaluation of nasal patency with a questionnaire, e.g., NOSE score, was available. The documentation of NOSE score at our department was not a routine practice during the study period, neither as a validated visit nor a validated postal questionnaire.[25, 26] Furthermore, documentation of NOSE score is generally not excepted at a Department of Orthopaedics and Traumatology during assessment of acute trauma. If researchers intend to document NOSE score during acute trauma, they should address issues such as documentation of patient-reported outcomes irrelevant to the field of acute trauma, patients' condition and willingness, time of documentation, etc. Alternatively, a postoperative subjective assessment reflecting the preoperative condition could be performed with the Glasgow Benefit Inventory score.[27] However, approximately four years after surgery might be considered a long period of time for the use of Glasgow Benefit Inventory score.[28] Therefore, investigation of the correlation of the deviation of the several septal areas with subjective evaluation of nasal patency was not feasible.

Moreover, a single coronal plane might not fully describe the effect of nasal septal swell body, septal spur, perpendicular plate or vomer. Furthermore, nasal septal swell body is a mucosal structure. However, the variable "deviation of the nasal septal swell body" examined here was occasionally affected by a bony deviation (Figure 3b, c). This implied that the "deviation of nasal septal swell body" did not solely represent the nasal septal swell body, but also a bony deviation of the perpendicular lamina to some extent.

This study intended to compare different nasal septal areas between patients with nasal obstruction scheduled for nasal surgical procedure, and patients without clinically relevant nasal obstruction. For this cause, CT scans of cases and controls were used, as a method that could investigate the nasal septum. At our department, cone beam CT scan with low radiation exposure [29] is a routine practice before nasal surgical procedure. CT scan can assess the anterior cartilaginous nose without adapter or nozzle related tissue distortion.[30] It can identify the bone, mucosa, airway lumen and skeletal pathologies in a less stressful way compared to nasal endoscopy. It is less error-prone than functional rhinometric procedures and it simultaneously depicts pathologies of the paranasal sinuses. It is verifiable and not examiner-dependent. On the contrary, it is a static measure that cannot reflect the dynamic changes of the nasal mucosa observed during functional rhinometric procedures.

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Concluding, septal spur and vomer were a much more frequent cause of nasal obstruction than nasal septal swell body and perpendicular plate. However, perpendicular plate could also be a significant, still less often found, cause of nasal obstruction. On the contrary, nasal septal swell body did not differ in any way between patients with and without nasal obstruction. These findings might indicate towards a more conservative and skeptical approach before indicating septal surgery at the nasal septal swell body. Nevertheless, the design of the study clearly did not suffice to draw such a definite conclusion.

Summary

- There is a paucity of case-control studies that investigate the deviation of different septal areas.
- We compared septal areas of special interest in computed tomography scan of patients scheduled for functional nasal surgical procedures (cases) and of patients with trauma unrelated to the head and face serving as controls.
- The anteroinferior cartilaginous-osseus septum and the posteroinferior vomer were severely more deviated in 56 cases than in 56 controls. On the contrary, the anterosuperior nasal septal swell body was similarly deviated in cases and controls.
- A deviation of the posterosuperior perpendicular plate was found in 28 subjects only. The perpendicular plate was more deviated in cases than in controls. This difference was, however, not significant.

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- Among the four examined septal areas, the nasal septal swell body was the only one found to be similarly deviated in subjects with and in subjects without nasal obstruction.

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Tables

Table 1. Comparison of the deviation of nasal septum and size of the inferior turbinates at the level of the incisive canal

Variable	Parameter	Cases (nasal obstruction)		Controls	
		Value	n	Value	n
Nasal septal swell body[1]	Right	6.0±2.0 (4.7-7.2)	56	5.8±1.6 (4.8-6.7)	56
	Left	5.2±2.1 (3.9-6.5)	56	5.8±1.6 (4.4-6.5)	56
	Large	6.5±1.5 (5.7-7.7)		6.4±1.1 (5.9-7.2)	
	Small	4.5±1.8 (2.7-5.5)		4.8±1.5 (3.6-5.5)	
Septal spur[1]	Right	3.7±2.2 (2.7-5.4)	56[2]	3.7±1.4 (2.8-4.5)	56
	Left	4.3±2.2 (2.8-6.0)	56	3.9±1.7 (2.9-5.1)	56
	Large	5.6±1.9 (4.7-7.4)		4.7±1.5 (3.5-5.4)	
	Small	2.8±1.0 (2.0-3.7)		3.1±1.9 (2.4-4.0)	
Inferior turbinate[3]	Right	118±45 (34-217)	56	127±37 (63-246)	56
	Left	120±40 (48-213)	56	122±44 (14-229)	56
	Large	124±42 (56-217)		132±39 (61-230)	
	Small	114±42 (34-201)		117±42 (14-246)	

[1]median value ± standard deviation (lower to upper quartile) in mm

[2]In the right sides, a deviation of the septal spur from the midline was found in 56 subjects with nasal obstruction [median value ± standard deviation (lower to upper quartile): 3.7±2.2 mm (2.7 to 5.4 mm)]

[3]mean value ± standard deviation (minimum-maximum) in mm^2

Table 2. Comparison of the deviation of the nasal septum at the level of the dorsal edge of the crista galli

Variable	Parameter	Cases (nasal obstruction)		Controls	
		Value	n	Value	n
Perpendicular plate[1]	Right	1.8±0.9 (1.7-3.0)	11	2.0±1.1 (1.4-2.4)	17
	Left	2.3±1.3 (1.8-3.9)	10	1.8±0.7 (1.2-2.3)	17
	Large	3.0±1.1 (2.1-3.7)		2.2±1.0 (1.6-2.6)	
	Small	1.7±0.7 (1.2-2.4)		1.5±0.6 (1.0-2.1)	
Vomer[1]	Right	4.4±3.0 (2.4-8.3)	32[2]	4.3±2.3 (2.6-5.6)	37
	Left	6.4±3.1 (2.9-8.2)	39	3.4±2.4 (2.3-5.8)	34
	Large	7.1±2.8 (4.0-9.0)		4.8±2.3 (3.5-6.2)	
	Small	2.3±0.8 (1.2-2.7)		2.4±0.8 (1.6-2.9)	

[1]median value ± standard deviation (lower to upper quartile) in mm

[2]In the right sides, a deviation of the vomer from the midline was found in 32 subjects with nasal obstruction [median value ± standard deviation (lower to upper quartile): 4.4±3.0 mm (2.4 to 8.3 mm)]

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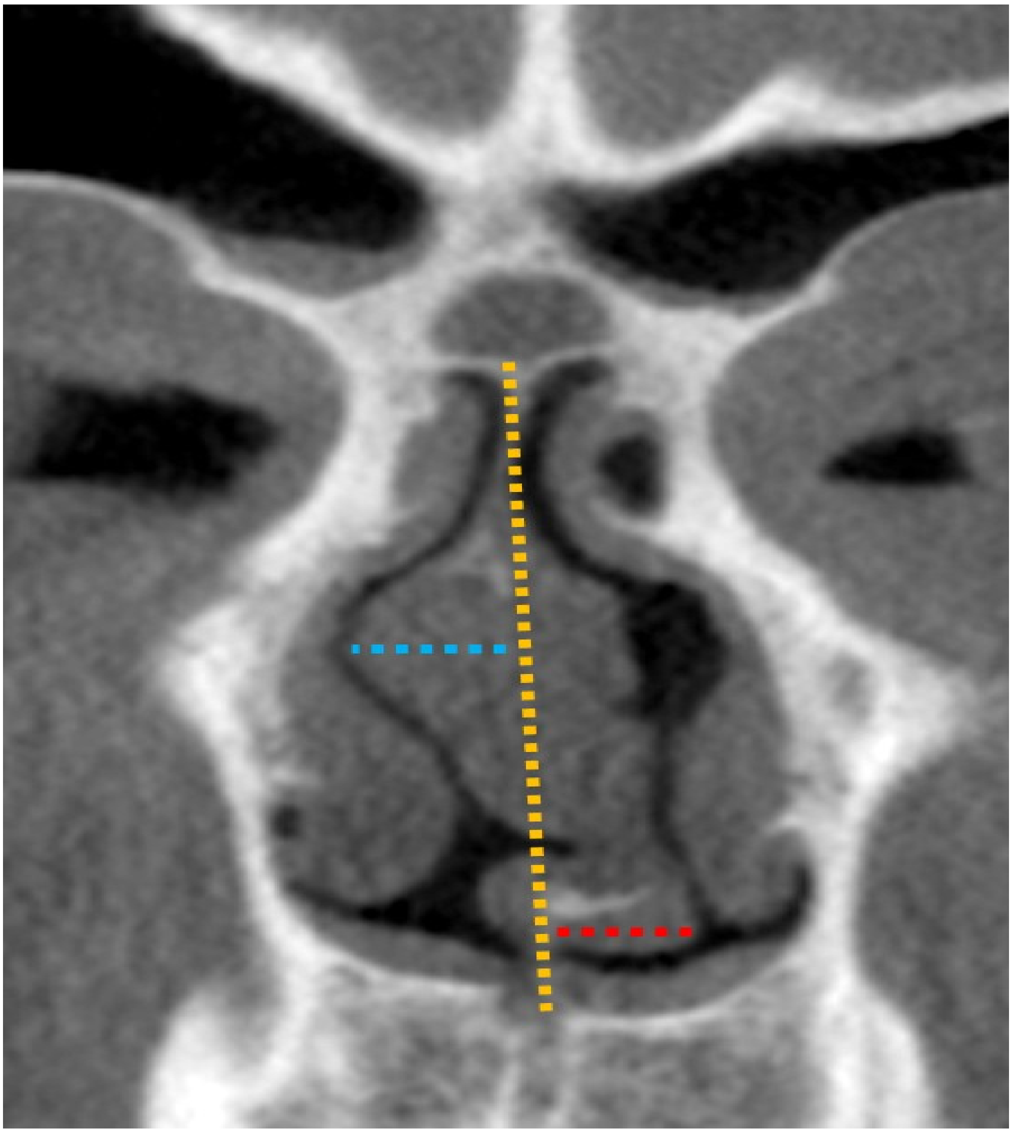

Figure 1.

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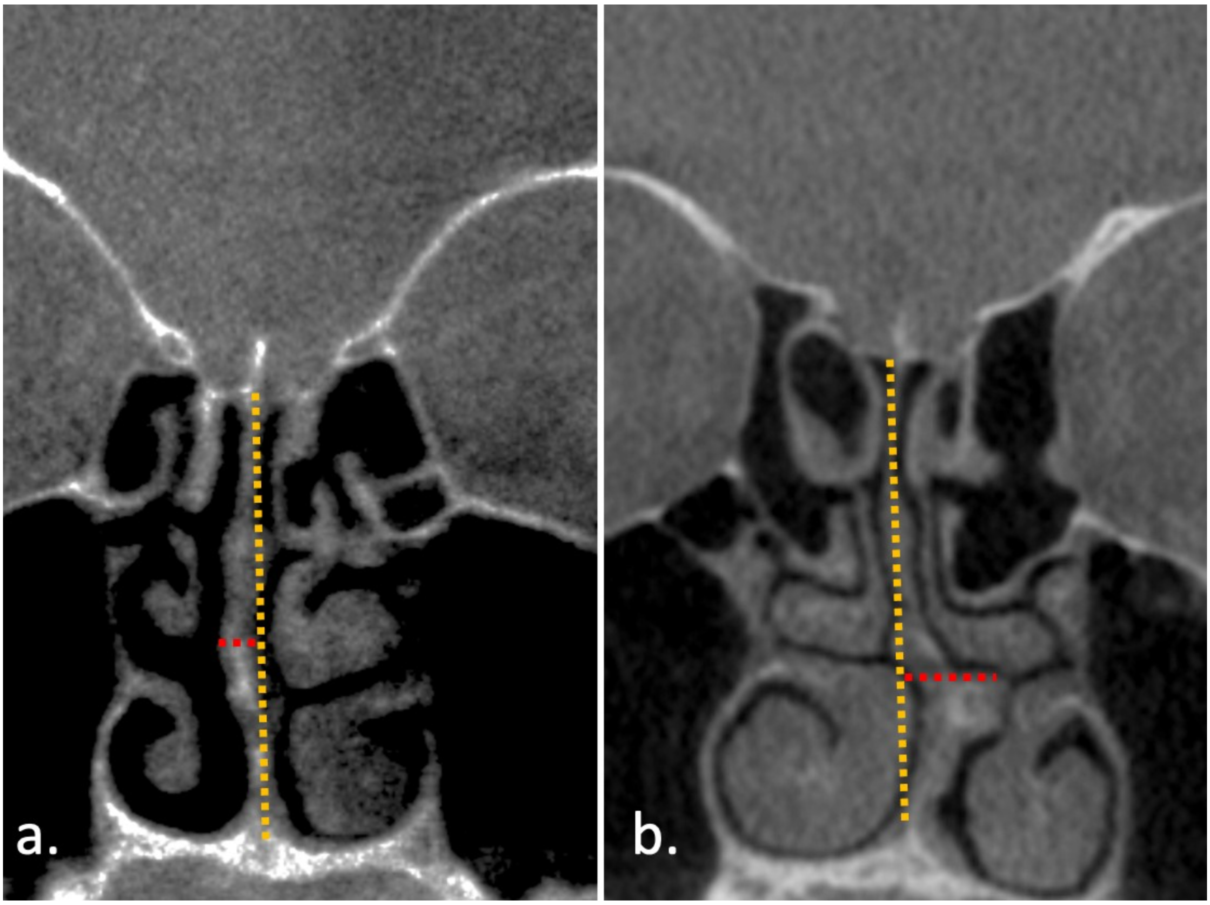

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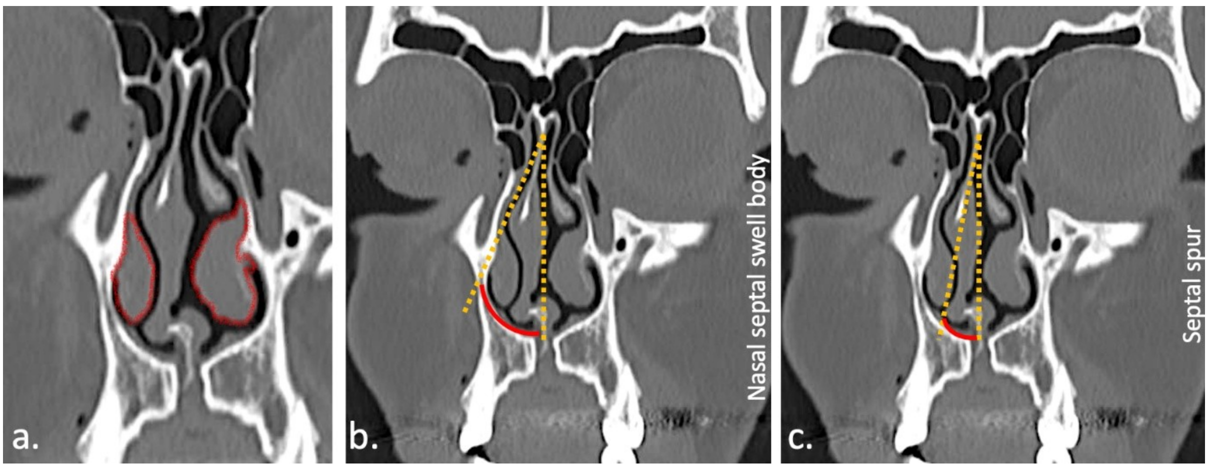

Figure 3.

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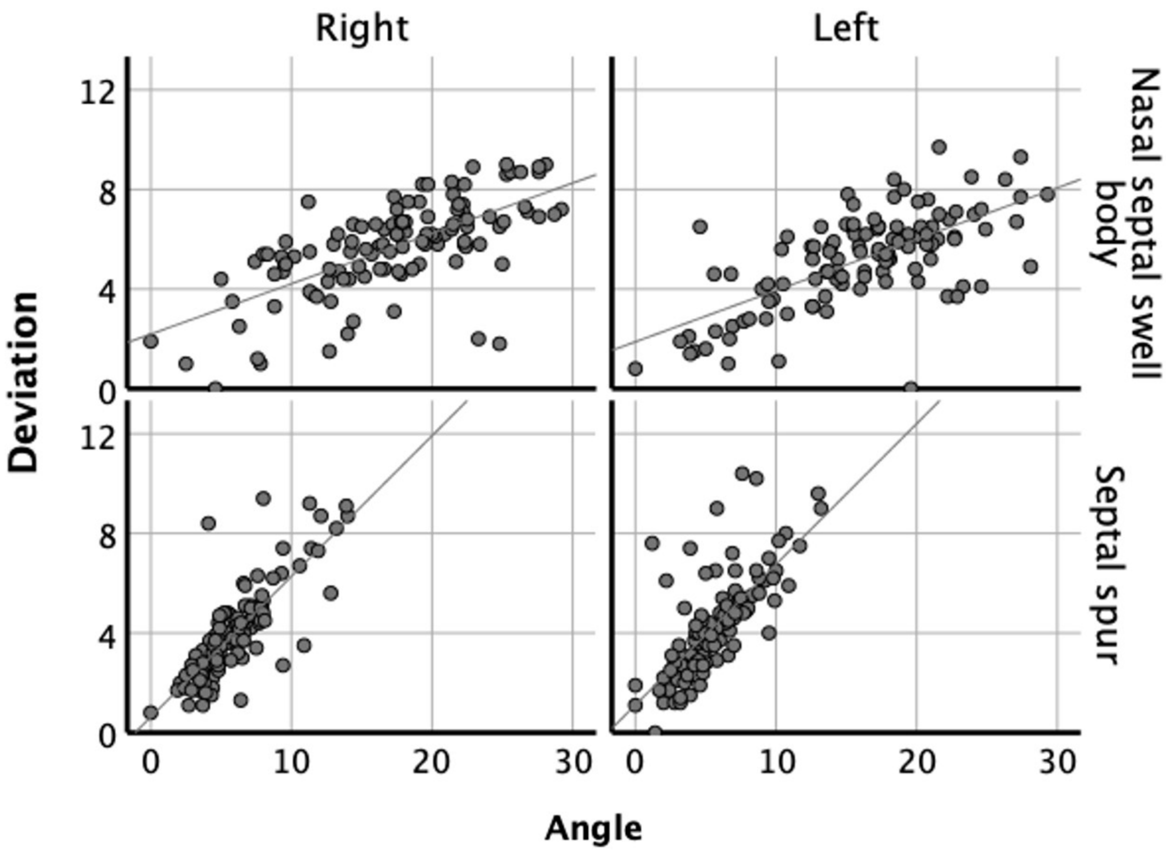

Figure 4.

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