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The accuracy of different methods for diagnosing septal deviation in patients undergoing septorhinoplasty: A prospective study

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Summary *Objective:* This study aimed to determine the diagnostic accuracy of different diagnostic tests in predicting nasal septum deformities during preoperative planning for septorhinoplasty.
Methods: Consecutive patients who underwent septorhinoplasty between June 2011 and August 2012 were included ($n = 30$) and underwent a protocol of diagnostic tests, including nasal speculoscopy, craniofacial computed tomography (CT), three-dimensional (3D) reconstruction of the nasal septum by CT and nasal endoscopy. A modified Guyuron classification of septal deformities was used for classifying the septal deviations. Direct surgical assessment of the nasal septum during open septorhinoplasty was the reference standard with which each of the diagnostic tests was compared. Sensitivity, specificity and predictive values of each test were calculated.
Results: The preoperative diagnosis was nasal bone fracture in 11 patients, nasal septal fracture in 15 and post-traumatic nasal deformity in four. For type A deviations (localised), craniofacial CT showed the highest performance with a sensitivity of 100%, specificity of 100%, positive predictive value (PPV) of 100% and negative predictive value (NPV) of 99%. For type B septal deformations (C shape), nasal endoscopy (sensitivity, 100%; specificity, 87.5%; PPV, 87.7%; and NPV, 100%) showed the highest performance. For type C deformities (S shape), nasal endoscopy (sensitivity, 70%; specificity, 100%; PPV, 100%; and NPV, 87%) showed the highest performance. The accuracy for nasal endoscopy was 27/30 (90%), 26/30 (87%) for

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craniofacial CT, 22/30 (73%) for 3D reconstruction and 10/28 (36%) for speculoscopy.
Conclusions: Nasal endoscopy and craniofacial CT were more accurate and precise than nasal speculoscopy and 3D reconstruction for preoperative evaluation of the nasal septum, thus enabling more appropriate surgical planning for septorhinoplasty.

Introduction

Septorhinoplasty is one of the most complex and challenging surgeries in plastic surgery, even for the most skilled surgeons.[1–3] Its success requires a thorough knowledge of the nasal anatomy and function, as well as a complete understanding of the complex surgical techniques, with the aim of achieving appropriate correction of the specific problems associated with each type of deformity.[1,4,5] In this context, appropriate and rigorous preoperative planning is essential for avoiding unforeseen problems that may affect the surgical outcomes.[6–8] Assessment of the nasal septum and type of deformity is a fundamental step in preoperative planning, as they define the type of technique and the level of surgical complexity.[4,9–14]

The nasal septum not only provides structural support but is also one of the determining factors for nasal shape. In addition, its association with the lateral walls of the nose regulates intranasal flow and breathing.[13,15] Septal deviations have been associated with various levels of obstruction and alterations in nasal breathing.[16–20] Despite their pivotal role in nasal structure and function, consensus regarding the best diagnostic study to investigate septal deviations is lacking,[21,22] and many groups utilise their own protocol based on experience. Therefore, this study aimed to compare the diagnostic accuracy of different tests in predicting the actual state of the nasal septum for appropriate surgical planning.

Materials and methods

Design and patients

Consecutive patients with a suspected clinical diagnosis of nasal bone fracture, nasoseptal fracture or post-traumatic nasal deformity were included. Patients with a medical contraindication for surgery were excluded. To define the septal deformities, all patients underwent a preoperative evaluation that included a prospective protocol of diagnostic tests on consecutive days.

All patients underwent septorhinoplasty at the Division of Maxillofacial Surgery, Hospital del Trabajador de Santiago between June 2011 and August 2012 and provided written informed consent to participate in the study. The institutional review board of the Hospital del Trabajador de Santiago approved the study, which was conducted according to the standards of good clinical practice, the Declaration of Helsinki and the STARD guidelines.

Diagnostic tests

The tests included nasal speculoscopy, craniofacial computed tomography (CT), three-dimensional (3D) reconstruction of the nasal septum by CT and nasal endoscopy, which were assessed by independent observers. One surgeon performed both speculoscopy and nasal endoscopy in all patients. One radiologist performed the CT and 3D reconstruction of the nasal septum. The surgeon and radiologist were blinded to each other's results.

Nasal speculoscopy was performed using a nasal speculum to spread the nasal cavity open through the nostrils, allowing direct visualisation of the nasal septum and turbinates. Preoperative CT consisted of coronal, axial and sagittal views. Using the Brilliance Workspace Station software R4.5 2010 (Philips Medical System, Best, The Netherlands), a 3D reconstruction image of the head was obtained. After perfect symmetrical 3D image parallelisation and use of the segmentation option with the cursor in a freehand mode, all of the structures on the left and right sides of the nasal septum were erased, and a 3D reconstruction image of the nasal septum was obtained (Figure 1). Figures 2 and 3 illustrate the complete preoperative examination for two clinical cases.

To classify the septal deviation, a modified Guyuron classification of septal deformities was used[4]; the modification simplified the method and made it easier to use in daily practice. The findings were classified into three groups: type A, localised deviation; type B, C-shaped deviation; and type C, S-shaped deviation. Type A deformities included Guyuron Classes I and VI (septal tilt and localised spicule, respectively). Type B deformities included Guyuron Classes II and III (C-shaped anteroposterior and cephalocaudal septal deviations, respectively). Type C deformities included Guyuron Classes IV and V (S-shaped anteroposterior and cephalocaudal septal deviations, respectively; Figure 4). The Video in supplemental digital content 1 shows the complete preoperative examination and classification for three cases.

Supplementary video related to this article can be found at http://dx.doi.org/10.1016/j.bjps.2016.02.019.

Measurements

The preoperative findings were validated using the intraoperative anatomical findings. Direct surgical assessment of the nasal septum during open septorhinoplasty was considered the reference standard with which each of the diagnostic tests was compared; this is because after

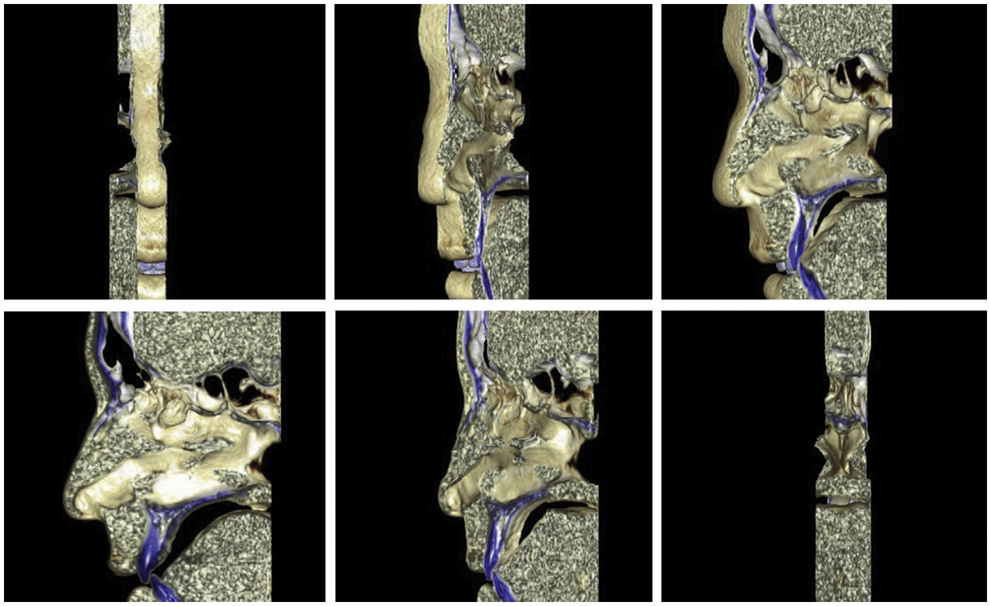

Figure 1 Using the Brilliance Workspace Station software R4.5 2010 (Philips Medical System, Best, The Netherlands), a three-dimensional (3D) reconstruction of the head was obtained. After perfect symmetrical 3D parallelisation and using the segmentation option with the cursor in a freehand mode, all the structures on the left and right side of the nasal septum were erased and a 3D reconstruction of the nasal septum was obtained. Special care was taken to find the exact plane of cleavage between the nasal septum and the surrounding structures and obtain the clearest image. This 3D reconstruction is from patient in Figure 2.

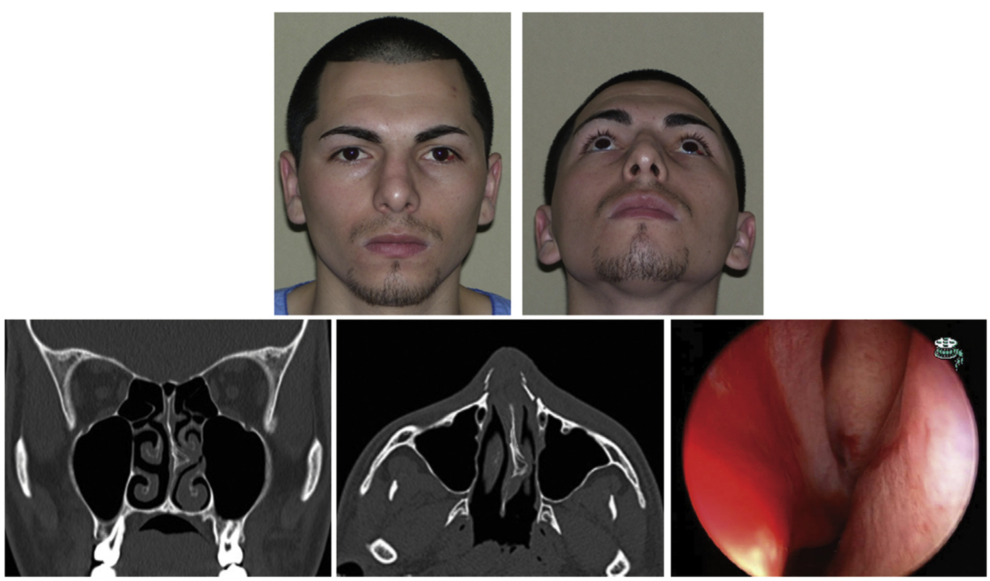

Figure 2 (*Above*) Patient 2 weeks after nasal trauma resulting in a nasoseptal fracture. A mild right nasal axis deviation is observed due to nasal bone fracture. Nasal speculoscopy did not reveal any acute lesion of the mucosa nor a septal deviation. (*Below, left and centre*) CT scan confirms a septal bone fracture, with no major septal deviation but only a posterior spicule at the junction of the vomer and ethmoid bones, protruding into the left nasal fossa. (*Below, right*) Endoscopy and 3D reconstruction (Figure 2) correlate accurately with these findings.

complete subperichondrial and subperiosteal dissection through an open approach, visualisation of the septum is complete and is considered to be 100% sensitive and specific.

The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of each test were calculated for each of the three types of septal deviations. In the comparison of the results from each diagnostic test and the reference standard, global accuracy was defined as the number of correct diagnoses divided by the total number of tests performed with each diagnostic method, that is, the concordance between each test and the reference standard. The demographic characteristics of the studied population were also examined.

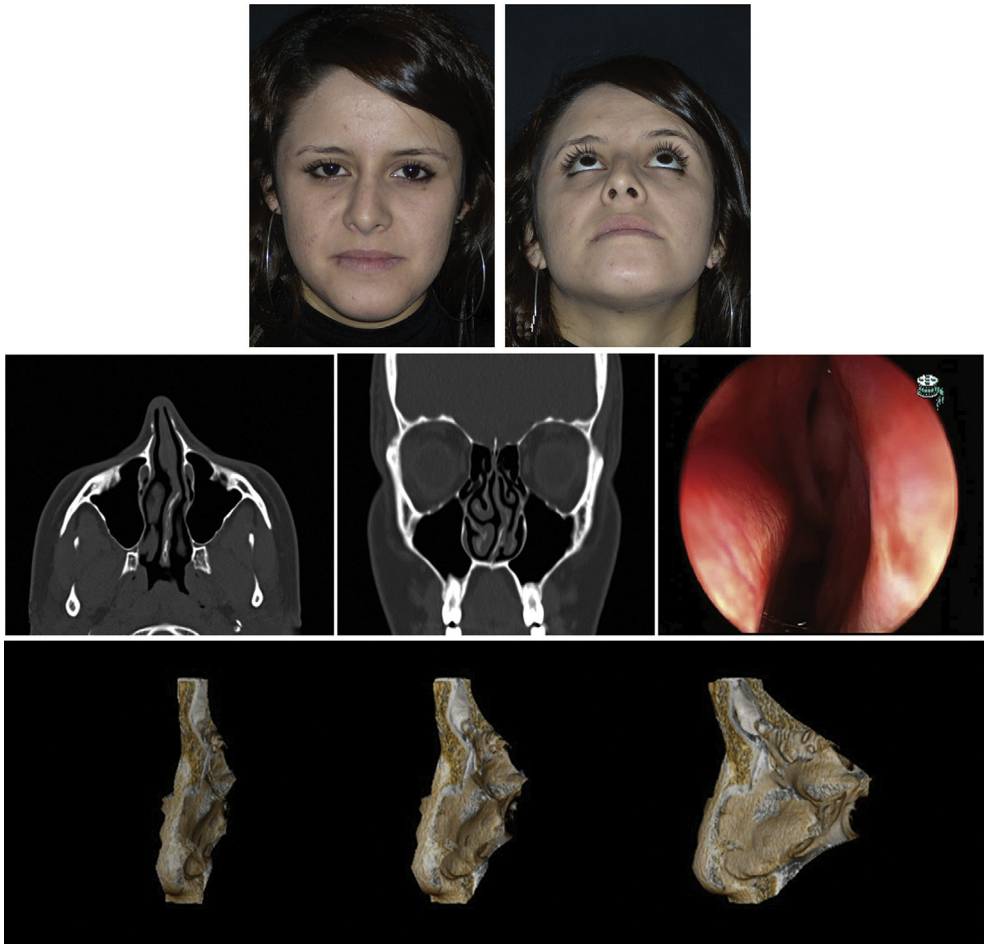

Figure 3 (*Above*) Patient with a post-traumatic nasal deformity. A moderate right nasal axis deviation is observed. Nasal speculoscopy revealed a narrow left nasal fossa. (*Middle, left and centre*) CT scan showed an inverted C septal deviation more prominent in the anteroposterior direction. (*Middle, right*) Nasal endoscopy confirmed these findings. (*Below*) Three-dimensional reconstruction demonstrated a convex septum protruding into the left nasal fossa but with many irregularities and artefacts over its left surface.

Results

The mean age of the 30 consecutive patients (24 men and six women) was 34.4 ± 12.3 years (range, 18–58). The demographic characteristics and preoperative diagnoses are shown in Table 1. Only seven patients had co-morbidities. The diagnosis was nasal bone fracture in 11 patients, nasoseptal fracture in 15 and post-traumatic nasal deformity in four. The intraoperative findings (reference standard) were type A septal deformity in six patients, type B deformity in 14 and type C deformity in 10. Except for two patients who did not undergo nasal speculoscopy, the rest of the study group completed all of the preoperative tests. No adverse effects were associated with the diagnostic tests or the reference standard.

The category analyses for each type of septal deviation are shown in Tables 2–4. For type A deviations, the test with the highest performance was craniofacial CT with a sensitivity of 100%, specificity of 100%, PPV of 100% and NPV of 99%. The test with the lowest performance was speculoscopy (sensitivity 0%, specificity 91%, PPV 0% and NPV 81%; Table 2).

For type B deviations, the test with the highest performance was nasal endoscopy with a sensitivity of 100%, specificity of 88%, PPV of 88% and NPV of 100%. The test with the lowest performance was speculoscopy (sensitivity 57%, specificity 43%, PPV 50% and NPV 50%; Table 3).

For type C deformities, the test with the highest performance was also nasal endoscopy with a sensitivity of 70%, specificity of 100%, PPV of 100% and NPV of 87%. Speculoscopy had the lowest performance with a sensitivity of 22%, specificity of 95%, PPV of 67% and NPV of 72% (Table 4).

The agreement between each diagnostic test and the reference standard is shown in Tables 5–8. Craniofacial CT and nasal endoscopy had the highest global accuracy (90% and 87%, respectively), followed by 3D reconstruction (73%) and nasal speculoscopy (36%).

Discussion

In the present study, craniofacial CT and nasal endoscopy had the highest diagnostic performance for different septal

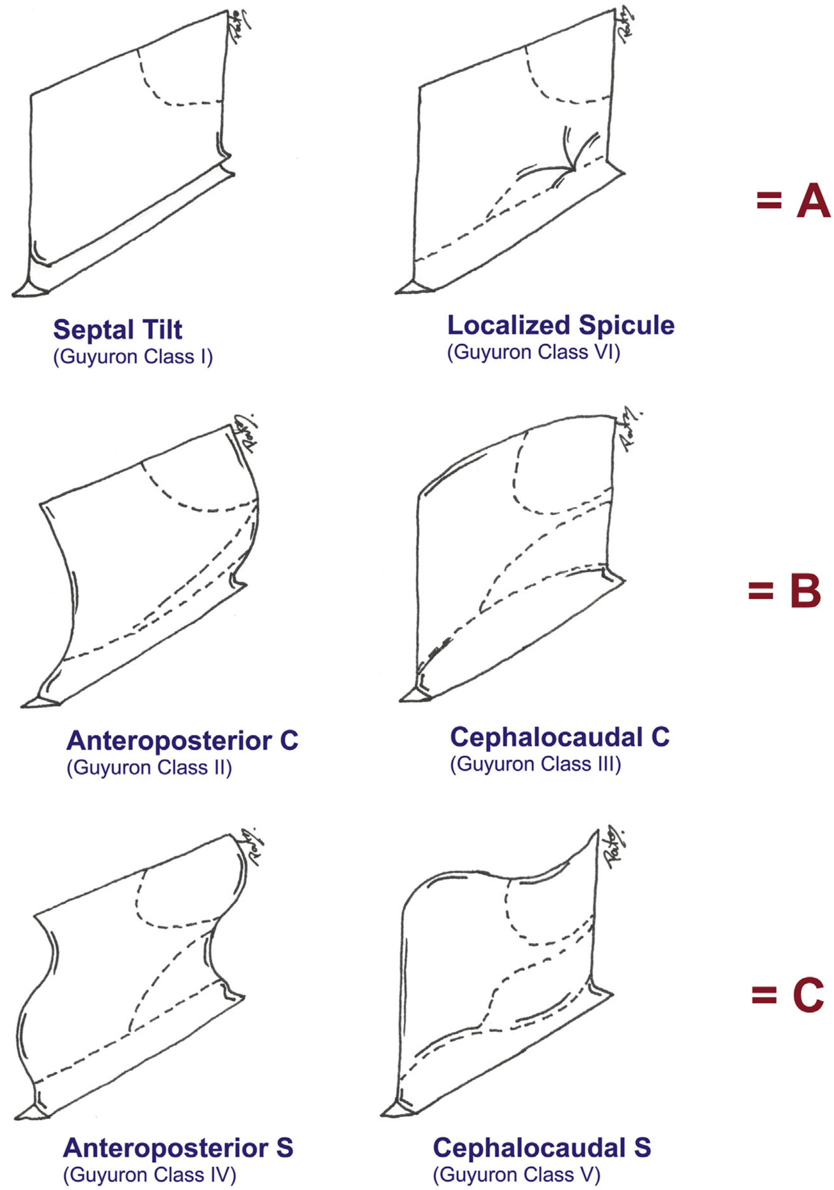

Figure 4 Modification of the Guyuron classification of septal deformities. Findings were classified into three groups, type A: localised deviation, type B: C-shaped deviation, type C: S-shaped deviation. (*Above*) Type A deformities included Guyuron Class I and VI (septal tilt and localised spicule, respectively). (*Middle*) Type B deformities included Guyuron Class II and III (C-shaped anteroposterior or cephalocaudal septal deviations, respectively). (*Below*) Type C deformities included Guyuron Class IV and V (S-shaped anteroposterior or cephalocaudal septal deviations, respectively).

deviations. While craniofacial CT showed the highest performance for type A septal deformities, nasal endoscopy showed the highest performance for type B and C septal deformities; however, the differences in performance were very small. Owing to the small group sizes, statistical analyses were not conducted for the differences between the diagnostic methods. However, these results correlate well with those in the literature; furthermore, the most commonly used methods for visualisation of the nasal septum are CT and endoscopy. The choice between endoscopy and CT depends on the availability and expertise of the resources in each centre. Although CT is operator independent, it exposes the patient to ionising radiations and is expensive. By contrast, endoscopy depends on the operator, with greater interobserver variability; however, it is very reliable when performed by an experienced professional and has lower long-term costs. Therefore, we consider endoscopy as the first choice for preoperative examination in our institute. However, both tests are useful tools during surgical planning because they provide valuable information about the septal deformities.

We also assessed the utility of nasal speculoscopy and 3D reconstruction in the preoperative diagnosis of the nasal septum. Nasal speculoscopy demonstrated the lowest performance of all tests. The technique is simple and inexpensive but only allows visualisation of the anterior third of

Table 1 Characteristics of patients with a suspected clinical diagnosis of nasal bone fracture, nasoseptal fracture or post-traumatic nasal deformity ($n = 30$).

	Mean, standard deviation (range) or n
Age (years)	34.4, 12.3 (18—58)
Gender	
Female	6
Male	24
Co-morbidities	
No	21
Yes	7
Hypertension	2
Previous rhinoplasty	2
Hypothyroidism	1
Tobacco	1
Drug abuse	1
Diagnosis	
Nasal bone fracture	11
Nasoseptal fracture	15
Post-traumatic nasal deformity	4

the nasal septum. Although 3D reconstruction was expected to show better performance, technical issues prevented a clear image of the septum for many patients. During the processing of the 3D images, the turbinates or lateral nasal walls were often in contact with the septum, and it was very difficult to determine the exact plane of cleavage between these structures. Consequently, interpretation of the many artefacts of the 3D images was difficult, thus impairing the performance of this method for the diagnosis of septal status.

Although this study was well designed, some limitations of this study might affect the interpretation of the results. First, the small sample size restricted the number of patients in each group, thus limiting the ability to conduct statistical analyses. Second, there was no control group of patients with a normal septum; however, owing to the use of surgery as the reference standard, it was not possible to use people with a normal nasal septum as controls. Based on the present results, craniofacial CT or nasal endoscopy could be considered the reference standard for a control group in future studies.

We demonstrated that nasal endoscopy and craniofacial CT are more accurate and precise than nasal speculoscopy and 3D reconstruction for preoperative evaluation of the

Table 2 Diagnostic properties for type A deviations ($n = 6$).

	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)
Nasal speculoscopy	0% (0—52)	91% (72—99)	0% (0—84)	81% (61—93)
Computed tomography	100% (64—100)	100% (86—100)	100% (64—100)	100% (86—100)
3D reconstruction	83% (36—100)	92% (73—99)	71% (29—96)	96% (78—100)
Nasal endoscopy	100% (64—100)	96% (79—99)	86% (52—100)	100% (85—100)

CI, confidence interval.

Table 3 Diagnostic properties for type B deviations ($n = 14$).

	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)
Nasal speculoscopy	57% (29—82)	43% (18—71)	50% (25—75)	50% (21—79)
Computed tomography	93% (66—100)	81% (54—96)	81% (54—96)	93% (66—100)
3D reconstruction	86% (57—98)	69% (41—89)	71% (44—88)	85% (55—90)
Nasal endoscopy	100% (77—100)	88% (62—98)	88% (62—98)	100% (77—100)

CI, confidence interval.

Table 4 Diagnostic properties for type C deviations ($n = 10$).

	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)
Nasal speculoscopy	22% (3–60)	95% (74–100)	67% (9–99)	72% (51–89)
Computed tomography	70% (35–93)	95% (75–100)	88% (47–100)	86% (65–97)
3D reconstruction	50% (19–81)	95% (75–100)	83% (36–100)	79% (58–93)
Nasal endoscopy	70% (35–93)	100% (83–100)	100% (59–100)	87% (66–97)

CI, confidence interval.

Table 5 Agreement between nasal speculoscopy and the reference standard.

Nasal Endoscopy	Reference Standard				Total
	Normal	A	B	C	
Normal	0	3	4	0	7
A	0	0	1	1	2
B	0	2	8	6	16
C	0	0	1	2	3
Total	0	5	14	9	28
Agreement	10/28				

Agreement was defined as the number of results that matched between the test and reference standard.

Table 6 Agreement between computed tomography and the reference standard.

Computed Tomography	Reference Standard				Total
	Normal	A	B	C	
Normal	0	0	0	0	6
A	0	6	0	0	2
B	0	0	13	3	16
C	0	0	1	7	8
Total	0	6	14	10	30
Agreement	26/30				

Agreement was defined as the number of results that matched between the test and reference standard.

Table 7 Agreement between 3D reconstruction and the reference standard.

3D Reconstruction	Reference Standard				Total
	Normal	A	B	C	
Normal	0	0	0	0	0
A	0	5	1	1	7
B	0	1	12	4	17
C	0	0	1	5	6
Total	0	6	14	10	30
Agreement	22/30				

Agreement was defined as the number of results that matched between the test and reference standard.

Table 8 Agreement between nasal endoscopy and the reference standard.

Nasal Endoscopy	Reference Standard				Total
	Normal	A	B	C	
Normal	0	0	0	0	0
A	0	6	0	1	7
B	0	0	14	2	16
C	0	0	0	7	7
Total	0	6	14	10	30
Agreement	27/30				

Agreement was defined as the number of results that matched between the test and reference standard.

nasal septum, thereby enabling more appropriate surgical planning for patients undergoing septorhinoplasty.

Conflict of interest

None.

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