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Confirmation of anatomical proximities in endoscopic sinus surgery with computer tomography: A cadaveric study

Confirmation the endoscopic sinus surgery with computer tomography

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Abstract
Aim: The aim of this study was to investigate the confirmation of anatomical proximities between endoscopic sinus surgery with computer tomography.
Material and Methods: This study was done on 5 fresh frozen cadaver heads between May 2017 to June 2018. High-resolution computed tomography (HRCT) was taken before the operations. Firstly uncinectomy was done. Then all stages of functional endoscopic sinus surgery (FESS), which contains anterior-posterior ethmoidectomy, dissection of the sphenoid sinus and frontal recess, and maxillary sinusotomy were performed from anterior to posterior. Distances between each other landmarks and distances to the nasal vestibule were measured during the surgery. All measurements taken during dissection were measured on the coronal, axial, and sagittal section HRCT. Dissection data were compared with radiological data.
Results: As a result of comparing the radiological data and dissection data, there was no significant difference between the data obtained from the sagittal section and the dissection data. A significant difference (P=0.03) was found between the dissection and radiological evaluation in the coronal section except for the measurements of SO-UT (p=0.853) and MP-SA (p=0.972), and in the axial section except for the measurements of the SO-C (p=0.579) and MP-SA (p=1).
Discussion: Measurements obtained in the paranasal sinus CT can be used during FESS. While the data obtained in the sagittal section are suitable for the operation plan and can be used directly, the coronal and axial section are not.

Keywords
Endoscopic Surgical Procedure, Multidetector Computed Tomography, Nasal Sinuses

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Introduction

Technological advances in the therapeutic and diagnostic field in the last three decades have changed the diagnosis and treatment methods in sinonasal and skull-based diseases. With the widespread use of the endoscope, the external approaches applied in the sinonasal region have been replaced by endoscopic methods. Since it is a minimally invasive method, its usage and popularity are increasing day by day.

Working in a narrow field in endoscopic nasal surgeries brings difficulties in the field of view. The fact that the paranasal sinuses are adjacent to vital structures such as the orbit, optic nerve, carotid artery, and skull base carries the risk of complications that may lead to significant morbidity and even mortality [1]. The way to minimize complications is to have a good knowledge of the anatomy of this region [2]. In addition, anatomical orientation and anatomical knowledge during surgery are also very important [3]. In the preoperative examination, endoscopic examination and imaging methods are very important. Anatomical evaluation and variations of the person should be carefully analyzed [4]. The most important guides during surgery are the patient’s radiological images and preoperative evaluations [5]. The most commonly used radiological method in the evaluation of the paranasal sinus region is computed tomography, which provides cross-sectional images [6, 7].

There are many studies that made some anatomical measurements from the radiological images of the paranasal sinuses [8-11]. In the same way, some anatomical measurements were made from cadaver dissections in the literature [12-15]. However, the studies that are comparing radiological data with dissection data are insufficient [16, 17]. In this study, we aimed to find out which section is suitable for the surgical plan by evaluating the measurements taken during the dissection for landmarks and their neighborhoods used in endoscopic sinus surgery in paranasal sinus computed tomography.

Material and Methods

This study was approved by the Ethics Committee of Necmettin Erbakan University (Date: 2016-10-07, No: 2016/687). Between May 2017 and June 2018, functional endoscopic sinus surgery was performed on a total of 10 nasal regions, bilaterally, on 5 fresh frozen cadaver heads in the anatomy laboratory. Before surgery, high-resolution computed tomography (HRCT) was performed on all cadavers with a multislice computed tomography device (SOMATOM Sensation 64 model Siemens). The images were taken with the head parallel to the orbitomeatal line and positioned on the occiput in accordance with the axial plane. Scanning limits were from the alveolar root to the frontal sinus roof. Sections were taken at 120 kilovoltages, 500 milliamperes/second and 0.6 mm thick. Coronal and sagittal sections were obtained with reconstruction.

Cadaver heads were prepared in a position suitable for the operation with a fixation device. For endoscopic sinus surgery, 0°, 30° (Youshi, China: 4.0 mm in diameter, 18 cm in length) and 45° (Karl Storz, Tuttlingen, Germany: 4.0 mm in diameter, 18 cm in length) telescopes were used. After the nasal cavity was cleaned with aspirator and forceps before surgery, the distances of important anatomical landmarks to the nasal vestibule (NV) and each other were measured. Endoscopic sinus surgery was first applied to the right and then left nasal cavity. Various anatomical landmarks were determined to be used in measurements. These anatomical landmarks are Nasal Vestibule (NV), Basal Lamella (BL), Sphenoid Ostium (SO), Sphenoid sinus anterior wall (SA), Posterior wall of sphenoid sinus (SP), Posterior Wall of Maxillary Sinus (MP), Choana (C), Upper turbinate (UT). The following measurements were made between the determined anatomical landmarks: BL – NV, SO – NV, SA – NV, SP – NV, MP – SA, SO – C, SO – UT.

Evaluation of High-Resolution Computed Tomography Images

The distances in the coronal and axial sections were measured by multiplying the number of slices by the slice thickness. The distance between the two structures in the sagittal section was measured directly. However, measurements between the anterior surface of the sphenoid sinus and the posterior wall of the maxillary sinus were made directly between two structures in all sections (Figure 1). Dissection and radiological measurements were statistically evaluated.

Results

Endoscopic sinus surgery procedures were performed on 10 nasal cavities of five fresh frozen cadavers. Demographic characteristics of cadavers are given in Table 1.

Dissection data and radiological data were compared, and the

Table 1. Demographic features.

Cadaver No	Age	Weight	Gender
Cadaver 1	77	170	Female
Cadaver 2	89	79	Female
Cadaver 3	62	200	Female
Cadaver 4	53	175	Male
Cadaver 5	64	120	Male
Mean	69	148	

Table 2. Comparison of Dissection Measurements and Radiological Measurements.

Measurements	Dissection Measurements (cm) Mean ± Sd	Radiological Measurements (cm) Mean ± Sd		
		Coronal	Axial	Sagittal
BL-NV	5.4 ± 0.2	4.3 ± 0.2	2.7 ± 0.1	5.3 ± 0.3
		p=0.003	p= 0.003	p=0.24
SO-NV	6.8 ± 0.09	5.4 ± 0.2	3.4 ± 0.1	6.8 ± 0.3
		p=0.003	p=0.003	p=0.31
SO-C	1.7 ± 0.1	1.2 ± 0.1	1.6 ± 0.1	1.7 ±0.1
		p=0.003	p=0.579	p=1
SO-UT	1.8 ± 0.1	1.8 ± 0.1	0.8 ± 0.1	1.7 ± 0.1
		p=0.853	p=0.003	p=1
SA-NV	6.6 ± 0.3	5.4 ± 0.2	3.3 ± 0.1	6.6 ± 0.3
		p=0.003	p=0.003	p=1
SP-NV	8 ± 0.2	6.5 ± 0.2	4 ± 0.1	8 ± 0.2
		p=0.003	p=0.003	p=1
MP-SA	0.8 ± 0.1	0.8 ± 0.1	0.8 ± 0.1	0.8 ± 0.1
		p=0.853	P=1	p= 1

BL: basal lamella, C: choana, MP: posterior wall of the maxillary sinus, NV: nasal vestibule, SA: anterior wall of the sphenoid sinus, SO: sphenoid ostium, SP: posterior wall of the sphenoid sinus, UT: upper turbinate.

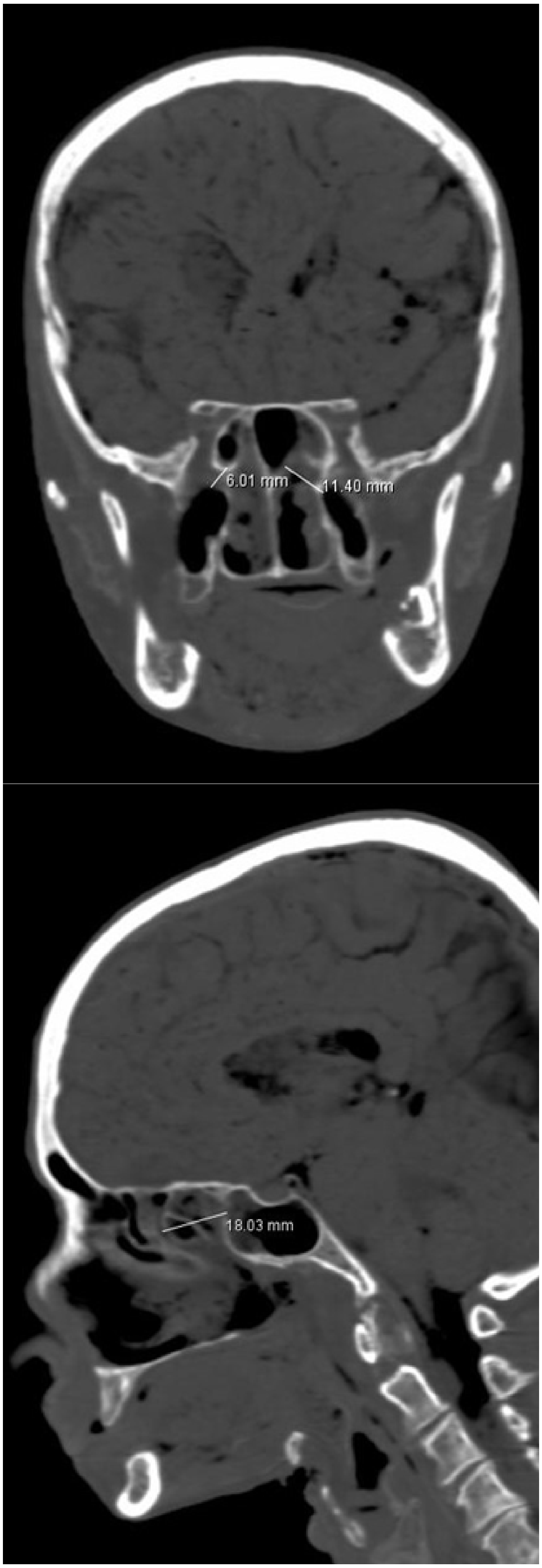

Figure 1. (A) Distance from the posterior wall of the maxillary sinus to the anterior wall of the sphenoid sinus. (B) Sphenoid sinus-superior turbinate measurement in sagittal section.

difference between them was statistically evaluated (Table 2). Since the data obtained from the dissection and sagittal section CT images were measured in the same plane, we used the Wilcoxon signed-rank test in the analysis of the data. The Kruskal-Wallis test was used to compare dissection with the axial and coronal sections, and the Mann-Whitney U test with Bon Ferroni correction was used as the postok. The Mann-Whitney U test was used to compare the axial and sagittal sections. Logistic Regression analysis was used to make the estimation of the dissection data. P<0.05 was considered statistically significant.

No significant difference was observed between the data obtained from the sagittal section and dissection measurements. A significant difference (P=0.03) was found between the dissection and radiological evaluation in the coronal section except for the measurements of SO-UT (P=0.853) and MP-SA (P=0.972), and in the axial section except for the measurements of the SO-C (P=0.579) and MP-SA (P=1).

In the regression evaluation, the data obtained in the axial and coronal sections were considered significant with the R square value of 93.6% to determine the BL dissection measurement. 'BL-NV = (axial section BL measurement*1.21) + (coronal section BL measurement* 0.65) - 6.96' was found. To measure the SO distance, only data in the axial section were considered significant with the R square value of 95.6%. 'SO-NV= 41.11+ (SO-NV * 0.79 in axial section)' was found. For SO-UT, a correlation was found with the sagittal section with an R square rate of 93%. It was 'SO-UT=1.89 + (SO-UT * 0.893 in sagittal section)'. The distance of the SA was found to be related to the sagittal section, with an R square value of 90.7%.'SA-NV=3.2 + (SA-NV * 0.953 in sagittal section)' was found. There was no correlation in the regression test for SP-NV, MP-SA, SO-C.

Discussion

Endoscopy is used in many areas from skull base surgery to simple sinus surgery, orbital decompression, dacryocystorhinostomy or ethmoid/sphenoethmoidal artery ligation [18]. With the development of surgical instruments and the use of angled endoscopes, this diversity continues to increase [19].

Understanding the surgical anatomy of the paranasal sinuses and knowing their anatomical variations can reduce complications in endoscopic nasal surgeries. This requires preoperative evaluation with paranasal sinus tomography [20]. The contribution of imaging methods and measurements to the operation is indisputable, especially in patients who have undergone surgery or whose anatomy is impaired due to pathologies.

Another way to reduce complications is to know the surgical anatomy and the landmarks used during surgery. In functional endoscopic sinus surgery, it is necessary to know the landmarks for anterior ethmoidectomy, maxillary antrostomy, posterior ethmoidectomy, sphenoidotomy and frontal recess.

The basal lamella is a landmark for posterior ethmoidectomy. The distance of the basal lamella to the nasal vestibule was 5.4 ± 0.2 cm. Dissection data and radiological data were almost the same in the sagittal section radiologically. There was no correlation between the axial and coronal sections and the dissection data. However, in the regression analysis, the dissection value was obtained from the axial and coronal sections.

The middle turbinate, superior turbinate, choana and septum are landmarks for the sphenoid sinus. The sphenoid sinus is placed at the posterior end of the middle turbinate. The ostium is located at the anteroinferior border of the superior turbinate and approximately 1-1.5 cm above the choana [20]. The anterior wall of the sphenoid sinus is 5–6 cm from the anterior nasal spine. In our study, we measured the distance between the anterior wall of the sphenoid sinus to nasal vestibule (6.6 cm ± 0.3), and the posterior wall (8 cm ± 0.2).

When comparing dissection measurements with radiological measurements, there was a significant difference in the coronal and axial sections. On the sagittal section, the data were fully compatible with each other. These values showed us that the most suitable image to be used to evaluate the sphenoid sinus is obtained from the sagittal sections.

According to the study by Gupta et al [21], the distances from the sphenoid ostium to the choana (21.21 ± 6.02 mm.), to the posteroinferior of the superior turbinate (8.03 ± 3.52 mm) and to the vestibule (55.1 ± 3.54 mm) were measured on cadavers. In our dissections, the mean distance from the sphenoid sinus ostium to the choana was 1.7 cm ± 0.1, to the anterior border of the superior turbinate: 1.8 cm ± 0.1, and to the nasal vestibule: 6.8 cm ± 0.09. In the comparison of radiological data and dissection data, there was no significant difference in the distance of the SO-NV only in the sagittal section (P=0.317). There were no significant differences in the sagittal and axial sections for the distance of the sphenoid ostium-choana, and in the sagittal and coronal sections for the distance of the SO-UT. In all measurements related to the sphenoid sinus, the sagittal section was the most compatible section. For SO, dissection data were obtained from the axial sections radiologically. The relationship of the SO with UT can be viewed in the coronal section, and its relationship with C can be viewed in the axial section.

Since the sphenoid sinus has gained importance in many fields, including neurosurgery, the search to find a reliable landmark for the sphenoid sinus is still ongoing. Recently, it has been tried to reveal its relationship with the maxillary sinus. In a study by Dedhia et al. [22], the distance of the posterior wall of the maxillary sinus to the sphenoid ostium was measured as 1.5 mm. However, this study was obtained in alive surgery and by calculating the distances of the sphenoid sinus ostium and the posterior wall of the maxillary sinus to the columella. In another study, the measurement was made with the anterior surface of the sphenoid sinus and it was 2-4 mm [23]. In our study, the measurement was made between the anterior surface of the sphenoid sinus and the posterior wall of the maxillary sinus. The average distance was anatomically and radiologically similar and was 8 ± 1 mm. We think that we obtained more reliable data as we directly measured the distances between the two structures in our dissections and in the radiological evaluation.

Limitation

Since the number of cadavers in this study is low and they are of American origin, the data obtained in this study cannot be used in patients. Since we operated on cadavers, it was easy to recognize and measure landmarks due to less bleeding. However, it may not be possible to perform the same measurements in alive surgery due to bleeding and limited access to the operating area. In the future, extensive studies can be conducted on races. The usability of the measurements can be evaluated by comparing the measurements taken in the alive surgery with the measurements taken from cadaver dissection.

Conclusion

In order to evaluate the basal lamella, sphenoid sinus, choana, superior concha, nasal vestibule and maxillary sinus, which are important landmarks used in endoscopic nasal surgery, the sagittal section is the most reliable and suitable section as accordance with the dissection data. Although coronal sections are frequently used in paranasal sinus CT nowadays, the data obtained from sagittal sections are more suitable with the operation plan.

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Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and Human Rights Statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or compareable ethical standards.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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