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Morphometric assessment of sphenoid sinus ostium by cone-beam computed tomography: A retrospective study

Sfenoid sinüs ostiumunun konik ışınlı bilgisayarlı tomografi ile morfometrik olarak değerlendirilmesi: Retrospektif bir çalışma

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ABSTRACT

Objective: The aim of this study was to evaluate the sizes of the sphenoid sinuses ostia, the distance between them, and the distance between the lateral margin of the sphenoid sinuses ostia and the anterolateral wall of the sinuses in the Turkish population.

Methods: The analysis was performed as a retrospective study of 240 cone-beam computed tomography scans of patients using NNT Viewer software program (CeflaGroup, Verona, Italy). Patients over 18 years old with no pathologies present in the sphenoid sinuses were included in the study. Patients who had suffered from head trauma or undergone nasal, orbital, or cranial basis surgery were excluded from the study.

Results: The mean size of both sphenoid sinuses ostia was 2.18 ± 0.42 mm for females and 2.26 ± 0.53 mm for males. The mean distance between both sphenoid sinuses ostia was 6.19 ± 2.10 mm for females and 6.87 ± 2.10 mm for males. The mean distance between the lateral margin of the sphenoid sinuses ostia and the anterolateral wall of the sinuses was 9.66 ± 2.06 mm for females and 10.61 ± 1.95 mm for males. There was no statistically significant difference between the right and left ostium sizes of males and females. Right ostium diameters of cases over 45 years of age were statistically significantly higher than those under 45 years of age.

Conclusion: Intraoperative identification of sphenoid sinus ostium is difficult, and its inadequate excision could lead to potential iatrogenic complications. Therefore, detailed morphometric measurements in populations are needed to perform safe and effective procedures.

Keywords: Anatomy, CBCT, morphometric, sphenoid sinus, spheonid sinus ostium

ÖZ

Amaç: Bu çalışmanın amacı Türk popülasyonunda sfenoid sinüs ostiumlarının boyutunu, aralarındaki mesafeyi ve sfenoid sinüs ostiumlarının lateral kenarı ile sinüslerin anterolateral duvarı arasındaki mesafeyi değerlendirmektir.

Yöntemler: NNT Viewer yazılım programı (CeflaGroup, Verona, İtalya) kullanılarak hastalara ait 240 konik ışınlı bilgisayarlı tomografi (KIBT) taraması retrospektif olarak incelendi. Hastaların 18 yaşından büyük olması ve sfenoid sinüslerde herhangi bir patolojik oluşumun bulunmaması bu çalışmaya dahil edilme kriterleridir. Kafa travması, burun, orbita veya kafa tabanı ameliyatı geçirmiş hastalar çalışmaya dahil edilmemiştir.

Bulgular: Her iki sfenoid sinüs ostiumunun ortalama boyutları kadınlarda 2,18 ± 0,42 mm ve erkeklerde 2,26 ± 0,53 mm idi. Her iki sfenoid sinüs ostiumu arasındaki ortalama mesafe kadınlarda 6,19 ± 2,10 mm, erkeklerde ise 6,87 ± 2,10 mm idi. Sfenoid sinüs ostiumlarının lateral kenarı ile sinüslerin anterolateral duvarı arasındaki ortalama mesafe kadınlarda 9,66 ± 2,06 mm, erkeklerde 10,61 ± 1,95 mm idi. Erkeklerde ve kadınlarda sağ ve sol ostium boyutları arasında istatistiksel olarak anlamlı fark yoktur. 45 yaş üzeri olguların sağ ostium boyutları, 45 yaş altı olgulardan istatistiksel olarak anlamlı düzeyde yüksektir.

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Sonuç: Sfenoid sinüs ostiumlarının intraoperatif tanımlanması zordur ve yetersiz eksizyonlar potansiyel iatrojenik komplikasyonlara yol açabilir. Bu nedenle güvenli ve etkili prosedürleri gerçekleştirmek için popülasyonlarda ayrıntılı morfometrik ölçümlere ihtiyaç vardır.

Anahtar kelimeler: Anatomi, CBCT, morfometrik, sfenoid sinüs, sfenoid sinüs ostiumu

INTRODUCTION

The sphenoid sinuses are located in the center of the skull base and are enclosed by many anatomical structures such as the internal carotid artery, sella turcica, optic nerve, pterygoid nerve, and maxillary nerve.[1,2] The bony septum separates 2 sinuses from each other and is located in the midline. Sizes, dimensions, pneumatization type, and shapes of the sphenoid sinuses vary between individuals.[3,4]

The sphenoid sinuses open sphenoethmoidal recess via an ostium that is located on the superior anterior wall of the sinus.[5,6] Sphenoid ostium is one of the principal points in surgical transsphenoidal approaches.[6-9] The ostium is located 4-5 mm in lateral of nasal septum and 11-14 mm above the base level of the sinus and the diameter of ostium is 2-3 mm.[10-12]

Transsphenoidal surgery is a classical process for the treatment of intrasellar lesions and is generally performed by intervening in the ostium.[13] Differences in morphometry and positions of this ostium may lead to difficulties during surgery.[6,14] Therefore, prior to transsphenoidal surgery, the visualization of this ostium and surrounding structures may decrease the risk of the complication.[15,16]

For preoperative radiological evaluation, knowledge of the morphometric anatomy of the sinus and the ostium is required for transsphenoidal surgery.[6] Computed tomography (CT) and cone-beam computed tomography (CBCT) are fundamental imaging techniques for preoperative assessment.[16] Cone-beam computed tomography is a better technique for assessing the paranasal sinuses and has superiorities compared to CT, such as a shorter imaging time, lower cost, and lower radiation exposure.[17-19]

The goal of this study is to assess the size of the ostium, the distance between both ostia, and the distance between the lateral margin of the ostium and the anterolateral wall of the sinuses by CBCT in the Turkish adult population and investigate the relationship between these parameters with age and sex.

MATERIAL AND METHODS

This retrospective study was approved by the Clinical Research Ethical Committee of Altınbaş University (approval number: 2021/91). The study group consisted of the records of the patients who had x-rays with various indications in the CBCT archive of Altınbaş University Faculty of Dentistry, Department of Dentomaxillofacial Radiology. Written consent forms were obtained from patients before CBCT examinations.

Inclusion criteria were patients over 18 years of age with healthy sphenoid sinuses and patients who had both sphenoid sinuses ostia. Poor quality images and pathological changes such as mucosal thickening, benign or malignant lesions, foreign body, bone destruction, and surgical procedures of nasal, orbital, or cranial basis in one or both sphenoid sinuses were excluded from the study. The study consisted of a CBCT scan of 480 healthy sphenoid sinuses ostia of 240 patients (134 females and 106 males) between the ages of 18 and 86 years.

All CBCT images of the patients were obtained using NewTom VGi evo (CeflaGroup, Verona, Italy) device. The device was set at 1-32 mA and 110 kV with a single 360° rotation created images with a voxel size of 0.3 mm and a field of view (FOV) of 24 × 19 cm. Cone-beam computed tomography images were evaluated using NNT Viewer volumetric software program. Radiological images were evaluated on a 22" high image quality and 1920 × 1080 display resolution Barco medical monitor to provide an effective evaluation by Oral and Maxillofacial Radiology specialist (Ö.O).

The horizontal diameter of sphenoid sinus ostium (Figure 1), the distances between 2 ostia (Figure 2), and the distance between the lateral margin of the ostium and the anterolateral wall of the sinuses (Figure 3) were measured bilaterally by using axial sections. The ostium diameter was determined from the widest points on the axial sections where both ostia were seen together. All measurements were performed by the first author (Ö.O), and 2 weeks later, 20% of CBCTs were selected randomly from all the samples and re-evaluated to test the agreement between observations by the same researcher.

Statistical Analysis

Statistical differences in the diameters of the ostium were analyzed in terms of sex, age, and sinus side. Statistical Package for the Social Sciences (SPSS) Statistics 22 (SPSS International Business Machines, Turkey) software program was used for all statistical analyses. The conformity of the parameters to the normal distribution was analyzed using Shapiro–Wilks and Kolmogorov–Smirnov tests. In addition, Student's *t* test was used for the comparison of normally distributed parameters between

Figure 1. The measurement of the size of the sphenoid sinuses ostia with CBCT axial section. CBCT, cone-beam computed tomography

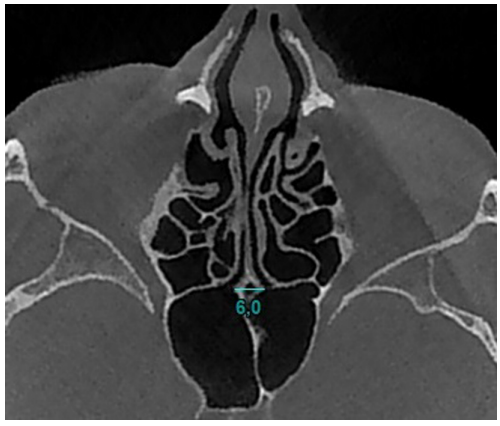

Figure 2. The measurement of the distance between 2 sphenoid sinuses ostia with CBCT axial section. CBCT, cone-beam computed tomography

the 2 groups. Paired sample *t*-test was used for right–left comparisons of normally distributed parameters. The intraobserver comparison was assessed by intraclass correlation coefficient. *P* values <.05 were considered statistically significant.

RESULTS

The coefficient of intraobserver reliability for the measurements was 0.95. This study was carried out on 480 sphenoid sinuses of 240 cases; 106 (44.2 %) males and 134 (55.8 %) females between the ages of 18 and 86 years old, and the mean age of all individuals was 44.6 ± 15.9. Since the average age was determined to be approximately 45 years, the age assessment was evaluated as under 45 years old and above.

The right ostium diameter was 2.10 ± 0.53 mm in females and 2.19 ± 0.58 mm in males. The left ostium diameter was 2.22 ± 0.51 mm in females and 2.29 ± 0.58 mm in males (Table 1). There was no statistically significant difference between the right and left ostium sizes of males and females ($P > .05$). Right ostium diameters of cases over 45 years of age were statistically significantly higher than those under 45 years of age ($P < .05$). Although the left ostium dimensions of the cases over 45 years of age were higher than those under 45 years of age, this difference was not statistically significant ($P > .05$) (Table 2).

Figure 3. The measurement of the distance between the lateral margin of the ostium and the anterolateral wall of the sphenoid sinus with CBCT axial section. CBCT, cone-beam computed tomography

Table 1. The diameter of the sphenoid sinuses ostia according to sex

	Male	Female	
	Mean ± SD	Mean ± SD	*P*
Right ostium	2.19 ± 0.58	2.10 ± 0.53	.247
Left ostium	2.29 ± 0.58	2.22 ± 0.51	.307
Ostium	2.26 ± 0.53	2.18 ± 0.42	.199

Student's *t* test.
SD, standard deviation.
$P < .05$

Table 2. The diameter of the sphenoid sinuses ostia according to age groups

	<45 Years	>45 Years	
	Mean ± SD	Mean ± SD	*P*
Right ostium	2.04 ± 0.58	2.25 ± 0.50	.003*
Left ostium	2.19 ± 0.57	2.32 ± 0.50	.052
Ostium	2.14 ± 0.51	2.31 ± 0.42	.005*

Student's *t* test, *$P < .05$.

The mean left ostium size in males and females was statistically significantly higher than the right side ($P < .05$). In cases under 45 years of age, the mean size of the left ostium was statistically significantly higher than the right side ($P < .05$). Although the mean size of the left ostium was higher than the right in cases over 45 years of age, this difference was not statistically significant ($P > .05$). The mean size of the left ostium in all cases was statistically significantly higher than the right side ($P < .05$) (Table 3).

The distance between the 2 ostia was 6.19 ± 2.10 mm in females and 6.87 ± 2.10 mm in males. The mean distances of the right–left sinus ostium of males were statistically significantly higher than that of females ($P < .05$). There was no statistically significant difference between the age groups in terms of the mean distances of the right–left sinus ostium ($P > .05$) (Table 4).

The distance between the lateral margin of the right ostium and anterolateral margin of the right sinus was 9.51 ± 2.14 mm in females and 10.22 ± 2.10 mm in males. On the left side, this distance was 9.77 ± 2.22 mm in females and 10.95 ± 2.23 mm in males. This measurement on both sides was statistically significantly higher in males ($P < .05$) (Table 5). There was no statistically significant difference between the age groups ($P > .05$) (Table 6).

Table 3. Evaluation of right–left ostium diameter difference according to gender and age groups

	Male	Female	<45 Years	>45 Years	Total
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Right ostium	2.19 ± 0.58	2.10 ± 0.53	2.04 ± 0.58	2.25 ± 0.50	2.14 ± 0.55
Left ostium	2.29 ± 0.58	2.22 ± 0.51	2.19 ± 0.57	2.32 ± 0.50	2.25 ± 0.54
P	.033*	.030*	.005*	.160	.003*

Paired sample *t* test, *$P < .05$.

Table 4. The distance between the right–left ostium according to sex and age groups

	Distance Between Right–Left Ostium	
	Mean ± SD	*P*
Male	6.87 ± 2.10	.013*
Female	6.19 ± 2.10	
<45 years	6.37 ± 2.16	.371
>45 years	6.61 ± 1.97	

Student's *t* test
$P < .05$

Table 5. The distance between the lateral margin of the ostia and the anterolateral wall of the sinuses according to sex

	Male	Female	
	Mean ± SD	Mean ± SD	*P*
Right anterolateral wall distance	10.22 ± 2.10	9.51 ± 2.14	.010*
Left anterolateral wall distance	10.95 ± 2.23	9.77 ± 2.22	.000*
Anterolateral wall distance	10.61 ± 1.95	9.66 ± 2.06	.000*

Student's *t* test.
$P < .05$

Table 6. The distance between the lateral margin of the ostia and the anterolateral wall of the sinuses according to age groups

	<45 Years	>45 Years	
	Mean ± SD	Mean ± SD	*P*
Right anterolateral wall distance	9.91 ± 2.11	9.72 ± 2.19	.503
Left anterolateral wall distance	10.55 ± 2.24	10.01 ± 2.33	.066
Anterolateral wall distance	10.25 ± 2.00	9.89 ± 2.12	.175

Student's *t* test.
P < .05

DISCUSSION

Many variations can occur in the sphenoid sinus and ostium during the development process. The most substantial of these variations relate to sinus type, shape, and size which are important in transsphenoidal surgery.[20,21] Transsphenoidal surgery, first performed in 1907, is a classical procedure for sphenoid sinuses and intracranial lesions.[6]

The ostium is a crucial structure for transsphenoidal surgery, due to its proximity to anatomical structures, including sella turcica, internal carotid artery, cavernous sinus, and optic nerve. If the ostium is missed during surgical process, complications such as arterial bleeding, or septal perforation, or cerebrospinal leakage may occur.[22,23]

In this study, we evaluated the ostium sizes using CBCT, since the ostium and surrounding structures should be assessed radiologically to prevent complications before surgical procedures such as transsphenoidal surgery.[6]

In a CBCT study by Yılmaz et al.[6] the right ostium diameter was found to be 2.19 ± 0.83 mm in females and 2.34 ± 0.84 mm in males, and the left ostium diameter was 2.20 ± 0.88 mm and 2.39 ± 0.93 mm in females and males, respectively. In our study, the right ostium diameter was 2.10 ± 0.53 mm in females and 2.19 ± 0.58 mm in males. On the left side, the ostium diameter was 2.22 ± 0.51 mm in females and 2.29 ± 0.58 mm in males. Similar to our results, Yilmaz et al[6] reported that there was no statistical difference between sex and ostium diameter. In contrast, in another study, the mean size of both ostia was 0.31 cm for both sexes in the Polish population, and statistically significant differences were found in terms of sex and the ostium size.[24] Gupta et al[25] reported that the mean size of the largest diameter of the ostium was 4.29 ± 1.89 mm, while the most of the ostia (83.3 %) were between 2 and 5 mm in diameter in a cadaveric study. In another study with dry skull, it was reported that the widest ostium diameter was 5.61 mm on right side and 5.63 mm on left side and the variability of the ostium location was confirmed during the surgery.[26] In a study with CT angiography, the mean horizontal diameter of ostium was 1.98 ± 0.99 mm and 2.24 ± 1.03 mm on the right and left side, respectively. No significant difference between sexes was reported in terms of the diameter of ostium.[7]

The distance between 2 ostia was 6.19 ± 2.10 mm and 6.87 ± 2.10 mm in females and males, respectively, and no statistical difference was reported between them in our study. Similarly, the distance between the 2 ostia was reported as 7.30 ± 2.77 and 6.09 ± 2.58 mm in females and males, respectively, and there was no statistically significant difference between them.[6] In addition, Jaworek-Troć et al[24] and Göçmez et al[7] reported that there was no statistical difference between sex with regard to distance to each other.

In our study, the distance between the lateral margin of the right ostium and anterolateral margin of right sinus was 9.51 ± 2.14 mm in females and 10.22 ± 2.10 mm in males. The distance between the lateral margin of the left ostium and anterolateral margin of left sinus was 9.77 ± 2.22 mm in females and 10.95 ± 2.23 mm in males. The mean distance between the lateral margin of the ostium and the anterolateral wall of the sinuses was 0.9 cm in females and 0.98 cm in males using CT in the study by Jaworek-Troć et al.[24] The results of their study were statistically significant and are similar to our findings.

When the relationship between ostium diameter and age was examined, right ostium diameters of cases over 45 years of age were statistically significantly higher than those under 45 years of age. In contrast, a significant decrease was found in the diameter of the left ostium with aging.[6]

In our study, no statistically significant difference was reported between age groups regards to the distance between 2 ostia. Similarly, no significant difference was found between age groups.[6]

The limitations of the present study are its small sample size and not being divided into more age groups. The findings may vary in different age groups. Therefore, further studies are needed with a greater number of subjects from different age groups to confirm and compare these findings.

In conclusion, the sphenoid sinus anatomy and ostium vary between individuals. Therefore, 3-dimensional imaging can provide detailed anatomy of the ostium to the surgeons in the preoperative examination. The results of this study may guide surgeons in planning an appropriate treatment and it may be precious to prevent complications during surgery.

Ethics Committee Approval: Ethical committee approval was received from the Clinical Research Ethical Committee of Altınbaş University (Date: December 10, 2021, Approval No: 2021/91).

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

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