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Assessment of the shape and dimensions of sella turcica using cone-beam computed tomography

Evalution of sella turcica with cone-beam computed tomography

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Abstract

Aim: This study aimed to evaluate the shape and dimensions of sella turcica in the Turkish population using cone-beam computed tomography (CBCT).

Material and methods: CBCT records of 798 individuals aged 9-78 years were examined retrospectively. The depth, diameter and length of sella turcica were measured. The shapes of sella turcica were examined and classified as round, oval and flat. The obtained findings were compared according to gender and age groups. The data obtained were analyzed statistically.

Results: The most common shape of sella turcica was round (46.1%). There was a statistically significant difference in all dimensions of sella turcica according to age groups ($p<0.0001$). The length and depth of sella turcica showed a statistically significant difference according to gender ($p<0.0001$). A significant positive correlation was found between age and the dimensions of sella turcica ($p<0.0001$).

Discussion: It was observed that the dimensions of sella turcica increased with increasing age and these dimensions were larger in males. This study with a large sample size can help determine the standard sella turcica sizes. Besides, CBCT can be useful in examining sella turcica and its surrounding anatomical structures.

Keywords

Anatomy; Cone-Beam Computed Tomography; Morphology; Pituitary Gland; Sella Turcica

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Introduction

Sella turcica is located in the sphenoid bone and is a saddle-shaped depression area. It is also known as the pituitary fossa. The boundaries of the sella turcica are formed by the tuberculum sella anteriorly, the dorsum sella posteriorly, and the roof of the sphenoid sinus inferiorly [1]. Sella turcica is located close to vital structures such as optic chiasma, cavernous sinus, hypothalamus, and sphenoid sinus [2]. The pituitary gland is located in sella turcica [3]. The pituitary gland is very substantial in growth and development as it is responsible for most of the endocrine functions. Since the pituitary gland is formed before sella turcica is formed, the development of the sella is associated with the pituitary gland. Changes in the development of the pituitary gland may cause differences in the dimensions and morphology of sella turcica. Sella turcica differs from its normal size, which may raise suspicion of a lurking disease [4, 5]. For example, an increase in the dimensions of sella turcica may indicate acromegaly, turner syndrome, empty sella syndrome and adenomas, while at decrease in size may indicate Williams syndrome, Sheehan's syndrome, type I diabetes, or unilateral cleft lip and palate [6, 7].

Sella turcica is one of the reference points in the analysis of cephalometric radiographs in orthodontics and is frequently used in the evaluation of craniofacial development and facial-skeletal pattern [8, 9]. By examining the morphology of sella turcica, early diagnosis of skeletal malocclusions can be achieved and less complicated treatments can be performed instead of complex treatment methods to be applied in the future [10].

Various methods such as lateral cephalometric radiograms (LCR) [10-12], computed tomography (CT) [1, 5, 13], and cone-beam computed tomography (CBCT)[2, 3, 9, 14] were used to evaluate the normal morphology of sella turcica. The LCR provides a two-dimensional view and the two-sided structures overlap. Therefore, it can be difficult to examine sella turcica with LCR [4]. Three-dimensional imaging techniques such as CT or CBCT can provide clearer information about the anatomy of the sella turcica. CBCT has advantages such as lower-priced equipment, shorter scanning time, and lower radiation dose compared to CT [15]. The evaluation of sella turcica with CBCT is important for examining craniofacial defects, evaluating orthodontic treatment, determining the abnormal structures of sella turcica and establishing standard norms [13].

The dimensions and shape of sella turcica may vary depending on genetic and racial factors, syndromes, and congenital disorders [16]. To detect an abnormality in the sizes and morphology of sella turcica, it is necessary to know the normal morphology and dimensions first. Establishing normal standards is very useful in identifying any abnormality [11]. For this reason, we aimed to determine the shape and morphometric dimensions of sella turcica with a large sample size using CBCT and to investigate the effect of gender and age on sella turcica and contribute to the creation of standard norms in the literature.

Material and Methods

CBCT records of 1000 patients taken for various reasons in the Department of Oral and Maxillofacial Radiology were evaluated. Images of 202 patients were excluded from the study according to the exclusion criteria. The exclusion criteria were the presence of craniofacial deformity or syndrome, cleft lip-palate, history of pathology or surgical procedure in the pituitary region, and poor-quality images. Radiological measurements were made on images of 798 individuals. The dimensions of sella turcica were measured in mid-sagittal sections, but the first evaluation of the relevant region and examination of the suitability of images for the study were carried out in three sections.

All images used in the study were obtained using the CBCT (NewTom 5G, Quantitative Radiology, Verona, Italy) device operating at 110 kVp. Images with 15 × 12 cm FOV range and 0.200 mm voxel size were used. Images were analyzed by an oral and maxillofacial radiologist under dim light using NNT (NNT Software Version 9.1; NewTom; Italy) computer software. The study followed the Helsinki declaration and was conducted with the permission of the Izmir Katip Celebi University Non-Interventional Clinical Studies Ethics Committee (02.07.2020, IRB:835).

In the mid-sagittal section, the following distances were measured: the length from the dorsum sella (DS) to the tuberculum sella (TS); the depth from the middle of the length to the deepest part of the sella; the diameter as the longest distance on the posteroinferior direction between the TS and the pituitary fossa (Figure. 1). The shapes of sella turcica were classified as oval, round and flat (Figure. 2). The depth of the oval-shaped sella turcica was greater than its length, but this shape was not as symmetrical as the round one. The shape of sella turcica, whose depth was less than its length, and whose angles between its base and its anterior and posterior surfaces were close to vertical, was called flat.

Linear measurements were repeated 4 weeks later by the same observer on 160 randomly selected images (20% of images) to determine intraobserver consistency. The intra-observer reliability was evaluated for all variables using the intraclass correlation coefficient, and the intraclass correlation coefficients were between 0.85 and 0.93.

IBM SPSS Version 26 was used for statistical analysis. Descriptive statistical methods (mean, frequency, percentage) were used. Data distribution was determined by the Kolmogorov-Smirnov test. The Mann-Whitney U test was used for differences between means of two independent groups. The Kruskal-Wallis test was used for differences between the means of more than two independent groups. Spearman's rho correlation test was used to evaluate the correlation between measurements and age. A chi-square test was used to compare categorical variables. The level of significance (p-value) was accepted as 0.05.

Results

The study population consisted of 458 women (Mean age=40.3) and 340 (Mean age=42.9) men. The mean sizes of the sella turcica according to gender and age groups are presented in Table 1. There was a statistically significant difference in the length and depth according to both gender and age groups ($p<0.0001$). While no significant difference was observed in the diameter by gender ($p=0.464$), a significant difference was observed according to age groups ($p<0.0001$).

Among the sella turcica shapes, the most common shape was

Table 1. Comparison of the dimensions of sella turcica by gender and age groups

Gender	N	Length Mean (SD)	Depth Mean (SD)	Diameter Mean (SD)
Female	458	9.5 (1.4)	8.3 (1.4)	12.1 (1.4)
Male	340	10.1 (1.6)	7.9 (1.3)	12.1 (1.6)
Total	798	9.8 (1.5)	8.1 (1.4)	12.1 (1.5)
p-value		<0.0001*	<0.0001*	0.464
Age groups				
9-18	125	9 (1.4)[a]	7.5 (1.1)[a]	11.1 (1.2)[a]
19-30	121	9.4 (1.4)[a]	8.1 (1.3)[b]	12 (1.6)[b]
31-45	182	9.9 (1.5)[b]	7.9 (1.3)[b]	12.2 (1.4)[b]
45-60	252	10 (1.5)[b]	8.5 (1.5)[c]	12.5 (1.5)[c]
61≤	118	10.1 (1.5)[b]	8.4 (1.3)[c]	12.4 (1.6)[c]
p-value		<0.0001*	<0.0001*	<0.0001*

The lowercase superscript indicates statistical differences within column (Dunn-Bonferroni post hoc analysis), N: Number of patients, SD: Standard deviation, *Significance (p<0.0001)

Table 2. Spearman's coefficient correlation for evaluating the relationship of age to sella turcica dimensions.

Spearman's rho		Age	Length	Depth	Diameter
Age	Correlation Coefficient	1	0.227**	0.255**	0.266**
	Sig. (2-tailed)		0.000	0.000	0.000
Length	Correlation Coefficient	0.227**	1	0.122**	0.573**
	Sig. (2-tailed)	0.000		0.001	0.000
Depth	Correlation Coefficient	0.255**	0.122**	1	0.487**
	Sig. (2-tailed)	0.000	0.001		0.000
Diameter	Correlation Coefficient	0.266**	0.573**	0.487**	1
	Sig. (2-tailed)	0.000	0.000	0.000	

**Correlation is significant at the 0.01 level (2-tailed).

Table 3. Measurements of the dimensions of sella turcica in the literature

	Imagine Technique	Number of Patients	Sella Length	Sella Depth	Sella Diameter
Nagaraj et al., 2015	LCR	200	9.52	8.21	11.83
Ogunnaike et al., 2016	CT	297	9.81	8.49	11.37
Islam et al., 2017	CT	166	8.63	8.42	9.9
Yasa et al., 2017	CBCT	177	10.32	7.99	11.87
Magat and Sener, 2018	LCR	362	8.22	7.73	11.00
Gargi et al., 2018	CBCT	100	9.15	8.39	9.54
Taner et al., 2019	CBCT	80	10	9	12.2
Silveira et al., 2020	CBCT	95	10.40	8.37	12.89
Usman et al., 2020	CT	175	12.4	9.6	14.1
Present Study	CBCT	798	9.8	8.1	12.1

LCR, lateral cephalometric radiographs; CT, computed tomography; CBCT, cone-beam computed tomography.

round (46.1%), followed by an oval (41.5%) and flat (12.4%). There was a statistically significant difference between sella turcica shapes and gender (p<0.0001). Round-shaped sella turcica (52%) was the most common in females, followed by an oval (40.6%) and flat (7.4%). Oval-shaped sella turcica (42.6%) was the most common in males, followed by round (38.2%) and flat (19.2%).

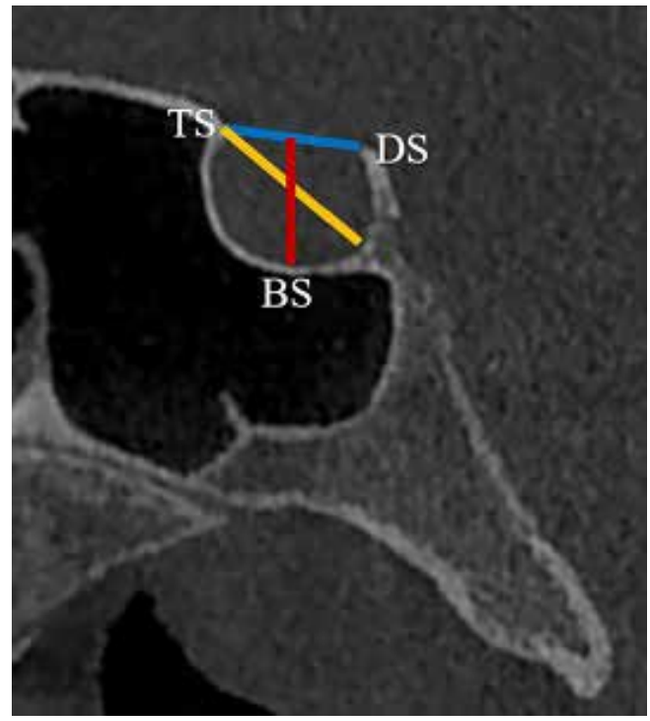

Figure 1. Measuring the sizes of sella turcica. TS, tuberculum sella; DS, dorsum sella; BS, base of sella turcica; blue line, the length of sella turcica; yellow line, the diameter of sella turcica; red line, the depth of sella turcica.

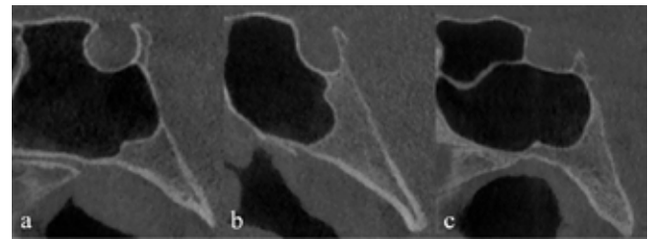

Figure 2. The shapes of sella turcica. (a) Round, (b) oval (c), flat.

Differences in the sizes of sella turcica according to their shapes were investigated. The flat-shaped sella turcica had a mean length of 10.9 mm, a mean depth of 6.8 mm, and a mean diameter of 12.5 mm. The oval-shaped sella turcica had a mean length of 9.9 mm, a mean depth of 8.4 mm, and a mean diameter of 12.5 mm. The round-shaped sella turcica had a mean length of 9.3 mm, a mean depth of 8.3 mm, and a mean diameter of 11.7 mm. There was a statistically significant difference between the shapes of sella turcica and their length, depth and diameter (p<0.0001). The mean lengths of the three shapes of the sella turcica were statistically significantly different from each other. The mean depths of oval and round-shaped sella turcica were similar, while the depth of flat-shaped sella turcica was statistically different from the others. The mean diameters of oval and flat-shaped sella turcica were similar, while the diameter of round-shaped sella turcica was statistically different from the others.

Also, it was investigated whether age affects dimensions. A significant positive correlation was found between age and the length, depth and diameter (p<0.0001) (Table 2).

Discussion

Understanding the morphology of sella turcica is important for examining the pathologies in the pituitary gland and cephalometric analysis. Abnormal situations in the form of sella turcica can provide information about underlying diseases or syndromes [17]. LCR was used in the studies to evaluate sella turcica [12, 18-21]. Although useful data have been obtained with studies performed with LCR, it should be kept in mind that sella turcica cannot be fully examined without using three-dimensional imaging [22]. CT and CBCT are used to obtain more accurate information without magnification and distortion. CBCT enables similar hard tissue images to be acquired with lower radiation dose compared to CT. It also ensures reliable measurements of bone structures without superposition [4]. For these reasons, images obtained with CBCT were used and evaluated in our study.

Researchers have examined the dimensions and anatomical variations of sella turcica according to gender and chronological age [3, 9, 12, 13, 23, 24]. However, there are not many studies with large sample sizes to determine the standard dimensions in the Turkish population [2, 11, 14, 25]. Determining the size of sella turcica is very valuable as it can be a mark of a pathology or a disease in the pituitary gland. For these reasons, in this study, the normal sizes of sella turcica and its relationship with age and gender in the Turkish population were investigated using CBCT images of 798 patients with a wide age range (9-78 years).

The age-related increase in the dimensions of sella turcica is thought to be associated with the increase in the size of the pituitary gland and this increase continues until the age of 16-18 [24]. Choi et al. [23] reported that the dimensions of sella turcica increased by the age of 25, but there was no significant increase after the age of 26. Magat and Ozcan Sener [11] evaluated the sella turcica in subjects between the ages of 9 and 21 and reported that the diameter and depth of sella turcica in the 15-21 age group were greater than in the 9-14 age group. Muhammed et al. [8] examined the sizes of sella turcica in subjects aged 8-28, consisting of Bosnian and Iraqi populations and reported that the diameter, depth and length of sella turcica in the 15-28 age group were greater than the 8-14 age group. Yasa et al. [2] found that sella turcica sizes showed statistically significant differences according to age groups in their study on individuals aged between 11-73 years. Silveira et al. [9] reported that there is no significant correlation between age and dimensions of sella turcica. Gargi et al. [3] determined that there was no correlation between the diameter and length of sella turcica and age, but they found a positive correlation between the depth and age. We also examined whether there was a correlation between age and dimensions of sella turcica and detected a positive correlation between the depth, diameter and length of sella turcica and age. According to the results we obtained, the dimensions of sella may change developmentally throughout life. In this study, we have presented that the sizes of sella turcica increase with increasing age without pathology. In studies, there was no statistically significant difference between the dimensions of sella turcica and gender [1, 2, 5, 12, 14]. Magat and Ozcan Sener [11] and Silveira et al. [9] reported that the mean values of length and depth did not differ significantly according to gender, but the diameter showed a statistically significant difference according to gender and was greater in women. In our study, unlike other studies, a significant difference was observed in mean length and depth according to gender, but there was no statistically significant difference between diameter and gender. The difference between previous studies and this study may be due to the difference in sample size.

Islam et al. [1] reported the prevalence of the basic shape of sella turcica as ovoid (48.2%), flat (28.3%) and circle (23.4%), respectively. Usman et al. [13] determined it as round (56.6%), oval (32%) and flat (11.4%). Yasa et al. [2] found the most common round (69.5%) shaped sella turcica, flat (16.4%) and oval (14%), respectively, and reported that there was no statistically significant difference between gender and sella turcica shapes. In our study, most frequently round (46.1%), then oval (41.5%) and flat (12.4%) were observed, and a statistically significant difference was found between sella turcica shapes and gender.

The normal morphology and dimensions of sella turcica may show ethnic differences and it is important to determine the normal anatomical structure with large sample groups for the detection of pathological conditions. We compared the findings we obtained in the study with the results of other studies in the literature (Table 3). It may be useful to compare the sizes of sella turcica with other studies. In this study, we believe that the dimensions of sella turcica obtained in the Turkish population using CBCT will guide clinicians and these measurements can be used in the detection of pathologies in the sellar region.

In conclusion, it was observed that the sizes of sella turcica increased with age, and the depth and length of sella turcica were greater in males. The results of this study carried out with a large sample size, can be used as reference standards in determining the dimensions of sella turcica in the Turkish population and can contribute to further studies. Besides, sella turcica and surrounding bone structures can be examined in detail using CBCT.

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 comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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