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ORIGINAL ARTICLE

Association between Sella Turcica Morphology and Obesity in Adolescents

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ABSTRACT

Sella turcica is an anatomic point in the cephalometric tracing of orthodontic treatment. The formula for body mass index (BMI) is calculated by using the height and weight of an individual. **Objective:** To evaluate the size and morphology of the sella turcica in healthy, overweight, and obese patients. **Methods:** The 66 individuals (24 males and 42 females; mean age, 15.05 ± 1.61 years) selected for the study were divided into three groups: obese; overweight; and healthy, according to the BMI percentile classification. The length, diameter and depth measurements of the sella turcica were measured on a lateral cephalometric radiograph. **Results:** No statistically significant differences were found among the groups, although the length, diameter, and depth of the sella turcica variations, was more common in 64.7% of the healthy patients, 61.1% of the overweight patients, and 64.3% of the obese patients. **Conclusions:** Normal sella turcica is more common than other types of sella turcica. In addition, no significant difference was found among the groups in terms of length, diameter, and depth of the sella turcica.

Keywords: body mass index percentile, obesity, sella turcica

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INTRODUCTION

The sella turcica, an important anatomic structure in the middle cranial region, is the anatomic formation on the sphenoid bone that holds the pituitary gland. The word "sella" originates from sedes or sedula, which means "seat, stool, or saddle" in Latin, and the word "turcica" refers to the Turks. The term first appeared in Blancard's Physical Dictionary in 1693, and was named due to its similarity with the Turkish saddle.¹

Researchers reported that the anterior and posterior walls of the sella turcica originate from diverse cells.^{2,3} While the anterior wall originates from neural crest cells, the posterior wall originates from notochord cells. Both walls first form as cartilaginous tissue and then become bony tissue due to their developmental processes. Morphologically, the sella turcica increases in size until it becomes stable at approximately 15 years of age.⁴ The sella turcica consists of three parts, including the tuberculum sella, a saddle-like depression for the pituitary gland, and the dorsum

sella.⁵ There are six different anatomic types of sella turcica: normal sella; oblique anterior wall; double contoured sella; sella turcica bridge; irregularity in the posterior part of the dorsum sella; and pyramidal shape of the dorsum sella.⁶ Sella point was determined using lateral cephalometric radiography as a routine standard before orthodontic treatment. In lateral cephalometric radiography, the geometric center of this cavity has an important anatomic structure in cephalometric evaluation before, during, and after orthodontic treatment.⁷

Body mass index (BMI) is calculated using the weight and height of an individual. The formula for BMI used by the Centers for Disease Control and Prevention (CDCP) is calculated by dividing the individual's weight (kilogram) by their height (meters). The CDCP uses BMI percentile to specify the weight status of children and adolescents. BMI percentile, compared with BMI, provides more accurate information about weight status in growing children and adolescent subjects. A BMI percentile <5, between 5 and 84, between 85 and 94, and >95 is considered underweight,



Figure 1. Diagrammatic scheme of sella turcica, and reference lines. DS, dorsum sella; TS, tuberculum sella. Length (1), diameter (2), and height (3) of sella turcica

normal-weighted, overweight, and obese, respectively.⁸ There is a close interaction between the sella turcica and pituitary gland. The pituitary gland completes its developmental stages before the sella turcica. If any disruption occurs in the growth of the pituitary gland, the morphology of the sella turcica also may be disrupted.³ Growth hormone (GH) is controlled by the growth hormone-releasing hormone (GHRH) and somatostatin effect inhibitory hormone (SRIH) released by the pituitary gland. Secretion of GH is decreased in obese individuals.⁹ The objective of this study was to evaluate the size and morphology of the sella turcica in normal-weighted, overweight, and obese adolescent subjects.

METHODS

The study included 66 individuals aged 12 to 18 years chosen from the Orthodontics Department archive of the Ordu University, Turkey, where their lateral cephalometric radiographs were evaluated in terms of the anatomic and physiologic integrity of the sella turcica.

Individuals with a history of orthodontic treatment or orthognathic surgery who underwent trauma or skull surgery, had scar tissue in the cranial area, or had radiographs with poor resolution were excluded from the study. The sample size was calculated based on a power analysis using G*Power Software version 3.1.9.2 (Universität Düsseldorf, Düsseldorf, Germany) for a sella turcica length at α error probability of 0.05 and a power of 85% (effect size = 0.8626578).⁶ The power analysis showed that a total of 54 samples was required. The randomized 66 individuals (24 male and 42 female subjects; average age, 15.05 ± 1.61 years) were divided into three groups of obese (14), overweight (18), and normal-weighted (34) patients, according to the BMI percentile classification.

The length, diameter, and depth measurements of the sella turcica were measured by the same researcher (A.K.) on a lateral cephalometric radiograph (Figure



Figure 2. Various types of sella turcica. (A) normal sella, (B) oblique anterior wall, (C) double contoured sella, (D) sella turcica bridge, (E) irregularity in the posterior part of dorsum sella, (F) pyramidal shape of dorsum sella

1). The distribution of six types of sella turcica was evaluated considering the lateral cephalometric radiographs (Figure 2). The length was defined as the posteroanterior distance between the tuberculum sella and dorsum sella, depth was defined as the distance connecting the deepest point of the sella floor perpendicular to the line connecting the tuberculum sella and dorsum sella, and posteroanterior diameter was defined as the distance between the tuberculum sella and deepest point of the posterior sella.

The Frankfurt plane was parallel to the ground plane during imaging of the lateral cephalometric radiographs using the same cephalometric film device. Linear measurements of the sella turcica were performed using the cephalometric software program (Facad software, trial version 3.6; Ilexis AB, Sweden).

Statistical Analysis

All measurements were analyzed statistically using the SPSS software package (SPSS, Inc., Chicago, IL, USA). After performing the normal distribution test, parametric tests were applied to interpret parameters with normal distribution, while those without normal distribution were analyzed using nonparametric tests. One-way analysis of variance (ANOVA) and a post-hoc Tukey honest significant difference (HSD) test were used to analyze the data measured between the groups, and an independent *t*-test was performed to compare the sexes. In all tests, a *P*-value <0.05 was considered statistically significant.

To analyze intraobserver reliability, 14 lateral cephalometric radiographs were reevaluated by the same researcher after the first assessment.

RESULTS

The intraclass correlation coefficients were 0.994, 0.991, and 0.990 for the sella turcica length, depth, and diameter, respectively, and κ statistic was 1.000 for sella turcica shape, with perfect reliability.

Sella Type	Normal-weighted group, n (%)	Overweight group, n (%)	Obese group, n (%)	All subjects, n (%)
Normal sella turcica	22 (64.7)	11 (61.1)	9 (64.3)	42 (63.6)
Oblique anterior wall	2 (5.9)	0 (0)	2 (14.3)	4 (6.1)
Low sella turcica	3 (8.8)	4 (22.2)	3 (21.4)	10 (15.2)
Sella turcica bridge	3 (8.8)	1 (5.6)	0 (0)	4 (6.1)
Irregular dorsum sella	2 (5.9)	2 (11.1)	0 (0)	4 (6.1)
Pyramidal shape	2 (5.9)	0 (0)	0 (0)	2 (3.0)
Total	34 (100)	18 (100)	14 (100)	66 (100)

Table 1. Distribution of shape of sella turcica among the groups *n*, frequency of subjects

Table 2. Comparisons of sella turcica linear dimensions among the groups

Measurements (mm)	Group	n	Mean	SD	Р	Tukey HSD		
			wiedli	3D		N-OW	N-OB	OW-OB
Length	Normal-weighted	34	9.50	2.21	0.168	0.991	0.999	0.999
	Overweight	18	8.62	1.40				
	Obese	14	8.59	1.53				
Depth	Normal-weighted	34	9.50	1.46	0.988		0.535	0.990
	Overweight	18	7.65	1.02		0.868		
	Obese	14	/.59	1.23				
Diameter	Normal-weighted	34	10.72	1.37	0.557		0.535	0.852
	Overweight	18	10.51	1.26		0.868		
	Obese	14	10.24	1.62				

P; P-value from one-way ANOVA parametric test; SD, standard deviation. p < 0.05. N, normal-weighted; OW, overweight; OB, obese; N-OW, comparison between normal-weighted and overweight groups; N-OB, comparison between normal-weighted and obese groups; OW-OB, comparison between overweight and obese groups

Our results indicated that the normal sella turcica, compared with other sella turcica variations, was more common in 64.7%, 61.1%, and 64.3% of the normal-weighted, overweight, and obese subjects, respectively (Table 1). No statistically significant difference was found among the three groups in terms of sella turcica measurements, although the length, diameter, and depth of the sella turcica were higher in normal-weighted individuals (p>0.05; Table 2).

No significant difference was found between the sexes in terms of the length, diameter, and depth of the sella turcica. However, the length was greater in male subjects, while the depth and diameter were greater in female subjects (p>0.05; Table 3).

DISCUSSION

The skeletal unit is affected by the decrease or increase in the functioning of the functional matrix of anatomic structures. Development of the pituitary gland begins before formation of the sella turcica is completed. The pituitary gland affects the size and shape of the sella turcica. Variations in the size of the pituitary gland indicate pathological diseases associated with

 Table 3. Sella turcica linear dimensions between female and male

Measurement (mm)	Sex	n	Mean	SD	p^{a}	
Length	Male	24	9.59	2.25	0.096	
	Female	42	8.77	1.64		
Depth	Male	24	7.23	1.31	0.069	
	Female	42	7.83	1.24		
Diameter	Male	24	10.28	1.69	0.271	
	Female	42	10.72	1.17		

^aResults of independent *t*-test. *n*, frequency of subjects; SD, standard deviation

hypothyroidism and hyperthyroidism. The presence of even the smallest mechanical coordination in the development of the pituitary gland affects the skeletal compartment.^{10,11}

Valizadeh et al.,⁶ Shah et al.,⁷ and Yasa et al.¹² reported no significant difference between sexes in terms of length, diameter, and depth of the sella turcica. Sakran et al.¹³ found no significant difference in these parameters in their study on male and female cadavers. In our study, no statistically significant difference was found between the sexes in terms of the variations of the sella turcica. However, Axelsson et al.¹⁴ and Sathyanarayana et al.¹⁵ reported in their studies that the sella turcica is longer in male than in female subjects. Likewise, we found the sella turcica to be longer in male subjects. In addition, Yassir et al.¹⁶ and Alkofide¹⁷ found no significant difference between the sexes in terms of the dimensional measurements of the sella turcica; however, they noted that the sella turcica measurements were higher in male subjects. Francis et al.¹⁸ found the sella turcica to be larger in girls. In our study, the depth and diameter of the sella turcica were greater in female subjects.

Canigur Bavbek and Dincer³ reported that a normally shaped sella turcica was less common in children with type 1 diabetes, and that there was no statistically significant difference in the dimensions of the sella between diabetic patients and controls. Korayem et al.¹⁹ found the diameter and depth of the sella turcica to be greater in individuals with Down Syndrome. In addition, the oblique anterior wall was more common in patients with Down Syndrome. Axelsson et al.¹⁴ reported 65% and 71% incidences of a normal sella turcica in females and males, respectively, while Yassir et al.¹⁶ reported incidences of 80.6% and 71.4%, respectively. Alkofide7 and Shah et al.17 reported a normal sella turcica incidence of 67% and 66.7%, respectively, in the majority of the subjects. Axelsson et al.¹⁴ performed a study on Norwegian individuals aged six to 21 years and found that the oblique anterior wall was more common in males, while the sella turcica bridge and irregularity in the posterior of the dorsum of the sella were more common in females. In our study, the normal sella turcica was more common in the normal-weighted, overweight, and obese groups compared with other variations of the sella turcica.¹⁴

GH is controlled by GHRH and SRIH, which are released by the pituitary gland. The secretion and metabolic effect of GH is reduced in obese individuals.9 In addition, when spontaneous somatotropin secretion is impaired in obese individuals, GH half-life, GH secretion attack frequency, and daily GH production are reduced.²⁰ Therefore, two main abnormalities appear because of hyposomatotropism in obese individuals; these are decrease in GH production and reduction in GH half-life. These two changes are correlated positively with excess weight gain. Daily GH secretion and production rates are calculated with a 6% decrease with each unit increase in BMI. When the BMI increases from 21 to 28kg/m², the expected decrease in GH is approximately 50%.²¹ In our study, the size of the sella turcica in overweight and obese subjects was smaller than that in normal-weight individuals; this was in line with the endocrine literature, although this difference was statistically insignificant.

In the literature, the size of the sella turcica has been reported to vary from 4 to 12mm vertically and from 5 to 16mm in the posteroanterior direction.^{11,22} In our study, the average length, diameter, and depth of sella turcica were 8.87 ± 1.7 , 8.25 ± 1.24 , and 10.49 ± 1.42 mm in normal-weighted, overweight, and obese subjects, respectively. In addition, the diameter, length, and depth values of the sella turcica were larger in normal-weighted compared with overweight or obese individuals.

CONCLUSION

In our study, normal sella turcica was the most common type of sella turcica in the normal-weighted, overweight, and obese groups. While trends were observed, no significant difference was found among the three groups in terms of the length, diameter, and depth of the sella turcica. Further studies should be performed using three-dimensional imaging methods in more demographically diverse areas.

CONFLICT OF INTEREST

There are no conflicts of interest or any financial or personal relationships with other people or organizations that could inappropriately bias the conduct and findings this study.

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