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Morphometric Assessment of the Sella Turcica in Different Morphological Types of Class II Malocclusion: A Retrospective Study

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ABSTRACT

Objectives: The sella turcica is a substantial anatomic reference structure used to assess craniofacial growth and treatment changes in orthodontics. The aim of this retrospective study was to analyze the size and morphology of the sella turcica in different subdivisions of Class II malocclusion and to compare these factors to those exhibited in Class I craniofacial development.

Materials and Methods: The study was conducted with 150 patients' pre-treatment lateral cephalometric radiographs. Good quality lateral cephalometric radiographs with a prominent appearance of the sella turcica were grouped into Class II division 1, Class II division 2, and Class I (control group). On lateral cephalograms, the length, diameter, and depth of the sella turcica were gauged and morphological types of the sella turcica were detected. For statistical analysis, one-way ANOVA, Kruskal–Wallis analysis with a Dunn-Bonferroni test, and a chi-square test were used ($p < 0.05$).

Results: A significant difference was found in the length of the sella turcica in the Class II division 2 group ($p < 0.05$) compared to the other groups. The differences in depth and diameter of the sella turcica among all 3 groups were non-significant ($p > 0.05$). The shape of the sella turcica was normal in most of the subjects (60.6%). Conclusion: No significant differences were found among the skeletal Class II division 1, Class II division 2, and Class I groups in terms of diameter and depth of the sella turcica. A smaller length of sella turcica was found in patients with Class II division 2 anomalies.

Keywords: sella turcica, morphology, size, skeletal type

Sınıf II Maloklüzyonun Farklı Morfolojik Tiplerinde Sella Turcica'nın Morfometrik Değerlendirilmesi: Retrospektif Bir Çalışma

ÖZET

Amaç: Sella turcica, ortodontide kraniyofasiyal büyüme ve tedavi değişikliklerini değerlendirmek için kullanılan önemli bir anatomik referans yapıdır. Bu retrospektif çalışmanın amacı, Sınıf II maloklüzyonun farklı alt bölümlerindeki sella turcica'nın boyutunu ve morfolojisini analiz etmek ve bu faktörleri Sınıf I kraniyofasiyal gelişim özellikleri ile karşılaştırmaktır.

Gereç ve Yöntem: Çalışma 150 hastanın tedavi öncesi lateral sefalometrik radyografileri ile gerçekleştirilmiştir. Sella turcica'nın belirgin görünümüne sahip iyi kalitede lateral sefalometrik radyografiler Sınıf II bölüm 1, Sınıf II bölüm 2 ve Sınıf I (kontrol grubu) olarak gruplandırılmıştır. Lateral sefalogramlarda sella turcica'nın uzunluğu, çapı ve derinliği ölçülmüş ve sella turcica'nın morfolojik tipleri belirlenmiştir. İstatistiksel analiz için, tek yönlü ANOVA, Dunn-Bonferroni testi ile Kruskal-Wallis analizi ve ki-kare testi kullanılmıştır ($p < 0.05$).

Bulgular: Diğer gruplara göre Class II divizyon 2 grubunda sella turcica uzunluğunda anlamlı bir fark bulunmuştur ($p < 0.05$). Her 3 grup arasında sella turcica'nın derinlik ve çap farklılıkları önemsizdi ($p > 0.05$). Sella turcica'nın şekli olguların çoğunda normaldi (%60.6).

Sonuç: İskeletsel Sınıf II bölüm 1, Sınıf II bölüm 2 ve Sınıf I gruplar arasında sella turcica çapı ve derinliği açısından anlamlı fark bulunmadı. Sınıf II divizyon 2 anomalisi olan hastalarda daha küçük bir sella turcica uzunluğu bulundu.

Anahtar kelimeler: sella turcica, morfoloji, boyut, iskelet tipi

Lateral cephalograms are generally used in orthodontics to diagnose, plan treatment, predict treatment outcomes, and assess skeletal maturation (1). In the analysis of lateral cephalometric radiographs, several landmarks are used as reference points for the diagnosis of facial skeletal type and evaluation of orthodontic treatments (1, 2). The sella turcica, which means "Turkish saddle" in Latin, is located on the sphenoid bone in the region of the pituitary gland. The sella point in the center of the sella turcica is a crucial reference point in evaluating cranial morphology and intermaxillary relationships (3).

The sella turcica is a saddle-shaped, concave structure that is positioned over the corpus ossis sphenoidale, surrounded by the anterior and posterior vertical walls of the bone (4, 5). It consists of 3 parts: the tuberculum sellae in the front, the dorsum sellae in the posterior, and the fossa hypophysialis in the middle; the pituitary gland, also called the glandula pituitaria, is located in the middle part (5). Abnormal sella size or shape may be detected using cephalometric radiographs of patients with dental anomalies and syndromes (6–9).

The size and shape of the sella turcica have been evaluated by many investigators, and many morphological variations in the sella turcica have been reported (10–14). One of the first studies in this field was carried out by Gordon and Bell (15), who divided sella turcica shapes into 3 groups in general: circular, oval and flattened, or saucer shaped. Later, Davidoff and Epstein (16) used the term "J-shaped sella," whereas Fournier and Denizet (17) used the term "omega sella." However, Axelsson et al. (18) classified the sella turcica morphology into 6 different categories: normal, oblique anterior wall, double contour of the floor, sella turcica bridging, irregularity in the posterior part of the dorsum sellae, and pyramid-shaped dorsum sellae.

The relationships between skeletal facial types and the sella turcica have also been stated by many researchers (10, 19–21). Alkofide (10) compared sella sizes in patients with different skeletal malocclusions and found smaller diameter sizes in skeletal Class II patients; however, larger sizes were found in Class III patients. Karatas et al. (20) identified a significant difference in the sella diameters of skeletal Class I and Class II patients. In the literature, studies analyzing the relationship between skeletal malocclusions and sella turcica morphology have examined Class II malocclusion under a single roof (10, 11). However, there are 2 morphologically quite different subtypes of Class II malocclusion (21). Basdra et al. (21) indicated that Class II division 2 anomalies are closely related to congenital dental anomalies. It has also been observed that the size and shape of the sella turcica differ in congenital anomalies, such as tooth deficiency, impacted teeth, transposition in teeth, or cleft lip and palate (6–8).

Therefore, the aim of this retrospective study was to analyze the size and morphology of the sella turcica in different subdivisions of Class II malocclusion and to compare it to normal Class I craniofacial development using lateral cephalometric radiographs. The null hypothesis was as follows: There are no differences between different skeletal patterns in terms of the size and morphology of the sella turcica.

MATERIALS AND METHODS

This retrospective study was confirmed by the Ethics Committee of İzmir Katip Çelebi University (No: 842). A power analysis was performed using the G*Power statistical software (Cunningham & McCrum-Gardner, 2007). The optimal sample size of the study was calculated as 51 based on an alpha score of 0.05 and a power of 80%. The effect size was calculated as 0.89 based on the study by Sheresta et al. (22), who reported that the length of sella turcica was 7.32±1.62 in the Class II group and 9.16±2.42 in the Class III group. To increase the power of the study, a total of 150 cephalograms were included.

Subjects

The study was performed with 150 pre-treatment lateral cephalograms of patients acquired from the archives of the Department of Orthodontics' Faculty of Dentistry at İzmir Katip Çelebi and Adıyaman University. Good quality cephalometric radiographs featuring a prominent appearance of the sella turcica were grouped into Class II division 1, Class II division 2, and Class I (control group), with 50 persons in each group. The Class II division 1 group included 20 females and 30 males with a mean age of 14.85±1.61 years. The Class II division 2 group included 21 females and 29 males with a mean age of 15.30±1.77 years. The Class I group included 22 females and 28 males with a mean age of 15.32±1.76 years. The demographics of the groups are shown in Tables 1 and 2.

The inclusion criteria for Class I cases were as follows: angle between A point, nasion, and B point (ANB) between 0 and 4 degrees and Angle class I dental relationship. For class II division 1 cases; ANB angle more than 4 degrees, U1/SN (angle between axis of the upper central incisor and plane joining S and N points) more than 98 degrees,

overjet more than 3.5 mm and Angle class II dental relationship. Criteria for class II division 2 cases were; ANB angle more than 4 degrees, U1/SN angle less than 98 degrees, overjet less than 3,5 mm and overbite more than 4 mm. Subjects with congenital tooth anomalies (impaction, missing teeth, supernumerer teeth, transposition cases), or congenital syndromes as a cleft lip/palate, a high angle growth pattern (SN/GoGn>38) and systemic diseases were excluded (21).

Cephalometric evaluation

Dimensions and morphology of sella turcica were evaluated from cephalometric radiographs by the same author (MAY) using Adobe Photoshop CC 2020. To measure of the linear dimension of sella turcica, Silverman (23) and Kisling (24) methods were used. Accordingly; length of sella turcica (distance between the tuberculum sella and the tip of the dorsum sella), anteroposterior diameter of sella turcica (distance from the tuberculum sella to the furthest point on the posterior wall of the fossa) and the depth of the sella turcica (perpendicular to the deepest point of the ground from the line above) were measured (Figure 1).

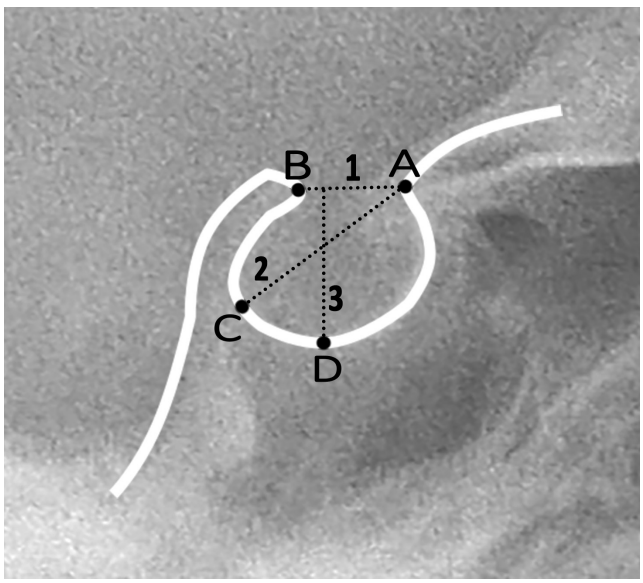

Figure 1. Reference lines used in the measurement of sella turcica size: A, tuberculum sella; B, dorsum sella; C, the furthest point to dorsum sella; D, base of the pituitary fossa. 1, length of sella; 2, sella turcica diameter 3, sella turcica depth

The morphological variations of Sella turcica was detected with respect to classification of Axelsson et al. : (18) normal sella turcica, irregularity in the posterior part of the sella turcica, oblique anterior wall, sella turcica bridge, double contour of the floor and pyramid shaped dorsum sella (Figure 2).

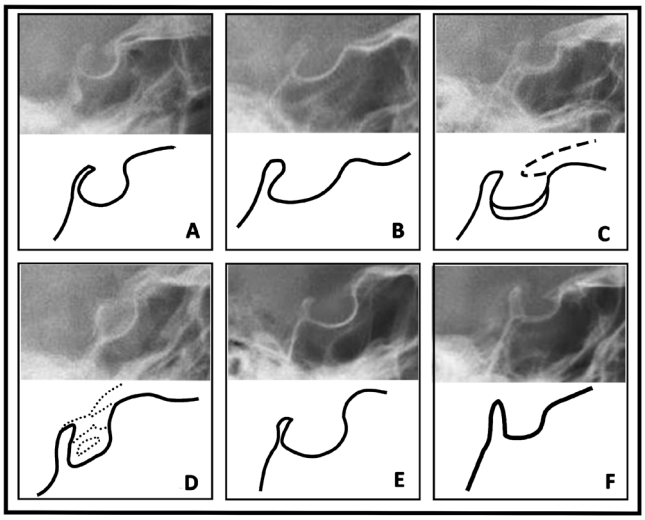

Figure 2. The different shapes of sella turcica: (a) normal sella turcica, (b) oblique anterior wall, (c) double contour of the floor, (d) sella turcica bridge, (e) irregularity in the posterior part of the sella turcica, (f) pyramidal shape of the dorsum sella.

2 weeks after the initial measurements were performed, 10 randomly selected cephalograms in each group were re-evaluated by the same researcher (GG). The Dahlberg (25) formula was employed for the assess of method error. The intra-class correlation coefficient (ICC) was used to quantify intra-examiner reliability.

Statistical analysis and error of the method

The data obtained from the study were analyzed with the IBM SPSS V23 (Armonk, N.Y., USA) software program. Shapiro Wilk normality test and Q-Q graphs were used for the normally distributed variables. Homogenity of variances was evaluated by Levene test. Comparisons of numerical variables by gender were made using Student's t test for variables with normal distribution, and Mann-Whitney U test for variables that did not demonstrate normal distribution. Comparisons of numerical variables by groups were evaluated using one-way analysis of variance for variables with normal distribution, and Kruskal-Wallis analysis for variables that did not show normal distribution. Multiple comparisons were made by Dunn-Bonferroni test in case of difference in Kruskal-Wallis analysis. The relationship among numerical variables was appraised with Spearman correlation analysis. In order to compare the groups with categorical variables, chi-square test was used and $p < 0.05$ was accepted statistically significant.

RESULTS

Intra-observer reliability values were 0.983, 0.989, and 0.999 for length, diameter, depth of the sella turcica, in order of and high level of intra-examiner reliability was detected for each parameter.

In the study, all groups were similar with about gender and age ($p > 0.05$) (Table 1,2). The descriptive statistics for different sella turcica parameters (length, diameter and depth) are presented for skeletal Class II div 1, Class II div 2 and Class I groups separately, in Table 2. No significant differences were found in the depth and diameter values among three groups ($p > 0.05$). However, a significant difference was found in the length of the sella turcica in Class II div 2 group ($p < 0.05$) as per to the other groups. The length of sella turcica was significantly smaller in Class II div 2 subjects (Table 3).

Table 1. Distribution of subjects according to gender

			Gender		Test Stat.	p
			Female	Male		
Groups	Class II div 1	n	20	30	0.164	0.921$^{\Psi}$
		%	40.0	60.0		
	Class II div 2	n	21	29		
		%	42.0	58.0		
	Class 1	n	22	28		
			44.0	56.0		

$^{\Psi}$Pearson Chi Square test. *$p < 0.05$

Table 2. Distribution of subjects according to age

Groups	n	Age (x̄±sd)	Test Statistic	p
Class II div 1	50	14.85±1.61	1.704	0.427$^{\Psi}$
Class II div 2	50	15.30±1.77		
Class I	50	15.32±1.76		

$^{\Psi}$Kruskal Wallis Test. *$p < 0.05$

Table 3. The mean and standard deviation (SD) values of linear measurements of sella turcica by skeletal classifications

	Groups	n	(x̄±sd)	Test Stat.	p
Lenght of sella	Class 1	50	7,74±1,66a	12,120	0.002 ψ
	Class 2 div 1	50	8,19±1,18a		
	Class 2 div 2	50	6,94±1,15b		
Diameter of sella	Class 1	50	7,58±2,46	10,530	0.495 Δ
	Class 2 div 1	50	8,18±1,49		
	Class 2 div 2	50	6,91±1,54		
Depth of sella	Class 1	50	6,56±1,89	10,530	0.731 Δ
	Class 2 div 1	50	7,91±1,34		
	Class 2 div 2	50	7,09±1,06		

$^{\Delta}$ One-way ANOVA; $^{\Psi}$ Kruskal Wallis Test;
a, b,: represent a statistically significant difference; *$p < 0.05$

The appearance of the sella turcica was normal shaped in most of the subjects (60.6%) whereas followed by double contour of floor (18%), oblique anterior wall (8.6%), irregular dorsum (5.3%), pyramidal shape (4.6%). The least seen sella turcica shape was sella turcica bridge (Table 4). There was no significant difference in the morphological appearance of the sella turcica among all different skeletal classes ($p > 0.05$, Table 4).

The relationship of the size of sella turcica among genders and age was also analyzed. Accordingly, there were no statistically significant differences between gender and the mean values of length, diameter and depth of the sella turcica ($p > 0.05$). On the other hand, when the effect of age on the sella turcicas dimensions was investigated, no significant effect was found ($p > 0.05$).

DISCUSSION

In the current study, lateral cephalometric radiographs were used to analyze the size and morphology of sella turcica with different subgroups of Class II malocclusion and to compare it with normal Class I craniofacial development. In addition, the effects of gender and age on sella turcica dimensions were evaluated. Based on the results of the study, the null hypothesis was rejected since differences were found in the sella turcica length in Class II div 2 group.

Table 4. The distribution of shape of sella turcica according to skeletal classification

			Type of sella						Test Stat.	p
			Normal	Oblique Anterior Wall	Doubling of floor	Bridging	Irregularity	Pyramidal		
Groups	Class II div 1	n	34	6	7	1	1	1	11.57	0.315 ψ
		%	68.0	12.0	14.0	2.0	2.0	2.0		
	Class II div 2	n	26	3	10	1	6	4		
		%	52.0	6.0	20.0	2.0	12.0	8.0		
	Class I	n	31	4	10	2	1	2		
			62.0	8.0	20.0	4.0	2.0	4.0		

ψPearson Chi Square test; *p< 0.05

Although the morphology and dimensions of the sella turcica in different skeletal patterns have been examined in the literature, to the author's knowledge, there is no study comparing Class II malocclusion into 2 subgroups as Class II div 1 and Class II div 2. Studies examining the craniofacial characteristics of patients with Class II division 2 malocclusion reported the great variability in forms of Class II malocclusion (21,26). Therefore, it was concluded that examining the patients with skeletal Class II pattern in 2 subgroups while evaluating the sella turcica shape and dimensions would provide more detailed and accurate information.

The estimation of the sella turcica dimensions and its morphological types are significant since changes in the size and shape of sella turcica may be a sign of both pathology in the pituitary gland and various cranio- facial syndromes. Meyer-Marcotty et al. (27) reported an unusual sella turcica morphology like sella turcica bridge in Axenfeld–Rieger, Gorlin-Goltz and Rieger syndromes. Assessments of the size and shape of the sella turcica are important, not only in evaluation of syndromes or pathology in the pituitary gland, but also in terms of craniofacial morphology, growth changes and orthodontic treatment outcomes (18). The association of changes in the dimensions and morphology of the sella turcica with skeletal anomalies has been the focus of our study and it is aimed to use this relationship as a predictor of facial growth models (28).

In many studies, the changes in sella turcica morphology during the growth period were examined and it was reported that sella turcica morphology did not show a significant change after the age of 12 (29,30). Thus, patients aged over 12 years were included in our study.

The morphologic alterations in the sella turcica have been investigated by many authors (10-12). Axelsson et al. (18) concluded that the normal shaped of sella turcica was observed in 14.90% of Class I patients and 13.30% of Class II patients. Alkofide (10) reported that about 67% of Saudi subjects had a normal-shaped sella turcica regardless of skeletal type. Additionally, Shah et al. (31) found normal sella turcica in 65% of Class I subjects and 61.7% of Class II subjects. Sathyanarayana et al. (9) observed normal shaped sella turcica in 75% of Class I patients and 60% of Class II patients. Motwani et al. (2) observed normal shaped sella turcica in 40.59% of Class II subjects. Whereas, Valizadeh et al. (11) reported normal shaped sella turcica only in 16.1% of Class II Pakistani subjects. In our study, normal sella turcica was found in 68% of Class II div 1 patients, 52% of Class II div 2 patients and 62% of Class I patients, which is higher than previously reported. It is thought that the differences in the results obtained in the studies on sella turcica morphology are due to ethnic variability.

The first of the abnormal sella shapes described by Axelsson et al. (18) was the oblique anterior wall. Motwani et al. (2) observed oblique anterior wall in %6.06 of Class I and %4.95 of Class II subjects. Similar results were obtained by Shah et al. (31) They found oblique anterior wall in 3.3% of Class I and 1.7% of Class II patients. In addition, Satyanarayan et al. (9) reported oblique anterior wall in 3% of Class I and 5% of Class II patients. In our study, an oblique anterior wall was seen in 8.6% of the subjects, which was higher than previously obtained.

The double contour incidence was found 14%, %20 and 20%, respectively Class II div 1, Class II div 2 and Class I patients in the current study. In contrast to our study, Shah et al. (31) reported a double contour in 5% of both Class I and Class II patients. Kucia et al. (12) reported double contour incidence rate of 66.6% in class I patients and 11.1% in class II patients.

The rate of sella turcica bridge in normal individuals was reported as 5.5-22% and this rate could be increased in patients with craniofacial disorders (24,32,33). Leonardi et al. (6) reported that the possibility of development dental anomalies was higher in individuals with sella turcica bridge. Shrestha et al. (22) reported that the incidence of the sella turcica bridge was higher in Class II (12.5%) than Class I (5%). Similarly, Obayis et al. (34) observed increased the incidence of the sella turcica bridge in skeletal Class II patients. In contrast, Karatas et al. (20) observed the incidence of sella turcica bridge similar in all 3 skeletal patterns and reported that this value was on average 1.3%. In the current study, we found sella turcica bridge in 4% of Class I cases and 2% of Class II div 1 and div 2 cases. In addition, there were no significant differences between sella morphology and skeletal type. The reason for the low incidence of the sella bridge in our study may be the exclusion of congenital dental anomalies claimed to be related to sella morphology.

We found no significant differences among males and females in terms of the sella turcica dimensions and the shape which was also corroborated by Alkofide (10), Shrestha et al. (22) and Kucia et al (12). However, Axelsson et al. (18) and Sathyanarayana et al. (9) reported that sella turcica depth and anteroposterior diameter were similar between males and females, but sella length was larger in males.

In the current study, no relationship was found among age and the variables of length of sella, diameter of sella, and depth of sella. The current study is in agreement with the study of Silveira et al (35). In contrast, Alkofide (10) and Sathyanarayana et al. (9) concluded that dimension of the sella turcica increase with age. Similarly, Tejavathi Nagara et al. (36), Valizadeh et al. (11) and Turamanlar et al. (37) reported statistically significant differences in terms of chronological age for all three linear dimensions of the sella turcica.

In another cephalometric studies performed by Preston (38) and Shrestha et al. (22), no difference was found among Skeletal Class I and Class II patients in terms of the sella size. Similarly, Tepedino et al. (39) reported no differences in sella length or depth among patients with Class I, Class II, and Class III skeletal patterns. The present study showed that, antero-posterior diameter and depth of the sella turcica did not differ by subgroups of Class II and Class I relationships. While, length of the sella turcica was found significantly lower in Class II div 2 group as per to other groups. This result is predictable, considering that Class II div 2 malocclusion shows more frequent dental anomalies with many other morphological differences (21). Class II div 2 anomaly is similar to Class II div 1 anomaly in terms of mandibular retrognathy, but it exhibits quite different morphological features such as retroclination of the upper incisors, jaw tip prominence, prominent labiomental sulcus, strong masseter muscle (24). The dimensionally significant difference in the morphology of Sella Turcica can be explained by the fact that Class II div 2 anomalies may exhibit different properties not only in viscerocranium but also in cerebrocranium.

Linear difference obtained in sella turcica length in class II div 2 group can be informative for assessment of skeletal pattern on lateral cephalometric radiographs. Thus, it is important for orthodontists to be familiar with the different shapes and sizes of sella turcica.

The results of this study may be highly informative in evaluating the skeletal pattern of adolescent by measuring the diameter of the Sella.

Limitations

Performing the study on 3-dimensional images with a larger sample may increase the accuracy of the results. These are the limitations of our study.

CONCLUSION

1. There was no significant difference between skeletal Class II division 1, Class II division 2 and Class I groups in terms of diameter and depth of the sella turcica.

2. A smaller length value of sella turcica was detected in the Class II division 2 group.

3. There was no significant difference in the dimensions of the sella turcica among genders and age.

DECLARATIONS

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Compliance with ethical standards

Conflict of interest

The authors declare that they have no competing interests.

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Ethical approval

The research ethics committee of Faculty of Dentistry, İzmir Katip Çelebi University, had approved the study (Reference number: 842).

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