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Examination of the Relationship Between Sella Turcica and Impacted Maxillary Canine Teeth: A Retrospective Study

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ABSTRACT

Objectives: In the present study, we aimed to compare the morphological shape and linear dimensions of the sella turcica (ST) between individuals with and without impacted maxillary canines (IMC).
Materials and Methods: Cone-beam computed tomography scans of 120 individuals with IMC (study group) were obtained, retrospectively. This study group was divided into three subgroups: group I (n=40), right IMC; group II (n=44), left IMC; and group III (n=36), bilateral IMC. A control group of 40 individuals without IMC were included in this study from the same archive. The study group was divided into three subgroups: group I (n=40), right IMC; group II (n=44), left IMC; and group III (n=36), bilateral IMC. The shape and the linear dimensions of the ST were evaluated in all groups. Data were analyzed using an independent sample t-test and the chi-square test. The significance level was assigned as p<0.05.
Results: The linear dimensions –length, depth, and diameter– of the ST in the control group were significantly different from those in group I (p=0.050, p=0.001, and p=0.018, respectively), group II (p=0.040, p=0.048, and p=0.006, respectively), and group III (p=0.014, p=0.039, and p=0.007, respectively). In addition, there were no statistically significant associations among ST types in the control and study groups.
Conclusions: The length, depth, and diameter of the ST were greater in the control group than in the individuals with unilateral or bilateral IMC. Also, no relationship was found between the morphological shapes of the ST in individuals with and without IMC.

Keywords: Cone-Beam Computed Tomography, Impacted Canines, Sella Turcica.

Gömülü Maksiller Kanin Dişleri ile Sella Tursika Arasındaki İlişkinin İncelenmesi: Retrospektif Bir Çalışma

Süreç

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ÖZ

Amaç: Bu çalışmada, gömülü maksiller kanin dişleri (GMKD) gömülü olan ve olmayan bireyler arasında sella tursikanın (ST) morfolojik şeklini ve doğrusal boyutlarını karşılaştırmayı amaçladık.
Gereç ve Yöntemler: GMKD olan 120 bireyin (çalışma grubu) konik ışınlı bilgisayarlı tomografi görüntüleri retrospektif olarak elde edildi. Bu çalışma grubu üç alt gruba ayrıldı: grup I (n=40), sağ GMKD olan bireyler; grup II (n=44), sol GMKD olan bireyler ve grup III (n=36), iki taraflı GMKD olan bireyler. Aynı arşivden GMKD olmayan 40 bireylik bir kontrol grubu çalışmaya dâhil edildi. ST'nin şekli ve doğrusal boyutları tüm gruplarda değerlendirildi. Veriler bağımsız örneklem t testi ve ki-kare testi kullanılarak analiz edildi. Anlamlılık düzeyi p<0,05 olarak belirlendi.
Bulgular: Kontrol grubundaki ST'nin doğrusal boyutları –uzunluk, derinlik ve çap– grup I (sırasıyla p=0,050, p=0,001 ve p=0,018), grup II (sırasıyla p=0,040, p=0,048 ve p=0,006) ve grup III'tekilerden (sırasıyla p=0,014, p=0,039 ve p=0,007) önemli ölçüde farklıydı. Ayrıca kontrol ve çalışma gruplarında ST tipleri arasında istatistiksel olarak anlamlı bir ilişki bulunamamıştır.
Sonuçlar: ST'nin uzunluğu, derinliği ve çapı, kontrol grubunda tek taraflı veya iki taraflı GMKD olan bireylere göre daha büyüktü. Ayrıca GMKD olan ve olmayan bireylerde ST'nin morfolojik şekilleri arasında bir ilişki bulunamamıştır.

Anahtar Kelimeler: Konik Işınlı Bilgisayarlı Tomografi, Gömülü Kanin Dişler, Sella Tursika.

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Introduction

The sella turcica (ST), where the pituitary gland is located, is an important anatomical structure of the middle cranial fossa.[1,2] This structure develops through a complex process with different origins. The anterior part of the ST predominantly develops from neural crest cells, while the posterior part develops from the paraxial mesoderm, which is adjacent to the notochord.[3-7] The morphology of the ST ocur during the early embryonic period and retained throughout life.[8,9] However, dimensions of the ST increase during growth and remain constant around 15 years old.[9] To date, many studies have examined the relationship of the ST shape and dimensions with craniofacial dimensions and conditions in the literature.[1,8,10-22] The structural changes in the ST are associated with craniofacial deviations,[11,23] maxillary length,[21] and mandibular prognathism.[22]

ST (especially the sella point) plays a considerable role in orthodontic cephalometric analyses, the determination of the type of skeletal malocclusion, the evaluation of growth changes, and orthodontic treatment results.[17,21,24,25] It has been suggested that the morphology of ST is also related to skeletal malocclusion, craniofacial dimensions, and various congenital and dental anomalies.[1,8,10-18,21,22,24,26-34] This relationship appears to arise from the joint embryological origin of the anterior part of the ST, pituitary gland, and dental epithelial progenitor cells, specifically neural crest cells.[35,36] ST is the main region for migrating these neural crest cells to the maxillary, palatal, and frontonasal developmental zones.[37] Thus, it is of considerable importance to examine the relationship between ST and dental anomalies, especially in the midfacial region. In studies investigating the relationship of ST with various dental anomalies (microdontia, transposition, impaction, hypodontia, hyperdontia), salient differences were observed in morphology and dimensions of ST, and it was stated that there was a clear relationship between these two.[31-34]

Impacted teeth remain completely or partially embedded in the bone or mucosa for over two years beyond the physiological eruption time.[26,38,39] Although there are individual variations in impacted teeth, third molars are the most common, followed by maxillary canines.[40] In the literature, the relationship of impacted maxillary canines (IMC), especially with the morphology and dimensions of ST, attracts attention.[15,17,18,41-44] It is noteworthy to investigate the relationship of the morphological shapes and linear dimensions of ST to these teeth based on possible common embryological or genetic origins of ST and IMC, such as the HOX gene and neural crest cells.

In this research, we aimed to compare the morphological shapes and linear dimensions of the ST among the control group and individuals with IMC with cone-beam computed tomography (CBCT).

Materials and Methods

Study Design

This present study was planned to use CBCT scans from the radiological archives of the Faculty of Dentistry, Atatürk University, retrospectively. After design and planning, the research was approved by the Atatürk University Faculty of Dentistry Ethics Committee (decision number: 2018/1/4), and conducted in eligibility with the Helsinki Declaration as revised in 2013.

Subjects

We included individuals aged 15 years and above in our study. We used CBCT scans of 120 individuals (95 females, 25 males, mean age=31.75) with IMC. The study group was divided into three subgroups: group I (n=40), individuals with right IMC; group II (n=44), individuals with left IMC; and group III (n=36), individuals with bilateral IMC. As a control group, we also included 40 individuals (26 females, 14 males, mean age=26.78) without IMC from the same archive, retrospectively.

CBCT Analysis

All measurements and analyses in this study and control groups were performed with NNT Viewer software (QR-NNT, Quantitative Radiology, Verona, Italy) on CBCT (NewTom FP QR-DVT 9000, Verona, Italy; 110 kVp, 15 mA, 36 s scan time, 21x19 cm field of view-FOV) views in the midsagittal plane (Figure 1a). All evaluations were performed by a dentomaxillofacial radiologist with at least four years of CBCT experience. In case of a conflict in decision making, consensus was reached after discussions with an expert with 10 years of experience at CBCT. All of the CBCT views in this study were re-assessed one mont after the initial assessments by the same observer under the same conditions.

The localization of IMC was classified according to Archer's[45] in our study. Linear dimensions, including the length, depth, and diameter of the ST, were calculated with the methods used by Silverman[46] and Kisling.[47] The length of the ST was calculated as the distance from the tuberculum sellae to the hill of the dorsum sellae (two-pointed arrow in Figure 1b). The depth of the ST was calculated as the perpendicular distance from the arrow joining the tuberculum sellae and the hill of the dorsum sellae to the deepest point on the floor of the fossa (the straight-line in Figure 1b). Finally, the diameter of the ST was measured as the distance among the tuberculum sellae to the farthest point on the posterior inner wall of the fossa (dashed-line in Figure 1b).

The morphology was analyzed according to the classification of basic shapes (oval, round, and flat) by Camp[48] and the classification into six types (type I, normal morphology of ST; type II, oblique anterior wall; type III, ST bridging; type IV, the double contour of the floor; type V, irregularity in the posterior part of the dorsum sellae; and type VI, pyramidal shape of the dorsum sellae) by Axelsson *et al.*[24]

Statistical Analysis

The SPSS ver. 20 (IBM, SPSS Inc., Chicago, IL, USA) was used for all statistical analyses. The agreement between the intra-observer measurements was evaluated using weighted kappa statistics. An independent sample t-test was used to compare the ST dimensions among the study and the control groups. The associations among the morphological shapes of ST were analyzed with the chi-square test. When the p-value was below 0.05, the relationship among the control and study groups was considered statistically significant.

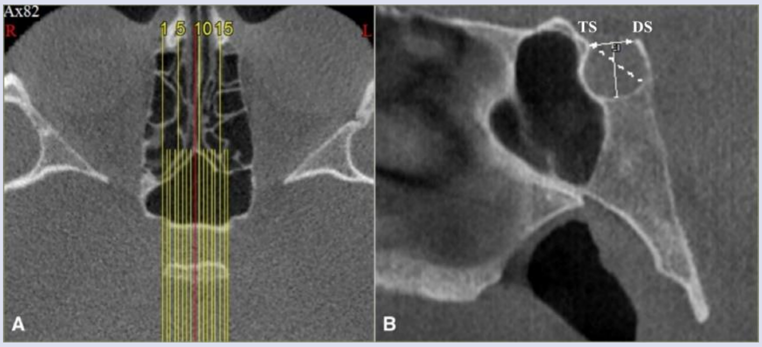

Figure 1. The red line viewed the midsagittal plane selected as a reference CBCT scan for measurements and analysis (a). Reference lines used for measuring the ST sizes on the midsagittal plane (two-pointed arrow, the length of ST; straight-line, the depth of ST; dashed-line, the diameter of ST) (b). TS: Tuberculum Sellae, DS: Dorsum Sellae.

Results

The kappa value for the intra-observer reliability was 0.81. This value indicates good agreement and reliability between the intra-observer measurements. IMC was located in the palatal in 94 (60.25%) of 156 impacted teeth, the vestibule in 19 (12.20%), in both buccal and palatal bone in 21 (13.45%), centrally between the lateral and first premolar teeth in the alveolar process in 17 (10.90%), the edentulous jaw in five (3.20%) (Table 1).

The length, depth, and diameter of the ST in the control group were significantly different from those in group I (p=0.050, p=0.001, and p=0.018, respectively) (Table 2), group II (p=0.040, p=0.048, and p=0.006, respectively) (Table 3), group III (p=0.014, p=0.039, and p=0.007, respectively) (Table 4). The length of the ST in the control group (10.46±1.66 mm) was greater than that in groups I (9.76±1.48 mm), II (9.77±1.37 mm), and III (9.54±1.54 mm) (Tables 2-4). The depth of the ST in the control group (8.76±1.09 mm) was greater than that in groups I (7.86±1.00 mm), II (8.24±1.26 mm), and III (8.18±1.34 mm) (Tables 2-4). The diameter of the ST in the control group (13.28±1.71 mm) was greater than that in groups I (12.46±1.29 mm), II (12.35±1.30 mm), and III (12.28±1.40 mm) (Tables 2-4).

According to the classification of basic shapes, a flat ST was the most common type in groups I and II and the control group, whereas a round ST was the most common type in group III. Oval ST was the least common type in all groups (Table 5). There were no significant differences in ST shape among the control and study groups ($p > 0.05$).

According to the second classification (Axelsson *et al.*[24]), type I was the most common, with a frequency of 47.5% (n=19) in the control group, 57.5% (n=23) in group I, 50% (n=22) in group II, and 47.2% (n=17) in group III. The second most common type of ST was type V in the control and study groups. Type IV ST was detected in only two individuals in the control group and no individual in the study group (Table 6). There were no significant associations among ST types in the control and study groups ($p>0.05$).

Table 1. The localization of IMC according to Archer's.[45]

	n	%
Palatal	94	60.25
Vestibule	19	12.20
Both buccal and palatal bone	21	13.45
Between the lateral and first premolar	17	10.90
The edentulous jaw	5	3.20
Total	156	100

Table 2. Comparison of the ST dimensions (mm) among the study group I and the control group.

	Control Group		Study Group I		t	P*
	n	mean±sd	n	mean±sd		
Length	40	10.46±1.66	40	9.76±1.48	1.990	0.050**
Depth	40	8.76±1.09	40	7.86±1.00	3.856	0.001***
Diameter	40	13.28±1.71	40	12.46±1.29	2.415	0.018****

* Independent sample t-test
**p = 0.05
***p = 0.01
****p < 0.05

Table 3. Comparison of the ST dimensions (mm) among the study group II and the control group.

	Control Group		Study Group II		t	P*
	n	mean±sd	n	mean±sd		
Length	40	10.46±1.66	44	9.77±1.37	2.085	0.040**
Depth	40	8.76±1.09	44	8.24±1.26	2.008	0.048**
Diameter	40	13.28±1.71	44	12.35±1.30	2.779	0.006***

* Independent sample t-test
**p < 0.05
***p < 0.01

Table 4. Comparison of the ST dimensions (mm) among the study group III and the control group.

	Control Group		Study Group III		t	P*
	n	mean±sd	n	mean±sd		
Length	40	10.46±1.66	36	9.54±1.54	2.517	0.014**
Depth	40	8.76±1.09	36	8.18±1.34	2.103	0.039**
Diameter	40	13.28±1.71	36	12.28±1.40	2.767	0.007***

* Independent sample t-test
**p < 0.05
***p < 0.01

Table 5. Comparison of the morphological shape of the ST among the control and study groups, according to basic shapes classification of Camp.[48]

	Control Group		Study Group I		Study Group II		Study Group III	
	n	%	n	%	n	%	n	%
Oval	9	22.5	8	20.0	12	27.3	4	11.1
Round	15	37.5	14	35.0	15	34.1	18	50.0
Flat	16	40.0	18	45.0	17	38.6	14	38.9
x^2			0.211		0.269		2.124	
P*			0.900		0.874		0.346	

* Chi-square test

Table 6. Comparison of the morphological shape of the ST among the control and study groups, according to six types of classification of Axelsson et al.[24]

	Control Group		Study Group I		Study Group II		Study Group III	
	n	%	n	%	n	%	n	%
I	19	47.5	23	57.5	22	50.0	17	47.2
II	1	2.5	3	7.5	2	4.5	2	5.6
III	4	10.0	6	15.0	4	9.1	6	16.7
IV	2	5.0	0	0.0	0	0.0	0	0.0
V	11	27.5	6	15.0	13	29.5	7	19.4
VI	3	7.5	2	5.0	3	6.8	4	11.1
x2			5.452		2.535		3.676	
P*			0.363		0.771		0.597	

* Chi-square test

Discussion

It has been suggested that structural differences in ST are related to the facial skeletal class,[1,8,16,27] skeletal and dentoalveolar dimensions,[21,22,26,28] systemic diseases,[7] and specific anomalies of the midfacial region, such as craniofacial anomalies,[13,24] cleft lip and palate,[11,12,29] and various dental anomalies.[10,14,15,17,18,30] The ST, within which the pituitary gland is situated, mainly develops from neural crest cells, and dental epithelial progenitor cells differentiate from neural crest-derived mesenchyme stem cells.[35,36] Previous studies have reported the relationship of ST with dental anomalies, such as hypodontia,[14,30] dental transposition,[10] and impacted canines.[15,17,18] IMC are one of the most crucial dental anomalies of the midfacial region. Despite the possible common embryological or genetic origin of the s ST and teeth, such as the HOX gene and neural crest cells, a few studies have explored the relationship between the ST morphology with these teeth.

Of the 120 individuals with IMC in our study group, 25 (20.8%) were males and 95 (79.2%) were females. Thus, IMC were more common among females. Many studies have found that age[14,15] and sex[1,8,11,14-16,24,49] do not affect the linear dimensions (length, depth, or diameter) of the ST. However, some studies have reported that age is significantly associated with the size of the ST.[8,17,27] According to Silverman's studies, the dimensions of the ST become nearly stable around 15 years of age in both genders.[46] Additionally, previous research showed that there was no remarkable change in the morphology of the ST after 12 years old.[50] Given the development of the ST, for the ST not to be affected by age-related size changes, we included individuals aged 15 years and above in the present study.

IMC in the palatal position may occur three to six times more often than vestibule position.[26,38,39] In our study, also, 60.25% of all impacted maxillary teeth were located in the palatal. Based on lateral cephalograms, Ali *et al.*[15], Tepedino *et al.*[43] and Vitali *et al.*[42] reported that the length of the ST significantly reduced in patients with impacted palatal canines. Canigur Bavbek *et al.*[44] showed that the diameter of ST was significantly smaller in the bilateral impaction group than in unilateral impaction and control groups. Baidas *et al.*[17] reported significant differences in the three linear dimensions of the ST among individuals with and without impacted canines. On the contrary, in the study of Omastova *et al.*[41], the linear dimensions of ST were significantly higher in subjects with IMC than in controls. Uğurlu *et al.*[25], in CBCT images, reported no among-group differences in the ST measurements of individuals with unilateral or bilateral impacted canines and without impacted canines, other than the right sella length. In the present study, based on CBCT scans, we observed significant differences in the linear dimensions – length, diameter, and depth– of the ST among the control and study groups. Specifically, the length, depth, and diameter of the ST were greater in the control group than in the study groups. This may support the theory that these structures have the same embryological origin. Advanced imaging techniques, such as CBCT, can generate precise information about the ST. The conventional radiographic techniques, which indicate the two-dimensional structure of the ST, cannot provide detailed information about this structure.[12] El Wak *et al.*[20] found significant differences in findings between CBCT scans and lateral cephalograms of the ST. Therefore, we used CBCT scans from archives in our assessments.

According the classification of basic shapes[48] based on CBCT scans of 177 subjects, Yasa *et al.*[49] reported that the ST was round in 69.5%, flat in 16.4%, oval in 14% subjects. Furthermore, Axelsson *et al.*[24] classified the ST shapes into six different types –type I, normal ST; type II, oblique anterior Wall; type III, ST bridging; type IV, double contour of the floor; type V, irregularity in the posterior part of the dorsum sellae, and type VI, pyramidal shape of the dorsum sellae–. In addition, Alkofide[19] examined the shape of the ST in lateral cephalometric radiographs of 180 patients according to the classification of Axelsson *et al.*[24] and revealed that the ST was abnormally shaped in majority of patients with unilateral or bilateral cleft lip/palate compared with that in the individual without this anomaly. Yasa *et al.*[11] found that the shape of the ST significantly differed between patients with and without cleft lip/palate. Valizadeh *et al.*[1] showed a significant association between the facial skeletal class and ST shape, for example, the ST bridging was frequent in class III patients. Omastova *et al.*[41] and Vitali *et al.*[42] reported a higher prevalence of ST bridging in subjects with IMC, and the impaction status was positively associated with the presence and severity of ST bridging. Baidas *et al.*[17], found the ST morphology was normal in 56.4% of individuals with palatally impacted canines, and no significant associations between impaction with the ST shape. In the study by Canigur Bavbek *et al.*[44], normal ST was the most common morphological type in all groups (with and without IMC). It was followed by irregularity (notching) in the posterior part of the dorsum sella. On the other hand, Tepedino *et al.*[43] reported differences in sella morphology between patients with IMC and controls. In our study, according to the classification of basic shapes, a flat ST was the most common type in groups I and II and the control group, whereas a round ST was the most common type in group III. Also, concerning the second classification (Axelsson *et al.*[24]), normal ST (type I) was seen as the most common in the control and study groups. The second most common type of ST also was "irregularity in the posterior part of the dorsum sellae" (type V) in all groups. There were no significant associations among ST shapes in the control and study groups, although the prevalence of various shapes according to the two classifications used differed among the groups. Although few studies have investigated the connection between ST and IMC in the literature, the findings obtained in our study are consistent with the result of Baidas *et al.*[17] and Canigur Bavbek *et al.*[44]

Although this study fulfilled its aims, this study has some limitations. First, the study population could have been designed to be relatively larger. Second, no evaluation was made regarding ST volume, in addition to linear dimensions. Finally, IMCs were classified according to location, but their relationship with ST was not examined. Further studies should be conducted with a larger sample size and other parameters (e.g., volume and the localization of IMC) should be added.

Conclusions

The linear dimensions of the ST differed between individuals with and without IMC in our study. The length, depth, and diameter of the ST were greater in the control group than in the study groups. Therefore, it can be suggested that there is a significant association between IMC and ST sizes. Additionally, no significant difference was found among the control and study groups in the morphology of ST according to both classifications. Also, compared to conventional radiography, CBCT can provide more accurate data about the anatomical structure and linear dimensions of the ST. Although there are many studies conducted cadaver, 2D, and 3D imaging techniques about ST, there are few studies on the relationship between ST and IMC. The present research can be a reference for further studies on the common embryological origin of ST and maxillary canines.

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Conflicts of Interest Statement

The authors declare that they have no conflict of interest.

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