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Association between sella turcica bridging and palatal canine impaction

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Introduction: The association of sella turcica bridging and various dental anomalies has been an area of interest for researchers. Based on the evidence of a common embryologic origin between sella turcica and the teeth, the objectives of this study were to measure the dimensions of sella turcica and to test whether an association exists between sella bridging and impacted canines. **Methods:** Orthodontic records comprising standard-quality lateral cephalograms and dental panoramic radiographs were selected. Thirty-one patients with palatally impacted canines (20 female, 11 male; mean age, 18.4 ± 8.9 years) and 70 controls with erupted canines (35 male, 35 female; mean age, 17.1 ± 7.5 years) were included in the study. Comparison of sella dimensions between the patients and the controls was carried out by independent sample *t* tests, whereas the association of sella bridging with impacted canines was analyzed using the chi-square test. **Results:** The frequencies of complete and partial calcification of sella in the patients were 8 (25.8%) and 17 (54.8%), respectively, whereas those in the controls were 0 and 36 (51.4%), respectively. The frequency of sella bridging was significantly higher in subjects with canine impaction than in the controls ($P < 0.001$). The sagittal interclinoidal distance was found to be significantly reduced in the patients ($P = 0.028$). According to the statistical analysis, age and sex do not influence the dimensions and calcification of sella turcica. **Conclusions:** Sella bridging is frequently found in patients with impacted canines. Hence, sella bridging can complement other diagnostic parameters in confirming the status of canine impaction. (Am J Orthod Dentofacial Orthop 2014;146:437-41)

Maxillary canine impaction is a dental anomaly found in 1% to 2% of clinical situations, with a higher prevalence rate in female patients.[1] The etiology of this anomaly is diversified with underlying local, systemic, and genetic factors. Common theories contributing to the etiology of maxillary canine impaction are guidance theory and the genetic theory.[2,3] According to the genetic theory, impacted maxillary canines are conjointly associated with other genetic abnormalities such as submerged deciduous molars, hypoplastic enamel, mandibular premolar aplasia, and diminutive maxillary lateral incisors.[3,4] Early detection and timely intervention of impacted canines can reduce the time, expense, and complexity of treatment in the permanent dentition. Conventional 2-dimensional and 3-dimensional imaging is routinely used in diagnosing the position and the expected path of eruption of the permanent canines. These radiographs are also a diagnostic tool in detecting skeletal variations related to the skull and cervical spine, including abnormal sella turcica morphology, a sella bridge, or fusion of the cervical vertebrae occurring with craniofacial and dental deviations.[5,6]

Sella turcica has a major importance in the field of orthodontics. The anterior contour of sella turcica is useful in predicting patient growth and in assessing the craniofacial morphology and superimposing serial cephalograms.[7] Orthodontists should be familiar with the morphologic variations of sella turcica that will aid in diagnosing any underlying pathologies associated with it. One common morphologic variation of sella turcica is the sella bridge. Exaggerated ossification of the dura mater between the anterior and posterior clinoidal processes of the sphenoid bone or abnormal embryologic development of the sphenoid bone results in this irregular bridge formation.[8-10] Hence, the sella bridge can be treated as a developmental anomaly.

In healthy persons, the frequency of sella bridging ranges from 1.1% to 13%.[11,12] The dimensions of sella

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turcica vary from 5 to 16 mm in the anteroposterior diameter and from 4 to 16 mm for the vertical depth.[13,14] Until lately, studies have linked the sella turcica bridge to multiple hereditary developmental syndromes affecting the craniofacial region and various systemic disorders.[15-20] It has also been discovered that many local dental anomalies such as tooth transposition, hypodontia, and missing mandibular second premolars have associations with interclinoidal calcification.[21,22]

A survey of the pertinent literature has shown that only limited data are available on this topic; even though the dimensions of sella turcica have a significant impact on interclinoidal calcification, there has only been 1 study in this area.[23] Since sella bridging is considered as a developmental and genetic anomaly, variations in the genetic makeup of different populations might lead to different results. Hence, to establish authentic results, the findings of previous studies need to be replicated in different populations with varying racial backgrounds.

The aims of our study were to compare the dimensions of sella turcica in Pakistani orthodontic patients with impacted vs erupted canines and to test whether an association exists between sella turcica bridging and canine impaction.

MATERIAL AND METHODS

Pretreatment records of 35 subjects with impacted canines were collected retrospectively after screening the records of 707 Pakistani orthodontic patients visiting the dental clinics in the last 5 years. Inclusion of subjects in the study was based on good-quality standardized lateral cephalograms with a clear reproduction of sella turcica. Impacted canines were diagnosed on the basis of dental panoramic radiographs, whereas the buccopalatal position was diagnosed using the vertical parallax technique (dental panoramic radiograph and anterior occlusal radiograph).[24,25] Of the 35 subjects, 31 had palatal impactions, and 4 had buccally impacted canines. Those with buccal impactions were excluded, and the study was conducted on a sample of 31 patients (11 male, 20 female; ages, 14-30 years; mean age, 18.9 ± 8.9 years) with maxillary palatal canine impactions. Subjects with cleft lip and palate, craniofacial anomalies and syndromes, trauma, or previous orthodontic treatment were excluded from the study.

The control group consisted of 70 subjects (35 male, 35 female; ages, 15-33 years; mean age, 17.1 ± 7.5 years) with normally erupted canines. This group was randomly selected from the orthodontic records of 707 patients who visited the dental clinics in last 5 years. The exclusion criteria of the controls were similar to those of the subjects.

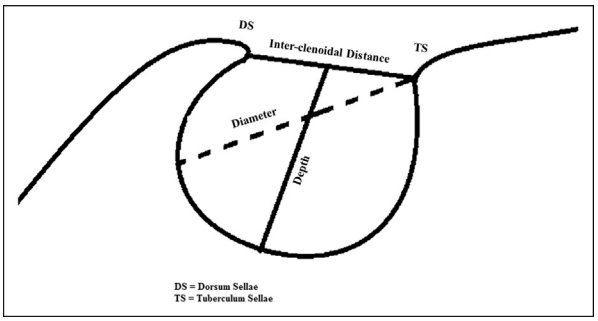

Fig. Linear dimensions of sella turcica (interclinoidal distance, sella depth, and sella diameter).

The post hoc analysis showed that this sample size achieved a statistical power of 0.82 for detecting a clinically significant difference greater than 25% in sella bridging between the subjects and the controls.

Cephalograms were traced manually on acetate sheets with a 0.5-mm lead pencil in a dark room with conventional methods. Sella turcica was drawn as a U-shaped structure from the tip of the dorsum sellae to that of the tuberculum sellae as seen on the radiograph. The linear dimensions shown in the Figure were measured as follows.

1. Interclinoidal distance: distance from the tip of the dorsum sellae to that of the tuberculum sellae.
2. Depth of sella turcica: distance of a line dropped perpendicular from the line above to the deepest point on the sella floor.
3. Anteroposterior diameter of sella turcica: distance from the tip of the tuberculum sellae to the farthest point on the inner wall of the hypophyseal fossa.

To evaluate and quantify the level of bridging, the standard scoring scale developed by Leonardi et al[21] was used. On the basis of sella dimensions, the bridging was classified into 3 groups.

1. No calcification: this was rated as type I, where the length was either equal to or greater than three fourths of the diameter.
2. Partial calcification: this was rated as type II, where the length was equal to or less than three fourths of the diameter.
3. Complete calcification: this was rated as type III, where only the diaphragm sellae was visible on the radiograph.

To determine the intraexaminer agreement in the identification of the sella turcica bridge, 30 randomly

selected lateral cephalometric radiographs were retraced and reevaluated by the principal investigator (B.A.) 2 weeks after the initial analysis. The kappa coefficient value was 0.83, showing a substantial strength of agreement.[26]

SPSS software for Windows (version 19.0; SPSS, Chicago, Ill) was used for the statistical analysis of the data. The chi-square test was performed to test the degree of calcification in both groups. The strength of the association between sella bridging and impacted canines was estimated by calculating the odds ratio. Subjects with partial and complete bridging were grouped in 1 category, and logistic regression analysis was performed. The independent sample t test was used to evaluate differences in the mean sella dimensions between the patients and the controls. $P \leq 0.05$ was considered statistically significant.

RESULTS

The mean dimensions of sella turcica in the subjects and the controls are shown in Table I. Independent sample t tests comparing the mean interclinoidal distances between the groups showed a reduced distance among the subjects with impacted canines ($P < 0.012$). The comparison of mean depths and diameters between the subjects and the controls was insignificant. The patient group was further analyzed for sex dimorphism, which showed no statistically significant difference in sella dimensions ($P > 0.05$) (Table II).

The highest frequency of type II calcification was reported in 17 patients (54.8%), whereas most subjects in the control group (34; 48.6%) had type I calcification of sella ligaments. Type III calcification of the interclinoid ligament was observed in 8 (25.8 %) subjects with impacted canines, whereas no subjects had type III calcification in the control group (Table III). Chi-square statistics were calculated for evaluating the degree of sella bridging in both groups, and the overall proportion of interclinoid ligament calcification differed significantly ($P < 0.001$). When we computed the degree of sella bridging between the sexes in the patients, no significant difference ($P < 0.436$) was noted (Table IV). The strength of the association between sella bridging and impacted canines was estimated by calculating the odds ratio. The odds of having partial and complete bridging among the patients was 3 to 4 times greater than in the control group (odds ratio, 3.93; 95% CI, 1.43-10.7).

DISCUSSION

In this study, we focused on the dimensions of sella turcica and the association of sella bridging in subjects with impacted vs erupted canines. These 2 parameters have not been previously studied in Pakistani orthodontic patients.

Altered morphology of the anterior wall of sella, anterior clinoidal process, and sella length plays a pivotal role in bridge formation. True bony union occurs at an early age, and insignificant changes are observed in sella length and sella bridge as a child matures.[11] Moreover, the anterior part of sella turcica, the pituitary gland, and the dental epithelial progenitor cells share a common embryologic origin, which is the predominant derivative of neural crest cells.[27] The sella turcica is the prime area for the migration of neural crest cells to maxillary, palatinal, and frontonasal developmental fields.[20] In addition, mutations in the *homeobox*, *HOX*, or *sonic hedgehog* genes negatively influence the development of the midface, the teeth, and parts of sella turcica.[28,29] According to the above theories, the canines and sella turcica share a common embryology; hence, alterations at the developmental level can result in a sella bridge that can simultaneously lead to impacted canines.

According to our study, the interclinoidal distance was reduced in patients with impacted canine, whereas sella depth and diameter showed no significant differences between the study groups. Our results agree with those of Najim and Nakib[23] on an Iraqi sample with subjects ranging from 13 to 25 years. A study conducted on a sample of fixed orthodontic and surgical-orthodontic

Table I. Comparison of sella dimensions (mm) among subjects and controls

	Sella dimensions (mean ± SD)		
Study group	*Sagittal interclinoidal distance*	*Sella depth*	*Sella diameter*
Subjects (n = 31)	6.80 ± 2.26	7.96 ± 1.18	11.29 ± 2.61
Controls (n = 70)	8.05 ± 2.27	8.25 ± 1.63	11.23 ± 2.21
P value*	0.012†	0.146	0.608

*Independent sample t test; †$P < 0.05$.

Table II. Sella turcica measurements (mm) in impacted canines (subjects) stratified by sex

Sella measurements	*Males (n = 11)*	*Females (n = 20)*	P *value**
Sagittal interclinoidal distance	7.22 ± 2.84	6.57 ± 1.92	0.200
Sella depth	7.77 ± 1.75	8.07 ± 1.36	0.120
Sella diameter	11.40 ± 3.43	11.22 ± 2.14	0.228

$P \leq 0.05$.
*Independent sample t test.

Table III. Degree of calcification in cases and controls

	Sella Bridging, n (%)			
Study groups	*Type I*	*Type II*	*Type III*	P *value**
Subjects (n = 31)	6 (9.67)	17 (54.8)	8 (25.8)	0.000†
Controls (n = 70)	34 (48.6)	36 (51.4)	0 (0)	

Type I, No calcification; *Type II*, partial calcification; *Type III*, complete calcification.
$P \leq 0.05$.
*Chi-square test; †$P < 0.001$.

Table IV. Sella bridging in the subjects

Sella bridging	*Males (n = 11)*	*Females (n = 20)*	P *value**
Type I	2	4	
Type II	7	10	0.436
Type III	2	6	

Type I, No calcification; *Type II*, partial calcification; *Type III*, complete calcification.
$P < 0.001$.
*Chi-square test.

patients showed a reduced sella length in the surgical-orthodontic group.[30] A study of Pakistani subjects with different skeletal malocclusions found no correlation between the skeletal classes and sella dimensions.[31] In our study, the size of sella with impacted canines was similar between the sexes. However, a longitudinal study conducted on the sizes and morphologies of Norwegian subjects reported an increased sella length in male subjects compared with female subjects, with no significant differences in depths and diameters.[11] The results reported by Francis[32] differed in this aspect; this author found larger sellae in female subjects. The difference in results might be due to ethnic and racial variations between the study populations.

The results of our study also demonstrated an increased frequency of sella bridging in patients with impacted canines. The 80.6% frequency of partial and complete bridging in our study compared favorably with the 70% frequency reported by Najim and Nakib.[23] The 25.8% frequency of complete calcification of sella in our study is higher than that reported by Leonardi et al,[6,21] who found complete sella bridges in only 16.7% and 18.4% of the subjects in their studies on palatally displaced canines. Similarly, studies reported incidences of 16.7% in patients undergoing combined surgical orthodontic treatment,[30] 18.6% in patients with craniofacial deviations,[33] 18.7% in patients with premolar aplasia,[21] and 33.3% in patients with dental transpositions.[22] In our study, no significant difference was found between the sexes; however, these results contrast with those of Najim and Nakib,[23] who found an increase in sella bridging in male subjects compared with female subjects.

A review of the literature suggests that women have a higher prevalence of canine impactions than do men.[1] In our study, sella bridging did not show a predilection for a particular sex, and the risk of canine impaction was therefore equal in both sexes. A strong association between sella bridging and palatally impacted canines suggests that factors affecting the development of sella turcica might also affect the development of the maxillary canines.

Thus, sella bridging highlights the risk of future palatal canine impactions, especially in children with a history of canine impaction in their parents or siblings and who are undergoing phase 1 orthodontic treatment. The results of our study suggest that careful monitoring is needed for the eruption timing of the maxillary canines in children diagnosed with complete calcification of sella turcica.

CONCLUSIONS

The following conclusions can be drawn from this study, which interrelates sella turcica bridging with impacted canines.

1. The frequency of sella turcica bridging is increased in patients with canine impactions.
2. Sella turcica length is reduced in patients with canine impactions.
3. Sex does not influence the size of sella and the ossification of the interclinoid ligament.
4. The chances of having partial or complete bridging in subjects with impacted canines are approximately 4 times greater than those with erupted canines.

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