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ORIGINAL ARTICLE

RELATIONSHIP OF PALATALLY IMPACTED CANINE WITH SKELETAL AND DENTAL ANOMALIES IN ORTHODONTIC PATIENTS

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ABSTRACT

Objective: *To determine the relationship of palatally impacted canine with skeletal and dental anomalies in orthodontic patients.*

Material and Methods: *This retrospective study involved a total of 94 participants, with 47 cases with PICs and 47 controls. The inclusion criteria were high-quality orthodontic radiographs including lateral cephalograms and panoramic radiographs and dental casts. Exclusion criteria involved patients with incomplete orthodontic records, medical pathologies, syndromes, history of head and neck radiotherapy or surgery, and previous orthodontic treatment. The dental anomalies investigated in this study focused on upper lateral incisor anomalies, while skeletal anomalies included sella turcica bridging and ponticulus posticus. The extent of sella turcica bridging and ponticulus posticus was evaluated using a standardized scoring system developed by Leonardi et al. Association was determined using the Chi-square test.*

Results: *The mean age of the participants in this study was 27.30±7.14 years. Among the cases, there were 28 females (59.57%), while among the controls, there were 27 females (57.45%). Significant associations were found between sella turcica bridging and maxillary impacted canine (p = 0.005), indicating a strong relationship. Additionally, there was a marginally significant association between ponticulus posticus and maxillary impacted canine (p = 0.042), suggesting a weaker but still noteworthy association. On the other hand, the association between anomalous lateral incisors and palatally impacted canine did not reach statistical significance.*

Conclusion: *There is a significant association of the bridging of sella turcica and ponticulus posticus with palatal canine impaction. However, no statistical association was found between anomalous lateral incisor and palatal impaction of canine.*

Keywords: *palatal impaction, canine, sella turcica bridging, ponticulus posticus, dental anomalies*

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INTRODUCTION

The term "impacted tooth" is used for a tooth whose eruption is delayed after the formation of three fourth root length. The incidence of maxillary canine impaction is tenfold higher than the mandibular ones.[1] Females are affected three times more frequently than males, and this condition is more prevalent in a bilateral pattern than a unilateral pattern.[2]

The occurrence of maxillary canine impaction has been observed to be increasing significantly in the recent years. Published literature has shown that the incidence of impacted maxillary canine ranges from 0.97% to 7.1%.[3,4] The increase in the incidence of maxillary impacted canine can be attributed to more frequent detection due to the improved socio-economic status of the population, which is now undergoing more regular dental check-ups, and the availability of advanced radiological methods such as cone beam computed tomography.[5,6]

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Maxillary canine impaction can lead to several clinical and sub-clinical problems like delayed eruption, resorption of the roots of adjacent teeth, and the abnormal growth patterns of the facial bones.[7,8]

Dental anomalies of Maxillary lateral incisors such as peg-shaped laterals, missing laterals and smaller mesiodistal crown width may occur in subjects with Maxillary palatal canine impaction. Evidence suggests association between lateral incisor anomalies and palatal canine impaction.[2,9]

The sella turcica (ST) is an anatomically important structure of the sphenoid bone. A sella turcica bridge (STB) is formed by the ossification of the interclinoid ligaments (ICL) between the anterior clinoid process (ACP) and the posterior clinoid process (PCP).[10]

The atlas, first cervical vertebra (C1), may exhibit some anatomical variations, the most common among them is the calcification of the atlanto-occipital ligament, commonly known as ponticulus posticus (PP). The PP is a bony emergence from the posterior arch of the atlas. It encompasses the vertebral artery and the first cervical nerve either completely or partially. Therefore, depending on its extent of calcification, PP is generally distinguished as partial or complete.[11]

The lateral cephalogram can show skeletal anomalies like sella turcica bridging and ponticulus posticus, which are associated with palatal canine impaction.[12] Early detection of impacted canines can help the orthodontics for timely interceptive treatment and prevent potential problem associated with this anomaly.[13] Impacted maxillary canines and these skeletal anomalies have been found to stem from a common embryological origin, i-e the neural crest cells.[14] Orthodontic and surgical treatments, including minimally invasive surgical approaches, can prevent maxillary canine impaction. Early diagnosis and careful evaluation of the clinical, and radiographic elements are important for successful interceptive interventions of the impaction.

The objective of this study was to determine the relationship of palatally impacted canine with skeletal and dental anomalies in orthodontic patients.

METHODOLOGY

This study was carried out on orthodontic records including panoramic radiographs and lateral cephalograms. Ethical approval (EC Ref No. RCD-06-23-149) was obtained from the Ethical Review Committee of Rehman College of Dentistry, Peshawar. Informed consent was already available for each patient, as patients consented before record taking that their records can be used for research purposes.

Using WHO calculator, the sample size turned out 94 (47 cases with PICs and 47 controls with normal canines) using 33% class I type sella turcica bridging cases from the previous study.[13]

The inclusion criteria were complete set of good quality orthodontic records of patients 12-40 years of age, including dental casts, panoramic radiograph and lateral cephalometric radiograph with clearly visible cervical spine. The patients with incomplete information, medical pathologies, syndromes, history of radiotherapy or surgery in head and neck area and previous orthodontic treatment were excluded. Maxillary lateral incisor anomalies (missing, microdont, conical), either unilateral or bilateral were observed on the dental casts.

To evaluate the degree of calcification of sella turcica, the sella dimensions were determined manually (Fig 1). All the tracings and measurements were done by a single observer. The shape of the sella turcica was outlined by starting from the rear peak of the sella to the tuberculum of the sella. Then, a straight line was drawn to measure the length of the sella between the tuberculum sellae (ACP) and the rear peak (PCP), indicating the interclinoidal distance (Fig 1, line a). Finally, diameter of sella turcica (the greatest anteroposterior distance), was taken from the tuberculum sellae to the farthest point on the inner surface of the posterior wall of sella (Fig 1, line b).

To measure the extent of bridging, the scoring was done on lateral cephalograms using standardized classification developed by Leonardi et al.12 Class I (absence of calcification, no bridging, normal sella turcica) was assigned when the length exceeds three-quarters of the diameter. Class II (incomplete calcification) was assigned when the length is less than or equal to three-quarters of the diameter. Class III (completely calcified, complete bridge) was assigned for radiographically identifiable connection between ACP and PCP, i.e. sella diaphragm is clearly visible.[10]

Another skeletal anomaly, the ponticulus posticus ((Fig 2) was determined through visual assessment of the cervical spine. A standardized scoring was used to evaluate the extent of calcification, where Class I denotes the absence of calcification (absence of PP), Class II indicates partial calcification (partial PP), and Class III signifies complete calcification (complete PP, clearly visible bony ring).[11,12,16]

Data analysis was performed using R programming version 4.1.2. Descriptive statistics, such as mean and standard deviation (SD), were calculated for continuous variables like age, while percentages with frequencies were determined for categorical data such as gender, types of sella turcica bridging, and ponticulus posticus. A comparison between cases and controls was conducted for sella turcica bridging and ponticulus posticus using the Chi-square test or Fisher's exact test. The

significance level was set at $p < 0.05$.

RESULTS

The mean age of the participants was 27.30±7.14 years. The most common age group was 21-30 years (n=43, 45.74%) followed by 31-40 year (n=36, 38.30%) and 12-20 (n=15, 15.96%). (Fig 3)

Among cases, there were 28 females (59.57%) and 19 males (40.43%). Similarly, in the controls, there were 27 females (57.45%) and 20 males (42.55%). There was no significant difference in gender distribution between the two groups (p=0.99). Regarding the age group distribution, in the case group, there were 8 participants (17.02%) in the 12-20 age group, 21 participants (44.68%) in the 21-30 age group, and 18 participants (38.30%) in the 31-40 age group. In the control group, there were 7 participants (14.89%) in the 12-20 age group, 22 participants (46.81%) in the 21-30 age group, and 18 participants (38.30%) in the 31-40 age group. The difference in age group distribution between the cases and controls was not statistically significant (p=0.95). (Table 1)

Table 2 presents the comparison of sella turcica bridging and ponticulus posticus between cases and controls. In the case group, 15 cases (31.91%) had sella turcica bridging classified as Type I, while in the control group, 32 cases (68.09%) exhibited the same characteristic. For Type II sella turcica bridging, 24 cases (51.06%) were observed in the case group and 11 cases (23.40%) in the control group. Type III sella turcica bridging anomalies were found in 8 cases (17.91%) in the case group, and 4 occurrences (8.51%) were observed in the control group. Regarding ponticulus posticus, Type I was present in 24 cases (51.06%) in the case group and 31 cases (65.96%) in the control group. Type II and III ponticulus posticus anomalies were observed in 13 cases (27.66%) and 10 cases (21.28%), respectively, in the case group, compared to 9 cases (19.15%) and 7 cases (14.89%) in the control group. The statistical analysis revealed a significant association for sella turcica bridging ($p = 0.005$) and a marginally significant association for ponticulus posticus ($p = 0.042$) using Fisher's exact test and Pearson's Chi-squared test, respectively.

Among cases, 7 patients (14.89%) exhibited bilateral conical anomalies of lateral incisors, whereas in the control group, only 2 patients (4.26%) had such anomalies. Similarly, 6 patients (12.77%) in the case group had bilateral microdont anomalies, compared to 2 patients (4.26%) in the control group. When considering bilateral missing LIs, 2 cases (4.26%) were observed in the case group, whereas the control group had 1 (2.13%) such anomaly. Furthermore, only 1 case (2.13%) in the case group had unilateral missing LI, while none (0.00%) were found in the control group. Both the case and control groups had 1 case (2.13%) each with unilateral conical anomalies. Similarly, both groups had 1 case (2.13%) each with unilateral microdont anomalies. However, these differences were not statistically significant ($p = 0.151$), indicating a lack of significant variation in the prevalence of LI anomalies between the two groups. (Fig 4)

DISCUSSION

This study aimed to determine the relationship of palatal canine impaction with various skeletal and dental anomalies. The skeletal anomalies like sella turcica bridging and ponticulus posticus, develop and become stable quite early in age (6-7 years) and could be considered for the prediction of canine impaction; allowing its early diagnosis and management and thus may have a significant impact on the orthodontic treatment outcomes. The palatal canine impaction was chosen for this study because literature evidence shows that it is the most common type of impaction in the maxilla.[17]

Our study demonstrates that there were no significant differences in the distribution of gender and age between the cases and controls. This finding suggests that these variables did not act as confounding factors in our study. However, this may be due to the smaller sample size taken in our study.

Our findings revealed a significant difference in the

TABLE 1: FREQUENCY OF AGE AND GENDER IN BOTH CASES AND CONTROLS

Variable	Characteristic	case, N = 47	control, N = 47	p-value*
Gender	Female	28 (59.57)	27 (57.45)	>0.999
	Male	19 (40.43)	20 (42.55)	
Age group (years)	12-20	8 (17.02)	7 (14.89)	0.956
	21-30	21 (44.68)	22 (46.81)	
	31-40	18 (38.30)	18 (38.30)	

*Chi-square test

TABLE 2: COMPARISON OF SELLA TURCICA BRIDGING AND PONTICULUS POSTICUS BETWEEN CASES AND CONTROLS

Variable	Characteristic	case, N = 47	control, N = 47	p-value
Sella turcica bridging	I	15 (31.91)	32 (68.09)	0.005*
	II	24 (51.06)	11 (23.40)	
	III	8 (17.91)	4 (8.51)	
Ponticulus posticus	I	24 (51.06)	31 (65.96)	0.042**
	II	13 (27.66)	9 (19.15)	
	III	10 (21.28)	7 (14.89)	

*Fisher's exact test; **Pearson's Chi-squared test

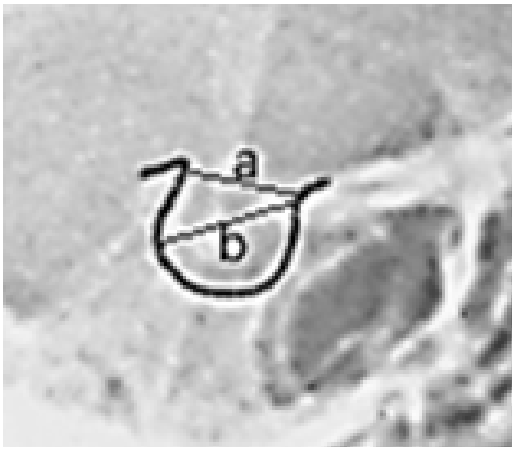

Fig 1: Measurements of sella turcica on Lateral Cephalogram

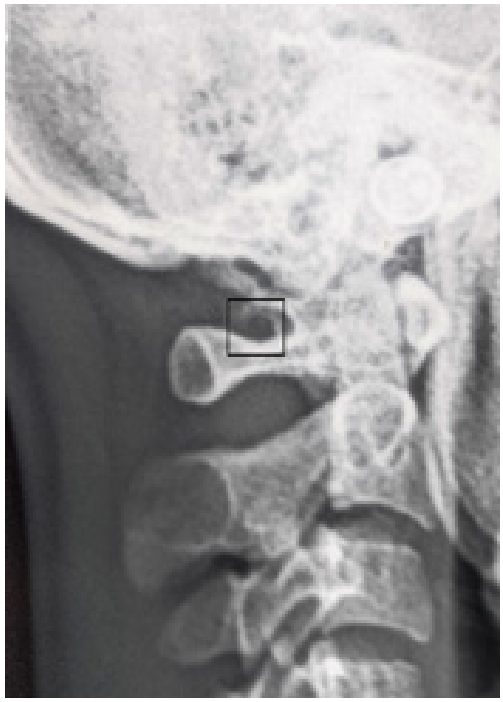

Fig 2: Ponticulus posticus on lateral cephalogram

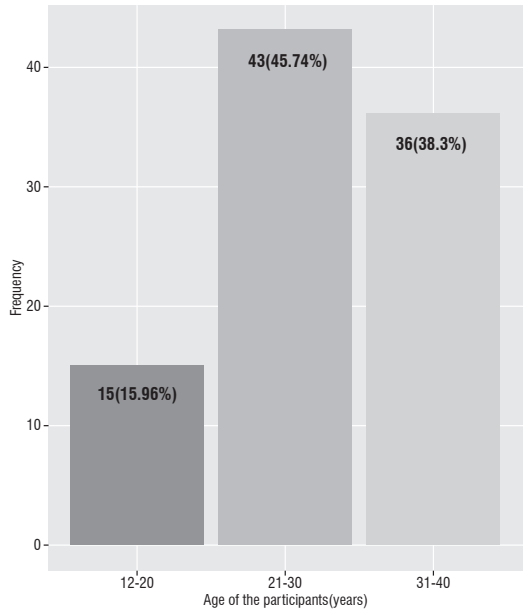

Fig 3: Age distribution of the participants

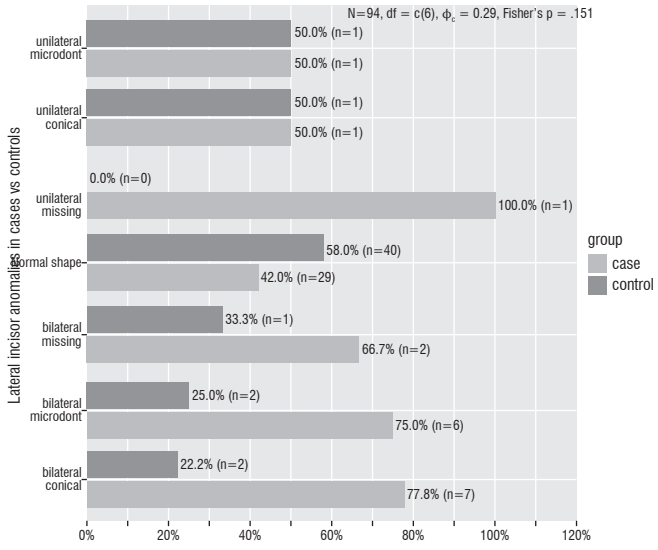

Fig 4: Distribution of lateral incisor anomalies between cases and control

types of sella turcica bridging and ponticulus posticus between cases of canine impaction and controls. Specifically, Type I (no calcification) Sella Turcica Bridging was more prevalent among controls, while type II (partial calcification) and type III (complete calcification) were more common in cases. This indicates that canine impaction cases tend to exhibit greater calcification of sella bridge compared to controls. The results that emerged from this study agree with the results provided by Leonardi et al.[12] Our results also align with the results of another study that reported similar findings.[14,15] Patients with severe craniofacial deviations, dental anomalies, and various skeletal disorders and syndromes have been reported to exhibit a high incidence of sella turcica bridging.[12,17] These findings suggest that skeletal anomalies observed in cephalometric radiographs are linked not only to other craniofacial anomalies and syndromes, but also to dental conditions such as impaction of the maxillary canine.[14]

Our results revealed that in controls, the prevalence of non-calcified ponticulus posticus (Class I) was higher (65.96%) compared to cases (51.06%), whereas the prevalence of partially calcified ponticulus posticus (Class II) and completely calcified ponticulus posticus (Class III) was higher in cases (27.66% and 21.28% respectively) compared to the controls (19.15% and 14.89% respectively) and it was statistically significant (p=0.042). These results are in line with the results of a previous study conducted by Leonardi et al.11 Another study also reported that the prevalence of both class II and class III ponticulus posticus was higher in the case group compared to the observed prevalence in the control group.[14]

Regarding the dental anomalies, our study showed that the distribution of anomalous maxillary lateral incisor (including microdont, missing, and conical shape maxillary lateral incisor) was higher in the maxillary impacted canine cases but the association was not statistically significant. Jena et al conducted a study on 66 patients with impacted canine in at least one quadrant of the maxilla.[19] Their results showed that 38.89% of the palatally impacted canines were associated with anomalous lateral incisors, however, no positive association was found between anomalous lateral incisors and maxillary impacted canines. Their results did not indicate any statistical association between lateral incisors malformations and impacted canine in the maxilla. Their results support the findings of our study. In another study, A total of 102 orthodontic patients with 70 maxillary and 32 mandibular canine impactions were assessed and their results showed that the prevalence of dental anomalies in orthodontic patients with impacted canines was higher than those without canine impaction.[20] In a study conducted by Kolokitha et al., a statistically significant difference was observed in cases involving peg-shaped maxillary lateral incisors, with the presence of peg lateral incisors increasing the likelihood of impacted canines by 83.3%.[21] Similarly, another study conducted in Iraq on 45 patients, found a significant association of impacted maxillary canine and anomalous lateral incisors.[22] Therefore, the literature is still controversial, and it remains unclear whether an anomalous lateral incisor is one of the local causal factors for palatally impacted canines (guidance theory) or if there is a genetic influence (genetic theory) or both play a role.

When interpreting the results of this study, it is crucial to consider its limitations. Firstly, the study design limits the establishment of causal relationships and introduce potential biases. Secondly, the reduced sample size may restrict the ability to detect significant associations that might be present in a larger and more diverse population. Furthermore, the study was conducted in the local settings. This limits the external validity of the findings.

CONCLUSION

Within the limitations of this study, it can be concluded that there is a significant association between the bridging of sella turcica and ponticulus posticus and they can be used to predict maxillary canine impaction. However, no statistical association was found between anomalous lateral incisor and maxillary palatally impacted canine.

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4 Faisal Farid:	Manuscript Preparation, Final Revision
5 Uzma Khalil:	Manuscript Writing and Revision