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RELATIONSHIP BETWEEN PALATALLY IMPACTED CANINES AND MAXILLARY LATERAL INCISOR'S CROWN-ROOT ANGULATION AND ROOT-CROWN RATIO; A THREE-DIMENSIONAL CONE BEAM COMPUTED TOMOGRAPHY EVALUATION

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Abstract

Background: *The adjacent relationship of the canine with the lateral incisor root suggests that it provides a guide for canine's eruption and an absent lateral incisor or malformed lateral incisor root will alter the eruption of the canine. This study aimed at determining the mean crown-root angulations and root-crown ratio of lateral incisors with maxillary canines on the impacted and non-impacted side by using Cone Beam Computed Tomography.*

Study design: Comparative cross sectional study

Place & duration of the study: This study was conducted at Margalla Institute of Health Sciences, Rawalpindi from October 2024 to December 2024.

Methodology: *After taking ethical approval from the Ethical Review Committee (ERC), Margalla Institute of Health Sciences, Rawalpindi. Cone Beam Computed Tomography (CBCT) scans of patients aged 12 to 45 years, of either gender, were collected using non-probability consecutive sampling from the available imaging pool at MIHS. The sample size was calculated using the OpenEpi calculator, resulting in 65 participants per group. Accounting for a 20% potential dropout rate, 78 CBCT scans were evaluated in each group. Group A consisted patient's CBCT showing palatally impacted canines whereas Group B included normally erupted canines on CBCT. Planmeca software was used to measure the angles between the long axis of the crown and the long axis of the root of each maxillary lateral incisor on the CBCT in sagittal view. Furthermore, the mesial, upright, and distal root angulations were noted. The lengths of the root and crown were measured independently, and the root length was divided by the crown length to determine the root-to-crown ratio. A standardized performa was used to record all findings. Each assessment's findings were recorded in performa. SPSS version 22 was utilized to analyze the data. The Mann Whitney U test was utilized to identify statistically significant differences between groups because the data was non-parametric. The significance level was set at p≤0.05.*

Result: *The study comprised 78 participants, the majority of whom were female (67.9%), with a mean age of 18.42 ± 3.55 years. Group A (palatally impacted canines PIC) had a lateral incisor angulation of 19.53°± 11.03, while Group B (non-palatally impacted NPIC) had an angulation of 8.1°±6.69. There was statistically a significant difference between angulation of lateral incisor among*

PIC and NPIC (p=0.00). Group A crown-to-root ratios (1.46 ± 0.30 mm) were marginally lower than Group B(1.60 ± 0.47 mm). 71.8% of the people in Group A had mesial angulation (16.9° ±10.53), and none of them were upright. However, in Group B, 93.5% of the lateral incisors were upright (7.12°±5.79), making mesial (5.1%) and distal (1.28%) angulation very rare.

Conclusion: *This study concluded that lateral incisors in group A had considerably higher mesial angulation and lower crown-to-root ratios than the group B.*

INTRODUCTION

In orthodontics, maxillary canines are the second most commonly impacted teeth after third molars [1] with a prevalence rate between 1 – 2.5%.[2] Palatal canine impactions are twice as prevalent as buccal canine impactions and are more common in females as compared to males with a ratio of 2:1.[3]

Guidance and Genetic theories are the earliest and prime theories behind etiology of palatally impacted canines.[4] The adjacent position of canine with the lateral incisor root suggests that, it provides a guide for canine's eruption and an absent lateral incisor or malformed lateral incisor root will alter the eruption of the canine. Besides this fact, Genetic theory proposes that impaction of canines is due to genetic predisposition. There is correlation of palatally impacted canines with other morphological dental variations of genetic origin, for instance agenesis of lateral incisors, small lateral incisor crown size, aplasia of premolars and third molars, distal displacement of mandibular second premolars and tooth transposition.[5]

Radiographic assessment is an essential requirement for diagnosis and resolution of impaction of canines.[6]The introduction of CBCT has led to accurate diagnosis and measurements required for the intervention of canine's impaction resolution.[7] Liuk et al. compared the dimensions of lateral incisors with and without palatally impacted canines using cone beam computed tomography (CBCT). They found significant morphological changes of lateral incisors in these patients on the impacted side.[8] It is difficult and costly to treat impacted maxillary canines with orthodontic treatment. Golez A et al., found factors associated with impacted maxillary canines may be used as a guide for treatment plans and can create screening techniques for earlier diagnosis, thereby lowering the need for surgical intervention.[9] Most studies ascertained the relationship between lateral incisor morphology, volume and root resorption with impacted canines on panoramic radiograph, which, has its inherent limitations.[10] The rationale of this study was to determine the relationship between maxillary lateral incisor (crown-root angulation and root-crown ratio) with or without palatally impacted canine on CBCT. This study used Cone Beam Computed Tomography to measure the root-crown ratio and mean crown-root angulation of lateral incisors with maxillary canines on the impacted and non-impacted side.

MATERIALS AND METHOD:

This comparative cross sectional study was conducted from October 2024 to December 2024. After taking ethical approval from Ethical Review Committee (ERC), Margalla Institute of Health Sciences, Rawalpindi, the CBCT scan of patients of either gender aged 12-45 years were collected from the pool available at MIHS, by using non-probability consecutive sampling. The sample size was calculated by using open epi calculator , keeping mean of group A 1.30±4.39 and group B 3.6±4.99 from a previous study [15] calculated "sample size" was found to be 65 in each group, 70 power of test and 95% Confidence interval. By keeping drop off rate 20%, 78 CBCT's were evaluated in each group. Group A constituted patients CBCT showing palatally impacted canines whereas Group B included normally erupted canines on CBCT and all data were anonymized before assessment by the investigator to fulfil the ethical criteria and each CBCT file was allotted a serial number. Measurements of the angles between the long axis of the crown and long axis of the root of all maxillary lateral incisors were performed on the CBCT in sagittal view using Planmeca software.

While measuring the long axis of the lateral incisor root, dilacerations at the root apex was not considered so as to obtain a better representation of the direction of the long axis. A mesial , upright and distal angulated root of lateral incisor were noted. A positive degree measurement was assigned to a root that was mesially angulated in relation to the crown, and a negative degree measurement was assigned to a root that was distally angulated.(Figure 1)

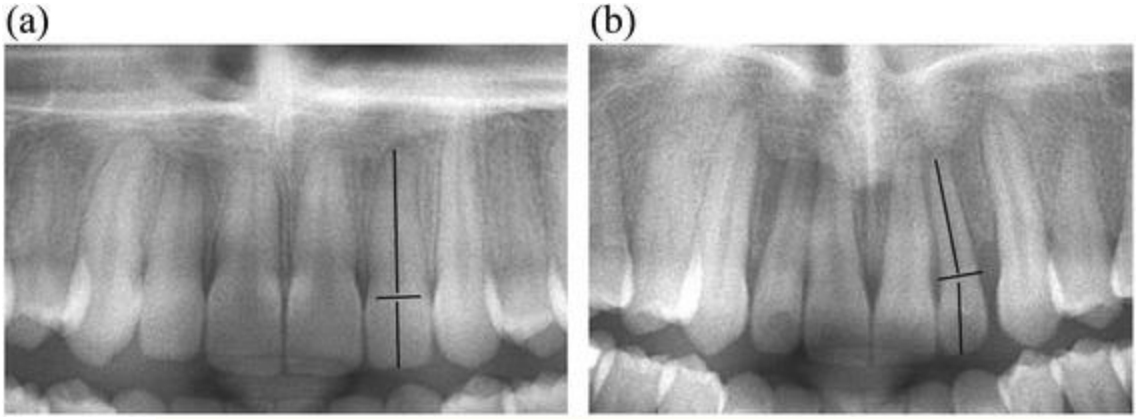

Figure 1: a "normal" (α-angle = 0) and (b) medially angulated lateral incisor (α-angle > 0).

In the sagittal view of CBCT, which was performed on both the canine and non-canine sides, the maxillary lateral incisor's crown-root angulations were measured.(Figure 2)

Figure 2: Angle "α" was used to measure mesio-distal crown to root angulations of the lateral incisors.

By measuring the lengths of the root and crown independently, then dividing the length of the root by the length of the crown, the root-crown ratio was determined. Each assessment's findings were documented in the performa. The data was analyzed by using SPSS version 22. Qualitative variables such as gender were presented as frequency and percentages. Quantitative variables like age, length, ratio and angles were measured as mean and standard deviation. Shapiro wilk test was applied to check for the normality of data. The data was non parametric therefore Mann Whitney U test was used to find statistically significant difference between groups. $p \leq 0.05$ was taken as significant.

RESULTS:

The mean age of study subjects were 18.42±3.55. The frequency distribution involving certain parameters showed out of total 78 study subjects females predominated 53(67.9%) and males were 25 (32.1%).

Table 1 shows the mean and standard deviation (ST.D) of study parameters and it was seen that angulation(Degree) of lateral incisor Among Group A (Palatally Impacted Canines) and Group B(Non-Palatally Impacted Canines) were 19.53± 11.03 and 8.1±6.69 respectively. Hence among Group A lateral incisor tend to have less angulation than Group B. The larger standard deviation also indicates more variability in their angulation.

For crown to root **ratio(mm) of lateral incisors , among Group A(Palatally Impacted Canines)** and Group B **(Non-Palatally Impacted Canines) Mean ± Standard Deviation were** 1.46 mm ± 0.30 and 1.60 mm ± 0.466 respectively. Therefore the ratio for Group B is marginally higher than Group A. There was statistically a significant difference between angulation of lateral incisor among PIC and NPIC (p=0.00) whereas no statistically significant difference was seen for crown root ratio among groups(p=0.211)

Table 1: Mean ± Std. Deviation of Angulation and ratio of Lateral incisors among groups

Parameters (n=78)		Mean±Std. Deviation	p-value
Angulation of lateral incisor	Group A(Palatally Impacted Canine)	19.53°± 11.03	0.00*
	Group B(Normally erupted Canine)	8.1°±6.69	
Crown Root Ratio of lateral incisor (mm)	Group A(Palatally Impacted Canine)	1.46±0.30	0.211
	Group B(Normally erupted Canine)	1.60±0.466	

Mann whitney U test Applied
Statistically significant *

Table 2 shows mesial, upright and distal angulation of lateral incisor among Group A **(Palatally Impacted Canines)** and Group B **(Non-Palatally Impacted Canines).** It was seen that mesial angulation is much more common (71.8%, n=56) in patients with palatally impacted canines. The mean angle for mesial angulation is smaller (16.9° ±10.53) compared to distal (26.23°±9.38). No tooth was seen in upright position. Among Non palatally impacted canine(Group B) a majority of lateral incisors (93.5%, n=73) were observed in an upright position, with a mean angulation of 7.12°±5.79. A smaller portion (5.1%, n=4) showed mesial angulation of the lateral incisors, with a mean angulation of 20.55°±2.52. Only one case (1.28%) presented with distal angulation, with a mean angulation of 26.2°. Overall, the data suggest that in Group A mesial angulation is much common whereas in Group B lateral incisors predominantly exhibit an upright alignment, with very few showing mesial or distal deviations.

Table 2: Mean ± Std. Deviation and Frequency distribution of angulation of lateral incisor among impacted and normally erupted canine groups

Groups	Parameters	Mean ± Std. Deviation	n(%)
Group A (Palatally Impacted canine) n=78	Mesial Angulation of Lateral incisor	16.9° ±10.53	56
	Distal Angulation of Lateral Incisor	26.23°±9.38	22
	Total		78
Group B (Normally erupted canine) n=78	Mesial Angulation of lateral Incisor	20.55°±2.52	4

	Upright angulation of lateral Incisor	7.12°±5.79	73
	Distal angulation of lateral Incisor	26.2°±0	1
	Total		78

Discussion:

It was established that maxillary canine impaction and the morphologic and angular characteristics of the maxillary lateral incisors were related. Strong predictors of maxillary canine impaction were found to include the lateral incisor's volume, the mesiodistal and buccolingual width of its crown, root, and overall length, as well as its lateral incisor angulation to the midline and the axis of adjacent canines. [11] The mean age of study subjects were 18.42±3.55. Out of total 78 study subjects females predominated 53(67.9%) and males were 25 (32.1%). The current study observed a significant difference in the mean angulation of lateral incisors between patients with palatally impacted canines (Group A) and those with non-palatal impactions (Group B). Group A exhibited a mean lateral incisor angulation of 19.53°± 11.03, while Group B had a mean of 8.1° ± 6.69 °. There was statistically a significant difference between angulation of lateral incisor among PIC and NPIC (p=0.00). In concordance with this a previous study by Koral et al.[11] found the total length of the lateral incisor on the impacted side was found to have mean of 20.48°± 2.71 compared to non-impacted side with a mean of 21.57 °± 2.1(p<0.05). Another similar study by Majumder S et al., found statistically a significant difference between groups(p<0.05). [12] Gomaa N and Ellaithy M studied crown-to-root angulation of lateral incisors with palatally impacted canines and found the roots of maxillary lateral incisors being more angulated on the impacted side as compared to normal side.[13] Contradictory to present study Dekel E et al., found among PIC mean of mesial angulation of lateral incisor (8.4°) [14] which is smaller than the current findings. Another dissimilar study by Kanavakis et al. reported the mean crown-root angulation of lateral incisor was 3.6±4.99 on impacted side compared to normal side mean 1.30±4.39 , although they showed showing statistically significant findings among groups(p=0.009)[14] alike current study(p=0.00). Additionally, this study discovered that by observing the adjacent lateral incisor, orthodontists have a tendency to "predict" the presence of a palatally impaired canine. 66.7% of the neighboring canines were palatally affected when the lateral incisor was deemed to be "abnormal." Similarly, the orthodontists' consensus stated that the adjacent lateral incisor appeared "normal" in 65.2% of canines that are normally erupted.[15]

Regarding the crown-to-root ratio this study showed, Group A had a mean of 1.46 mm ± 0.30, while Group B had a mean of 1.60 mm ± 0.466. There was statistically no statistically significant difference for crown root ratio among groups(p=0.211) Although the difference is marginal, it suggests that lateral incisors adjacent to palatally impacted canines may have a slightly shorter root length or longer crown, potentially due to developmental disturbances associated with the impacted canine. In concordance with this study Majumder S et al., also reported insignificant findings among groups(p>0.05)[12] Liuk et al. [8] used cone-beam computed tomography (CBCT) to compare the lateral incisor dimensions and they found that the former had noticeably smaller crown and root dimensions i.e 2.1mm shorter than normal canine. Becker et al.,[16] also reported lateral incisor of palatally displaced canine was 2.1mm shorter than normal canine these findings are in line with present study. Another similar study showed lateral incisors adjacent to palatally displaced canines showed shorter dimensions of roots than contra-lateral incisors.[17]

The study further revealed that mesial angulation was predominant in Group A, with 71.8% (n=56) of lateral incisors exhibiting this inclination. This finding aligns with previous research that reported increased mesial angulation of lateral incisors adjacent to palatally impacted canines.[15] The mean

angle for mesial angulation was 16.9° ±10.53 , compared to 26.23°±9.38 for distal angulation. In contrast, Group B predominantly displayed upright lateral incisors, with 93.5% (n=73) presenting a mean angulation of 7.12°±5.79. A smaller portion (5.1%, n=4) showed mesial angulation of the lateral incisors, with a mean angulation of 20.55°±2.52. Only one case (1.28%) presented with distal angulation, with a mean angulation of 26.2°. These findings corroborate the guidance theory, suggesting that the position of the lateral incisor influences the eruption path of the canine [8,9,15] The mesial angulation observed in Group A may be attributed to the guidance theory, which posits that the position and angulation of adjacent teeth influence the eruption path of canine teeth. In this context, the mesially angulated lateral incisors might not effectively guide the eruption of the canine, leading to its palatal displacement. This may act as a contributory factor in the ectopic eruption path of the maxillary canine, reinforcing the theory that improper guidance by the lateral incisor may lead to canine impaction.[9,15,18] Golez A et al., found that rotating tooth next to the impacted canine increased the chances of impaction by 3.5 times.[9] The fist premolar typically erupts one year before the canine, and the lateral incisor three years. Their root tips may tip into the canine's eruption path and prevent its normal eruption if neighboring teeth erupt in an incorrect root position[16] The observed mesial angulation in lateral incisors adjacent to palatally impacted canines underscores the importance of early orthodontic evaluation. Monitoring the angulation of lateral incisors can serve as a predictive indicator for potential canine impaction, facilitating timely intervention and management strategies .[8,15]

CONCLUSION:

This study concluded that lateral incisors in the PIC group exhibited significantly greater mesial angulation and lower crown-to-root ratios compared to the NPIC group. PIC group had a significantly lower prevalence of upright lateral incisors, which may indicate a relationship between canine impaction risk and mesially angulated lateral incisor. The significance of early radiographic assessment of lateral incisor angulation as a diagnostic indicator in orthodontic assessment and planning is highlighted by these findings.

LIMITATIONS:

Single Centre Study and small sample size are the limitations of this study.

ETHICAL APPROVAL:

Ethical approval was obtained before study initiation by the institutional review board of Margalla Institute of Health Sciences, Rawalpindi. All procedures performed in studies involving human participants were in accordance with the ethical standards of the Helsinki declaration.

CONFLICT OF INTEREST:

All authors do not have any conflict of interest.

FUNDING:

No funding was sought for this study.

CONSENT FOR PUBLICATION:

Prior to data collection, consent was taken from MIHS for using CBCT.

REFERENCES:

Ravi I, Srinivasan B, Kailasam V. Radiographic predictors of maxillary canine impaction in mixed and early permanent dentition–a systematic review and meta-analysis. International Orthodontics. 2021 Dec 1;19(4):548-65.

Margot R, Maria CD, Ali A, Annouschka L, Anna V, Guy W. Prediction of maxillary canine impaction based on panoramic radiographs. Clinical and Experimental Dental Research. 2020 Feb;6(1):44-50.

Alejos-Montante K, Martínez-Zumarán A, Torre-Delgadillo G, Rosales-Berber MÁ, Garrocho-Rangel A, Pozos-Guillén A. Early identification of permanent maxillary canine impaction: A radiographic comparative study in a Mexican population. Journal of Clinical and Experimental Dentistry. 2019 Mar;11(3):e282.

Mohammad RJ. Orthodontic Evaluation of Impacted Maxillary Canine by Panoramic Radiograph–A Literature Review. Journal of Research in Medical and Dental Science. 2021;9(8):220-7.

Kolokitha OE, Balli D, Zarkadi AE, Gizani S. Association between maxillary canine impaction and other dental anomalies: radiological study of a mixed dentition children's cohort from an orthodontic clinic. European Archives of Paediatric Dentistry. 2023 Apr 13:1-7.

Malik DE, Fida M, Sukhia RH. Correlation between radiographic parameters for the prediction of palatally impacted maxillary canines. Journal of Orthodontics. 2019 Mar;46(1):6-13.

Alhummayani FM, Mustafa ZA. A new guide using CBCT to identify the severity of maxillary canine impaction and predict the best method of intervention. Journal of Orthodontic Science. 2021;10.

Liuk W, Olive RJ, Griffin M, Monsour P. Maxillary lateral incisor morphology and palatally displaced canines: a case-controlled cone-beam volumetric tomography study. American Journal of Orthodontics and Dentofacial Orthopedics. 2013 Apr 1;143(4):522-6.

Golez, A., Vrcon, C. and Ovsenik, M., 2024. Jaw Morphology and Factors Associated with Upper Impacted Canines: Case-Controlled Trial. Applied Sciences, 14(17), p.7700.

Razeghinejad MH, Bardal R, Shahi S, Mortezapoor E, Mostafavi M. Volumetric Evaluation of Maxillary Lateral Incisor Root Resorption due to Positional Variations of Impacted Canine. International Journal of Dentistry. 2022 Jun 9;2022.

Koral S, Özçırpıcı A, Tunçer N. Association between impacted maxillary canines and adjacent lateral incisors: A retrospective study with cone beam computed tomography. Turk J Orthod. 2021; 34(4): 207-213.

Majumder S, Siddiqui S, Wani MA, Sattar S, Rozy F, Kundal S, Gupta S. Exploring the Link Between Adjacent Lateral Incisor Morphology and Unilateral Maxillary Canine Impaction: A Cone-Beam Computed Tomography Study. Cureus. 2025 Jan 2;17(1).

Gomaa N, Ellaithy M. Evaluation of crown-root angulation of lateral incisor adjacent to impacted canines using panorama and CBCT. Egyptian Orthodontic Journal. 2016 Jun 2;49(June 2016):49-63.

Dekel E, Nucci L, Weill T, Flores-Mir C, Becker A, Perillo L, Chaushu S. Impaction of maxillary canines and its effect on the position of adjacent teeth and canine development: A cone-beam computed tomography study. American Journal of Orthodontics and Dentofacial Orthopedics. 2021 Feb 1;159(2):e135-47

Kanavakis G, Curran KM, Wiseman KC, Barone NP, Finkelman MD, Srinivasan S, Lee MB, Trotman CA. Evaluation of crown-root angulation of lateral incisors adjacent to palatally impacted canines. Progress in orthodontics. 2015 Dec;16(1):1-6.

Becker A, Chaushu S. Etiology of maxillary canine impaction: a review. American Journal of Orthodontics and Dentofacial Orthopedics. 2015 Oct 1;148(4):557-67.

Leonardi R, Muraglie S, Crimi S, Pirroni M, Musumeci G, Perrotta R. Morphology of palatally displaced canines and adjacent teeth, a 3-D evaluation from cone-beam computed tomographic images. BMC Oral Health. 2018 Dec;18:1-9.

Pereira PM, Ferreira AP, Tavares P, Braga AC. Different manifestations of class II division 2 incisor retroclination and their association with dental anomalies. Journal of orthodontics. 2013 Dec 1;40(4):299-306.