Original Article

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Dentistry Section

Three-dimensional Evaluation of Dentoalveolar Parameters in Maxillary Unilaterally Impacted Buccal versus Palatal Canines: A Retrospective Cone Beam Computed Tomography Study

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ABSTRACT

Introduction: The accurate diagnosis and treatment planning of maxillary impacted canines are critical for achieving optimal aesthetic, functional, and periodontal outcomes. Buccal and palatal impactions often exhibit differing aetiologies, spatial characteristics and treatment challenges. Evaluating these differences may provide insights into tailored management strategies thus improving the treatment planning, minimising complications and optimising outcomes. By using Cone Beam Computed Tomography (CBCT) technology, the present study seeks to advance the understanding of the anatomical variations in buccal versus palatal maxillary impacted canines that may help in refining treatment approaches, improving surgical outcomes and reducing potential complications.

Aim: The aim of this investigation was to evaluate and compare dentoalveolar parameters of subjects having unilateral buccal, palatal impacted and normally erupted maxillary canines with CBCT.

Materials and Methods: The present retrospective observational study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, Faculty of Dental Sciences, SGT University, Gurugram, Haryana, India, over a period of one year starting from November 2022 to November 2023. Seventy CBCT scan of patients with no congenital deformity, in the age group of 12-16 years of age, of both the genders, having unilateral buccal, unilateral palatal and normal erupted maxillary canines were screened from the existing database of the department, out of which 30 unilateral buccal, 30 unilateral palatal and 10 normal erupted maxillary canines were selected. Statistical comparisons were made using One-way Analysis of Variance (ANOVA) test while comparing unilateral impacted buccal, palatal, and normally erupted maxillary canines. The intergroup comparison was done using independent t-test, and p-value of 0.05.

Results: Significant statistical differences ($p < 0.05$) were found between buccal and palatal impacted and normal erupted maxillary canines with respect to the following parameters- buccopalatal alveolar ridge width (p-value 0.001), transverse arch width (p-value 0.001), anterior dentoalveolar height (p-value 0.001), tooth size-arch perimeter discrepancy (p-value 0.001), tooth angulation (p value 0.001), Crown and root Length (p-value 0.001). Significant differences were also found between palatal and buccal impacted maxillary canines when compared individually with relation to the following parameters: buccopalatal alveolar ridge width (p-value 0.001), transverse arch width (p-value 0.01), tooth size-arch perimeter (p-value 0.012), anterior dentoalveolar height (p-value 0.01), tooth angulation (p-value 0.001), crown and root length (p-value 0.001).

Conclusion: In the present study, unilateral palatally impacted maxillary canines exhibited increased transverse arch width, tooth size-arch perimeter discrepancy, and root length compared to both buccally impacted and normally erupted canines. Conversely, cases with buccally impacted maxillary canines showed increased buccopalatal alveolar ridge width, anterior dentoalveolar height, and crown length compared to both palatally impacted and normally erupted canines.

Keywords: Crown length, Root length, Tooth size-arch perimeter discrepancy, Transverse arch width

INTRODUCTION

Maxillary canines play a critical role in dental aesthetics, function and occlusal harmony and their impaction may affect the above adversely. Maxillary impacted canines are not uncommon and are second only to that of third molars, with a prevalence of 0.27% to 2.4%, being more common in females and often detected in the palatal region (85%) [1]. An impacted tooth (dens retains) is a tooth that has a fully formed root with complete development, which is partially or totally covered by hard or soft tissues, being outside of the physiological period of eruption [2]. Canine impaction may be caused due to local, systemic, and genetic factors and the most common theories explaining the canine impactions are "Guidance Theory" and "Genetic Theory". According to the guidance theory, local conditions such as hypoplastic or aplastic lateral incisors, results in lack of guidance to the erupting canines thus resulting in their impactions. Whereas genetic theory states multiple factors that control expression of other concurring tooth anomalies thus resulting in canine impactions [3-8].

An impacted canine can cause several complications such as improper tooth positioning, migration of adjacent teeth in canine space thus leading to loss in arch perimeter, internal resorption, dentigerous cyst, external root resorption of impacted tooth and adjacent teeth and infections and pain caused by partial eruption [9]. Thorough clinical examination and radiographic analysis is needed to correctly determine the position of impacted maxillary canine. Clinical examination of impacted canine includes absence of normal canine protrusion, prolonged primary canine retention beyond the age range of 14-15 or delayed eruption of permanent canine, buccal/palatal bulge, distal tipping or migration of lateral incisors [10].

The previous studies have extensively studied impacted canines regarding their prevalence, aetiology and treatment outcomes and not directly compared specific dentoalveolar parameters associated with buccal and palatal impacted canines. The present study directly compared the dentoalveolar parameters observed in buccal and palatal impacted canines thus providing new insights into their distinct effects on surrounding structures. The findings can enhance the diagnostic accuracy and guide in effective management of impacted canines.

Apart from clinical examinations, radiographs play an important role in accurately diagnosing the position of the impacted tooth, as well the dentoalveolar parameters associated with them. The diagnostic information obtained from conventional radiographs such as panoramic radiographs is quite limited owing to may weaknesses such as image distortion and magnification, artifacts, blurring of image and sometimes superimpositions [11].

In contrast to conventional 2D, Cone-beam computed tomography has emerged as the gold standard for 3D imaging, offering superior spatial resolution and detailed visualisation of dentoalveolar structures. Despite the advancements in imaging, there is limited research directly comparing the 3D dentoalveolar parameters of buccally versus palatally impacted maxillary canines. Understanding these differences is essential for improving treatment planning, minimising complications and achieving optimal orthodontic or surgical outcomes. This aim of the study was to utilise CBCT to assess differences in dentoalveolar morphology between buccally and palatally impacted canines. The study had also help understand how dentoalveolar characteristics may influence orthodontic management of impactions.

MATERIALS AND METHODS

The present retrospective, observational study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, Faculty of Dental Sciences, SGT University, Gurugram, Haryana, India, over a period of one year starting from November 2022 to November 2023. The ethical approval was obtained from the Ethical Committee (IEC Number- FODS/EC/ORTHO/2022/04) of Faculty of Dental Sciences, SGT University, ensuring the compliance with ethical guidelines for retrospectives studies, including anonymisation of patient data and confidentiality. Since this a retrospective study, informed consent was waived as per institutional protocols.

Same size calculation: The sample sizes were calculated using G-Power Software, and as suggested a number of 30 cases in buccal, 30 cases of palatal and 10 cases of normal erupted maxillary canines were finalised. A level of significance of 0.05 and 80% power required a sample of 28 sides each of buccal and palatal impacted canines and was calculated to obtain an 80% power of study with effect of 0.5 and alpha error came out to be 0.05 In this study a total of 70 subjects were taken and further divided into three groups (30 buccal, 30 palatal and 10 control).

The previous records of 70 patients in the age group of 12 to 16 years age, having unilateral impacted canines were retrieved and screened. Sixty CBCT records were selected and segregated into 30 unilateral buccal and 30 unilateral palatal impactions. CBCT records of 15 patients, having the same age group were selected for normally impacted maxillary canines, out of which 10 CBCT records were selected for normally erupted maxillary canines. The samples were selected based on following criteria:

Inclusion criteria:

- Age- 12 to16 years of age;
- CBCT (maxillary arch) records of patients having unilateral buccal and palatal maxillary impacted canines;
- CBCT (maxillary arch) records of patients having normally erupted maxillary canines.

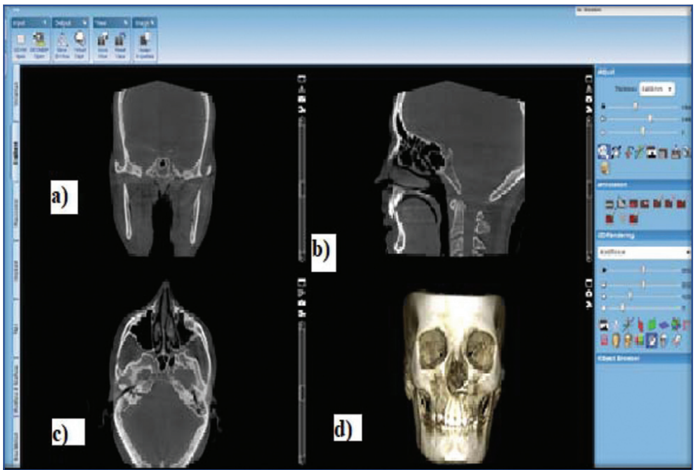
Exclusion criteria:

- History of any facial/dental traumas;
- History of any previous orthographic surgery;
- Maxillary canine transpositions;
- Congenitally missing teeth;
- Craniofacial malformations or any systemic disease.

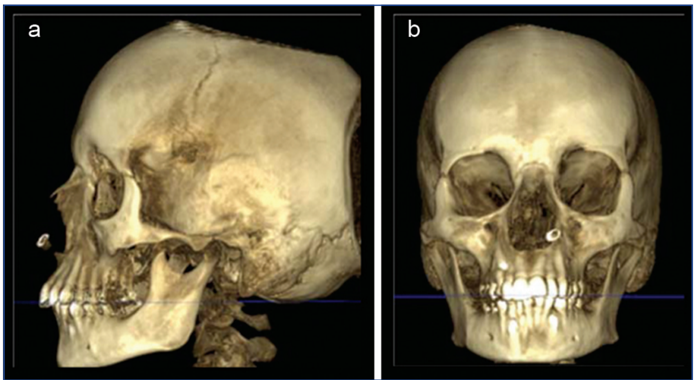
Study Procedure

The measurements and comparison were done on selected CBCT scans of maxilla using Planmeca Romexis software version 5.3.5 by a single operator. CBCT machine specification: The tomography scans were acquired with a Planmeca 3D Mid ProFace scanner (Planmeca, Heinski, Finland) with the following settings: 8 mA, 90 kvp, with a 16*10 cm field of view, 0.2mm slice thickness and exposure time of 18 seconds.

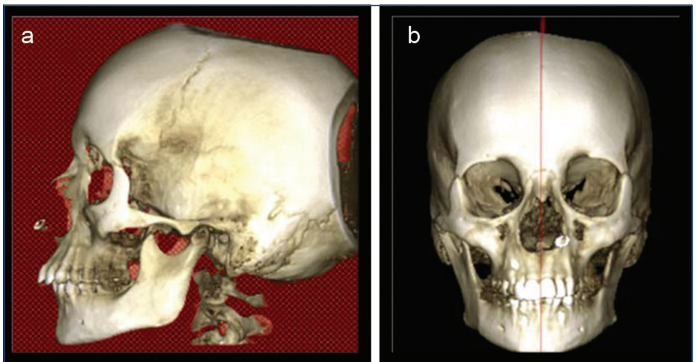
All the scans were displayed on Multiplanar Reconstructed View (MPR) [Table/Fig-1], showing axial, sagittal, and coronal views and were reoriented on volume rendered view on three reference planes, a horizontal, vertical and mid alveolus section [Table/Fig-2-4] for standardisation of all the scan.



[Table/Fig-1]: Multiplanar view showing: a) Axial; b) Sagittal; c) Coronal section; and d) 3D Reconstruction.

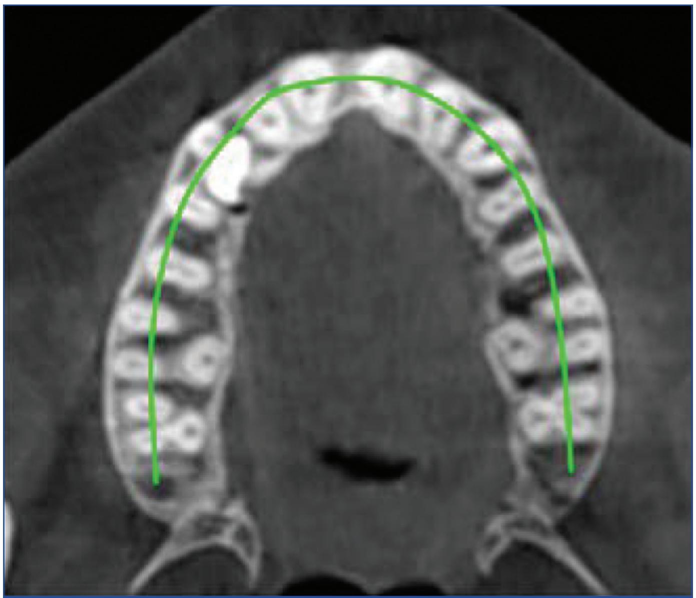


[Table/Fig-2]: Horizontal reference plane as viewed in sagittal section (a) and Transverse Section (b).



[Table/Fig-3]: Vertical reference planes as viewed in sagittal section (a) and transverse section (b)

Measurements: The [Table/Fig-5] shows parameters were evaluated for each buccal and palatal impacted canine and normal erupted maxillary canines: anterior alveolar height, buccopalatal alveolar ridge width, transverse arch width, arch perimeter, tooth size discrepancy, tooth size, anterior dentoalveolar height, tooth angulation, crown length and root length [Table/Fig-6-14] [10,12-14].

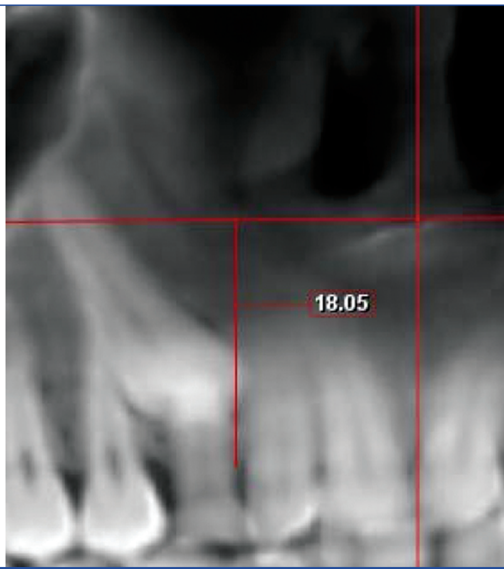


[Table/Fig-4]: Midalveolus section.

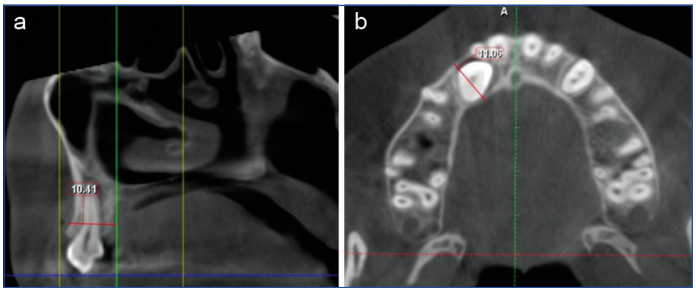
Intraobserver correlation coeffcient: Measurements were conducted by a single observer, and data were anonymised using number codes before sending to the statistical operator. Intraoperative variation was assessed by measuring 10 samples per group twice with a one-week interval. Each measurement session took approximately 15 minutes. Mean values from the reevaluation were calculated to confirm agreement [Table/Fig-15]: Intraobserver Correlation Coefficient (ICC) was used to quantify agreement, with

Measurements	Definition	View/Section
Anterior alveolar ridge height	Measured in millimeters from bony ridge of upper lateral incisors to horizontal line passing through floor of the nostril [12]	Coronal [Table/ Fig-6]
Buccopalatal alveolar ridge width	Buccally impacted canine: Measured 2 mm above alveolar crest on surrounding teeth of impacted canine (between lateral incisors and 1st premolar) [12]	Sagittal [Table/ Fig- 7a]
	Palatally Impacted Canine: Measured from buccal to palatal alveolar ridge surrounding palatally placed impacted canine.	Axial [Table/Fig- 7b]
Transverse arch width	Horizontal distance between contact points of 14 and 15 to contact points of 24 and 25, perpendicular to the midpalatine raphe (reference line). [12]	Axial [Table/Fig-8]
Arch perimeter	Measured in 4 sections: From mesial aspect of 16 to mesial aspect of 13. From distal aspect of 12 to mesial aspect of 11. From the mesial aspect of 21 to distal aspect of 22. From mesial aspect of 23 to mesial aspect of 26. Sum of all [13]	Axial [Table/Fig-9]
Tooth size-arch perimeter discrepancy	Calculated by adding mesiodistal width of each tooth till 2nd premolar on both sides and subtracting it from arch perimeter [13]	Axial [Table/Fig- 10a-c]
Tooth size	It was calculated by measuring mesiodistal width of each tooth till 2nd premolar on both sides [13]	Axial [Table/Fig- 11]
Anterior dentoalveolar height	Measured in millimeters from the incisal edge of upper central incisors by drawing a straight line parallel to the midsagittal plane to the floor of the nostrils on the side of the impacted canine [12]	Coronal [Table/Fig- 12]
Angulation of teeth in vicinity to horizontal plane	Value of external angle of longitudinal axis of impacted canine and teeth surrounding the impacted side (incisors and 1st premolar) with respect to nasal horizontal line passing through horizontal plane [10]	Coronal [Table/Fig- 13]
Length of crown and root	Length of root and crown measured of maxillary impacted canine. Length of the crown is measured from cusp tip to Cementoenamel Junction (CEJ). Length of the root is measured from CEJ to root apex [14]	Sagittal [Table/Fig- 14]

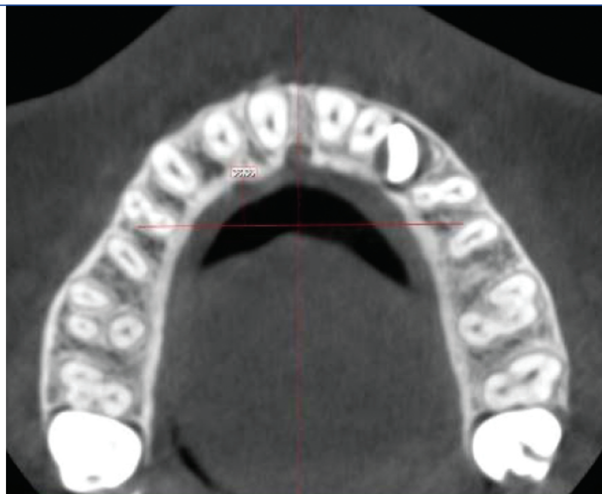
[Table/Fig-5]: Following parameters were evaluated with respect to buccal and palatal impacted teeth [10,12-14].



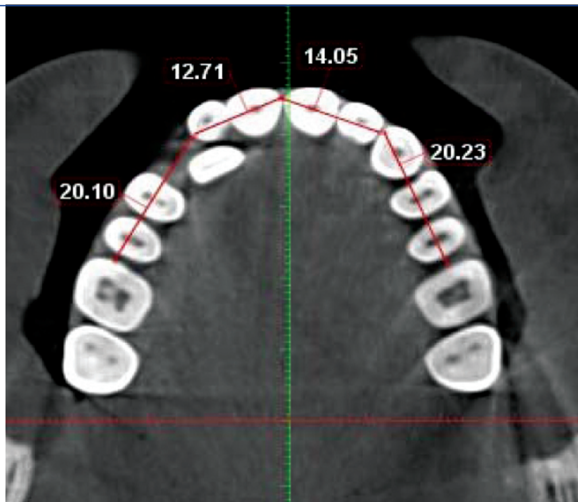
[Table/Fig-6]: Anterior alveolar ridge height.



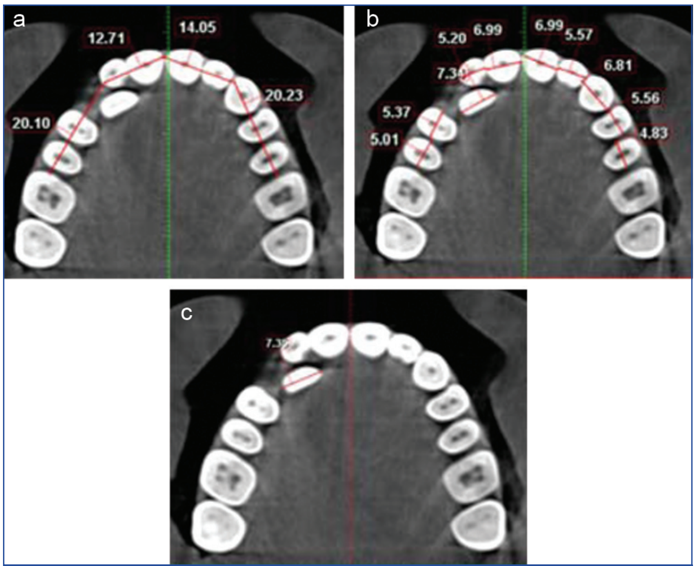
[Table/Fig-7]: a) Buccally impacted canine; b) Palatally impacted canine.



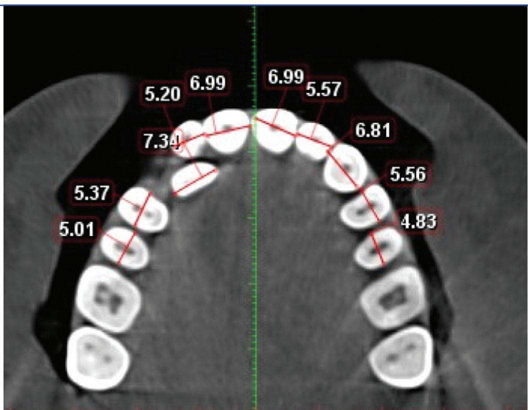
[Table/Fig-8]: Transverse arch width.



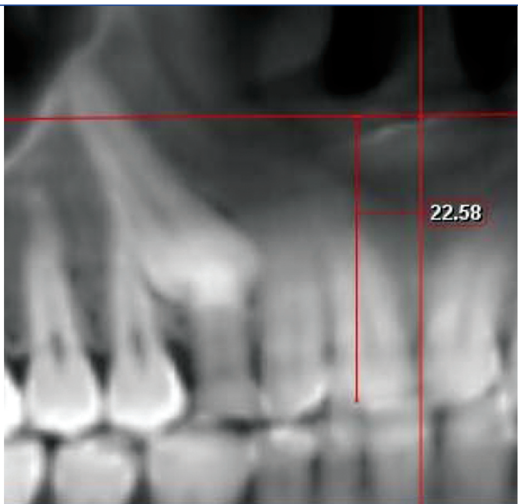
[Table/Fig-9]: Arch perimeter.



[Table/Fig-10]: a-c) Tooth size-arch perimeter discrepancy. a) Arch perimeter of teeth from mesial aspect of 1st molar of one side to mesial aspect of 1st molar of other side; b) Mesio distal width of each tooth from 2nd premolar of one side to 2nd premolar of other side; c) Mesio distal width of impacted maxillary canine.

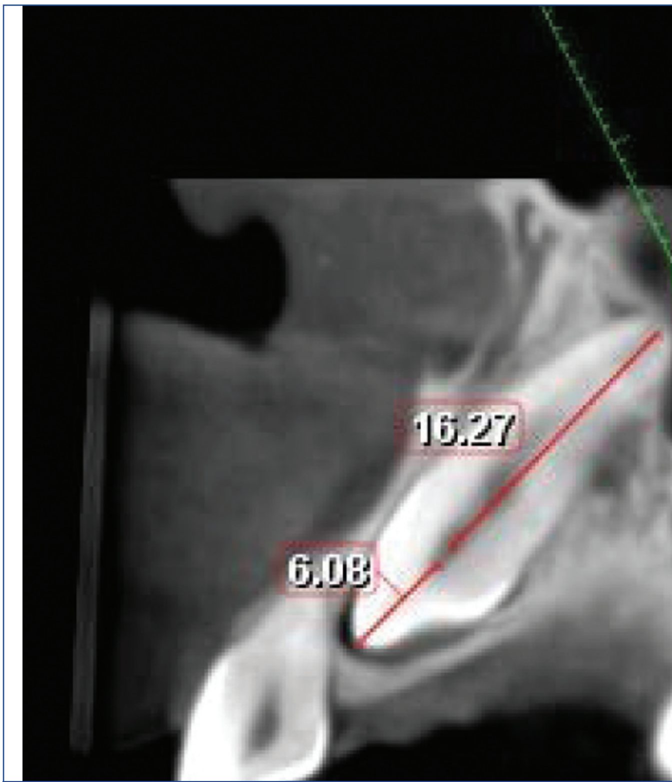


[Table/Fig-11]: Tooth size.



[Table/Fig-12]: Anterior dentoalveolar height.

[Table/Fig-13]: Tooth angulation.



[Table/Fig-14]: Crown length and root length of impacted maxillary canine.

Parameters	Intraclass correlation
Anterior alveolar ridge height	0.746
Bucco palatal ridge width	0.863
Transverse arch width	0.825
Arch perimeter	0.966
Tooth Size	0.830
Tooth size-arch perimeter discrepancy	0.971
Anterior dentoalveolar height	0.771
Angulation of tooth	0.943
Length of crown	0.681
Length of root	0.743

[Table/Fig-15]: Intraobserver Correlation Coefficient (ICC).

value less than 0.50 indicating poor agreement, between 0.50 and 0.75 indicating moderate agreement, between 0.75 to 0.90 indicating good agreement and between 0.90 to 1.00 indicating excellent agreement [14].

STATISTICAL ANALYSIS

Descriptive statistics was analysed with SPSS version 25.0 software, continuous variables were presented with as mean±Standard deviation. Categorical variables were expressed as frequencies and percentages. Independant t-test was used to determine the intergroup comparison between buccal and palatally maxillary impacted canine group. The Shapiro-Wilk test was used to investigate the distribution of the data and Levene's test to explore the homogeneity of the variables. $p<0.05$ was considered statistically significant. One Way ANOVA test was done to determine the intergroup comparison between buccally, palatally impacted and normally erupted (control) canine groups.

RESULTS

The intergroup comparisons of buccally impacted, palatally impacted, and normally erupted maxillary canines revealed significant differences [Table/Fig-16] for bucco-alveolar ridge width (buccally impacted -9.79 mm, palatally impacted -8.70 mm, normally erupted maxillary canines- 10.98 mm), transverse arch width (buccally impacted -35.68 mm, palatally impacted -37.15

mm, normally erupted maxillary canines- 41.05 mm), tooth size-arch perimeter discrepancy (buccally impacted -2.47 mm, palatally impacted -3.29 mm, normally erupted maxillary canines- 0.83 mm), Dentoalveolar height (buccally impacted -22.27 mm, palatally impacted- 20.55 mm, 20.5 mm), tooth angulation (buccally impacted -136.41°, palatally impacted -142.55°, normally erupted maxillary canines -93.37°), length of crown (buccally impacted -7.06 mm, palatally impacted -5.88 mm, normally erupted maxillary canines -5.88 mm), and Root Length (buccally impacted -14.49 mm, palatally impacted- 16.27 mm, normally erupted maxillary canines -15.95 mm).

Variables		Mean	Std. Dev	Std. Error	F value	p-value
Anterior alveolar ridge height	Buccal	16.17	1.126	0.205	0.112	0.827 (Non-Sig)
	Palatal	16.36	1.716	0.313		
	Control	16.11	0.634	0.200		
Bucco palatal ridge width	Buccal (Sagittal Section)	9.79	0.862	0.157	21.270	0.001 (Sig)
	Palatal	8.70	0.856	0.156		
	Control	10.98	0.615	0.194		
Transverse arch width	Buccal	35.68	2.470	0.451	25.449	0.001 (Sig)
	Palatal	37.15	1.243	0.227		
	Control	41.05	1.208	0.382		
Arch perimeter	Buccal	69.56	4.977	0.908	1.699	0.147 (Non-Sig)
	Palatal	68.85	2.206	0.402		
	Control	71.48	1.532	0.484		
Tooth size	Buccal	6.36	0.626	0.280	0.041	0.986 (Non-Sig)
	Palatal	6.44	0.850	0.380		
	Control	6.36	0.681	0.304		
Tooth size-arch perimeter discrepancy	Buccal	2.47	0.797	0.145	17.915	0.001 (Sig)
	Palatal	3.29	1.049	0.191		
	Control	0.83	0.962	0.304		
Anterior dento alveolar height	Buccal	22.27	1.929	0.352	4.293	0.001 (Sig)
	Palatal	20.55	1.676	0.306		
	Control	20.50	0.790	0.250		
Tooth angulation	Buccal	136.41	12.958	2.365	80.367	0.001 (Sig)
	Palatal	142.55	8.896	1.624		
	Control	93.37	4.582	1.449		
Crown length (sagittal section)	Buccal	7.06	0.783	0.143	18.287	0.001 (Sig)
	Palatal	5.88	0.335	0.061		
	Control	5.88	0.214	0.067		
Root length (sagittal section)	Buccal	14.49	0.879	0.160	11.815	0.001 (Sig)
	Palatal	16.27	1.072	0.195		
	Control	15.95	0.625	0.19767		

[Table/Fig-16]: Intergroup comparison of buccal vs palatal vs control group on the basis of all the parameters.
One-way ANOVA test used for intergroup comparison between buccal, palatal and control; *p-value less than 0.05 is statistically significant; Std Dev- Standard Deviation; Std Dev- Standard Error; Sig- Significant

However, anterior alveolar ridge height, arch perimeter, and tooth size came out to be statistically non-significant using a One-way ANOVA test.

An independent t-test analysis comparing buccally and palatally impacted maxillary canines found significant differences [Table/Fig-17] in buccopalatal ridge width (buccal 9.79 mm, palatal 8.70 mm), transverse arch width (buccal 35.68 mm, palatal 37.15 mm), tooth size-arch perimeter discrepancy (buccal 2.47 mm, palatal 3.29 mm), dentoalveolar height (buccal 22.27 mm, palatal 20.55 mm), tooth angulation (buccal 136.41°, palatal 142.55°), length of root (buccal 14.49 mm, palatal 16.27 mm), and length of crown (buccal 7.06 mm, palatal 5.88 mm).

Variables		Mean	Std. Dev	Std. Error	T value	p-value
Anterior alveolar ridge height	Buccal	16.17	1.126	0.205	0.292	1.000 (Non-Sig)
	Palatal	16.36	1.716	0.313		
Bucco palatal ridge width	Buccal (Sagittal Section)	9.79	0.862	0.157	2.840	0.001 (Sig)
	Palatal	8.70	0.856	0.156		
Transverse arch width	Buccal	35.68	2.470	0.451	1.693	0.010 (Sig)
	Palatal	37.15	1.243	0.227		
Arch perimeter	Buccal	69.56	4.977	0.908	0.412	1.000 (Non-Sig)
	Palatal	68.85	2.206	0.402		
Tooth size	Buccal	6.36	0.626	0.280	0.243	0.986 (Non-Sig)
	Palatal	6.44	0.850	0.380		
Tooth size-arch perimeter discrepancy	Buccal	2.47	0.797	0.145	1.972	0.010 (Sig)
	Palatal	3.29	1.049	0.191		
Anterior dento alveolar height	Buccal	22.27	1.929	0.352	2.136	0.010 (Sig)
	Palatal	20.55	1.676	0.306		
Tooth angulation	Buccal	136.41	12.958	2.365	1.231	0.001 (Sig)
	Palatal	142.55	8.896	1.624		
Crown length	Buccal	7.06	0.783	0.143	4.390	0.001 (Sig)
	Palatal	5.88	0.335	0.061		
Root length (sagittal section)	Buccal	14.49	0.879	0.160	4.071	0.001 (Sig)
	Palatal	16.27	1.072	0.195		

[Table/Fig-17]: Intergroup comparison between buccal and palatal impacted canines on the basis of all the parameters.
Independent t- test used for intergroup comparison between buccal, palatal impacted canine group; p-value less than 0.05 is statistically significant; Std Dev.- Standard Deviation; Std Dev.- Standard Error; Sig- Significant

DISCUSSION

The present study appears to focus on a detailed analysis of dentoalveolar parameters using CBCT to evaluate differences in maxillary unilaterally impacted canines comparing buccal and palatal impactions. CBCT provides a precise understanding of the position and relationship of the impacted canine with the surrounding structures thus aiding in treatment planning and improving decision-making regarding exposure, alignment and space closure techniques.

Maxillary canine owing to their complex and lengthy eruption pathway, quite often fail to erupt in the oral cavity, thus affecting both the smile as well as functional occlusion in such patients. Thorough knowledge of the difference in the various dentoalveolar parameters present in buccally and palatally impacted canines will help us to plan effective orthodontic treatment in such patients.

This three-Dimensional (3-D) study was designed to compare unilateral buccal and palatal maxillary impacted canine patients along with data of normally erupted canine based on various parameters such as position, angulation, alveolar bone thickness around it, and root and crown length to determine the level of complexity and the degree of impaction. Similar studies have been conducted in the past [15,16], but they either failed to use CBCT or did not include all the parameters undertaken in this study. Coronal and axial views have also received less attention in the scientific literature.

In this study the mean buccopalatal ridge width was significantly less in palatally impacted canine when compared with buccally impacted canine. This aligns with the study by Sun W et al., who noted thicker apical alveolar bone in buccally impacted canines in comparison to palatally impacted canines [17].

This study found greater tooth size-arch perimeter discrepancy and transverse arch width (as proposed by Mehta F et al., in palatally impacted canines compared to buccally impacted canines [18]. This may be due to crowding, constricted arch form, or premature loss of deciduous teeth that can reduce arch perimeter, limiting space for normal canine eruption.

Likewise, palatally impacted canines were the most angulated, followed by buccally impacted canines. Similar findings were reported by Sar SK et al., [19]. The higher angulation in palatally impacted canines may be attributed to either genetic factors or lack of lateral incisors guidance during eruption.

Buccally impacted canines had significantly greater anterior dentoalveolar height compared to palatally impacted. This aligns with Sar SK et al., who also reported increased height in buccally impacted canines due to the outward eruption pressure stimulating bone growth [19]. Palatally impacted canines, being deeper in the alveolus, were associated with decreased height.

In this study, root length measurements were made using the cemento-enamel junction as a reference point, following the method proposed by Kim Y et al., modified by Handelman CS, Beckmann SH et al., and Silva AC et al., [20-23]. This study found significantly decreased root length in buccally impacted canines when compared to palatally impacted canines. This was in accordance with the study by Cao D et al., who reported a strong correlation between impacted canine root length and the labiopalatal location of the tooth, with buccally impacted canines having shorter roots on average than palatally impacted ones [24]. However, there is no conclusive evidence for the same.

Crown length was measured following the method proposed by Rasheed T et al., [25]. Previous study by Viktroaviciutr V et al., found statistically significant differences between the crown length of impacted and contralateral canines and no statisticaly significant difference between crown length and the position of impacted canines in the labiopalatal direction [14]. They found longer and wider crowns in impacted canines which is similar to the findings of Kim Y et al., thus emphasising the necessity to create more space in dental arch for orthodontic extrusion of impacted canines [26]. However, in the present study, the authors found that buccally impacted had an increased crown length in comparison to palatally impacted and normally erupted canines.

The study found no significant difference in alveolar ridge height between buccally and palatally impacted maxillary canines. This aligns with D Oleo-Aracena MF et al., who reported similar findings. Since incisors erupt before canines, canine impaction may not significantly affect alveolar height in the incisor area [12]. Overall, research shows mixed results, with some studies indicating a decrease in height and others finding no significant difference while comparing the same between impacted maxillary canine and normally erupted canines. D Oleo-Aracena's MF et al., study found no significant relationship between alveolar ridge height between impacted and non-impacted side [12]. However, in Tadinada A et al., study the impacted side presented with decreased alveolar ridge height, as adjacent bones developed with the tooth's eruption, thus leading to increased bone height on the non-impacted side [15].

In this study, the arch perimeter showed no significant difference between buccally and palatally impacted canines. This aligns with findings by Fattahi H et al., and Cacciatore G et al., factors like palatal depth and length also influence arch perimeter, so it cannot solely determine the impaction site [27,28].

Limitation(s)

A limitation of this study is its retrospective nature. Future longitudinal studies with a larger sample size could provide more robust data on the impact of canine position on jaw development. Additionally, investigating the influence of factors like palatal depth and length, on arch perimeter could offer a more comprehensive understanding of canine impaction.

CONCLUSION(S)

The retrospective CBCT study on maxillary unilaterally impacted buccal versus palatal canines highlights the significant differences in dentoalveolar parameters between the two types of impactions. Impacted maxillary canines predominantly presented with Angle's Class I malocclusions. Dentoalveolar parameters such as Buccopalatal ridge width, anterior dentoalveolar height and crown length was more in buccal impacted maxillary canines. Palatal impacted canines tend to have increased transverse arch width, tooth size-arch perimeter discrepancy, tooth angulation and root length. These can be contributing factors resulting in canine impactions.

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