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# Topography of Maxillary Impacted Canines in Comparison to their normal Counterpart through CBCT

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## Abstract

**Introduction:** Developmentally Maxillary cuspid is the most wavering tooth in a dental arch. No other tooth in dental arch travels the tortuous pathway from initiation of formation to fully emergence into oral cavity. Maxillary canine impaction is often seen as a clinically presenting problem in dentistry. Unilateral impacted canine is prevalent among 1-3% of the general population.

**Objective:** The goal of the study was to measure and compare the mesio-distal and labio-lingual dimensions, anatomical crown and root height of a unilateral maxillary impacted canine with its normal counterpart through cone-beam computer tomography (CBCT).

**Methodology:** CBCT images of 38 patients including 18 males and 20 females having unilateral impacted canine were acquired from multiple teaching hospitals of Rawalpindi and Islamabad. Mesio-distal, labio-lingual, anatomical Crown and Root height were measured of the impacted and erupted canines with measuring tool in Planmeca Romexis® Viewer Launcher.

**Results:** Mean anatomical Crown and Root height were higher in non-impacted side, however, statistically the difference was non-significant (p=0.737 and 0.450 respectively). Mean mesio-distal width and Labio-lingual measurement were lower in non-impacted side, however, the statistically non-significant difference was found (p=0.255 and 0.853 respectively).

**Conclusion:** Statistically no significant difference between the mesio-distal, labio-lingual, anatomical Crown and Root height of the impacted canine with their normal counter-part were reported. However, Crown and Root height were higher in non-impacted side while mesio-distal width and labio-lingual measurement were lower in non-impacted side.

**Keywords:** Cone-beam computer tomography, unilateral impacted canine, crown length, root length, Canine

## Introduction

Developmentally Maxillary cuspid is the most wavering tooth in a dental arch. No other tooth in dental arch has to travel a more tortuous pathway from its initiation of formation to fully emergence into arch. However, it is sometimes disturbed from its usual course resulting in impaction or displacement. Impaction is a disturbance in tooth eruption that has frequently been observed. Impaction is defined as the failure to erupt in its predetermined site at its normal eruption period due to a physical obstruction or ectopic tooth germ position. Maxillary canine impaction is often seen as a clinically presenting problem in dentistry. 1-3% of the general population is affected by it. Unilateral impactions are more common compared to bilateral impactions having a higher prevalence in females than males.[1]

Etiology of impacted canines is a very diverse discussion.[2] Multifactorial etiologies have

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been proposed for impaction but the precise cause is unclear.[3,4] Becker A, Chaushu S repoted multifactorial etiology of canine impaction, one being suggested as local disturbance of the dental lamina.[5] Takahama and Aijjama suggested that microform cleft lip and palate might be the attributes to the canine impaction.[6] Other etiology can be; space deficiency in the arch, horizontal angulation of cuspid, trauma to first tooth bud, rotations of tooth buds, premature root closure, absence of adjacent incisor which acts as a "guide" for the normal eruption of canines.[5]

There are many complications related to maxillary canine impaction. Frequently impacted canine is associated with infections and cystic follicular lesions. Arch-length shortening and midline shift may also be present with it. Maxillary canine impaction may pose problem to the smile esthetics. The impacted tooth may sometimes be ankylosed. Maxillary canine impactions can cause complications to the adjacent teeth, particularly the maxillary lateral incisors.[7] These problems include devitalization, external root resorption and displacement of lateral incisors.[8] The functional significance of canines in disoccluding the posterior teeth during lateral excursions cannot be missed.

The evaluation and confirmatory diagnosis of maxillary impacted canines was historically done by several radiographic techniques including, parallax periapical, upper occlusal, orthopentomograph and lateral cephalometric or a combination of any of the mentioned approaches.[9] However, the vertically long axis and the relationship of impacted canines with the adjoining bony and dental structures, especially the root resorption assessment of adjacent teeth are often not very accurate with the aforementioned radiographs. These anatomical structures overlaps in the mid-facial region and hence are difficult for assessment. Therefore, researchers have opted to use computed tomography (CT)-particularly spiral CT-for locating the tooth impaction and assessment of resorption of incisors. This technique provides with exceptional hard tissue contrast of different anatomical structures and detailed three-dimensional (3D) images.[10-11]

The main issues concerning to this technique are its cost expenses and relatively exposure to high radiation dose, therefore, restricting its use in the diagnosis of impaction.[12,13] Over the period, cone-beam computed tomography (CBCT) units have been evolved and has been used for evaluating dental impactions location. CBCT is the gold standard for diagnosing canine impaction. CBCT units utilize cone-shaped radiation with significantly decreased radiation doses to gather information of the mid-facial region, with high spatial resolution.[14,15] Therefore, precise 3D localization of impacted canines can be the central and contemporary to managing the impactions clinically.[16,17]

This study focuses significantly on impacted maxillary canine, regardless of type of impaction (palatal or buccal) and thus measures the mesio-distal width, the labio-lingual dimension, anatomical crown and root height of the impacted maxillary cuspid and its normal counterpart. The rationale of this study is prompt diagnosis, effective management, and proper treatment planning of such patients who have unilateral impacted canines.

## Methodology

A comparative cross-sectional study was conducted. The ethical approval was granted by the Ethical Review Committee of Margalla Institute of Health Sciences. The study was conducted over a period of one year (Jan-Dec 2022). The sample size was measured based on the findings of Leonardi et al[1] comprising a sample of 76 (38 in each group) would yield a confidence level 95% and power of test of 5% making is sufficient to establish statistically significant difference. The sampling technique

applied was non-probability consecutive sampling.

The inclusion criteria of this study was patients having age ≥ 12 years, both males and females, patients with unilateral canine impaction with normal counter-part having good quality CBCT scans and no other pathology in the region of impaction or on the non-impaction side while exclusion criteria was patients with definitive obstructions (e.g. odontoma or supernumerary teeth), patients with systemic disease and craniofacial anomalies (e.g. cleft lip or palate), patients with several impacted teeth or congenitally missing teeth, radiographic artifacts due to patient's movement or metal fillings and cystic lesions in the region of interest. All patients fulfilling the inclusion criteria were selected and their CBCT's were analyzed. Digital Imaging and Communications in Medicine (DICOM) files of the selected CBCT's were opened on Planmeca Romexis® Viewer Launcher (Version 6.0.0.1). Mesio-distal width was measured from maximum bulge area in coronal view and labio-lingual width was measured from maximum bulge area in sagittal view using measuring tool in Planmeca Romexis® Viewer Launcher (Fig. A & B).

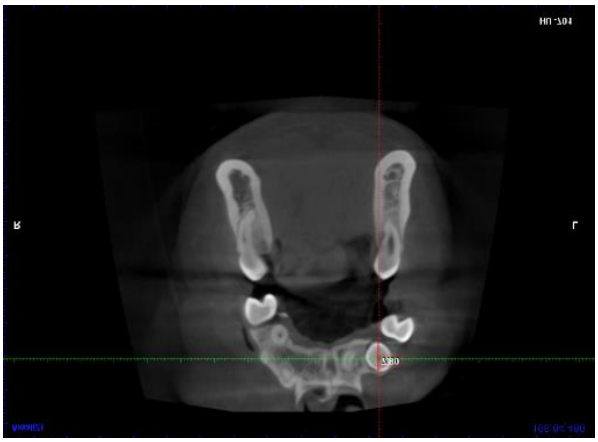

**Fig. A. Coronal View CBCT scan of maxillary impacted canine, measurement of the mesio-distal width in millimeters.**

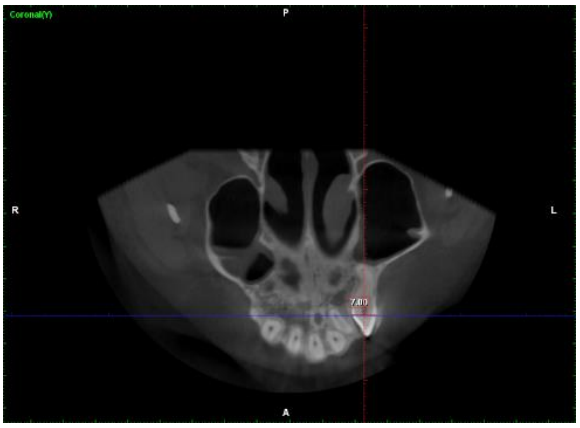


**Fig B. Sagital View CBCT scan of maxillary impacted canine, measurement of labio-lingual dimension in millimeters.**

Crown height was measured from incisal edge to cemento-enamel junction (Fig. C) and root height from CEJ to root apex (Fig. D). These measurements were carried out on both impacted and non- impacted side of maxillary dentition.

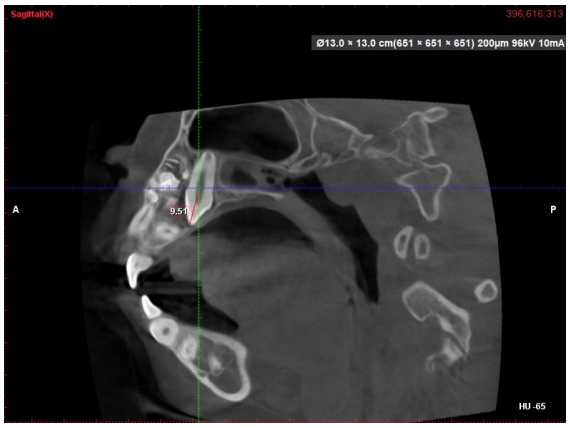


**Fig. C. Measurement of Crown Length from Incisal Edge to Cemento-Enamel Junction**

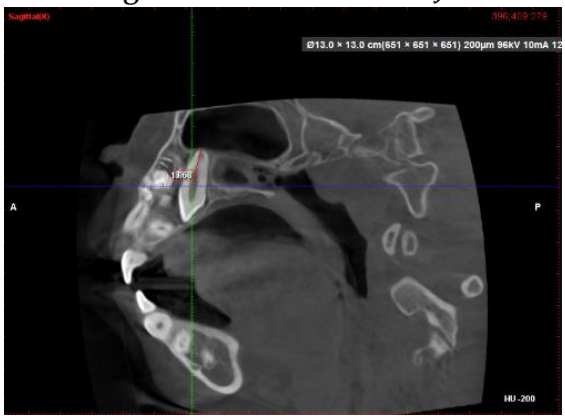


**Fig. D. Root Height from CEJ to Root Apex.**

Fig. C,D. CBCT scan of maxillary impacted canine, measurement of crown length from incisal edge to cemento-enamel junction (Fig. C). and root height from CEJ to root apex (Fig. D).

To decrease the randomization and systematic errors, single examiner performed all the measurements on CBCT images. Only 3 CBCT scans were assessed each day to avoid fatigue. To ensure intra-examiner reliability, 10 CBCT scans were reassessed after 4 weeks by the same examiner having no clue of previous readings.

**Statistical Analysis:**

Results from each CBCT were coded and analyzed using IBM® Statistical Package for the Social Sciences (SPSS®) version 26.0. Descriptive data were calculated for all the quantitative and qualitative variables. Qualitative variable such as gender was measured as frequency. Quantitative variables like age and length were measured as mean and standard deviation. Comparison of the difference between impacted side and the non-impacted sides were assessed by independent sample t test. Intra-examiner reliability was assessed by intra-class correlation coefficient. P value was set at ≤0.05 to be considered significant.

## Result

A total of thirty-eight cone-beam computed tomography (CBCT) scans were included in the study. To minimize bias depending on gender, out of 38 CBCT scans, 57.9% (N=20) were female and 42.1% (N=18) were male participants. Mean crown length, root length, mesio-distal width and labio-lingual measurement for impacted side were 8.43 ± 1.18 mm, 14.22 ± 2.35 mm, 6.85 ± 0.77 mm and 7.52 ± 0.7267 mm respectively (Fig E). Mean anatomical crown height, root height, mesio-distal width and labio-lingual measurement for non-impacted side were 8.49 ± 1.18 mm, 14.47 ± 2.04 mm, 6.74 ± 0.82 mm and 7.50 ± 0.78 mm respectively. Mean anatomical Crown and Root height were higher in erupted canines compared to the impacted canine side. However, the statistically non-significant difference of p=0.737 and 0.450 respectively was found. Mean Mesio-distal width and Labio-lingual measurement were lower of erupted compared to the impacted teeth, however, this difference was also statistically non-significant (p=0.255 and 0.853 respectively).

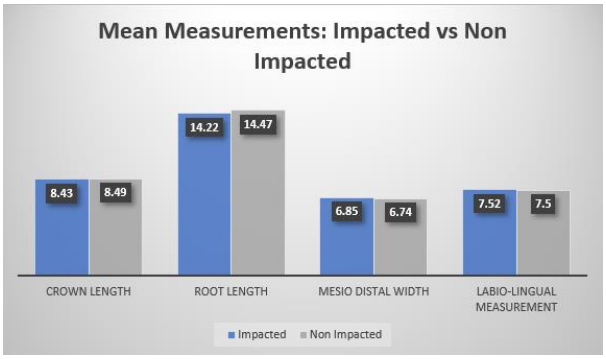


**Fig E: Clustered Bar chart comparing mean measurements (mm) among Impacted and Non-Impacted side of Maxillary Canine**

| Variable | Impacted Mean ± SD (mm) | Non-Impacted Mean ± SD (mm) | p-value |
|---|---|---|---|
| **Crown height** | 8.43 ± 1.18 | 8.49 ± 1.18 | 0.737 |
| **Root height** | 14.22 ± 2.35 | 14.47 ± 2.04 | 0.450 |
| **Mesio-distal width** | 6.85 ± 0.77 | 6.74 ± 0.82 | 0.255 |
| **Labio-lingual measurement** | 7.52 ± 0.7267 | 7.50 ± 0.78 | 0.853 |

**Table I: Comparison of measurements between impacted side & erupted side of maxillary dentition.**

## Discussion

This study was designed to test the hypothesis that dimensions of unilateral maxillary impacted cuspids differed from its normal erupted counterpart. The results of our study demonstrated some differences between the dimensions of unilateral maxillary impacted canine and their normal

counterpart, however, they were not statistically significant.

Miller and Bass separately conducted studies around 50 years ago to ascertain that the occurrence of lingual displacement of maxillary canine was predominant with congenitally missing lateral incisors. The conclusion of their study was that congenitally missing lateral incisor was main cause for the displacement of canine palatally as the guidance lost for erupting canine on the homolateral side. The conclusions of their study were a mere result of their clinical findings after observing a good number of patients in their clinical setting and not by performing a systematic organized study of an appropriate sample size having impacted canines in comparison to those having non-impacted canines.[18,19]

Viktoraviciute V et al in their study found significantly greater anatomical Crown height and width of impacted maxillary canine by 0.15 mm and 0.26 mm respectively than contralateral erupted canine.[20] However, the study suggest that the morphology of unilateral impacted canine and their normal counter-part is similar and the impaction of this tooth does not have significant influence on the morphology of canine.

The findings of our study substantiate findings of a previous study conducted by Leonardi et al[1] on canine morphology in which they concluded statistically non-significant variance in the morphology of canine on impacted and non-impacted side. Like our study, this study was also conducted on CBCT scans which possibly is a reason for it to have accurate and precise results.

Viktoraviciute V et al in their study found significantly shorter root heights by1.46 mm of impacted canines compare to the opposite erupted canines ($P$<0.001). [20] Al-Tawachi in the study compared the length of roots of buccally impacted maxillary cuspids with palatally impacted canines and normally erupted canines.[21] Hettiarachchi et al reported shorter anatomical root heights of the impacted teeth by 2.66-mm compared to the matched control group.[22] The same result is reported by Dekel et al, reporting anatomical root height of palatal and buccally impacted cuspids are shorter by 0.9 mm and 1.3 mm respectively, compared to their erupted counterparts.[23] The results of these studies differed from our study as they concluded significant variance between the root length of buccal impacted cuspids in comparison to normally erupted canine or palatal impacted canines.

There are some limitations to this study; the CBCT scans for unilateral impacted canine were obtained from teaching hospitals of Rawalpindi and Islamabad only which cannot be a true representation of the overall population of Pakistan due to the large diversity in ethnicity in different regions of Pakistan. Further studies that include a sample from various cities of Pakistan can give us a more accurate picture of the dimensional changes between impacted and erupted canines in our population. However, this study implies that settling of occlusion i.e. achieving Andrew`s six keys of occlusion in patients may not be any issue in Unilateral Impacted maxillary canine cases.

## Conclusion

There was statistically not a significant difference comparing between the mesio-distal width, labio-lingual dimension, anatomical crown and root height of the impacted canine with their erupted counter-part. However, anatomical crown height and root height were higher while mesio-distal width and labio-lingual measurement were lower of erupted maxillary canines.

## Ethical Approval

The study was approved by the Institutional Ethical Review committee of Margalla Institute of Health Sciences, Rawalpindi (MIHS). ERC Ref No: TA/128/21

## Disclaimer

No external funding.

## Conflict of Interest

It is declared that the authors don't have any conflict of interest.

## Authors' Contribution

**TA:** Principal Author, Data Analysis, Writing
**MS:** Conception and design.
**YS:** Writing.
**AM:** Supervisor, Validation, Proof Writing
**AUZ:** Critical Evaluation and Editing
**KI:** Data Analysis

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