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ASSESSMENT OF ROOT DILACERATION IN IMPACTED MAXILLARY CANINE VERSUS FULLY ERUPTED CANINE USING CONE BEAM COMPUTED TOMOGRAPHY: A RETROSPECTIVE STUDY

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KEYWORDS

Dilaceration, CBCT, dentistry, impacted canine.

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ABSTRACT

Introduction: Abnormal angulation or curvature formed in the root or crown of a tooth is defined as dilaceration. Dilaceration is of great importance to orthodontics because dilacerated roots are harder to move orthodontically, have a higher risk of impaction or external resorption, and impede favorable insertion of mini screws. **Aim**: The aim of this study was to evaluate incidence of root dilaceration in impacted maxillary canine and fully erupted canine using cone beam computed tomography. **Materials and Methods:** The sample consisted of 90 cone beam computed tomography scans presenting with unilateral or bilateral impacted maxillary canines were evaluated ranging in age from 15 to 30 years both sexes included that were selected and collected from the department of radiology, Faculty of Dentistry Suez Canal University. Prevalence of dilaceration subclassified to root curvature and apical hook based on severity in canines and adjacent teeth was determined in CBCT records. The root length of maxillary impacted canines was measured for further morphologic evaluations. **Results**: The results of the present study showed: Impacted canines had a significantly higher prevalence of root dilaceration than the control group. A significantly higher prevalence of root dilaceration was found in adjacent lateral incisors of the BICs subgroup than that of the control group. Adjacent premolars had a higher prevalence of dilacerated roots in the PICs than the control group. A significantly higher prevalence of curvature and hook were found in BICs, and PICs roots compared with the control group. Both types of impacted canines had significantly shorter roots than the control group. **Conclusion:** BICs and PICs have a higher tendency to present root dilaceration and shorter roots. Unlike BICs, adjacent teeth to PICs were more frequently observed to have root dilaceration.

INTRODUCTION

The specialty of orthodontics is filled with a variety of challenges that require careful diagnosis and planning; one of these challenges involves root dilaceration of maxillary canine. For a good treatment plan, it is necessary to correctly determine the exact location and curvature of maxillary canine in case of impacted canine and fully erupted one. With the recent advancements of Cone Beam Computed Tomography (CBCT) imaging, a practitioner has access to an abundance of information regarding an impaction [(1)].

Developmental anomalies such as dilacerations can affect the eruption pattern of permanent anterior teeth. They are characterized

by a curvature in the crown and roots of the teeth relative to their normal axis. This anomaly can cause some complexities in routine dental treatments such as root canal treatment, orthodontics, and surgery [2].

The etiologic factors for root dilaceration in permanent incisors, are often supposed because of trauma to the primary predecessors whose apices lie close to the permanent tooth germ. An intrusion injury places the apex of the primary tooth in close approximation to the tooth bud of permanent successors, increasing the likelihood of damage to the tooth bud and the Hertwig epithelial root sheath. Other probable etiologic factors include insufficient space for development, the effect of anatomic structures (such as the cortical bone of the maxillary sinus or the nasal fossa), supernumerary tooth, mechanical interference with an eruption in cases such as an ankylosed or retentive primary tooth, and hereditary factors [3].

After third molars, maxillary canines are the most frequently impacted teeth, with a prevalence in the range 0.9–3.0%, depending on the population examined. 85% of canine impactions occur palatally and 15% buccally. Impacted maxillary canines have been shown to occur twice as commonly in females as males and most impactions of maxillary canines are unilateral at 92%, and only 8% are bilateral [4]. So, this study was planned to evaluate incidence of root dilaceration in impacted maxillary canine and fully erupted canine using cone beam computed tomography.

MATERIALS AND METHODS

Ethical consideration

The study was waved by the Research Ethics Committee of Suez Canal University number 386/2021.

Study setting

In this retrospective study, a total of 90 CBCT scans of patients with unilateral or bilateral impacted maxillary canines ranging in age from 15 to 30 years old were gathered after the approval of the ethical committee. Using the same standard protocol, all CBCT scans were taken using Soredex SCANORA 3D* and handled by OnDemand Imaging Software.

Sample size calculation

The sample size for this study was calculated according to **Charan and Biswas** [5] used the following equation:

$$\mathbf{N} = \frac{(Z_\alpha)^2 * (S)^2}{(d)^2}$$

Inclusion criteria:

1. Presence of unilateral or bilateral impacted canine.
2. Cone beam computed tomography scans of good quality and sufficient field of view covering at least half of the maxilla.
3. Age is from 15 to 35. 4. Both sexes were included. 5. Non extraction cases. 6. No craniofacial anomalies or syndromes.

Methodology

a. Impacted maxillary canine localization (bucco-palatal position):

From a CBCT axial view, and relative to the most central line of maxillary arch; the buccolingual maxillary canine position is determined as: palatal (If more than half of the canine crown was located palatally), labial (If more than half of the canine crown was located labially) or in line with the arch (If the canine crown was located at central line).

b. Assessment of root dilaceration:

For all groups, maxillary canines and their adjacent teeth were classified as no dilaceration, with a root curvature (dilaceration of the apical third of the root between 10 degree and 50 degrees), and with an apical hook (dilaceration in the apical third of the root 50 degree or more).

Evaluation Methods:

1. On sagittal view, the long axis of the canine is determined which is a line connecting cusp tip to midpoint of the root.
2. On sagittal view, the angle of root dilaceration of palatally impacted canine was measured, which is the angle between the long axis of the tooth (a line joining from the cusp tip and the midpoint of the root) and the deviation from this long axis at the apical third, (**Figure 1A**).
3. With the same way, the dilaceration of buccally impacted maxillary canine is assessed, (**Figure 1B**).
4. Root dilaceration in fully erupted maxillary canine also measured with the same way, (**Figure 1C**).
5. With the same way, root dilaceration of adjacent teeth (lateral incisors and first premolar) was assessed.
6. Assessment of maxillary canine length was measured from the cusp tip to root apex.

All images were analyzed separately by two independent oral radiologists. Each performed the analysis twice with a two weeks' period in between the two readings to assess the intra-observer and inter-observer agreement.

Statistical analysis

All data was calculated, tabulated and statistically analyzed using suitable statistical tests as follow.

A normality test (Kolmogorov-Smirnov) was done to check normal distribution of the samples.

Statistical analysis was performed using the computer program SPSS software for windows version 22.0 (Statistical Package for Social Science, Armonk, NY: IBM Corp) at significant levels < 0.05 (P- Value < 0.05).

A. ***Descriptive data:*** Descriptive statistics was calculated in the form of Mean ± Standard deviation (SD), range (Maximum - Minimum).

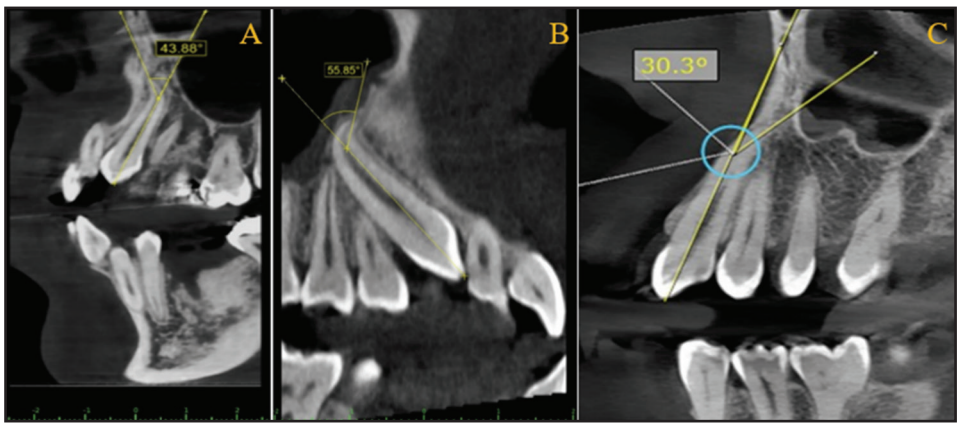

Fig. (1) Cone beam CT **A**. Palataly dilacerated impacted maxillary canine. **B**. Bucally dilacerated impacted canine. **C**. Fully erupted dilacerated maxillary canine.

According to the types of data:

B. ANOVA - test or Kruskal-Wallis test

One -way ANOVA (Analysis of variance) was used to compare between the five groups under study. **Tukey's** or other post hoc test was performed for the evaluation of statistical significances among the groups. P value < 0.05 is considered statistically significant.

C. T- test or Mann-Whitney test

Independent Student's T-test or Mann-Whitney was performed for comparison of the mean differences between the two materials at the same method at P value < 0.05.

RESULTS

The present study was conducted on 90 CBCT scans that were selected and collected from the Department of Radiology Faculty of Dentistry (Suez Canal University). The sample was divided into three main groups, 30 scans included buccally impacted maxillary canine (BIC) and identified as G1, 30 scans included palatally impacted maxillary canine (PIC) and identified as G3 and 30 scans included fully erupted maxillary canine and identified as G2. The patient's age ranged from 15 to 35 years and both sexes are included.

1. **Demographic data:** This study included 90 cases, and they divided equally into three groups the most cases were female as overall. The females were 60%, 53.3% and 63.3% for G1, G2 and G3 respectively. The cases ranged from15-35 years in all groups the mean ages were 24.13±6.02 years in G1, 23.30±6.67 in G2 and 24.70±5.56 in G3 with average overall 24.04 ±6.06 years.

2. **Comparison between the three groups according to canine length**: In this study one-way ANOVA test at P<0.05 and revealed that there was a statistically significant difference between groups for canine length (P-value=<0.001). Pair-wise comparisons between the groups used Bonferroni Post Hoc Tests revealed that there was no statistically significant difference between Groups I and III, but both showed the statistically significantly with group I. Group 2 gave the high mean value for canine length (26.01±2.66) compared with group II (23.24±2.66) and GIII (24.12±1.70).

3. **Comparison between the three groups according to incidence of canine root dilaceration**:

3.a. Incidence of root dilaceration: There was a statistically significant difference between groups for canine root dilaceration determined by one-way ANOVA test at P<0.05 (P-value=0.020) (figure, 1) (Table 1). Pair-wise comparisons used Bonferroni Post Hoc Tests between the groups revealed that there was statistically significant difference between each group to another. The high mean value was in group III (18.33±16.78) followed by group I (14.31±18.35) while group II was the lowest one.

Classification of canine root dilaceration according to angle degree: Chi square test was used at P<0.05 and illustrated the classification of cases according to the degree of the dilaceration angle as more than 50 degrees defined as apical hook and between 10-50 degree defined as root curvature. In group I there were 2 cases that had apical hook which are more than 50 degrees and one case only in group III, while in group 2 there were no cases apical hook.

Table (1) *Comparison between the three groups according to canine root dilaceration*

	Mean	Std. Deviation	Min.	Max.
Group (G1)	14.31[b]	18.35	0.0	65.0
Group (G2)	6.95[c]	10.58	0.0	30.3
Group P (G3)	18.33[a]	16.78	0.0	60.0
	Mean difference	**P value**		
G1 *Vs* G2	7.35	0.021**		
G1 *Vs* G3	4.03	0.041**		
G2 *Vs* G3	11.38	0.018**		

*** and different super script letters means significant difference between the groups*.

4. Comparison between the groups according to incidence of root dilaceration in maxillary lateral incisors (Table 2):

There was a statistically significant difference between groups for incidence of root dilaceration in maxillary lateral incisors that revealed by one-way ANOVA test at p<0.05 (P-value=0.04). Pair-wise comparisons used Bonferroni Post Hoc Tests between the groups revealed that there was no statistically significant difference between Groups I and III and while both groups showed statistically significantly with group II. High mean value was in group I (12.95±8.90) followed by group III (9.56±9.88) while group II was the lowest.

5. Comparison between the groups according to incidence of root dilaceration in maxillary First premolar (Table 3):

There was no statistically significant difference between groups for incidence of root dilaceration in maxillary First premolar that revealed by one-way ANOVA test at p<0.05 (P-value=0.155). Pair wise comparison used Bonferroni Post Hoc Tests the high mean value was in group III (12.39±9.76) followed by group I (14.97±9.83) while group II was the lowest one (9.91±10.55).

6. Correlation between root dilaceration in maxillary canine with root dilaceration in lateral incisor and first premolar:

There were positive and no significant correlation coefficient between canine dilaceration with lateral dilaceration (r= 0.12) and first premolar dilaceration (r=0.08) at p <0.05.

Table (2) *Comparison between the groups according to incidence of root dilaceration in maxillary lateral incisors*

	Mean	Std. Deviation	Min.	Max.	F test	P values
Group B (G1)	12.95[a]	8.90	0.0	32.2	3.96	0.04 **
Group (G2)	6.96[b]	9.76	0.0	28.4		
Group (G3)	9.56[a]	8.05	0.0	28.0		
	Mean difference	P value				
G1 *Vs* G2	5.98	0.03**				
G1 *Vs* G3	3.39	0.614				
G2 *Vs* G3	2.53	0.894				

*** and different super script letters means significant difference between the groups*.

Table (3) *Comparison between the groups according to incidence of root dilaceration in maxillary first premolar*

	Mean	Std. Deviation	Min.	Max.	F test	P values
Group B (G1)	12.39[a]	9.76	0.0	32.2		
Group F (G2)	9.91[a]	10.55	0.0	27.0	1.90	0.155
Group P (G3)	14.97[a]	9.83	0.0	33.5		
	Mean difference	P value				
G1 *Vs* G2	2.48	0.607				
G1 *Vs* G3	2.58	0.582				
G2 *Vs* G3	5.06	0.131				

ns and similar super script letters mean no significant difference between the groups.

DISCUSSION

Diagnosis and interpretation of canine impaction are considered one of the greatest esthetic and functional challenges that face the orthodontist. Impacted maxillary canine are the second most impacted tooth after the third molar teeth because it has the longest path of eruption. Impacted canine is one of the most difficult malocclusions that face the orthodontist, so some studies tried to understand the path of its eruption to early predict its impaction and hence early intervention to prevent impaction of the canine[6,7,8]. The specialty of orthodontics is filled with a variety of challenges that require careful diagnosis and planning; one of these challenges involves root dilaceration of maxillary canine. Dilaceration is defined as an acute deviation of the long axis of the tooth, located to the crown or the root portion and originating from a traumatic nonaxial displacement of already formed hard tissue in relation to the developing tooth [4]. Therefore, this study was carried out to differentiate BIC, PICs and fully erupted canines regarding the prevalence of dilaceration in their own and adjacent roots based on the retrieved CBCT diagnostic data.

Population and sample characterization: Considering the demographic data, the age range for the three groups in this study ranged from 15 to 35 years old. This was selected beyond the average eruption date of the canine to ensure its impaction. It was suggested that if the maxillary canine has not erupted at the age of 13.1 years in boys or 12.3 years in girls, it can be considered impacted [9].

The use of Cone Beam Computed Tomography (CBCT): The CBCT has largely replaced other diagnostic techniques because of its accuracy in both localization of canine impaction and identification of any associated complications as root resorption, which may alter treatment plan for orthodontists. Moreover, CBCT radiographs have eliminated superimposed structures that may interfere with identifying reference points of measurements [10]. Therefore, in this study, due to the limitation of 2D imaging modalities, cone beam computed tomography (3D imaging modality) was used to investigate the incidence of root dilaceration of maxillary canine and its adjacent.

Analyzing the results: Regarding distribution of patients with maxillary impacted canine according to Gender: The results of the present study showed a significantly high female prevalence (37 were females and 23 were male) in agreement with **Alhammadi et al.,**[11], **SR et al.,**[12], **Alyami et al.,**[13], **Sathiyamoorthy and Ravindra**[14], **Sacerdoti and Baccetti** [15], **Walker et al.,**[16], **Ericson and Kurol**[17] .

Regarding canine length it was 26.01±2.66 mm for fully erupted canine, 24.12±1.70mm for palatally impacted canine and 23.24±1.65mm for buccally impacted canine. From this result of the current study, the fully erupted canine has the highest length in comparison with the other two groups. But there is no significant difference between palatally and buccally impacted canine in length. This agreed with **Sun et al.,** [18], **Hettiarachchi et al.,** [19], **Cao et al.,** [20] **Dekel et al.,** [21]. However, this was not in agreement with **Okasha et al.,** [22] and **Kim et al.,**[23] as they used different diagnostic modalities and sampling, they found that no statistically significant difference on crown/root ratio between the impacted side and the normally erupting side except for the lateral incisor and canine which showed increased crown/root ratio.

Regarding incidence of root dilaceration it was 6.95±10.85º for the fully erupted canine group, 18.33±16.78º for the palatally impacted group and 14.31±18.35º for the buccally impacted canine. So, this current study revealed that there was a statistically significant difference between groups for canine root dilaceration and the palatally impacted canine group had the higher incidence of root dilaceration. This agreed with **Hettiarachchi et al.,**[19] **Cao et al.,** [20] **Okasha et al.,** [22] **Bishara and Becker,**[24] **Grisar et al.,**[25] **Inhee**, [26]. However, this was not in agreement with **Nabavizadeh et al.,**[27] as they used different diagnostic modalities such as periapical radiographs of 250 patients and found that dilaceration was not detected in the maxillary canine, second premolar and mandibular lateral incisor, canine and first premolar.

Regarding presence of root dilaceration in maxillary lateral incisor related to impacted and non-impacted maxillary canine it was 6.96±9.76º for the fully erupted canine group, 9.56±8.05º for the palatally impacted group and 12.97±8.90º for the buccally impacted canine group. From this result, there was no statistically significant difference between palatally and buccally impacted canine groups and while both groups showed statistically significantly with fully erupted canine group. This agreed with **Cao et al.,** [20], **Kanavakis et al.,** [28].

Regarding presence of root dilaceration in maxillary first premolar related to impacted and non-impacted maxillary canine it was 9.90±10.55º for the fully erupted canine group, 14.97±9.83º for palatally impacted canine group and 12.39±9.76º for buccally impacted canine group. So, this current study revealed that there was no statistically significant difference between groups. This agreed with **Cao et al.,** [20], **Turk and Elekdag-Turk**, [29], **Pedulla et al.,** [30].

This study showed that there was positive and no significant correlation coefficient between canine dilaceration with lateral dilaceration and first premolar dilaceration.

CONCLUSIONS

1. Buccally and palatally impacted maxillary canine both had a higher tendency to present curved root configuration.
2. Adjacent teeth to palatally impacted maxillary canines were more frequently observed to have root dilaceration.

3. Buccally maxillary impacted canines had shorter roots compared with palatally impacted and normally erupted canines.

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