EVALUATION OF CROWN-ROOT ANGULATION OF LATERAL INCISOR ADJACENT TO IMPACTED CANINES USING PANORAMA AND CBCT

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ABSTRACT:

Maxillary canines are the most commonly impacted teeth, second only to third molars. Maxillary canine impaction occurs in approximately 2% of the population and is twice as common in females as in males. Approximately one-third of impacted maxillary canines are located labially and two-thirds are located palatally. Lateral incisor demonstrates an important role in the etiology of palatally impacted canines. So, the objective of this study is to compare the difference in the shape of lateral incisor (crown-to-root angulation) adjacent to palatally and labially impacted canine using conventional 2D and 3D radiographs. Sample of this study consisted of 60 patients (32 females and 28 males) with a mean age of 13.94 years. For each subject, two sets of radiographs (panoramic and CBCT scan) had been obtained. These patients were divided into 2 groups: The first group consisted of 35 patients with palatally impacted maxillary canines; the second group consisted of 25 patients with labially impacted maxillary canines. The control group (third group) consisted of normally erupted maxillary canines (25 subjects). Crown to root angulations of lateral incisors were measured. t test for independent samples was used to assess the crown-root angulation of lateral incisors. The results revealed that There was

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no significant difference for crown root angulation of lateral incisor between palatally and labially impacted canines groups using panoramic x-ray or CBCT (P=0.831, 0.395 respectively). Insignificant difference was found between panorama and CBCT in determining crown-root angulation of lateral incisor. In impacted canines groups, the roots of the adjacent lateral incisors were more angulated compared to those adjacent to normally erupted canines.

INTRODUCTION

Canines are the cornerstone of dental arches. Maxillary canines contribute fundamentally to the stylish and biting capacities, any unsettling influences in the emission or eruption of permanent maxillary canines can bring about problems in the dental arch and contiguous teeth, which require special consideration[1].

Impacted canines are a frequently encountered problem in orthodontics[2]. Impacted canines are defined as a state where a tooth stays inserted in the oral mucosa or bone past its normal period. This definition can be expanded to incorporate teeth that are anticipated to experience abnormal eruption, even before its normal eruption period, due to position of tooth germ, tooth shape, direction of eruption and accessible space[3].

The maxillary canines are the most frequently impacted teeth after the third molars with a prevalence rate ranging between 1-3%. Canines may be impacted palatally or labially[4]. Maxillary canines impactions cause aesthetic problems, like tipping of adjacent teeth, midline deviation and root resorption on adjacent teeth[3].

Genetic and guidance theories are the primary theories that can clarify the development of palatally impacted canines. Genetic theory proposes that impaction is because of genetic predisposition; bolstered by proof uncovering a relationship between palatally impacted canines and

other dental varieties of genetic origin, for example, agenesis of lateral incisors, small lateral incisor crown size, distal displacement of mandibular second premolars, aplasia of premolars and third molars, and tooth transposition[4].

The maxillary canines are prone to be deviated from the normal path of eruption as their total eruption path extends over 2cm between the age of 5-15 years[5].

Ordinary two dimensional (2D) radiographic imaging was the most widely recognized methodology used to restrict impacted canines, treatment arranging and assessment of treatment results. All-encompassing radiograph is considered as a standard symptomatic guide in orthodontics utilized for preoperative determination of routine cases. In any case, the precision and validity for confinement of impacted canines and nearby structures might be disparaged because of lacks, for example, distortion projection blunders, blurred images and complex maxillofacial structures that are anticipated onto a 2D plane prompting misinterpretation.

As of late, cone beam computed (CBCT) unit has been presented with lessened radiation exposure and 3D imaging capacity for dental structures[6].

As said some time recently, the exact etiology of palatally impacted canines is obscure, it gives the thought that neighboring lateral incisor assume a basic part, either in light of the way that its eruption and measurements are controlled by the same genes that control the eruption or emission of the canine (genetic hypothesis), or in light of the fact that its position in the arch impacts the eruption path of the canine (guidance theory)[4]. So, the aim of this study was to compare the difference in the shape of lateral incisor (crown-to-root angulation) adjacent to palatally and labially impacted canine using conventional 2D and 3D (CBCT) radiographs.

METHODS

Sample of this study was patients in the Orthodontic Department, Faculty of Dentistry, Tanta University. The research sample consisted of 60 patients (32 females and 28 males).The age of the patients was

between 12 and 17.5 years of age, with a mean age of 13.94 years. For each subject, two sets of radiographic information had been obtained. First set consisted of traditional panoramic radiographs and the second set consisted of 3D volumetric images obtained from CBCT scan (Planmeca, proline xc, Helsinki, Finland). The scanning conditions were 90 kV, 4 mA. field of view 20 x19 cm, scan time: 24 seconds, voxel size: 0.4 mm.

These patients were divided into 2 groups: The first group consisted of 35 patients with palatally impacted maxillary canines, the second group consisted of 25 patients with labially impacted maxillary canines (The impacted canines have no sign of eruption in the oral cavity).The control group (third group) consisted of normally erupted maxillary canines (25 subjects), selected from the archives of the orthodontic clinic. The aim of this study was to compare the difference in the shape of lateral incisor (crown-to-root angulation) adjacent to palatally and labially impacted maxillary canines. So, each maxillary canine was considered as an individual sample. Meaning that, if a subject had two labially impacted canines, so we had two study samples. Also, in palatally impacted canines, there were two samples. But, in subjects with unilateral impaction, we had only one study sample, because the morphology of the lateral incisor is affected by genetic predisposition so, the lateral incisor on the contralateral side was not considered as a control. Unclear root morphology of lateral incisor was excluded. To have a better representation of the direction of long axis of lateral incisor root, dilacerations at its root apex was not considered. Cone beam technique was used to differentiate between palatally and labially impacted canines.

A positive degree measurement was recorded when long axis of the root was angulated mesially in relation to that of the crown, and a negative degree measurement was recorded when long axis of the root was angulated distally.
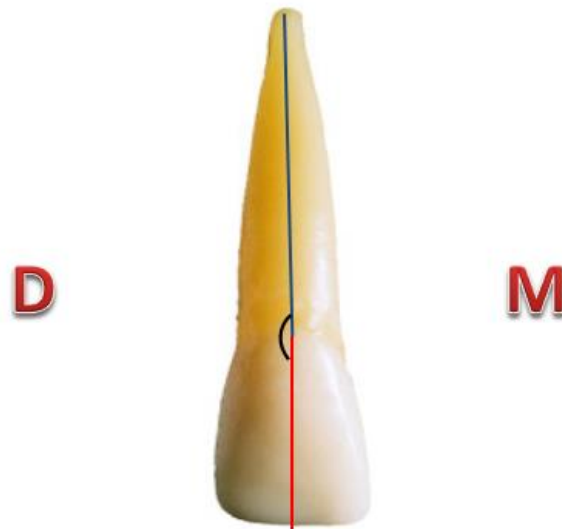
Student's t test for independent samples was used to assess the crown-root angulation of lateral incisors. P value less than 0.05 was considered significant.

(Figure 1) Crown-root angulation of maxillary lateral incisor using panoramic radiograph.
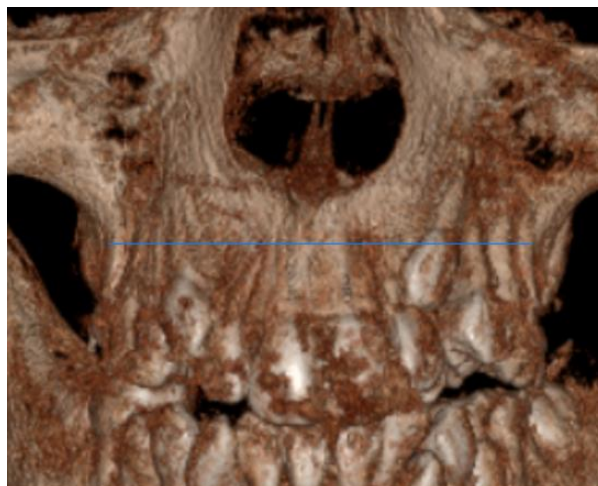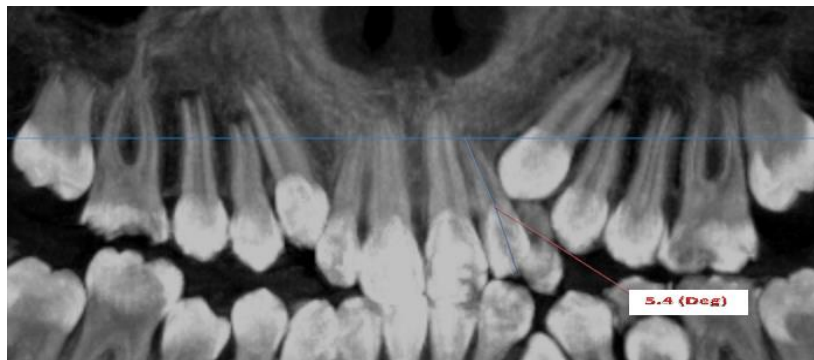
(Figure 2) Crown-root angulation of maxillary lateral incisor using CBCT.

(Figure 3) Diagram of crown-root angulation of maxillary lateral incisor.

RESULTS

Mean and standard deviation for crown root angulation of lateral incisor of palatally and labially impacted canines using panoramic x-ray are shown in Table 1.

There was no significant difference between the two groups (P=0.831).

Also, results revealed an insignificant difference between palatally and labially impacted canines in CBCT group (P=0.395).Table 2.

No significant difference was found between panorama and CBCT in crown root angulation in both groups (P=0.850 and P=0.292 respectively) Table 3, 4.

As regard control group, the outcome of this study showed that mean value of crown root angulation of lateral incisor adjacent to palatally or labially impacted canines (which is considered abnormal) is higher than that adjacent to normally erupted canines even in panoramic or CBCT. Table 5, 6.

Table 1: Range, mean and standard deviation for crown root angulation of lateral incisor of palatally and labially impacted canines using panoramic x-ray

	Panorama		Difference		Paired T-test	
	1st group	2nd group	Mean	SD	T	P-value
Range	0 : 8	-6 : 8	0.286	4.906	0.218	0.831
Mean ± SD	4.714 ± 2.335	4.429 ± 4.783				

Table 2: Range, mean and standard deviation for crown root angulation of lateral incisor of palatally and labially impacted canines using CBCT:

	CBCT		Difference		Paired T-test	
	1st group	2nd group	Mean	SD	T	P-value
Range	-5.1 : 9	-2.2 : 9.5	-1.136	4.833	-0.879	0.395
Mean±SD	4.986 ± 4.555	6.121 ± 3.678				

Table 3: Range mean and standard deviation of crown root angulation in palatally impacted canines group (1st group) using panorama and CBCT:

	1st group		Difference		Paired T-test	
	Panorama	CBCT	Mean	SD	T	P-value
Range	0 : 8	-5.1 : 9	-0.271	5.256	-0.193	0.850
Mean±SD	4.714 ± 2.335	4.986 ± 4.555				

Table 4: Range mean and standard deviation of crown root angulation in labially impacted canines group (2nd group) using panorama and CBCT:

	2nd group		Difference		Paired T-test	
	Panorama	CBCT	Mean	SD	T	P-value
Range	-6 : 8	-2.2 : 9.5	-1.693	5.768	-1.098	0.292
Mean±SD	4.429 ± 4.783	6.121 ± 3.678				

Table 5: Range, mean and standard deviation for crown root angulation of lateral incisor of control group, palatally and labially impacted canines using panoramic x-ray:

		Panorama		T-test	
		Panorama	**Controls**	**T**	**P-value**
1st group	**Range**	0 : 8	-1 : 0.5	7.985	0.000
	Mean±SD	4.714 ± 2.335	-0.393 ± 0.525		
2nd group	**Range**	-6 : 8	-1 : 0.5	3.749	0.001
	Mean±SD	4.429 ± 4.783	-0.393 ± 0.525		

Table 6: Range, mean and standard deviation for crown root angulation of lateral incisor of control group, palatally and labially impacted canines using CBCT:

		CBCT		T-test	
		CBCT	**Controls**	**T**	**P-value**
1st group	**Range**	-5.1 : 9	-1 : 0.5	4.389	0.000
	Mean±SD	4.986 ± 4.555	-0.393 ± 0.525		
2nd group	**Range**	-2.2 : 9.5	-1 : 0.5	6.560	0.000
	Mean±SD	6.121 ± 3.678	-0.393 ± 0.525		

DISCUSSION

For every orthodontist, treatment of impacted maxillary canines has been an interesting challenge from diagnostic and therapeutic point of view.

Abnormally shaped, peg or missing lateral incisors tend to guide the adjacent canine into an incorrect position in the dental arch. This concept is supported by some investigators. Others were suggesting that palatally impacted canines and abnormal shape of maxillary lateral incisor tend to occur concomitantly.

So, the aim of this study was to compare the difference in crown-to-root angulation of lateral incisor adjacent to palatally and labially impacted canines using conventional 2D and 3D (CBCT) radiographs.

The sample of this research consisted of 60 patients. For each subject, two sets of radiographic information had been obtained. First set consisted of traditional panoramic radiographs and the second set consisted of 3D volumetric images obtained from CBCT scan. These patients were divided into 2 groups. The first group consisted of palatally impacted maxillary canines; the second group consisted of labially impacted maxillary canines. Control group (third group) composed of 25 subjects with normally erupted canines.

As the morphology of the lateral incisor is affected by genetic predisposition, the lateral incisor on the contralateral side of unilateral impacted canine was not considered as a control. So, subjects of control group were selected from the archives of the orthodontic clinic with no canine impactions.

Results of this study found that there was no significant difference in crown root angulation between palatally and labially impacted canine groups. A significant difference was present between these two groups and the control group. No significant difference was found between panorama and CBCT.

A significant difference was found in crown to root angulation between impacted canine (palatally and labially) groups and the control group.

The relation between palatally displaced canine and upper lateral incisor morphology was studied previously[7,8,9]. Becker et al[10], Jacoby[11], Becker et al[12], Peck et al[13,14], Sacerdoti and Baccetti[9], and Mossey et al[15], found that presence of excess space in the maxillary arch(due to agenesis or shape anomaly of maxillary lateral incisor) can be a causative factor for the canine to deflect from its normal path of eruption. So, it can move more downward and directed palatally. They added that there is a relation or a connection between the gene or genes responsible for agenesis or hypodontia of the incisor and that gene or

genes responsible for eruption or displacement of the canine. Liuk et al[16] used cases with palatally impacted canines to compare the dimensions of lateral incisors to normal controls using cone-beam-computed-tomography. They found that the lateral incisors had significantly smaller crown and root dimensions. Peck et al [8] and Sacerdoti and Baccetti [9] concluded that their findings are in line with the hypothesis that an abnormally shaped, peg, or aplasia of lateral incisor and palatally displaced canine are biologically covariables in a complex of genetically related dental disturbances.

Bass[17] and Saiar et al[18]; found that canine malposition or impaction most frequently occurs in sufficient space and regular shape of dental arch. Bass added that only 10 patients of his experimental group had crowding with buccally impacted canines and thirty six percent of patients with impacted canines had regular arch. This result corresponds to the findings of Jacoby[11] who reported that canine impaction can occur even if a sufficient space is present in the dental arch. Nagpal et al;[19]; found that in a sample of palatally impacted canines, the mesiodistal diameter of maxillary incisors crown was less than that of the control group. Also, Carvalho et al;[20] in their work concluded that the appearance of small sized permanent incisors in initial permanent dentition may be an indicator of future impaction of the canines, especially if it is combined with other dental anomalies. However, Jacoby found crowding in 15% of palatally impacted canine cases.

Sajnani and King[21] concluded that both buccally and palatally impacted canines are associated with other odontogenic anomalies including hypodontia, enamel hypoplasia, transposition of other teeth and supernumerary teeth.

On the other hand, Brenchley and Oliver[22] are not in line with the relation between canine impaction and an anomaly of maxillary lateral incisor. They did not have a control group as the other works. Their control group was the maxillary lateral incisors on other side of impacted canines.

The work done by Purnell et al;[23] goes in line with the results found by this work, in that they concluded that in patients with impacted canines(either palatally or labially), the roots of lateral incisors are angulated mesially or distally in relation to patients with normally erupted canines.

These results were in agreement with the study done by Kanavakis et al;[24] who found that the roots of lateral incisors adjacent to palatally impacted canines were more angulated in comparison to lateral incisors adjacent to canines without impaction with the use of panoramic radiographs. They added that early diagnosis may prevent future canine palatal impaction by visual observation of crown root angulation of adjacent lateral incisor.

Panoramic radiographs have been used for many years as routine radiographs in orthodontic treatment and to diagnose impacted canines. However, in this study, CBCT was used as a primary mean for diagnosis because, panoramic radiograph was unreliable for determining the position of impacted canine in relation to adjacent lateral incisor and resorption of adjacent teeth as described by Ericson and Kurol, 1987[25].

Kanavakis et al; [24] proposed that panoramic radiographs tend to overestimate mesial angulation of lateral incisor in comparison to CBCT. They stated that bucco-lingual tooth angulation may affect mesio-distal measurements on panoramic radiographs. So, an error in using two dimensional image during predicting three dimensional structures. However, we found no significant difference between CBCT and panorama.

Shen et al;[26] and Knosel et al;[27] studied crown root angulation of maxillary central incisor from another point of view. They determined crown root angulation to indicate this angle difference with different types of malocclusion using cephalometric radiographs. They concluded that the class II division 2 malocclusion group had a significantly greater crown root angulation. McIntyre et al;[28] added that shorter root, longer crown and axial bending of central incisor can cause deep bite in class II division 2 malocclusion leading to limit the amount of palatal root torque in fixed appliance treatment.

CONCLUSION

1- The root of maxillary lateral incisor adjacent to palatally or labially impacted canines are more angulated than that adjacent to normally erupted canines.

2- Orthodontist can predict impaction of the canine by examination of crown-root angulation of the lateral incisors.

3- Since insignificant difference was found between panorama and CBCT in determining crown-root angulation, panoramic radiography is sufficient to investigate this angle to reduce un-needed radiation exposure of CBCT unless other causes are in need for CBCT to complete the diagnosis.

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