ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 8, Issue, 5, pp. 17246-17250, May, 2017

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

EVALUATION OF FREQUENCY OF THE POSITIONS OF IMPACTED MAXILLARY CANINES IN CONE BEAM COMPUTED TOMOGRAPHY IMAGES IN NORTH OF IRAN

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DOI: http://dx.doi.org/10.24327/ijrsr.2017.0805.0314

ARTICLE INFO

Article History:

Received 15th February, 2017
Received in revised form 25th March, 2017
Accepted 23rd April, 2017
Published online 28th May, 2017

Key Words:

Canines, Impacted canines, positions, Cone Beam Computed Tomography

ABSTRACT

The present study aimed to assess the frequency of the impacted maxillary canine positions and how it is related to adjacent structures through Cone Beam Computed Tomography (CBCT) images. The parameters evaluated in CBCT scans of 50 patients referred to the oral and maxillofacial radiology centers in north of Iran included: gender, bucco-palatal position and mesio-distal direction of the longitudinal axis of the canine, unilateral/bilateral occurrence, presence, severity and location of root resorption of adjacent incisors, root dilaceration, proximity of canine root to the maxillary sinus or the floor of the nasal cavity, and the distance between the canine crown and adjacent incisors root. Among 50 subjects 34 (68%) were female. The subjects' ages ranged from 14 to 52 years (mean age: 25.18 ± 9.44 years). Most of the impacted canines were observed to be positioned unilaterally 37 (74%), palatally 51 (81%), and mesially 63 (100%), and adjacent to the floor of the nasal cavity 41 (65.1%). The root resorption frequency in adjacent central and lateral incisors was five (7.9%) and 11 (20.4%), respectively. Root dilaceration was observed in three (4.8%) cases. In 75% of the cases, the distance between the canine crown and the adjacent central and lateral incisors root was less than 3.5 mm and 0.0 mm, respectively. Preoperative evaluation of impacted canines using CBCT provides an accurate and reliable assessment for proper diagnostic and therapeutic considerations.

INTRODUCTION

An impacted tooth is the one that fails to erupt into the dental arch within the expected time (Miloro *et al*., 2011). In addition to the significant delay in eruption, the clinical and radiological evidences indicate its non-eruption in the future as well (Ezoddini-Ardakani *et al*., 2015). After the third molar, the maxillary canine with 1-3% frequencyrate is the second tooth which is commonly impacted due to the long development period and indirect path of eruption. However, contrary to the third molar, canine has an important role in aesthetics and occlusion, particularly in the maxilla. Therefore, it is important to avoid the complications caused by its impaction (Ezoddini-Ardakani *et al*., 2015; Hoseini Zarch *et al*., 2013; Ghoneima *et al*., 2014; Petcu *et al*., 2015; Dean and Avery, 2016; Uribe *et al*., 2016, in press). Treatment plan of this condition varies based on the type of impaction and the position of the tooth and includes:

1. No treatment,
2. Interceptive treatment,
3. Extraction of the impacted tooth,
4. Canine autotransplant,
5. Surgical exposure and orthodontics (Aslan and Ucuncu, 2015; Uribe *et al*., 2016, in press).

Surgical procedures of the impacted teeth, even to an experienced surgeon, could be either quite difficult or simple. According to the different positions of the impacted canine and its anatomical proximities, the most important issues, to a surgeon, are determining the exact position of the impacted

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tooth, relationship to the adjacent structures, surgical accessibility and predicting the probable complications caused by surgeries, etc. An appropriate imaging has a key role in the preoperative examinations. First used in angiography in the early 1980s, Cone Beam Computed Tomography (CBCT) is currently a popular technique in the process of diagnosis and treatment in dentistry. CBCT is a three-dimensional (3D) diagnostic imaging technique which through providing volumetric information of structures produces accurate 3 Dreconstructed images with high resolution and, compared with CT, it incurs less patient radiation dose, distortion and costs (White and Pharoah, 2014; Santos *et al*., 2014). Similar studies which used CBCT in evaluating the position and direction of the impacted canine and how it is related to adjacent structures found that CBCT led to an accurate diagnosis, proper treatment, and consequently, decreasing the relevant complications (Miloro *et al*., 2011; Ezoddini-Ardakani *et al*., 2015; Al-Ghurabi *et al*., 2013; Motaghi *et al*., 2016; Santos *et al*., 2014; Ericson and Kurol, 2000; Ucar *et al*., 2017, in press; Sandhu *et al*., 2016). Several studies compared CBCT and panoramic techniques and the results were in favor of CBCT and its superiority over panoramic radiography in terms of sensitivity and accuracy and, hence, suggested that it is a more effective tool for diagnosing and treatment planning, particularly in complicated cases (Hoseini Zarch *et al*., 2013; Petcu *et al*., 2015; Alqerban *et al*., 2011; Alqerban *et al*., 2014; Eslami *et al*., 2017). In the present study aiming at increasing the success of the treatment and decreasing the probable complications, the frequency of the position and direction of impacted maxillary canines and how they are related to adjacent structures in CBCT images were investigated in a population recruited in north of Iran.

MATERIALS AND METHODS

In this cross-sectional retrospective study, 50 CBCT images obtained from the patients who referred to the oral and maxillofacial radiology centers located in north of Iran were collected. The inclusion criterion was patients who had both impacted maxillary canine(s) and adjacent teeth with the age range from 14 to 60 years. The unclear images with radiographic artifacts were omitted. The 3D evaluation of the collected images was implemented by an oral and maxillofacial radiologist in sagittal, axial and coronal planes (0.5mm in thickness and 1.0 mm in interval). Following parameters were evaluated: gender, bucco-palatal position and mesio-distal direction of the longitudinal axis of the impacted canine, unilateral/bilateral occurrence, presence and severity (based on the classification proposed by Ericson and Kurol, 2000) and location (based on apical, medial, and cervical one third of the root) of root resorption of adjacent teeth, root dilaceration, proximity of canine root to the maxillary sinus or the floor of the nasal cavity, and the distance between the canine crown and the adjacent incisors root. A checklist was prepared for registering the demographic information and the information related to the parameters. The criteria for the bucco-palatal position and the mesio-distal direction of impacted tooth was evaluating the longitudinal axis of the impacted canine with respect to the longitudinal axis of the adjacent lateral incisor (in cases which the lateral incisor did not exist, the central incisor was utilized) in, respectively, cross-sectional plane and sagittal plane. The severity of the resorption was analyzed based on the classification proposed by Ericson and Kurol (2000) is as follows:

1. No resorption: the root surface is intact; however, the cementum layer is at risk.
2. Mild resorption: the resorption extends up to half of the dentin thickness.
3. Moderate resorption: the resorption has neared the pulp, but pulp exposure has not occurred yet.
4. Severe resorption: pulp is exposed due to resorption,

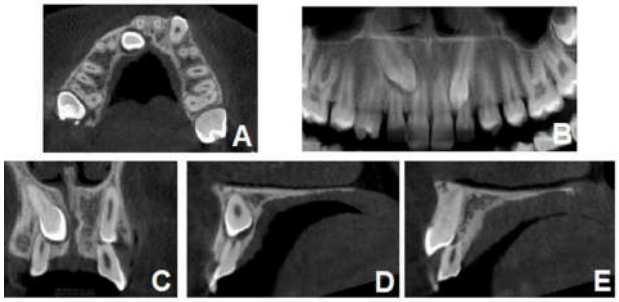

Fig 1 Axiall (A), panoram (B), coronal (C) and sagittal (D and E) slices of cone beam computed tomography (CBCT) show bilaterally impacted maxillary canines causing severe root resorption of the adjacent lateral incisors. 4. Severe resorption: pulp is exposed due to resorption

The closest distance between the canine crown and the adjacent incisors root was measured through NNT Viewer software (version 7.2), in millimeter (mm). Being fed into Statistical Package for Social Sciences (SPSS), version 22.00, the data were analyzed through descriptive statistics, frequency, and percentage indices, and compared through conducting the independent-samples t-test and the chi-square (x^2) test. A p-value lower than 0.05 ($p< 0.05$) was considered to be statistically significant.

FINDINGS

Out of a total of 50 subjects who possessed impacted maxillary canines, 34 (68%) were female, the difference between two genders was statistically significant ($p= 0.002$). The subjects' age ranged from 14 to 52 years (mean age: 25.18 ± 9.44 years). The highest and lowest frequency, respectively, belonged to the patients who were 14-23 and those who were over 44 years. The relationship between the frequency of the impacted canine and the age was statistically significant ($p< 0.001$), (Fig 2). The frequency of the impacted canine was more unilateral (74%) than bilateral (26%) and the difference was statistically significant ($p= 0.001$). Thus, a total of 63 impacted canines were evaluated which 33 (52.4%) and 30 (47.6%) of them were, respectively, observed in the left and right sides. Twelve (19%) impacted canines were in buccal position (22.7% in females and 10.5% in males) while 51 (81%) cases were in palatal position (77.3% in females and 89.5% in males) which this difference was statistically significant ($p< 0.001$). There was no relationship between the position of the impacted canine and gender. All the impacted canines (100%) were observed in the mesial direction. The frequency of root resorption in the adjacent central incisors equaled five (7.9%). The lack of lateral incisor was observed in nine cases; therefore, the frequency analysis was done in a population consisting of 54 cases.

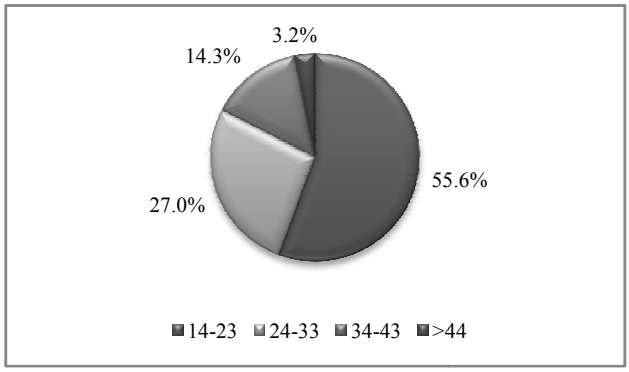

Fig 2 Frequency of patients with impacted canine in different age ranges.

The frequency of root resorption in adjacent lateral incisors was 11 (20.4%). The details about the severity and location of the adjacent incisors root resorption are shown in table 1. The frequency of the adjacent incisors root resorption in different age ranges and genders are shown in table 2.

1.0 mm (mean= 0.083 ± 0.27 mm) that 75% of the cases had no distance from lateral incisor root (d= 0).

DISCUSSION

As it was seen in this study, the frequency of the impacted canine was significantly higher among females than males. In similar studies, as well, the impacted canine was mostly observed in females which could be because of the differences in craniofacial development and growth factors between the two genders. In addition, aesthetics is more important to women than men; thus, they see the dentists more often (Al-Ghurabi *et al*., 2013; Motaghi *et al*., 2016; Santos *et al*., 2014; Walker *et al*., 2005). The frequency of the impacted canine was significantly more unilateral, in the present study, than bilateral. Motaghi *et al*. (2016) and Santos *et al*. (2014) argued that most of the impacted canines were unilateral with the frequency of 64.4% and 72%, respectively, which are in line with the present study whereas Al-Ghurabi *et al*. (2013) found

Table 1 Severity and location of the root resorptionin adjacent central and lateral incisors due to impacted canines

	Severity				Location		
	No resorption	**Mild resorption**	**Moderate Resorption**	**Severe resorption**	**Cervical one third of the root**	**Medial one third of the root**	**Apical one third of the root**
Central Incisor n=63	58 (92.1%)	2 (40%)	3 (60%)	0	0	1 (20%)	4 (80%)
Lateral Incisor n=54	43 (76.9%)	5 (45.5%)	2 (18.2%)	4 (36.4%)	1 (9.1%)	3 (27.2%)	7 (63.6%)

Table 2 The frequency of the adjacent central and lateral incisors root resorption in different age ranges and genders

		Central Incisor Root Resorption		*P* value	Lateral Incisor Root Resorption		*P* value
		No	**Yes**		**No**	**Yes**	
Age range	14-23	33 (94.3%)	2 (5.7%)	0.388	27 (81.8%)	6 (18.2%)	0.593
	24-33	16 (94.1%)	1 (5.9%)		8 (66.7%)	4 (33.3%)	
	34-43	7 (77.8%)	2 (22.2%)		7 (87.5%)	1 (12.5%)	
	≥44	2 (100%)	0 (0.0%)		1 (100%)	0 (0.0%)	
Gender	Female	40 (90.9%)	4 (9.1%)	0.606	31 (75.6%)	10 (24.4%)	0.193
	Male	18 (94.7%)	1 (5.3%)		14 (92.3%)	1 (7.7%)	

Three cases of canine root dilacerations (4.8%) were observed all of which were seen in males. In total, 53 (84.1%) impacted canines were posited adjacent to the maxillary sinus or the floor of the nasal cavity while 10 (15.9%) cases were adjacent to neither the maxillary sinus nor the floor of the nasal cavity and the difference was statistically significant($p< 0.001$). Also the frequency of the proximity of the impacted canine to the floor of the nasal cavity 41 (65.1%) was significantly higher compared to the maxillary sinus 12 (19%), ($p< 0.001$).

The distance from the canine crown to the adjacent central incisor root varied from 0.0 mm to 12.0 mm (mean= 1.833 ± 2.26 mm) that the position of a total of 75% of the cases was in a distance less than 3.5 mm (d≤ 3.5 mm). To clarify the results, the frequency of the cases which were posited in a distance less than 1.0 mm (d≤ 1.0 mm) and those that had no distance from central incisor root (d= 0) was separately examined and it was 50% and 25%, respectively. The distance of the canine crown from the adjacent lateral incisor root was reported to be 0.0 to

that the impaction, which was extremely significant, was bilateral (84.7%). The differences lied in genetic and geographic features and sample size. The relationship between the frequency of the impacted canine and the age was statistically significant.

In this study, the frequency of the impacted canine in the palatal position was significantly higher than in the buccal position, which is consistent with a number of studies (Al-Ghurabi *et al*., 2013; Santos *et al*., 2014: Walker *et al*., 2005). However, Ghoneima *et al*. (2014) found the lowest frequency for the palatally impacted canine (0.4%). In some studies, a significant difference, between the buccal and palatal positions, was not found either (Motaghi *et al*., 2016; Liu *et al*., 2008). All the impacted canines evaluated in this study were mesially-directed and no case in the distal direction was observed. In Liu *et al*. (2008), the obtained frequency for the impacted canine in the mesial, distal, and vertical directions were 82.7%, 7.7%, and 9.6%, respectively. In Al-Ghurabi *et al*. (2013) reported the

highest frequency for the mesial direction (67.1%). The differences in the frequency of the position and direction of impacted canines could be related to differences in craniofacial development and genetic features, which cause differences in bone structure, arch shape, dental arch length and width, and finally, varied positions of impaction in the dental arch. Sample size is another factor as well (Santos *et al*., 2014; Walker *et al*., 2005; Al-Ghurabi *et al*., 2013).

In the present study the frequency of the root resorption in the adjacent central and lateral incisors caused by the impaction of canine were not significant. The severe root resorption was only reported in the lateral incisors although the relationship between the proximity of the impacted canines to the lateral incisors and the severity of the root resorption was not significant. Furthermore, the greatest number of resorption, either in central or lateral incisors, was in apical one third of the root though none was statistically significant. In Walker *et al*. (2005), the root resorption frequency was 66.7% in the lateral incisors and 11.1% in the central incisors and a significant relationship was found between the proximity of the impacted canines to the adjacent incisors and the occurrence of the root resorption; therefore, the results are not consistent with the present study. In Liu *et al*. (2008), the root resorption in frequency was 27.2% in the lateral incisors and 23.4% in the central incisors and 94.3% of the root resorption occurred where the impacted canines closely touched the adjacent incisors. In Oberio *et al*. (2012), 35.7% mild, 14.2% moderate, and 4.0% severe root resorption was reported in the adjacent lateral teeth. In Motaghi *et al*. (2016), no root resorption in 18.8%, mild root resorption in 56.3%, and moderate root resorption in 25% of the cases were observed. No case of severe root resorption was reported either. The results of Petcu *et al*. (2015) and Hoseini Zarch *et al*. (2013), revealed that CBCT, compared with panoramic, is a more accurate technique for diagnosing and evaluating the position of impacted canines and the root resorption of the adjacent teeth. In Santos *et al*. (2014), root resorption in the adjacent teeth was mostly observed in the lateral incisors (67.6%) and was mild in severity (68.8%) and a statistically significant relationship was found with the proximity of the impacted canine in both parameters which is inconsistent with the results of the present study. Despite the other studies, however, in Al-Ghurabi *et al*.(2013), no case of root resorption in the adjacent teeth was recorded at all.

The results of the present study did not reveal a significant relationship between the position and the direction of the longitudinal axis of the impacted canine and the root resorption in the adjacent incisor teeth. This finding supports the results of Ucar *et al*. (2017), which looked into the effects of the impaction of canine on the root resorption in the adjacent lateral incisors.

In the present study, few cases of root dilaceration in impacted canines were observed, all of which were reported in males. In Santos *et al*. (2014), root dilaceration was observed in 59.5% of the cases. Mostly, morphological changes, such as root dilacerations in bucco-lingual dimension, are not noticeable in the priapical and panoramic images; however, they are displayed well in CBCT analyses (White & Pharaoh, 2014). In this study, most of the cases were close to the maxillary sinus or the floor of the nasal cavity and only a few of the cases were not close to neither of them that this difference was statistically significant. Also the frequency of the proximity of the impacted canine to the floor of the nasal cavity was significantly higher compared to the maxillary sinus. In line with Sajnani and King (2014), since it is possible that the root of the impacted canine be transferred into the maxillary sinus or the nasal cavity during the surgeries, a careful examination of the position and the amount of proximity of the canine root to these structures is of paramount importance.

In the present study, in most of the cases, the canine crown touched the root of the adjacent incisors or was very close to it. According to Sajnani and King (2014), damage to the adjacent teeth is not unlikely to occur while surgeries are being performed on impacted canines close to them. As a result, a careful examination of the distance of impacted canine to the adjacent teeth is imperative.

CONCLUSION

In the present study, most of the impacted canines were observed in females, unilaterally, in palatal position, mesial direction, and adjacent to the floor of the nasal cavity. The root resorption frequency in adjacent incisors was not significant. Root dilaceration was observed in few impacted canines. In most of the cases, the canine crown touched the root of the adjacent incisors or was very close to it. Based on the results of the present study, a careful pre-surgical examination of the position of the impacted canines and the adjacent areas through CBCT is recommended so that it is diagnosed precisely, treated properly, and the probable complications are avoided.

Acknowledgement

Hereby, the researchers acknowledge Dr. Alireza Mirshekar for his support in collecting the required data.

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How to cite this article:

Mohammad Mehdizadeh *et al*.2017, Evaluation of Frequency of the Positions of Impacted Maxillary Canines In Cone Beam Computed Tomography Images In North of Iran. *Int J Recent Sci Res.* 8(5), pp. 17246-17250.
DOI: http://dx.doi.org/10.24327/ijrsr.2017.0805.0314

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