Section A-Research paper
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EVALUATION OF THE POSITION OF IMPACTED MAXILLARY CANINES USING PANORAMIC AND CBCT IMAGING - A RETROSPECTIVE STUDY

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Abstract

Aim: To evaluate the efficacy of the novel method in determining the position of impacted maxillary canine using cone beam computed tomography and panoramic radiography. **Material and Methodology:** The study was conducted in Department of Orthodontics and Dentofacial Orthopedics, Yenepoya Dental college, Mangalore, Karnataka. CBCT scans of the craniofacial region and panaromic radiographs taken from January 2011 to December 2019 for various purposes was used for the study. A total of subjects (12 males and 12 females) with a total of 31 impacted canines were included. The sector locations of the impacted canine root apices on the panoramic radiographs were compared with the labio-palatal positions of impacted maxillary canines on cone beam computed tomography. **Result**: The efficacy of the root apex or the sector method was found to be 70.6%, 62.5% and 18.8% for palatally impacted, impaction in mid alveolus and buccal impactions respectively. The efficacy of magnification method is 60% for buccal canine impaction and 88% for palatal canine impaction. **Conclusion:** The magnification and sector method are reliable for analysing the palatal canine impaction. Although Periapical radiographs are user friendly and cost effective for diagnosis of impaction, CBCT plays a gold standard in accurate diagnosis and treatment planning.

Keywords: Cuspid, Teeth, Impacted, Radiography, Panoramic, Cone beam computed tomography

Introduction: Tooth impaction can be defined as the infra-osseous position of the tooth after the expected time of eruption. The most frequently impacted tooth is the maxillary canine after the third molars. Ericson and Kurol [1] estimated the incidence at 1.7%. Impactions are common in females (1.17%) as in males (0.51%) with 8% of bilateral impactions. The incidence of mandibular canine impaction is 0.35%.; the prevalence of impacted maxillary canine minimum of 0.92%- 4.3%. According to Dewel [2], maxillary canines have the longest period of development, as well as the longest and most tortuous course to travel from point of formation, lateral to the piriform fossa, until they reach their final destination in full occlusion, causing them to be impacted more often than other tooth. During their course of development, the crowns of the permanent canines are intimately related to the roots of the lateral incisors. canine impaction is also attributed to the lack of an eruptive guide supported by the lateral incisor, because of agenesis of the lateral incisor, and/or lateral incisor malformation (i.e. conoid or microdontic lateral incisor)[3] Impacted canines tend to cause resorption of the adjacent roots. Two main theories have been proposed to explain the occurrence of palatally displaced maxillary canines: the "guidance theory" and the "genetic theory".[4]

The best time to diagnose the potential impaction is during the early mixed dentition period, The proper localization of the impacted tooth plays a crucial role in determining the feasibility of, as well as the proper access for, the surgical approach, and the proper direction for the application of orthodontic forces. The diagnosis of canine impaction is based on both clinical and radiographic examinations.[1]

For an accurate diagnosis the clinical examination should always be supplemented with a radiographic evaluation. Although various radiographic exposures, including occlusal films, panoramic views, and lateral cephalograms, can help in evaluating the position of the canines, in recent times CBCT are uniquely reliable for that purpose. Panoramic films are also used to localize impacted teeth in all three planes of space, much the same as with two periapical films in the tube-shift method. [5]

A CBCT scan provides a three-dimensional image in which the position of the impacted canine with adjacent structures, such as incisors, are more easily seen. The disadvantages are increase in the radiation dose and cost to the patients. Thus, panoramic radiographs provide useful clinical information at a lower radiation dose and financial cost.

Material and Methodology: CBCT scans and panaromic radiographs of the craniofacial region taken from January 2011 to December 2019 for various purposes was used for the study.

Paired panoramic films and cone beam computed tomography images of patients with impacted maxillary canines was selected from the repository of Department of Oral Medicine and Radiology, Yenepoya dental college. Using CBCT data, each sample was classified according to the crown location of the impacted canine and specifically with regard to the labiopalatal relationship to yield the following groups: group labial, group palatal, and group mid-alveolus. Regarding the latter, if the impacted canine crown touched the line between the adjacent lateral incisor and first premolar crown, it was classified into group mid alveolus. A total of subjects (12 males and 12 females) with a total of 31 impacted canines were included. The radiographs were traced in a tracing paper using a tracer box with a Hi-tech pen and the measurements were made with a digital vernier caliper sensitive upto 0.01 mm. In the panoramic radiographs mesio-distal position of the impacted maxillary canine root apex relative to adjacent teeth was classified into four panoramic sectors using a modification of the method of Alessandri Bonetti. The sector locations of the impacted canine root apices on the panoramic radiographs was compared with the labio-palatal positions of impacted maxillary canines on cone beam computed tomography[1]

Inclusion Criteria

- Unilateral and bilateral maxillary canine impaction.

Exclusion Criteria

- Odontoma
- Mesiodens
- Cleft lip and palate

Fig 1: CBCT image of Mid alveolus canine impaction

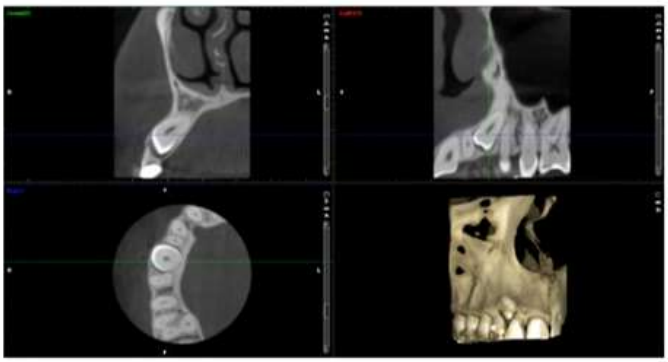

Fig 2: CBCT image of palatal canine impaction

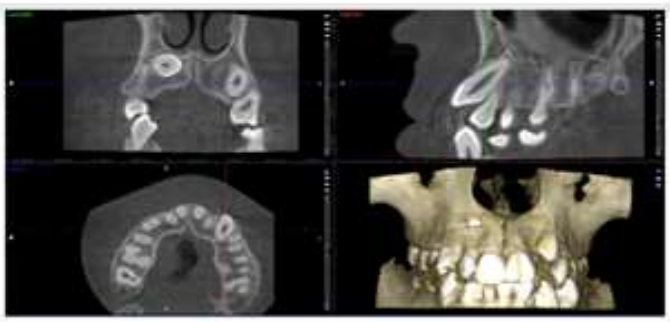

Fig 3: CBCT of buccal canine impaction

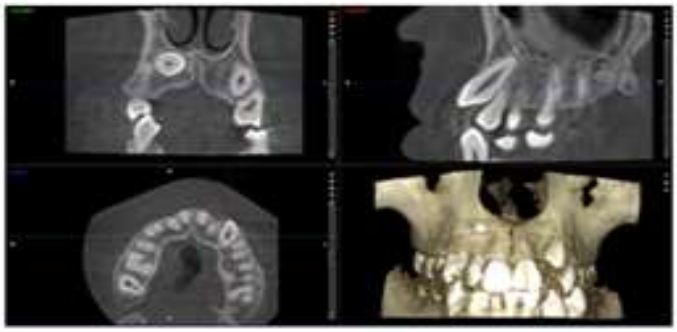

Fig 4: Vernier caliper

Fig 5: Sector classification

Fig 6: Impacted canine width and central incisor width

Statistical Analysis: The correlation between panoramic and CBCT findings was examined using the $\chi 2$ test and ANOVA test. The level of significance was $p < 0.05$. All of the analyses were carried out with SPSS version 21.0 software (IBM Corporation, formally SPSS Inc, Armonk, NY).

Results:

Table 1: Distribution of location of impacted maxillary canines

Bucco palatal position	Buccal canines			Mid alveolus canines			Palatal canines			Total sample	
Vertical zones	N	% of buccal	% of total	N	% of mid alveolus	% of total	N	% of palatal	% of total	N	% of total
Coronal	4	25.0%	21.1%	6	75.0%	31.6%	9	52.9%	47.4%	19	46.3%

Middle	12	75.0%	54.5%	2	25.0%	9.1%	8	47.1%	36.4%	22	53.7%
Total	16	100%	39.0%	8	100%	19.5%	17	100%	41.5%	41	100.0%

Graph 1: Distribution of location of impacted maxillary canines

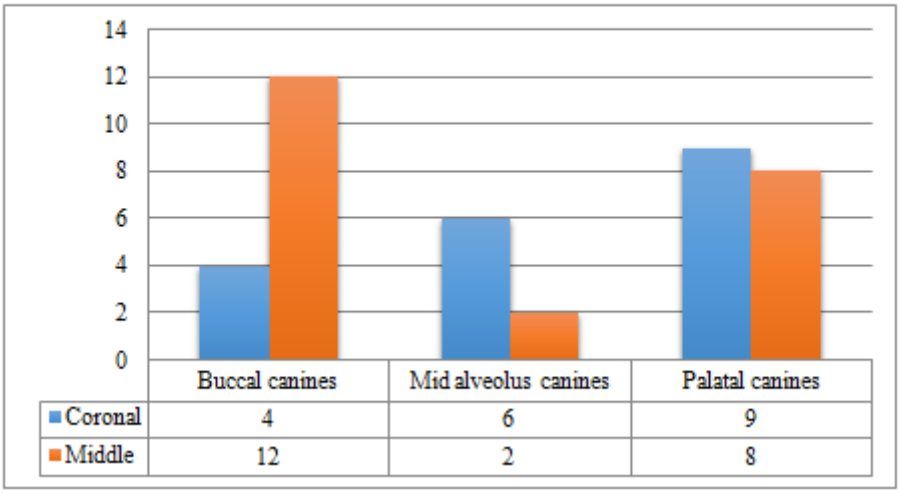

Table 2: Relationship between sector location on panoramic radiographs and position on CBCT images

			Sector cases				Total	Chi square (p value)
			1	2	3	4		
Impaction position	Buccal	N	1	2	5	8	16	6.66(0.353)
		%	6.3%	12.5%	31.3%	50.0%	100.0%	
	Mid alveolus	N	0	1	5	2	8	
		%	0.0%	12.5%	62.5%	25.0%	100.0%	
	Palatal	N	0	1	4	12	17	
		%	0.0%	5.9%	23.5%	70.6%	100.0%	
Total		N	1	4	14	22	41	
		%	2.4%	9.8%	34.1%	53.7%	100.0%	

Graph 2: Relationship between sector location on panoramic radiographs and position on CBCT images

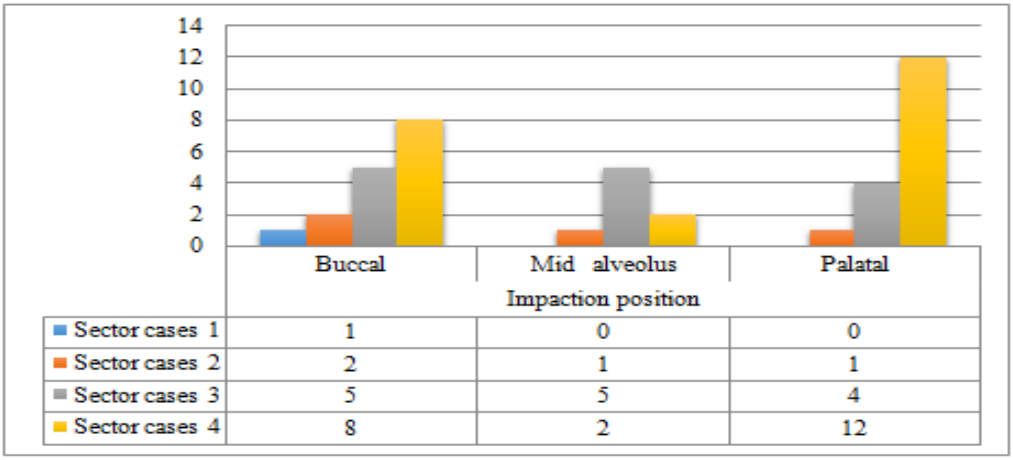

Table 3: Comparison of mean values of canine width, incisor width and magnification index between three canine positions using one way ANOVA test

		N	Mean	Std. Deviation	95% Confidence Interval for Mean		P value
					Lower Bound	Upper Bound	
Canine width	Buccal	16	8.4625	1.25736	7.7925	9.1325	0.541
	Mid alveolus	8	8.7963	1.54884	7.5014	10.0911	
	Palatal	17	8.9924	1.38316	8.2812	9.7035	
	Total	41	8.7473	1.35513	8.3196	9.1750	
Incisor width	Buccal	16	8.0156	1.49115	7.2210	8.8102	0.362
	Mid alveolus	8	8.4713	1.76821	6.9930	9.9495	
	Palatal	17	7.6141	1.12589	7.0352	8.1930	
	Total	41	7.9380	1.41134	7.4926	8.3835	
Magnification index	Buccal	16	1.0788	.19557	.9746	1.1830	0.085
	Mid alveolus	8	1.0533	.14307	.9337	1.1730	

	Palatal	17	1.1899	.14442	1.1156	1.2641	
	Total	41	1.1199	.17294	1.0653	1.1745	

Table 3 shows comparison of mean values of canine width, incisor width and magnification index between three canine positions using one way ANOVA test. The results were not statistically significant in all three cases ($p>0.05$). This indicates that the mean values of canine width, incisor width and magnification index did not differ significantly between different positions of impacted canine. Thus canine width, incisor width and magnification index may not be important tools to predict the position of an impacted canine

Table 4: Magnification method result vs actual outcome

			Actual outcome			Total	P value
			Buccal	Mid alveolus	Palatal		
Method result	Palatal	N	7	2	11	20	0.157
		% within method result	35.0%	10.0%	55.0%	100.0%	
		% within actual outcome	43.8%	25.0%	64.7%	48.8%	
	Buccal	N	9	6	6	21	
		% within method result	42.9%	28.6%	28.6%	100.0%	
		% within actual outcome	56.3%	75.0%	35.3%	51.2%	
Total		N	16	8	17	41	
		% within method result	39.0%	19.5%	41.5%	100.0%	
		% within actual outcome	100.0%	100.0%	100.0%	100.0%	

Table 4 shows comparison of magnification method results with actual outcome. The comparison was done using chi square test. It was found that the result is statistically not

significant ($p > 0.05$) indicating that no difference exists between magnification index method outcome and the actual results. This indicates that the method may be useful in predicting position of impacted canines.

Table 5: Sector method vs actual outcome

			Actual outcome			Total	P value
			Buccal	Mid alveolus	Palatal		
Sector method result	Buccal	N	3	1	1	5	0.216
		% within sector	60.0%	20.0%	20.0%	100.0%	
		% within actual outcome	18.8%	12.5%	5.9%	12.2%	
	Mid alveolus	N	5	5	4	14	
		% within sector	35.7%	35.7%	28.6%	100.0%	
		% within actual outcome	31.3%	62.5%	23.5%	34.1%	
	Palatal	N	8	2	12	22	
		% within sector	36.4%	9.1%	54.5%	100.0%	
		% within actual outcome	50.0%	25.0%	70.6%	53.7%	
Total		N	16	8	17	41	
		% within sector	39.0%	19.5%	41.5%	100.0%	
		% within actual outcome	100.0%	100.0%	100.0%	100.0%	

Table 5 shows comparison of sector method vs actual outcome using chi square test. The result was not statistically significant indicating no difference between sector method result and actual outcome. The method may be a predictor of canine positions.

Discussion: Maxillary canines are the most commonly impacted teeth, after third molars. Maxillary canines are the last anterior teeth to erupt in the oral cavity, after the third

molars with a prevalence of 0.92 to 2.6% [6].Disturbances in the eruption of maxillary permanent canines are common because they have the longest period of development, the most superior area of development and the most difficult path of eruption compared. Impacted canines may result in several complications such as displacement and root resorption of adjacent teeth, cystic degeneration, canine ankylosis, shortening of the dental arch.[7]

Early diagnosis and careful observation are necessary for the successful treatment of maxillary canine impaction. There are so many treatment options for this condition that may include observation, extraction, auto transplantation and orthodontic correction.[8]For the most appropriate treatment modality, the exact assessment of the position of the impacted maxillary canine in 3 planes of space is essential. This localization is based on the combination of clinical and radiographic findings. Canine impaction can be diagnosed at an early stage using visual examination, palpation, or radiography. Currently, panoramic film, lateral cephalography, posteroanterior cephalograph, and cone-beam computed tomography (CBCT)are the radiographic tools for diagnosis of impacted canines. Among these, CBCT can precisely identify and locate the positions of impacted canines; but they relatively have high radiation doses. [9]

The present study is aimed at evaluating position of impacted maxillary canine using cone beam computed tomography and panoramic radiography. The objective of the study is to evaluate the efficacy of the novel method for prediction of impacted maxillary canine, to compare and correlate the root apex position of impacted maxillary canine in panoramic radiograph with its labio-palatal position in cone beam computed tomography and to compare and correlate the magnification index of impacted maxillary canine and erupted central incisor in panoramic radiograph with the labio-palatal position in cone beam computed tomography.

In our present study, the incidence of the incidence of buccal canine impaction in the middle zone seems to be greater followed by palatal canine impaction in the coronal zone and middle zone. The mid alveolus canine impaction is the least. In previous study by Chaushu et al. (1999)[10], showed 8.75% labially and 3.75% palatally impacted canines in the apical zone in the study. Zhong et al. [2016][11] strongly supports this opinion, finding that the Chinese also exhibit a greater prevalence of labial impactions (2.1 times more than palatal). This differences may be attributed to the sample selection, method of the study and area of patient selection, which suggest racial and genetic differences.

In our present study, on comparing the relationship between sector location on panaromic radiographs and position on CBCT images, the palatal canine impaction coincides with sector 4 more followed by buccal canine impaction. The sector 1 and 2 showed the least incidence of

canine impaction in buccal, mid alveolus and palatal region. Warford et al.[12] reported that 48.6% of impacted canines were found in sectors 3, 4, and 5. Lindauer et al.[13] found that 41.5% of impacted teeth occurred in sectors 3, 4, and 5.Sung-Hun Kim(2017)[14] et al found Labially impacted canines were more frequent in sector 2, palatally impacted canines in sector 4, and mid alveolus impacted canines in sector 3.

In our present study, the comparison of mean values of canine width, incisor width and magnification between three canine position using ANOVA test were made. The results were not statistically significant in all three cases ($p>0.05$). This indicates that the mean values of canine width, incisor width and magnification index did not differ significantly between different positions of impacted canine. Thus canine width, incisor width and magnification index may not be an important tool to predict the position of an impacted canine. Mason C et al(2001) [15] have shown that the accuracy in diagnosis of the buccopalatal location of the impacted maxillary canines on the basis of magnification in the panoramic radiograph was 80% to 90%.Wazir et al (2013) have shown that no localization was possible between the canines that were placed in the apical zones from panoramic radiographs whereas buccopalatal localization was possible for canines that were placed in middle and coronal zones.

In our present study, the comparison of magnification method results with actual outcome was made using chi square test. It was found that the result is statistically not significant ($p>0.05$) indicating that no difference exists between magnification index method outcome and the actual results in both buccal and palatal canine impaction. Our study implies 60% of buccal canine impaction and 88% of palatal canine impaction can be identified by this method. This is in accordance with the study by Wolf and Mattila[16] who stated that the magnification method was much more accurate in detecting palatally impacted canines than buccal impacted canines. Mason et al,[17] stated that 90% of palatal canines and only 10% of buccal canines could be detected with magnification. Nagpal et al[18] stated that 68.00% of buccal canines and 69.57% of palatal canines could be localized correctly. The results implied that the magnification method could be used for prediction of palatal canine impaction.

In our study, comparison of sector method vs actual outcome using chi square test was made. The result was not statistically significant indicating no difference between sector method result and actual outcome. The method is a good predictor for palatal canine impaction but not for buccal canine impaction. Mason et al evaluated two localization methods and reported that 76% of the impacted canines are correctly located with vertical parallax and 66% with magnification method. Sudhakar S and Patil K concluded that a single panoramic radiograph can act as a

reliable indicator for determining the bucco-palatal position of the impacted canines when they are in the middle and coronal zones. Katsnelson A [19]et al., (2010) concluded that panoramic radiographs have a high sensitivity and specificity for determining impacted buccal maxillary canine position, with angulations greater than 65 degree.

Thus, in our study both the magnification and sector method are reliable for analysing the canine impaction for palatal canine impaction being more reliable. Although Periapical radiographs are user friendly and cost effective for diagnosis of impaction , CBCT plays a gold standard in accurate diagnosis and treatment planning

Conclusion

- The efficacy of the root apex or the sector method was found to be 70.6% , 62.5% and 18.8% for palatally impacted, impaction in mid alveolus and buccal impactions respectively.
- On comparing the root apex position of impacted maxillary canine in panoramic radiograph with its labio-palatal position in cone beam computed tomography it was concluded that the incidence of palatal canine impaction coincides with sector 4 more, followed by buccal canine impaction. The sector 1 showed least coincidence of canine impaction in buccal, mid-alveolus and palatal region.
- On comparing the magnification index of impacted maxillary canine and erupted central incisor in panoramic radiograph with the labio-palatal position of maxillary canine in cone beam computed tomography it was found that at a magnification index of 1.0205 the method showed 88 percent sensitivity and 40 % specificity meaning 88 percent of palatal canine position were correctly identified by this method. And at the magnification index of 1.0485 the method showed 56% sensitivity and 20 % specificity meaning only 60 percent of buccal canine position were identified by the method.

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