Comparative Evaluation of Impacted Maxillary Canine Position Using Panoramic Radiograph and Cbct

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Abstract

Aim: To correlate labiopalatal position of impacted maxillary canines and evidence of root resorption of permanent incisors in Cone Beam Computed Tomography [CBCT] relative to its position in panoramic radiographs [PAN].

Materials and Methods: Archived panoramic radiographs and CBCT of 10 patients with 15 impacted maxillary canines were assessed. Labiopalatal position in panoramic radiographs was assessed using sector location and angular measurements and compared to position and evidence of root resorption of adjacent incisors in CBCT. Data was analysed using Kendall's tau-b, Kendall's tau-c and Kappa statistics.

Results: Labially impacted maxillary canines were frequent in sector 1,2,&3 and palatally impacted canines were frequent in sector 5 in Panoramic Radiograph. Moderate agreement was obtained between panoramic Sectors and angulation of Impacted Maxillary Canine and Labio-palatal position in CBCT. Root resorption were frequently observed in panoramic sector 5. Only a slight agreement was observed between root resorption in panoramic radiograph and CBCT.

Conclusion: Labio-palatal position of impacted maxillary Canines can be predicted using sector location and Katnelson's angulation in panoramic radiograph. Root resorption can be more accurately predicted using CBCT.

Keywords: Localization, Impacted maxillary canine, sector location, panoramic radiograph, CBCT

INTRODUCTION:

Impaction is defined as a failure of tooth eruption at its appropriate site in dental arch, within its normal period of growth.[1] Maxillary canines are second most common impacted teeth with a prevalence of 1-6.04%.[1, 2]

Etiopathogenesis for impaction of permanent maxillary canine is attributed to their longest period of development, most superior area of development, and the most difficult path of eruption.[3] Three major theories have been proposed to explain the etiology of maxillary canine impaction. Guidance theory and Genetic theory explain palatally displaced maxillary canines and arch length discrepancy describes buccally impacted maxillary canines.[4] Maxillary canine impaction may result in malocclusion, root resorption of adjacent teeth and cyst formation. [3]

Earlier statistics based on two dimensional radiography indicated 85% maxillary canine impactions to be palatal and 15% buccal.[4] Recent studies on maxillary canine impaction are based on cone beam computed tomography [CBCT].[1,3,5] CBCT provides three dimensional images which helps in localization, surgical planning and assessment of damage to roots of adjacent teeth. CBCT studies have indicated that 41.1% of maxillary canine impactions were located labially, 27.4 % were located palatally and 31.5% midalveolus.[3]

CBCT is the gold standard for localizing maxillary canine impaction and assessing root resorption of adjacent permanent incisors. But it is expensive, has high radiation dose and limited availability. Eventhough several studies have shown that routine panoramic radiographs [PAN] can be used to localize maxillary canine impaction, our aim was to correlate the labiopalatal position of impacted maxillary canines and evidence of root resorption of permanent incisors in CBCT relative to its position in panoramic radiographs based on sector location and angular measurements.

MATERIALS AND METHODS:

Images of panoramic radiographs and CBCT of patients with impacted maxillary canine from archives of department of Oral medicine and Radiology, PMS College of Dental Science and Research were selected for the study. Ten patients who possess both panoramic radiograph and CBCT were included for the study. Out of 10 patients 4 were males and 6 were females. Five patients had bilateral canine impactions. Images of patients with congenital abnormalities like cleft lip or palate or craniofacial syndromes, pathologic abnormalities like cyst or tumour or supernumerary teeth in study zone, history of trauma, orthodontic treatment, orthognathic surgery were excluded from study.

Panoramic radiographs in archives taken using panoramic x-ray machine (ORTHOPHOS XG /XG5DS, model number: 5884999D3352, serial number: 17014 , 200-240 V , 12A , 50/ Hz , Exposure time is 14.5 sec) and archived CBCT scans taken using DENTRI SX CBCT unit with free FOV capability and with maximum FOV of 16X14.5 cm(stitch mode) manufactured by HDXWILLS.

Measurements in panoramic radiograph were done using SIDEXIS software and in CBCT using On demand 3D software provided along with the system. Measurements were made in dental mode using the Arch Definition tool to obtain cross sectional images.

This study aims to localize impacted canines using both sector location and angular measurement in panoramic radiograph and assessment of labiopalatal position using CBCT. Root resorption of adjacent permanent incisors was also assessed using CBCT.

SECTOR LOCATION IN PANORAMIC RADIOGRAPH

Sector location was assessed by panoramic sector classification by Alessandri etal[6].This was based on position of canine tip in relation to adjacent teeth. The sector 1 denotes the position of deciduous canine, sector 2 extends from distal aspect to midline of lateral incisor, sector 3 is the area between the midline of lateral incisor and distal aspect of central incisor, sector 4 extends from distal aspect to midline of central incisor, sector 5 from midline of central incisor midline to midline of maxillary arch . [Fig:1]

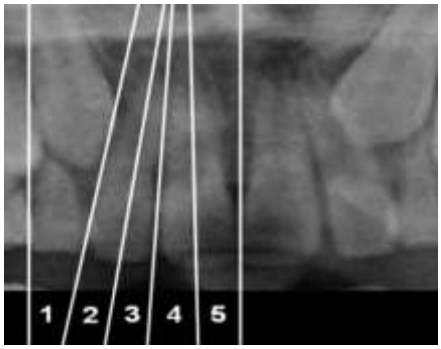


Fig 1: Demonstrates sector location

Sector location of the cusp tip of the unerupted maxillary canine is the most important predictor of eventual impaction. Labially impacted maxillary canine are frequently found in sector 1,2,3. Mid alveolus impacted canines were frequent in sector 4 and palatally impacted canines were frequent in sector 5. Evaluation of root resorption based on sector location was assessed.Root resorption was found in sector 3,4,&5. No resorption was found in sector 1,2. [3]

ANGULAR MEASUREMENTS IN PANORAMIC RADIOGRAPH

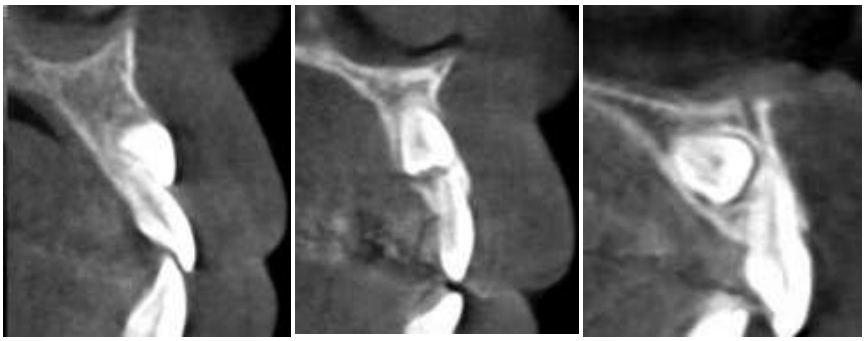
This method is used to localize the buccal / palatal position of impacted canine on panoramic radiograph based on angulation [Katnelson 2010].Angulation of the canine to the occlusal plane was measured .A horizontal line was drawn from the mesiobuccal cusp tip of the right and left maxillary first molars , and along the long axis of the impacted canines.The inclination of canine as measured lateral to the midline was recorded in degrees.Angulations greater than 65° were

more likely to reflect buccally impacted maxillary canines.[7] [Fig :2]

Fig 2: Demonstrates the angular measurement

EVALUATION OF CANINE POSITION USING CBCT

Entire CBCT volume was reviewed in dental mode using the arch definition tool to obtain cross-sectional images. Labiopalatal position based on position of canine crown to adjacent teeth was assessed in CBCT. Labio-palatal position of canines was classified into: a) Labial b) Mid alveolus c) Palatal.[3] [Refer Fig: 3]



LABIAL MIDALVEOLUS PALATAL

Fig 3: Demonstrates impacted canine locations in CBCT

EVALUATION OF ROOT RESORPTION USING CBCT

Resorption of adjacent permanent incisors can be grouped into:
a] No resorption [b] Resorption[3] [Refer Fig :4]


NO RESORPTION RESORPTION

Fig 4: Demonstrates root resorption in CBCT

STATISTICAL ANALYSIS

A sample size was obtained using the formula

$$Z = \frac{Z^2_{1-\alpha/2}\ S_N\ (1 - S_N)}{e^2 \times P}$$

$Z_{1-\alpha/2}$ = 1.96 for α = 0.05

S_N = 0.88 (Sensitivity in detecting Labial position) [3]

P = 0.55 (Proportion of Labial position among total) [3]

e = 0.22 25% of sensitivity

$$N = \frac{(1.96)^2 \times (0.88) \times (0.12)}{(0.22)^2 \times (0.55)}$$

=15

Sample size for the study is 15.

Data was analysed using SPSS Version 21.0. Sector location and angulation in panoramic radiograph were correlated with labiopalatal position in CBCT using Kendall's tau-b and Kendall's tau-c tests respectively. Root resorption of adjacent permanent incisors in panoramic radiograph was correlated with CBCT using Kappa statistics.

RESULTS

Among 10 patients in the study a total of 15 impacted maxillary canines [Unilateral = 5, Bilateral = 10]
were noted. [Refer Table :1]

	Distribution of impacted canines

	Unilateral	Bilateral	Total
Male [n=4]	1	6	7
Female [n=6]	4	4	8
Total [n=10]	5	10	15

Table 1: Distribution of impacted canine

Out of 15 impacted maxillary canines 60% cases were found labial, 33.3% cases were palatal and 6.7% cases were midalveolus in CBCT. Out of seven cases in sector 1 in PAN 85.7% were labial and 14.2% were palatal in CBCT and among two cases in sector 2 50% each were located in labial and palatal position in CBCT. One case each found in sector 3 & 4 were located in labial and palatal position respectively in CBCT. Out of four cases in sector 5, 50 % were located in palatally and 25% each in labial and midalveolus position. [Refer Table: 2]

Sector	Total cases	Interpretation in PAN			Interpretation in CBCT		
		Labial	Palatal	Mid alvelous	Labial	Palatal	Mid alveolus
1	7	7 (100%)	-	-	6 (85.7%)	1 (14.2%)	-
2	2	2 (100%)	-	-	1 (50%)	1 (50%)	-
3	1	1(100%)	-	-	1 (100%)	-	-
4	1	-	-	1(100%)	-	1 (100%)	-
5	4	-	4 (100%)	-	1 (25%)	2 (50%)	1 (25%)
Total	15	10	4	1	9[60%]	5 [33.3%]	1[6.7%]

Table: 2 Relationship between Sector Location in PAN and labiopalatal position in CBCT

Out of 9 cases labial in CBCT 88.9% were found labial in PAN and 11.1% palatal. Among 5 cases palatal in CBCT 40% cases each were located labial and palatal in PAN and 20% case in midalveolus Only 1 case of midalveolus in CBCT was located palatal in PAN. [Refer table: 3]

Interpretation of Sector in PAN	Position in CBCT			
	Labial	Palatal	Mid alveolus	Total
Labial [Sector 1,2,3]	8[88.9%]	2 [40%]	0	10
Palatal [Sector 5]	1[11.1%]	2 [40%]	1	4
Mid alveolus [Sector 4]	0	1 [20%]	0	1
Total	9	5	1	15

Table 3: Predictive power of sector in PAN when CBCT is gold standard

Kendall's tau-b test was done to assess the correlation between the sector location in PAN and actual location in CBCT, and a moderate agreement was obtained with a value of 0.46 [p= 0.036]. The sensitivity of sector method to locate labial canine impaction is 88.9% and to locate palatal canine impaction is 40%.

Out of 15 impacted maxillary canines 60% cases were found labial, 33.3% cases were palatal and 6.7% cases were midalveolus in CBCT. Out of 8 cases with > 65° angulation in PAN 87.5% were located labially and 12.5% was found to be palatal in CBCT. Out of the 7 cases showing <65° angulation in PAN , 28.6% cases were found to be labial, 14.2% midalveolus & 57.1% cases palatal in CBCT. [Refer table: 4]

Based on the measurements on PAN average angulation of the impacted maxillary canines in the labial group was 67.2° and the palatal group was 54.3°. The angulation of only one case in the midalveolus group noted in CBCT was 13.5°.

Angle	**Interpretation in PAN N**(%)				**Location in CBCT** N (%)		
	Total	Labial	Mid alveolus	Palatal	Labial	Palatal	Mid alveolus
>65	8	8(100%)	-	-	7(87.5%)	1(12.5%)	-
< 65	7	-	-	7(100%)	2(28.6%)	4(57.1%)	1(14.2%)
Total	15	8	-	7	9 (60%)	5(33.3%)	1 (6.7%)

Table 4: Relationship between Angulation in PAN and labiopalatal location in CBCT

Out of 9 cases labial in CBCT 77.8% were labial in PAN and 22.2% cases were in palatal. Among 5 cases palatal in CBCT 80% cases were located palatal in PAN and 20% cases labial. Only 1 case of midalveolus in CBCT was located palatal in PAN. [Refer table:5]

Interpretation of Angulation in PAN	Actual location in CBCT			
	Labial	Palatal	Mid alveolus	Total
LABIAL [>65 degree]	7 [77.8%]	1 [20%]	0	8
PALATAL [< 65 degree]	2 [22.2%]	4 [80%]	1	7
Total	9	5	1	15

Table 5: Predictive power of angulation in PAN when CBCT is gold standard

Kendall's tau-c test was done to assess the correlation between the angular measurement in PAN and actual location in CBCT, and a moderate agreement was obtained with a value of 0.57 [p= 0.008]. The sensitivity of angulation method to locate labial canine impaction is 77.8% and to locate palatal canine impaction is 80%.

Out of 15 impacted maxillary canines 26.7% had resorption and 73.3% cases with no resorption. Out of 4 cases with resorption in CBCT, 50 % cases were found in sector 3,4,&5 and sector 1&2 each. 63.3% cases without resorption are found in sector 1 & 2 and 36.4 % cases are found in sector 3,4,and 5.[Refer table 6]

Sector location in PAN	Root Resorption (CBCT)		
	Present	Absent	Total
1 & 2	2 [50%]	7 [63.3 %]	9
3,4 & 5	2 [50%]	4 [36.4 %]	6
Total	4 [26.7%]	11 [73.3%]	15

Table 6: Predicitive power of root resorption based on sector location in PAN when CBCT is gold standard

Kappa statistics was performed to assess the relation between the sector location in PAN and root resorption in CBCT. Kappa value was 0.12 [p= 0.634]. The results show only a slight agreement between two methods. The sensitivity to detect root resorption is 50%.

DISCUSSION

Position of impacted maxillary canine should be diagnosed early to prevent the displacement and root resorption of adjacent permanent incisors. This study was undertaken because limited studies are available comparing the sector location and Katnelson's angulation method in PAN to actual position in CBCT and prediction of root resorption of adjacent incisors based on sector location in PAN.

Present study showed that out of 15 impacted maxillary canines 60% cases were found labial, 33.3% cases were palatal and 6.7% cases were midalveolus in CBCT. Labially impacted maxillary canines were more frequently encountered in our study. This correlates with the studies of Jung et al and Kanwar et al where labial impaction is more frequent [41.1%, 35% respectively][3,8]. But this is not in accordance with the studies by An et al and Kositbowornchai et al where palatal impaction was 51.96% and 42.55% respectively. [9, 10]

On comparing the actual position in CBCT with sector location in PAN it was found that out of nine cases labially positioned in CBCT eight cases [88.9%] were distributed in sector 1,2 and 3 and 11.1% case in sector 5 . Among 5 cases of palatally located canines two [40%] were found in sector 5 and 1 [20%] case each in sector 1,2 and 4 . Only one case of midalveolus impacted canine in CBCT was found in sector 5 in PAN. This suggests that labially impacted canines were more frequent in sector 1,2,3 and palatally impacted canines were more in sector 5. This results were in accordance with study by Jung et al and Kanwar et al where labially impacted maxillary canines were more frequent in sector 1,2,&3 & palatally impacted canines in sector 5.[3,8] Midalveolus impactions were located in sector 4 in study by Jung et al, which was in contrast to sector 5 in our study.[3,] The results of midalveolus group in our study is not conclusive due to low sample size.

On correlating sector location on PAN with actual location in CBCT a moderate agreement was obtained [$p<0.05$], which suggests that sector location should be used to predict the location of impacted maxillary canine. This is similar to the results of Jung et al and Kanwar et al who also found a statistically significant association between sector location and actual location in CBCT.[3,8] Sensitivity of sector method to detect labial canine impaction is 88.9% & palatal is 40%. This is in accordance with the results of Kositbowornchai et al who demonstrated a sensitivity of 77.42% in locating labial canine impactions and 37.50% in locating palatal canine impactions.[10]

In the present study, average angulation of the impacted maxillary canines in the labial group was 67.2° and the palatal group was 54.3°. An angulation of 13.5° in panoramic radiograph was noted for the single case of midalveolus position in CBCT. This is in accordance with the results of Katnelson's study where an angulatuion of 75.1±18.2° was obtained for buccal group and 51.3 ±15.3° for palatal group.[7] Angulation for midalveolus case was not mentioned in their study. On correlating angulation of Impacted Maxillary Canine in panoramic radiograph with actual position in CBCT a moderate agreement was obtained

[p<0.05] in our study Kositbowornchai et al found that there was no statistically significant difference between angulation and CBCT hence angulation can be used interchangeably with localisation in CBCT which is in accordance with our results.[10] An et al observed that angulation of long axis of impacted canine to occusal plane is not a suitable method of localization [p>0.05], which is not similar to our study.[9] Sensitivity of angulation method to detect labial canine impaction in our study was 77.8% and palatal canine impaction 80% .This is in accordance with results of Kositbowornchai et al where sensitivity of labial impaction is 70. 97% while palatal impaction is 81.25%. [10] But An et al found that angulation cannot be used as a reliable method for localization of labially impacted canine where sensitivity is only 28.57% which is not in accordance with our study.[9]

Accurate diagnosis of root resorption is important in treatment planning. In the present study only 26.7% cases showed root resorption and 73.3 % showed no resorption. This was similar to the results of Jung et al where only 30% cases showed resorption & 69.9% cases showed no resorption. [3] This is also similar to the study by Kanwar et al where resorption is seen in 29% cases.[8] Present study showed that root resorption of adjacent permanent incisors in CBCT were more frequent in sector 3,4and 5 in PAN [50%] and cases without resorption is seen in sector 1& 2 [63.3%]. This is in accordance with results of Jung et al and Kanwar et al were they observed resorption in Sectors 3,4,5 and cases without resorption in sector 1&2. [3,8] Our study showed only a slight agreement between root resorption identified using panoramic radiograph and actual location in CBCT [p>0.05] and CBCT is a better method to assess root resorption. This is in accordance with results of Ali Alqebran where CBCT is found to be more accurate than PAN for detecting root resorption.[7,11] Kositbowornchai et al also suggested CBCT to assess root resorption. [10]But Jung et al 2012 suggested that root resorption of incisors can be predicted using sector location on panoramic radiograph.[3]

CONCLUSION:

Present study shows that labially impacted maxillary canines were more frequent in sector 1,2,&3 and palatally impacted maxillary canines were more frequent in sector 5 in PAN. There exists a moderate agreement between the sector location and angulation in PAN and actual position in CBCT. From this study it was concluded that sector location and angulation in panoramic radiograph can be used to predict labiopalatal position of impacted maxillary canine. Moreover, the resorption cases are frequent in sector 3,4&5 and non resorption cases in sector 1&2. Our study shows there was only a slight agreement between root resorption in PAN and CBCT. So CBCT is a better predictor for root resorption. But the use of CBCT can be limited to the cases that are located in sector 3,4&5 in panoramic radiograph.

Contributions of Authors

[1]Dr. Sunila Thomas, Dr. Vivek .V - Concept, design, analysis & interpretation of data.

[2]Dr. Jincy Thomas - Critical revision of article for intellectual content.

[3]Dr. Sruthy C.S- Analysis and interpretation of data and drafting of article.

[4]Dr. Soumya R Potti - Drafting the article

[5]Dr. Anjali subramony –Drafting the article

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