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Prevalence of Impacted Teeth in a South Indian Population using Cone Beam Computed Tomography: A Retrospective Study

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ABSTRACT

Localisation of impacted teeth is essential for surgical and orthodontic management. The study objective was to evaluate the prevalence and type of tooth impaction in the jaws using cone beam computed tomography (CBCT). The CBCT records of subjects between 2018 and 2020 were retrieved from our institution archives and examined by two oral radiologists. A total of 760 CBCT scans were evaluated, of which 140 (18.4%) scans had impacted teeth. From the 140 CBCT scans, 216 impacted teeth were identified. Maximum impactions were in the age group of 21–30 years. Third molars were the most commonly impacted teeth (66.2%), followed by canines (23.6%), supernumerary teeth (4.6%), premolars (3.2%), incisors (1.4%), and second molars (0.9%). Among the impacted canines, 53% were buccally impacted, 43% were palatally impacted and other impactions were 4%. Among the third molars, mesioangular impactions were the most frequent (41.2%), followed by horizontal (28%), vertical (16.7%) and distoangular impaction (4.1%). The most frequently impacted teeth were the third molars, followed by canines. Canine impactions were more frequent in the maxilla, while third molar impactions were thrice as common in the mandible compared to the maxilla. Mesioangular third molar impactions were the commonest, followed by horizontal, vertical and distoangular.

Keywords: *Canine; cone beam computed tomography; impaction; prevalence; third molar*

INTRODUCTION

Impaction is described as a failure in tooth eruption due to obstruction of the eruption path or improper tooth position (Sandhu *et al.*, 2016). Tooth impaction may occur due to physical barriers, abnormal tooth position, or small jaws compared to tooth size (Ravikumar *et al.*, 2019). Impaction may be related to genetic factors, early tooth loss, oral conditions such as trauma, systemic diseases and syndromes (Ravikumar *et al.*, 2019).

Tooth impaction occurs in approximately 25%–50% of the population (Guerrero *et al.*, 2011). The most frequently impacted teeth are the mandibular third molars followed by maxillary canines (Guerrero *et al.*, 2011; Sandhu *et al.*, 2016). Around

1%–3% of maxillary canines may be impacted, with females affected twice as commonly as males (Guerrero *et al.*, 2011). Management of impacted canines requires an interdisciplinary approach that includes both surgical and orthodontic correction.

The location and position of third molars and their relation to adjacent anatomic structures are important in surgical treatment planning. Unerupted third molars may give rise to various problems in the jaws, such as caries, cysts and tumours, and root resorption (Juodzbalys & Daugela, 2013; Santosh, 2015). Angulation of the third molar long with depth of impaction and root morphology affects the difficulty of surgical removal (Juodzbalys & Daugela, 2013). Frequent side effects of impacted teeth removal include pain, swelling and trismus. Neurosensory impairment has been reported in 0.35%–8.4% of cases (Sarikov & Juodzbalys, 2014). Horizontal and distoangular impaction, unerupted teeth, lingual inclination, lingual flap retraction, depth of impaction, and time taken during surgery affect the occurrence of sensory impairment (Lata & Tiwari, 2011).

Management of impacted teeth requires localisation of the teeth using appropriate imaging methods. Localisation of impacted teeth is done traditionally using two-dimensional imaging techniques like intraoral periapical, occlusal and panoramic radiographs. Methods like the tube shift technique and right angle techniques help object localisation by using conventional radiography (Guerrero *et al.*, 2011; Matzen & Wenzel, 2015). With the advent of newer imaging modalities like computed tomography (CT) and cone beam computed tomography (CBCT), 3-dimensional visualisation is possible, leading to more accurate diagnosis and tooth localisation. CBCT, in particular, has the advantages of lesser radiation exposure, lesser cost, smaller physical footprint and submillimetre resolution with resultant images comparable to CT for hard tissue details (Rossini *et al.*, 2012). The prevalence of impacted teeth varies among different populations. Accurate localisation of impacted teeth can ensure less removal of healthy bone during surgery and minimise iatrogenic trauma. The objective of the present study was to evaluate the prevalence and type of tooth impaction in the jaws using CBCT.

MATERIALS AND METHODS

The present study was a retrospective, institution-based study conducted among the population of Dakshina Kannada and North Kerala, two districts in India. CBCT volumes were retrieved from the Department of Oral Medicine and Radiology, A B Shetty Memorial Institute of Dental Sciences. This study was reviewed and approved by the Institutional Ethical Committee (Cert No.: ABSM/EC/42/2020).

All scans were taken using the Promax 3D Mid (Planmeca, Helsinki, Finland, Rotation 360°). CBCT scans taken over a period of two years (2018–2020) were considered. CBCT volumes with medium field of view (image size 16 × 10.2 cm, voxel size 200 μm, 90 Kvp, 6.3 mA, 678 mGy cm², 76.82 μSv) and full field of view (image size 20.2 × 17.5 cm, voxel size 400 μm, 90 kVp, 8 mA, 2102 mGy cm², 238.16 μSv) were considered. Inclusion criteria were CBCT volumes of subjects between the ages of 13 and 65 showing the complete tooth-bearing region and where age and gender details were present. Third molars were considered as impacted in subjects above 18 years of age where the root bifurcation was mineralised. Exclusion criteria were subjects diagnosed with syndromes associated with impacted teeth, subjects with congenital defects like cleft lip and palate, and CBCT scans where age and gender details are not available. CBCTs of poor quality due to artefacts were excluded.

CBCT scans were evaluated for the presence and type of impaction on Dell desktop computer with a screen resolution of 1,280 × 1,024. All scans were evaluated by two oral and maxillofacial radiologists. Teeth were considered as impacted when they had not erupted to the functional position in the occlusal plane. Third molar impactions were categorised as mesioangular, distoangular, vertical and horizontal according to Winter's classification by evaluating the longitudinal axes of the impacted tooth and the adjacent second molar (Winter, 1926). The location was categorised as "mesial", "distal", "facial" and "palatal". Canine impactions were categorised as "buccal", "palatal/lingual" and "inverted". Associated pathologies, if any, were recorded. Descriptive statistics were calculated using counts and percentages. Frequency distribution was used to know the number and proportion of the entities. Chi-square test was used to compare the association of age and gender with incidence of impaction, and $p < 0.001$ was considered as statistically significant.

RESULTS

A total of 760 CBCT scans were evaluated for the presence of impacted teeth out of which 140 (18.4%) scans had impacted teeth and 620 (81.5%) did not. Among the scans, 329 (43.3%) were females and 431 (56.7%) were males. Among the females, 58 (41.3%) had impacted teeth while in males 82 (58.7%) were diagnosed with impactions. In 140 CBCT scans, a total of 216 impacted teeth were identified. Table 1 summarises the age distribution, prevalence and location of impacted teeth in the study population. Impacted teeth were highly observed in the age group of 21–30 years old (27.4%) followed by the age group of 41–50 years old (14.7%) and less than 20 years old (14.4%). The difference was statistically significant. Impacted canines accounted for 51 (23.6%) of impacted teeth while third molar impactions accounted for 143 (66.2%). Other teeth accounted for 23 (10.1%) impactions.

Table 1 The age distribution, prevalence and location of impacted teeth in the study population

Impacted teeth in different age groups					
<20 years	21–30 years	31–40 years	41–50 years	51–60 years	>60 years
14.4%	27.4%	13.2%	14.7%	6.8%	13.3%

Prevalence of impacted teeth in maxilla and mandible					
Type of teeth	Maxillary right	Maxillary left	Mandibular right	Mandibular left	Total
Canines	19 (2.5%)	18 (2.3%)	6 (0.8%)	8 (1.1%)	51 (6.7%)
Third molars	17 (2.2%)	18 (2.3%)	58 (7.6%)	50 (6.5%)	143 (18.8%)
Others	Supernumerary teeth (10)	Premolars (7)	Incisors (3)	Second molar (2)	23 (3.02%)

Location of impacted canines		
Buccal	Palatal	Others
27 (53%)	22 (43%)	2 (4%)

Location of impacted third molars						
Buccal	Lingual	Mesioangular	Distoangular	Horizontal	Vertical	Inverted
28 (19.6%)	11 (8%)	59 (41.2%)	6 (4.1%)	40 (28%)	24 (16.7%)	1 (0.7%)

Canine Impaction

A total of 51 impacted canines with an overall prevalence of 6.7% were identified in the present sample. Maxillary right canines were impacted in 19 (2.5%) cases, maxillary left canines in 18 (2.3%) cases, mandibular left canine in 8 (1.1%) cases and mandibular right canine in 6 (0.8%) cases. Both the right and left maxillary canines were impacted in 0.3% cases while both the right and left mandibular canines were impacted in 0.12% cases. Among the impactions, 27 (53%) were buccally impacted, 22 (43%) were palatally impacted and other impactions were 4%. Mesial impaction was noted in 3.6%, 1.8% was inverted and horizontal impaction was noted in 1.8% cases. No root resorption of adjacent teeth was noted in any volume (Fig. 1).

Third Molar Impactions

A total of 143 third molars were impacted with an overall prevalence of 18.8%. Mandibular molars were impacted in 108 (14.21%) cases and maxillary molars in 4.6% cases. One sample chi-square was used to analyse the difference in occurrence of the third molar impaction in maxilla and mandible. A highly statistically significant difference was found in the occurrence of third molar impaction between maxilla and mandible, wherein the mandibular region had a higher number of third molar impactions (p = 0.000) (Table 2).

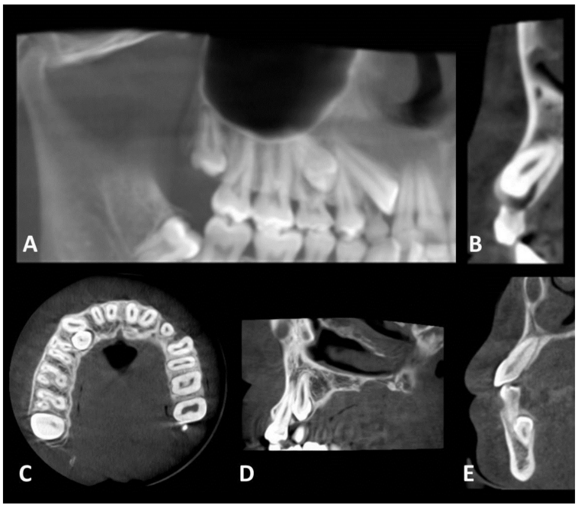

Fig. 1 CBCT images of canine impaction: (A) Case 1, panoramic reconstruction showing impacted right maxillary canine and second premolar; (B) Cross section of the same case showing buccally impacted canine; (C) Case 2, axial section of showing palatally impacted right maxillary canine; (D) Cross section of same case showing palatally impacted canine; (E) Case 3, cross sectional image with lingually impacted mandibular right canine.

Table 2 Comparison of third molar impaction in maxilla and mandible using chi-square test

Region	Observed N	Expected N	Comparison using chi-square test
Maxilla	35 (24.47%)	–71.5	$X^2 = 37.266$, $p = 0.000$*
Mandible	108 (75.53%)	71.5	

Note: *A highly statistically significant difference was found in the occurrence of third molar impaction between maxilla and mandible, wherein the mandibular region had a higher number of third molar impactions ($p < 0.001$ was considered as statistically significant).

The maxillary right third molars were impacted in 17 (2.2%) cases, maxillary left third molar in 18 (2.3%), the mandibular left third molar in 50 (6.5%) cases and the mandibular right third molar in 58 (7.6%) cases. One sample chi-square was used to analyse the difference in occurrence of the third molar impaction in the maxillary right and left and mandibular right and left regions. No significant difference was found in the occurrence of third molar impaction between the right and left positions in both the maxillary and mandibular regions (p = 0.866 and 0.441, respectively) (Table 3).

Third molars were buccally impacted in 28 (19.6%) cases and lingually impacted in 11 (8%) cases. Mesioangular impaction accounted for 59 (41.2%), horizontal impaction in 40 (28%), vertical impaction was present in 24 (16.7%), distoangular in 6 (4.1%) and an inverted impaction in 0.7% cases (Fig. 2).

Table 3 Comparison of third molar impactions in right and left maxilla and mandible using chi-square test showed no significant difference

Comparison	Variable	Observed N	Expected N	Chi-square test
Maxillary right vs maxillary left third molar impaction	Maxilla right	17 (48.57%)	−17.5	$X^2 = 0.029$, $p = 0.866$
	Maxillary left	18 (51.43%)	17.5	
Mandibular right vs mandibular left third molar impaction	Mandibular right	58 (53.7%)	4.0	$X^2 = 0.593$, $p = 0.441$
	Mandibular left	50 (46.3%)	−4.0	

Note: No significant difference was found in the occurrence of third molar impaction between the right and left positions in both the maxillary and mandibular regions ($p < 0.001$ was considered as statistically significant).

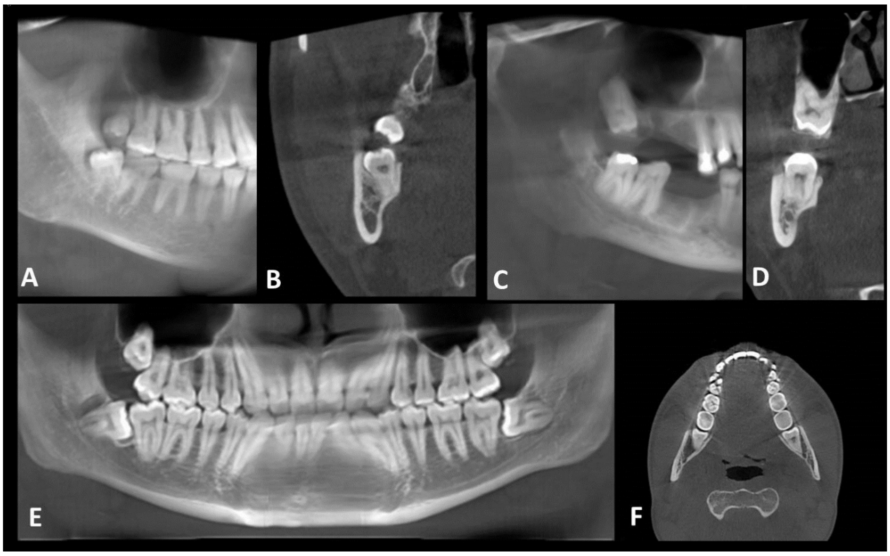

Fig. 2 CBCT images of molar impaction: (A) Case 4, panoramic reconstruction showing distoangularly impacted mandibular right third molar; (B) Cross section of the same case; (C) Case 5, panoramic reconstruction showing vertical impaction of maxillary right third molar; (D) Cross section of the same case; (E) Case 6, panoramic reconstruction showing mesioangular impaction of mandibular right third molar and horizontal impaction of mandibular left third molar; (F) Axial section of the same case.

Other Impactions

Impaction of other teeth accounted for 10.6% of impacted cases with an overall prevalence of 3.02%. The teeth impacted included the maxillary right lateral incisor (0.2%), maxillary right first premolar (0.2%), mandibular left second premolar (0.2%), mandibular left second molar (0.2%), maxillary right central incisor (0.13%), maxillary right second premolar (0.13%), mandibular left lateral incisor (0.13%), mandibular right second premolar (0.13%) and mandibular left second premolar (0.13%). Supernumerary teeth accounted for 10 (1.3%) of the impacted teeth.

Associated Pathologies

A total of 18 (8.3%) of impacted teeth were associated with pathologies. Cystic changes were the most frequent with 11 (5.1%) cases followed by hyperplastic tooth follicle in 2 (0.9%) cases, idiopathic osteosclerosis in 1 (0.5%) case and compound odontome in 2 (0.9%) cases. Cystic changes were noted predominantly in mandibular molar region in 5 (2.3%) cases followed by mandibular premolars in 2 (0.9%) cases, maxillary molar in 1 (0.5%) case, maxillary canine in 1 (0.5%) case, mandibular canine in 1 (0.5%) case and maxillary premolar in 1 (0.5%) case. Impacted supernumerary teeth were noted in association with impacted teeth in 3 (1.4%) cases (Fig. 3).

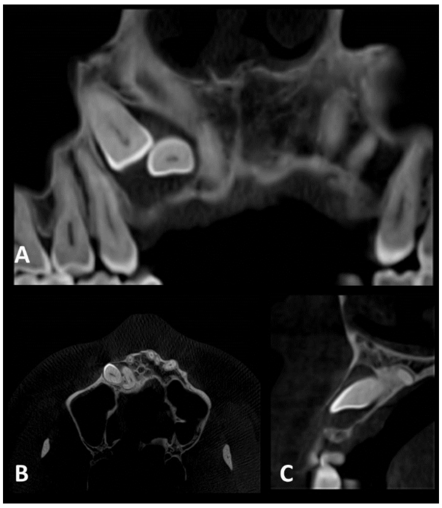

Fig. 3 (A) Case 7, Coronal CBCT section showing impacted maxillary right lateral incisor and canine. Radiolucency surrounding the crowns of both teeth is suggestive of a cyst; (B) Axial section showing the location of the impacted teeth. The canine is buccally impacted while the lateral incisor is located horizontally and has a dilacerated root; (C) Cross section of the same case showing a well-defined radiolucency surrounding the crown of the impacted tooth.

DISCUSSION

CBCT is a three-dimensional imaging modality. Thus, it can help in accurate localisation of the impacted tooth, visualise the proximity to the adjacent teeth, and help assess the presence or absence of root resorption and the size of the dental follicle. It can also help identify pathologies such as cysts in association with impacted teeth. Accurate visualisation can help to formulate an appropriate treatment plan (Sandhu *et al.*, 2016). Most impacted teeth were identified in the age group of 21–30 years old in the present study. Patil & Maheshwari (2014) reported a mean age of 34.6 years old in their study on tooth impaction, while Quek *et al.* (2003) reported a mean age of 26.5 ± 5 years old. Ravikumar *et al.* (2019) reported the highest impactions in the age group of 18–30 years old, which is similar to the present study results.

The present study showed that the prevalence of impacted teeth in the South Indian population was 18.4%. The occurrence of impacted teeth differs worldwide due to racial, genetic and dietary variations which can cause alterations in the size of jaws and teeth (Jain *et al.*, 2019). The present study is similar to the study by Patil & Maheshwari (2014) where the reported prevalence was 16.8% in a North Indian population. Passi *et al.* (2019) reported a prevalence of 26.04% in Delhi, India. Chu *et al.* (2003) reported a prevalence of 28.3% in a Hong Kong Chinese population, while in an Iranian population, Kazemian *et al.* (2015) detected a prevalence of 33.74%. Quek *et al.* (2003) found a prevalence of 68.6% and concluded that impacted teeth are three to four times more frequent in the Singapore Chinese population when compared to Caucasians. However, Jain *et al.* (2019) found that 52.3% of the population in central India had at least one impacted third molar. Thus, the overall prevalence of impacted teeth varies among populations.

In the present study, third molars were most commonly impacted followed by canines, supernumerary teeth and others. Most studies report third molars as the most frequently impacted tooth (Chu *et al.*, 2003; Jain *et al.*, 2019). Kazemian *et al.* (2015) found that the third molar was the most frequently impacted tooth in both jaws, followed by canines. Ravikumar *et al.* (2019) reported that third molar impaction accounted for 96.5% of impacted teeth in their study. The mandibular right third molar was the most commonly impacted tooth followed by the maxillary left third molar. In contrast, Patil & Maheshwari (2014) and Alamri *et al.* (2020) reported the highest prevalence of impacted canines followed by premolars. They attributed this to the fact that maxillary canines are the last teeth to erupt into the dental arch ahead of the third molars. Racial and genetic variations and differences in study methodology could account for these differences in different populations.

Studies have shown that European populations have a higher incidence of palatally impacted canines, while in Asians, canine buccal impaction is more frequent (Guerrero *et al.*, 2011). These results are consistent with the present study, where canines were more frequently impacted buccally. Wriedt *et al.* (2012) recommended CBCT for analysis of impacted canines when canine inclination in the panoramic X-ray exceeds 30°; if root resorption of adjacent teeth is suspected, and if the canine root apex is not clearly visible in a panoramic radiograph, suggesting dilaceration of canine root. Oberoi & Knueppel (2012), in their study on CBCT localsation of impacted maxillary canines, found that palatal, mesial, and gingival impactions were most frequent with 4% cases showing severe root resorption of the adjacent lateral incisor. In the present study, we found no subjects with root resorption of the lateral incisor. The reason for this could be early detection since 86% of canine impactions in the present study were identified in subjects below 30 years of age. Buccal impaction was the most frequent followed by palatal, mesial, horizontal and inverted.

The causes for third molar impaction include lack of space for eruption, insufficient anterior-posterior dimension, and decreased transverse width of the arches. Quek *et al.* (2003) analysed panoramic radiographs for impacted third molars and found that 68% had at least one impacted third molar. They reported that mandibular third molars were impacted three times as often as maxillary third molars with mesioangular impaction being the most frequent. Pillai *et al.* (2014) and Sivaramakrishnan & Ramani (2015) found that mandibular third molars were more commonly impacted than maxillary third molars. This is consistent with the results of the present study.

Many studies note that females have a higher predilection for the occurrence of impacted teeth, especially impacted third molars (Kumar *et al.*, 2017; Ravikumar *et al.*, 2019). The small jaw size in females compared to males and cessation of jaw growth at the time of the eruption of third molars was cited as the most probable cause (Kumar *et al.*, 2017). However, a meta-analysis on the prevalence of third molar impactions found no gender predilection (Carter & Worthington, 2016). In the present study, males had more number of impacted teeth when compared to females. This was similar to the results by Patil & Maheshwari (2014) and Passi *et al.* (2019), who reported that though males had more impacted teeth than females, the difference was not statistically significant and was probably the result of genetic variations.

Mesioangular impaction of third molar teeth was cited as the most frequent followed by vertical, distoangular and horizontal (Padhye *et al.*, 2013; Carter & Worthington, 2016; Jain *et al.*, 2019). Sivaramakrishnan & Ramani (2015) in their study on a South Indian population found that mesioangular impactions were the most frequent. Evolutionary changes have caused decreased size of the jaws leading to increased impactions. Other factors associated with third molar impactions include racial and genetic variation and refined diet, which has reduced interproximal tooth attrition (Pillai *et al.*, 2014; Sivaramakrishnan & Ramani, 2015). Chu *et al.* (2003), Pillai *et al.* (2014) and Kazemian *et al.* (2015) using panoramic radiographs, determined that vertical impaction was the most frequent followed by mesioangular, distoangular, horizontal and buccolingual. In contrast, a Saudi Arabian study reported that horizontal impaction was the most frequent (Ravikumar *et al.*, 2019). In the present study, mesioangular impaction was most frequent, followed by distoangular, vertical, horizontal and inverted.

Impacted teeth are often associated with increased follicular space or cysts. Adaki *et al.* (2013) calculated the dental follicular space in completely impacted third molars and found that 23.3% had cystic changes. The authors reported that distoangular impactions were most commonly associated with cystic changes. In the present study, 6% of impacted teeth had associated cystic changes and hyperplastic dental follicles, of which half were associated with impacted third molars. However, no specific type of impaction was associated with cyst occurrence.

Supernumerary teeth denote an excess in tooth number and are often encountered in dental practice. The prevalence of supernumerary teeth in the present population was 1.7%. This is similar to the study by Patil & Maheshwari (2014). Most supernumerary teeth are detected during routine radiographic examinations. Erupted supernumerary teeth can cause crowding, while unerupted mesiodens can cause midline diastema. Supernumerary teeth are associated with displacement of adjacent teeth and, in some cases, with failure of tooth eruption and impaction (Patil & Maheshwari, 2014). Odontoma-shaped supernumerary teeth have been associated with impacted maxillary central incisors (Jung *et al.*, 2016).

The present study has a few limitations. Since we included only CBCT scans, the sample size is limited compared to studies using only panoramic radiographs since only subjects who were advised CBCT were included in the analysis. Alqerban *et al*. (2014) stated that CBCT was helpful in evaluating complicated canine impactions and improves orthodontic management. Matzen & Wenzel (2015) recommended the use of CBCT when a close relation is observed between mandibular third molars and the mandibular canal in panoramic radiographs. For this reason, we included only CBCT volumes in the present study. Guerrero *et al.* (2011) conducted a systematic review of studies evaluating the diagnostic efficacy of CBCT in the location of impacted teeth. They concluded that CBCT was more accurate in localising the position of impacted teeth. Future studies with a greater sample size would overcome this limitation.

CONCLUSION

There was a lower prevalence of impacted teeth in the present study when compared to other populations. Impacted third molars were most frequently impacted teeth followed by canines, supernumerary teeth, premolars, incisors and second molars. Among third molars, mesioangular impaction was the most frequent, followed by vertical, distoangular and horizontal. Most canines were buccally impacted, followed by palatal impactions.

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