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Three-dimensional Localization of Impacted Maxillary Canine and Assessment of Adjacent Root Resorption Incidence using Cone-Beam Computed Tomography

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ABSTRACT

Introduction: The most common complication related to canine impaction is root resorption.

Aims: To investigate the relationship of selective linear measurements of maxillary impacted canine to the incidence of adjacent root resorption by using CBCT scans records.

Methodology: The linear measurements selected were: impacted canine crown width, available space for canine eruption, distance from canine cusp tip to the midline and occlusal plane, and resorption grade. Mann Whitney U test was used to compare non-parametric variables, with a significance threshold set at 5%. The correlation coefficient at 95% CI was used to investigate the relationship between resorption and variables.

Result: Our sample comprised of 100 subjects. Of them, (30%) bilateral and (70%) unilateral. Regarding impaction localization frequency, 87.6% palatally, 8.4% buccally than within arch (3.8%). The resorption was mostly located at the apical third of adjacent teeth. In term of resorption, 28.4% of subjects had single tooth resorbed, 56% had two teeth resorbed, and three teeth resorption in 12.6% of subjects. Resorption severity was higher frequent in grade I (35.4%). There was an association of resorption incidence to type of impaction = 0.173, p= 0.048, contact relationship = 0.995, p< 0.01, and location of contact = 0.613, p< 0.01.

Conclusion: Correlation found between root resorption to contact relationship and location of contact. Resorption mostly encountered with lateral incisors, and grade 1 was more frequently seen, with the common area being the apical third.

Key Words: Canine impaction, CBCT, Lateral incisor, Orthodontic, Premolar, Root resorption

INTRODUCTION

Maxillary canine has the longest and complex eruption pathway to reach occlusion, making it more likely to have disturbances while erupting. No wonder it is the novel impacted tooth for orthodontists, and is the second most common impacted tooth after the third molar tooth.[1,2] Shrouder et al.[3] report its prevalence was not exceeded 3-5% depending on the studied population; nevertheless, it is 8.3% among the Yemeni population, which was not included in his systematic review.[4] This study reports the prevalence of orthodontist and non-orthodontist patients.

The location and position of the impacted canine will determine the treatment complexity.[2,5,6] In these studies, the palatal side was more than buccal, followed by within the arch. The variation in position may be attributed to genetic or environmental factors, for instance crowding or missing guidance.[7] Those predisposing factors may be managed earlier to avoid such complications.

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The most common complication related to canine impaction is root resorption.[3,8,9] A higher incidence of root resorption occurs with the lateral incisor being adjacent to the impacted canine.[6,10] The majority of impacted canine keeps silent unless the patient complains; at this moment, the treatment plane will have further complications.[11-14] Variation in the prevalence of adjacent root resorption in studies is due to the employed radiographic technique.[15,16] Orthopantogram is the standard technique to localize the impacted canine; however, it is limited to precisely determining the canine's actual dimension.[17] Therefore, CBCT introduced and resolve the drawbacks of conventional radiograph, it produces a detailed image, providing valuable data revealing the relationship between structures; consequently, helps in establishing a treatment planning.[18] According to the American Academy of Oral and Maxillofacial Radiology, cone beam computed tomography (CBCT) is the suitable tool for determining resorption's presence and severity.[19]

This study aimed to localize the impacted canine using CBCT, then investigate the positional relationship of the impacted maxillary canine to incidence and extent of adjacent teeth root resorption in a sample of Yemeni population. Secondly, to explore specific suspected linear parameters correlated with the corresponding resorption.

Subjects and Methods

This retrospective study was conducted based on the dental records of 930 patients aged between 18 and 30 years, who were referred to Oral and Maxillo-facial Radiology Centers in Sana'a city from August 2017 to January 2019 for diagnostic purposes. Only patients who had completed medical, dental, and family histories and demographic details were taken. The final sample was comprised of 100 subjects (31% male and 69% female).

The radiographs were evaluated in the Department of Orthodontics and Dentofacial Orthopedics at the College of Dentistry, Sana'a University, Sana'a, Yemen.

The inclusion criteria included sample of age 18 – 30 years, within normal range medical and dental history, devoid any craniofacial abnormalities or abnormality in head and neck region, and without history of previous orthodontic treatment, with CBCT image of good quality.

CBCT images with any orthodontic appliance, missing lateral incisor at the side of impaction, or any pathological lesion, were excluded. Further, this study did not include subjects with maxillofacial trauma, evidence of syndrome, and those with radiographic images that presenting deformations.

After applying the exclusion criteria, the final sample obtained numbered 100 (31 male [M] and 69 female [F]) subjects, with a mean age of 23.32 ± 4.18 years.

The CBCT images data were obtained from the system unit and software (Pax-flex3DP2, Vatech, Korea). CBCT images were reconstructed in slices, and examined slice by slice in all the three dimensions (sagittal, coronal, and axial) on 1:1 scaled images, using a specialized software program (Ez3D plus®). A bite block was used during the CBCT imaging scan, and the height of X-ray unit was adjusted so that the occlusal plane was perfectly horizontal with a field of view.

Canine impaction was assessed and recorded according to the following criteria:

- Type, side, and position of maxillary canine impacted.

Direct contact of the impacted canine with adjacent teeth according to Walker et al.[20] criteria and the presence of root resorption of adjacent incisors.

Location of the contact and root resorption to the long axis of the involved tooth, classified as on cervical third, middle third or apical third of the root (Fig 1).

Resorption scoring for root adjacent to maxillary impacted canine was graded according to Ericson and Kurol[21] criteria: grade 0: no resorption; grade 1: mild (resorption not reaching the medium thickness of dentine); grade 2: moderate (resorption exceeding half the thickness of dentine, but not reaching pulp); and grade 3: severe resorption reaching the pulp (Fig 2).

Linear measurements were made according to Cernochova et al.[22] as follows:

- Canine cusp to the midline was measured in the axial view (Fig 3. a & b).
- Canine cusp tip to the occlusal plane was measured in the coronal view (Fig 3. c).
- Canine cusp tip to the lateral incisor was measured in the sagittal view.
- The mesiodistal dimension of impacted canine.
- The mesiodistal space available between the distal surface of the lateral incisor and the mesial surface of the first premolar.

Two operators evaluated images independently (LA and HA). To estimate the reproducibility of the diagnosis, twenty cases were selected at random and the radiologist re-measured linear measurements and the degree of severity of root resorption two weeks later to ensure accuracy. The same investigators re-measured the same selected cases after a month to assess the intra-examiner and inter-examiner reliability of the registration. These values were compared with the data already obtained using the Kappa test.

Statistical analysis:

The collected data were analysed using the Statistical Package for the Social Sciences (SPSS) program, (version 23; Inc., Chicago. IL, USA). Mann-Whitney U test was used to determine the significance of age, gender, and bilateral subjects to parameters. Multiple comparisons were also performed with

age subgroups, and p< 0.05 was considered significant. The correlation coefficient was used to show how impaction and the resorption of adjacent teeth are associated

RESULTS

Intra-examiner Kappa value ranged from 0.7 to 1, indicating acceptable agreement between the first and second evaluations. The result revealed sufficient inter-examiner reliability, ranging from 0.6 to 1 (Table 1). The results were considered valid according to the interpretation of Viera and Garrett. [23]

The study sample consisted of 100 subjects. The mean age of the subjects was 23.32 ± 4.18 years; 31 were males and 69 females (male/female ratio, 1:1.5), and the sum of canine impaction was 130, 65 (50%) impacted for each side (Table 2). Of the analysed CBCT, 70% of the canine was unilaterally impacted and 30% was bilateral.

Table 2 depicts the distribution of impacted canine on the bucco-palatal direction. The majority (87.7%) were located on palatal direction, 8.5% in the buccal direction, and 3.8% on the line of the arch (Fig 4).

The four linear measurements of impacted canine were evaluated; the canine cusp to the midline measured in axial view was 6.73mm (range 0.7 – 15.1mm). There was no statistically significant difference between the genders or bilateral subjects (*P*> 0.05). And the mean distance of the root apex of the impacted canine to the midline of the upper jaw in axial view was 14.68 mm (range: 3.2 – 20.8 mm). The mean distance of the cusp tip of the impacted canine to the occlusal plane in the sagittal view was 12.62mm (range: 5.3 – 23.4mm). The mean width of the impacted canines was 7.77mm (range: 6.2 – 9.3mm). The mean distance measurements of mesiodistal space between the distal of the lateral incisor and the mesial of the first premolar were 6.23mm (range: 0.10 - 9.20mm), see Table 3.

The measurements of the width of the impacted canines and the mesiodistal space between the distal of the lateral incisor and the mesial of first premolar on the same side of impaction in the axial view or sagittal view, then scoring and found 27.7 of subjects were with sufficient space without crowding, 72 cases, lake of space for canine eruption, and 22 cases with complete loss of space (Table 3).

Root resorption was observed in 26.2% of laterals with premolars and 16.9% with laterals only (p = 0.92). Among the 30 cases of bilateral impacted maxillary canines, there were 19cases with bilateral root resorption on adjacent teeth of impacted canines, and 5 cases with only one side affected, and in those patients, there was no statistically significant difference between the right and left canine impaction variables (*P*> 0.05) (Table 4).

Root resorption on permanent adjacent teeth (incisors and first premolar) waslocated primarily in the apical third of the affected root (30%),followed by the middle third of the affected root (16.2%) the cervical third of the affected root (1.5%). In 6 cases, there was root resorption located on the apical third of the lateral incisors exhibited visible root resorption in middle third of central incisors, in 20.8% of subjects, there was root resorption located on the middle third of the lateral incisors exhibited visible root resorption in apical third of the first premolars, and in (6.2%) there was root resorption located on the middle third of the central and lateral incisors exhibited visible root resorption in apical third of the first premolars, see fig. 5, 6 and 7.

Analysis of the grade of resorption was found (26.2%) grade 0, (35.4%) grade 1, (28.5%) grade 2, and 13 cases, with severe root resorption (grade 3). Table 4 shows that neither sex differences nor side of impaction were found (p>0.05).

There was a strong positive correlation between root resorption and contact relationship where the correlation coefficient = 0.995, p< 0.01, moderate positive correlation with location of contact correlation coefficient= 0.613, p< 0.01, and week positive correlation with type of impaction if it's vertical or horizontal correlation coefficient = 0.173, p= 0.048. Also, there were negative correlations between root resorption with a side of impaction (right or left) p= 0.503, and location of impaction *P* = 0.933 (Table 5).

DISCUSSION

Orthodontic management of cases with impacted maxillary canine relay on the location and position of the impaction and its relation to adjacent structures.[2,5] Resorption of adjacent teeth increase treatment complication; however, the factors associated to this phenomenon are still unclear; since, not all impacted canine cause adjacent resorption.[3,24] Several studies examined specific parameters.[5,6,9] For that reason, this study was accomplished to localize impacted maxillary canine and assess its effect on the incidence of adjacent roots resorption by employing CBCT technology as a reliable construction tool for linear measurements.[19]

Our study excludes the orthodontic cases to establish a representative sample of Yemeni population. We select the adult age to focus on treatment modality difficulty in this age. Alqerban et al.[15] studied a sample younger than 30 years of age, Dagsuyu et al.[2] and Ali et al.[25] selected subjects have more than twelve years, and Kalavritinos et al.[5] sample were between 9 – 57 years. All of them reported the effect of impacted canines with their different location on the incidence of adjacent resorption phenomena using CBCT.

Gender shows no difference with study variables, but females were affected more than male; in consistency, with Rafflenbeul et al.[6] and Kalavritinos et al.[5] whom reported a ratio of 1.3: 1 and 2.2:1 female to male, respectively. In this study, higher female-to-male ratio must critically be assessed; thus, the association of sex to adjacent root resorption was not undertaken, since this may influence the outcome if we had equal study subjects. Higher female participants may be this because females are more reliable to seek dental treatment than males.

The majority of subjects have impaction palatally (87.6%), followed by buccal side (8.4%) than within arch (3.8%). This contrary to Kalavritinos et al.[5] palatally (51.6%) followed by midway (35.1%) than buccally (13.1%) in a Greek sample. In a Turkish sample, maxillary impacted canines were most frequently located palatally (54.3%), followed by centrally (27.8%) and buccally (17.8%).[2] Etiological causes of prevalence diversity may be attributed to genetic tendencies or race factors.

In terms of the location of the impacted tooth, unilateral was more than bilateral in present study. The predominance of the unilateral impaction has been reported in several studies with unilateral impaction prevalence of 61.7%, and 69.4%, respectively.[3,6]No significant differences were observed in our study between sides of impaction in bilateral cases with all variables. These results are consistent with those of Ali et al.[25] findings. However, our results are contrary to the findings of Rafflenbeul et al.[6] and Schroder et al.[3] which revealed differences between the two sides. This may be related to the impaction location in the maxilla or sample selection variety in other studies.

The impacted teeth may be in contact with the adjacent erupted teeth. In this case, complications such as resorption are to be highly expected. The evaluation of the root resorption degree relies on the Ericson and Kurol classification.[21] This classification is applied to a cross-sectional view of the lateral incisor using a grading system to calculate the loss of dental tissues on lateral incisor root's the apical, middle, and coronal part. The resorption was mostly located at apical third of adjacent teeth. The root resorption was detected on single tooth resorption (28.4%), and two teeth resorption (56%), and three teeth resorption in 12.6%, with higher frequency in grade I 35.4%. It is approximate to the prevalence Ali et al, reported (32.5%) in grade 1.[25] However, this is less than Dagsuyu et al.[2] findings reported grade 1 was prevalent in 50%. Rafflenbeul et al.[26] reported 71.7% of subjects were in grade 1. The higher percentage on these studies may be related to the greater younger age in their sample

There is a relation between resorption and location of contact, contact relationship and type of contact. Schroder et al.[3] proved the association between root resorption and contact relationship, which is reinforced by the present study, where 80.2% of the subjects were associated with contacting induce resorption. This is closer to another study that found contact in 91.6% of the cases, confirming the resorption correlation with 40.2% at apical third and 44.8 at the middle third.[6] Most of the contact between canine and adjacent teeth were encountered in the apical third of the affected teeth.[3] This is consistent with our findings which too found most of the contact located in the apical third of the affected teeth.

Here, we found strong correlation between the type of impaction and root resorption. This is in consistent with Chaushu et al.[26] and Rafflenbeul et al.[6] findings, the incisor resorption reveals higher association as in severe mesiodistally displaced and vertically positioned canine. The location of resorption is in accordance with the mesiodistal displacement of the impacted canine. Still, the apical resorption incidence is more frequent and requires conservative treatment than other locations requiring an aggressive approach.

This study used specific linear measures to predicate adjacent root resorption associated with maxillary impacted canine. The mean distance of the canine tip to the occlusal plane 12.62mm and to the midline 6.23mm represented a difficult treatment situation. This is near Ali et al.[25] findings that the mean distance of its cusps tip to the occlusal plane was 11.5 mm while the mean distance to the midline was 7.8 mm. Additionally, it was found to be 10 mm from cusp tip to the occlusal plane and 9 mm away from the midline in Turkey.[2] All these studies assess the linear measurements in a sample with displaced canine impaction.

This study found crowding only in 4 cases (3.1%), and in the majority of cases82.3% incisors align without spaces. This result agrees with result by Cernochova et al.[22] that found majority of cases (47.3%) incisors align without spaces, and not agree with Almuhtaseb et al.[27] that found crowding in total 82.6% patients and Alqerban et al.[28] found crowding in total (23.1%) these differences in result due to different in sample age and size. And also found the conditions in the lateral part of the dental arch on the affected side majority of cases with lack of space for the erupting canine (i.e., the distance between the roots of the incisor and first premolar is smaller than width of the canine crown measured on the CBCT scans) in (55.4 %), complete loss of space (i.e., crown and root of the lateral incisor is near the crown and root of the first premolar on the CBCT scans) in (16.9%), and sufficient space without crowding in (27.7%), our result consistent with findings by Alqerban et al.[28] in that most of cases with lack of space for the erupting canine in (47.7%). Cernochova et al.[22] that found that 47.3% of cases had well-aligned incisors without spaces. We disagree with him about the crowding in the incisor region (26%), and we also found that most cases had enough space without crowding in the lateral part of the dental arch on the affected side (63.8%). The differences in the result may be due to different sample sizes and the mean age of the patient's growth.

The present findings may assist orthodontists in diagnosis as well as treatment planning and design of treatment intervention of maxillary impacted canine. It also shows the need for studies that include children before eruption of canines and adolescents to establish a valid database.

CONCLUSION

From the results obtained, the following conclusions could be drawn:

1. Higher prevalence of maxillary canine impaction in females than males, is higher for palatal impaction.
2. Maxillary lateral incisors most frequently have root resorption. Resorption grade 1 was more frequently seen, with the common area being the apical third.
3. Gender and side of impaction show no significant differences vis-à-vis root resorption.
4. There was a positive correlation between root resorption with contact relationship and location of contact.

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4. Do statistics: Alharazi Ghamdan A
5. Record and interpreted the results: Aldhorae Khaled A
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REFERENCES

1. Sacerdoti Raffaele, Baccetti Tiziano, Dentoskeletal features associated with unilateral or bilateral palatal displacement of maxillary canines. Angle Orthod, 2004. 74(6): 725-32.
2. Dağsuyu, İlhan Metin Kahraman, Fatih Okşayan, Rıdvan, Three-dimensional evaluation of angular, linear, and resorption features of maxillary impacted canines on cone-beam computed tomography. Oral Radiology, 2018. 34(1): 66-72.
3. Schroder Angela Graciela, Guariza-Filho Odilon, de Araujo Cristiano, Ruellas Antonio Carlos, Tanaka Orlando Motohiro, Porporatti Andre Luis, To what extent are impacted canines associated with root resorption of the adjacent tooth?: A systematic review with meta-analysis. J Am Dent Assoc, 2018. 149(9): 765-777.e8.
4. Aldhorae Khalid, Altawili Zainab M, Assiry Ali, Alqadasi Basema, Al-Jawfi Khalid, Hwaiti Hisham., Prevalence and distribution of dental anomalies among a sample of orthodontic and non-orthodontic patients: A retrospective study. J Int Oral Health, 2019. 11(5): 309- 317.
5. Kalavritinos Michael, Benetou Vassiliki, Bitsanis Elias, Sanoudos Mattheos, Alexiou Konstantina, Tsiklakis Konstantinos, et al., Incidence of incisor root resorption associated with the position of the impacted maxillary canines: A cone-beam computed tomographic study. Am J Orthod Dentofacial Orthop, 2020. 157(1): 73-79.
6. Rafflenbeul Frédéric, Gros Catherine-Isabelle, Lefebvre François, Bahi-Gross Sophie, Maizeray Raphaëlle, Bolender Yves., Prevalence and risk factors of root resorption of adjacent teeth in maxillary canine impaction, among untreated children and adolescents. Eur J Oral, 2019. 41(5): 447-453.
7. Peck Sheldon, Peck Leena, and Kataja Matti, The palatally displaced canine as a dental anomaly of genetic origin. Angle Orthod, 1994. 64(4): 249-56.
8. Alassiry Ahmed Mohammed, Hakami Zaki, Root Resorption of Adjacent Teeth Associated with Maxillary Canine Impaction in the Saudi Arabian Population: A Cross-Sectional Cone-Beam Computed Tomography Study. Applied Science, 2022. 12(1): e1 – e9.
9. Dekel Eyal, Nucci Ludovica, Weill Tehilla, Flores-Mir Carlos, Becker Adrian, Perillo Letizia, et al., Impaction of maxillary canines and its effect on the position of adjacent teeth and canine development: A cone-beam computed tomography study. Am J Orthod Dentofacial Orthop, 2021. 159(2): e135-e147.
10. Liu Deng-gao, Zhang Wan-lin, Zhang Zu-yan, Wu Yun-tang, Ma Xu-chen, Localization of impacted maxillary canines and observation of adjacent incisor resorption with cone-beam computed tomography. Oral surgery, Oral Medicine, Oral Pathology, and Endodontology, 2008. 105(1): 91-98.
11. Vitria Evy Eida, Tofani Iwan, Bachtiar Endang, Winiati Kusdhany, Lindawati, Association of Maxillary Transverse Discrepancies and Impacted Maxillary Canines in Patients 10-25 Years Old. Journal of Int Dent Med Research, 2016. 9: 322 - 330.
12. Kumar M. Goyal M. Kaur A. Abrar M, Risk factors for maxillary impacted canine-linked severe lateral incisor root resorption. Am J Orthod Dentofacial Orthop, 2021. 159(4): 409-410.
13. Miresmaeili Amirfarrhang, Basafa Mohammad, Mahvelati Shamsabadi Reza, Farhadian Nasrin, Moghymbeigi Abbas, Mollabashi Vahid, Treatment decision analysis for palatally-displaced canines based on orthodontists' opinion and CBCT. Int Orthod, 2017. 15(4): 625-639.
14. Kumar Shahi Prashant AS, Parv Agrawal, Madhurima Nanda, Sakshi Tiwari, Aartika Singh. Survey on Evaluation of Awareness of Periodontal Health Among Subjects Undergoing Orthodontic Treatment and Trainee Orthodontists. IJCRR. 2021;13(21). 99-104.
15. Alqerban Ali, Jacobs Reinhilde, Fieuws Steffen, Nackaerts Olivia, Willems Guy, Comparison of 6 cone-beam computed tomography systems for image quality and detection of simulated canine impaction-induced external root resorption in maxillary lateral incisors. Am J Orthod Dentofacial Orthop, 2011. 140(3): e129-e139.
16. Margot Raes, Maria Cadenas De Llano-Pérula, Ali Alqerban, Annouschka Laenen, Anna Verdonck, Guy Willems., Prediction of maxillary canine impaction based on panoramic radiographs. Clinic exp dent research, 2020. 6(1): 44-50.
17. Katsnelson Alexander, Flick William G, Susarla Seenu, Tartakovsky Julia V, Miloro Michael, Use of panoramic x-ray to determine position of impacted maxillary canines. J Oral Maxillofacial Surg, 2010. 68(5): 996-1000.

18. Alqerban Ali, Jacobs Reinhilde, Fieuws Steffen, Willems Guy, Comparison of two cone beam computed tomographic systems versus panoramic imaging for localization of impacted maxillary canines and detection of root resorption. Eur J Orthod, 2011. 33(1): 93-102.
19. American Academy of Oral and Maxillofacial Radiology, Clinical recommendations regarding use of cone beam computed tomography in orthodontics, in Position statement by the Am Academy of Oral and Maxillofacial Radiology. 2013. 238-57.
20. Walker Leah, Enciso Reyes, Mah James, Three-dimensional localization of maxillary canines with cone-beam computed tomography. Am J Orthod Dentofacial Orthop, 2005. 128(4): 418-423.
21. Ericson Sune and Juri Kurol, Incisor root resorptions due to ectopic maxillary canines imaged by computerized tomography: a comparative study in extracted teeth. Angle Oerhod, 2000. 70(4): 276-283.
22. Cernochova Pavlina, Krupa Petr, Izakovicova-Holla Lydie, Root resorption associated with ectopically erupting maxillary permanent canines: a computed tomography study. Eur J Orthod, 2011. 33(5): 483-491.
23. Viera Anthony J, Garrett Joanne M, Understanding interobserver agreement: The kappa statistic. Fam Med, 2005. 37(5): 360-363.
24. Prasanna Arvind, Navaneethan Ramasamy. A Questionnaire Study on Assessing Newer Concepts and Diagnosis of Root Resorption Among Orthodontists and General Dentists- Knowledge, Awareness, Practice Survey. IJCRR. 2021;13(16). 129-137.
25. Ali Israa Hussein, Al-Turaihi Bassam Ali, Mohammed Lamis Khidher, Alam Mohammad Khursheed, Root Resorption of Teeth Adjacent to Untreated Impacted Maxillary Canines: A CBCT Study. BioMed Res Int, 2021. e1-e8.
26. Chaushu Stella, Kaczor-Urbanowicz Karolina, Zadurska Małgorzata, Becker Adrian, Predisposing factors for severe incisor root resorption associated with impacted maxillary canines. Am J Orthod Dentofacial Orthop, 2015. 147(1): 52-60.
27. Almuhtaseb Eyad, Mao Jing, Mahony Derek, Bader Rawan, Zhang Zhi-xing., Three-dimensional localization of impacted canines and root resorption assessment using cone beam computed tomography. Journal of Huazhong University of Science and Technology, 2014. 34(3): 425-430.
28. Alqerban Ali, Jacobs Reinhilde, Fieuws Steffen, Willems Guy, Radiographic predictors for maxillary canine impaction. Am J Orthod Dentofacial Orthop, 2015. 147(3): 345-354

Table 1: Inter and intra-reliability Kappa test of two raters

Variables	Inter-examiner reliability	Intra-examiner reliability
E:Canine cusp tip to occlusal plane	0.6	0.842
Contact relation	1.000	1.000
Location of contact	1.000	1.000
Root resorption of adjacent teeth	1.000	1.000
Location of resorption	1.000	1.000
Grade of resorption	1.000	1.000
Distance from cusp tip to midline	0.65	1.000
Mesiodistal impacted canine width	1.00	0.94
Mesiodistal space available between lateral and premolar	0.733	0.823

Table 2: Descriptive statistic for regarding location and variables related to impacted canine

Variables		Frequency	Percent
Gender	Male	31	(31%)
	Female	69	(69%)
Side of impaction	Right	65	(50%)
	Left	65	(50%)
Age	From 18 to 20	44	(33.8%)
	From 21 to 25	44	(33.8%)
	From 26 to 30	42	(32.3%)
Position of impaction	Palatal	114	(87.7%)
	Buccal	11	(8.5%)
	At the line of the arch	5	(3.8%)

Severity of resorption	Grade 0	34	(26.2%)
	Grade 1	46	(35.4%)
	Grade 2	37	(28.5%)
	Grade 3	13	(10%)
Space between lateral and premolar	Sufficient space	36	(27.7%)
	Lake of space	72	(55.4%)
	Complete loss of space	22	(16.9%)

Table 3: Linear measurements description and Mann Whitney U test comparison

Variable	Mean	SD	Minimum	Maximum	Sig. With gender	Sig. With side in bilateral subjects
Canine cusp tip to occlusal plane (sagittal view)	12.26	3.39	5.30	23.40	0.473	0.418
Canine apex tip to midline (coronal view)	14.68	2.61	3.20	20.80	9.20	0.668
Distance from canine cusp tip to midline (Axial view)	6.73	3.35	0.70	15.10	0.261	0 .470
Mesiodistal impacted canine width	7.77	0.65	6.20	9.30	0.031*	0.595
Mesiodistal space available between lateral and premolar	6.23	2.09	0.10	15.10	0.070	0.632

†*Significant at *P*< 0.05

Table 4: Descriptive statistics of study variables and Mann Whitney U test comparison

Variable	Mann Whitney U test	Sig. with bilateral subjects
Side of impaction	1880.0	0.854
Contact relation	1794.500	0.414
Location of contact	1694.500	0.809
Location of resorption	1738.0	0.728
Root resorption of adjacent	1809.0	0.414
Grade of resorption	1810.50	0.606
Type of impaction	1644.0	0.671
Location of impaction	1837.0	0.297

†*Significant at *P*< 0.05

Table 5: Correlation between the root resorption and some variables

	Side of impaction	Type of impaction	Location of impaction	Contact relationship	Location of contact
Root resorption	-0.059	0.173*	-0.007	0.995**	0.613**
	0.503	0.048	0.933	0.001	0.001
N	130	130	130	130	130

†* Correlation is significant at the 0.05 level (2-tailed)

†** Correlation is significant at the 0.01 level (2-tailed)

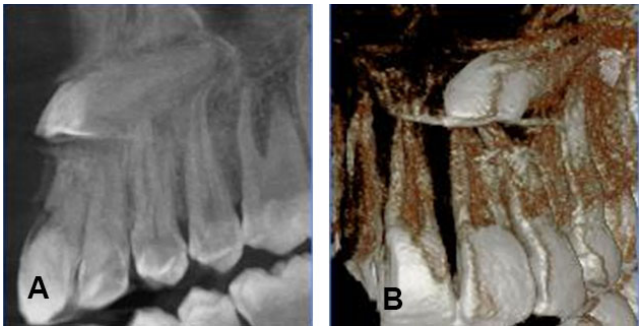

Figure 1: A scanned CBCT view image with sever resorption up to 3-4mm at apex of central and lateral incisors. a, sagittal view. b, coronal view.

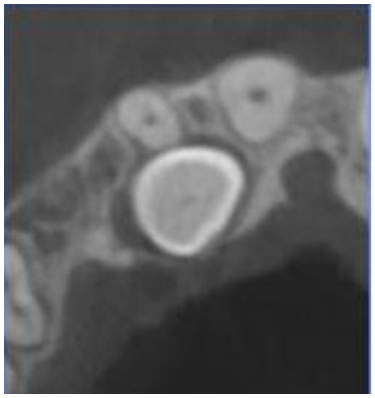

Figure 2: Mild root resorption of lateral incisor caused by palatal displaced impacted canine.

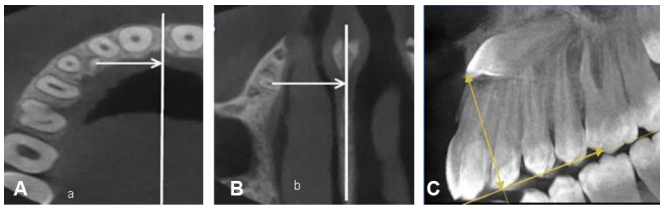

Figure 3: CBCT images illustrating the reference lines of linear measurements (axial view): a, canine cusp tip to the midline measured. b, canine root apex to the midline measured. (coronal view): c, canine cusp tip to the occlusal plane measured.

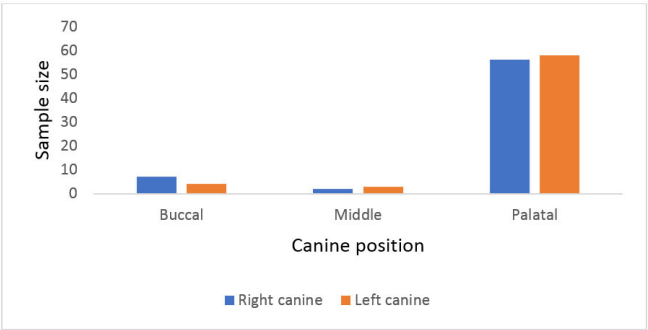

Figure 4: Distribution of impacted canine through maxilla.

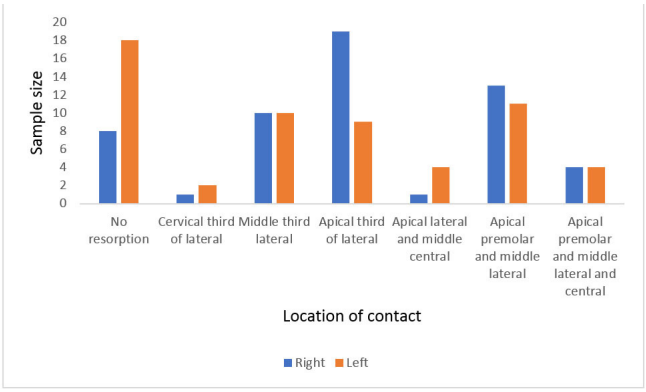

Figure 5: Impacted canine contact location to adjacent root.

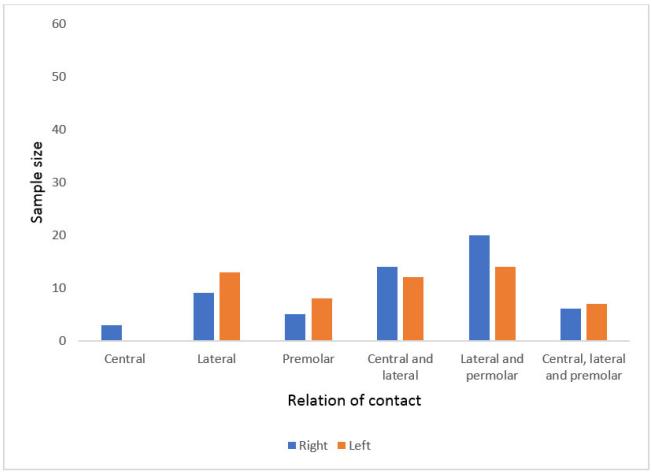

Figure 6: Impacted canine contact relation to adjacent root.

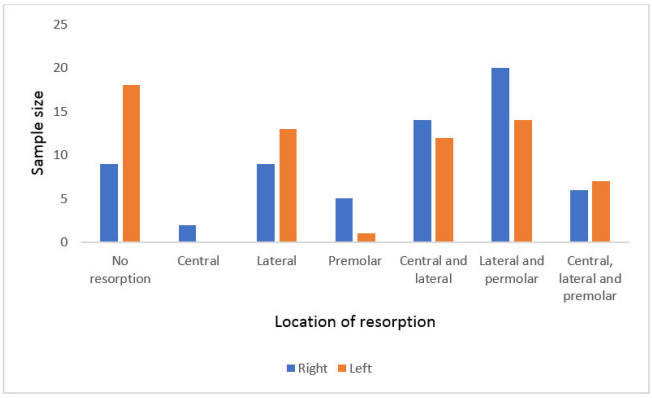

Figure 7: Location of resorption impacted canine to adjacent root.