

Effect of Different Angulations of Impacted Maxillary Canine on Root Resorption of lateral incisor Using Cone Beam Computed Tomography: A Retrospective Study.



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Abstract— The objective of this study was Evaluate the effect of different angulations of impacted maxillary canine on root resorption of lateral incisor using cone-beam computed tomography (CBCT). **Methods and material:** The sample included 30 CBCTs presenting with unilateral or bilateral impacted maxillary canines were evaluated ranging in age from 15 to 30 years that were selected and collected from the Department of Radiology Faculty of Dentistry (Suez Canal University). Canine angulation relative to the maxillary occlusal plane and adjacent lateral incisor was measured, as well as the locations of the impacted canines. **Results :** The results of the current study showed (58.8 %) with slight resorption, and (26.5%) with moderate resorption of lateral incisor root. Lateral incisor root resorption was more common in the apical third and palatal surface. There was a statistically significant relationship between root resorption severity and angulation of impacted maxillary canine relative to the lateral incisor. Angle of impacted maxillary canine with occlusal plane can't be solely relied on determining the severity of root resorption (RR). **Conclusion:** RR occur due to proximity of impacted maxillary canine to adjacent lateral incisor .Slight RR occur most commonly at apical and palatal surface.

Introduction

An impacted tooth is one that fails to erupt at its proper location in the dental arch during its normal eruption period.¹ Maxillary canines are the most frequently impacted teeth after third molars, with a prevalence ranging from 0.9 to 3.0% depending on the population studied². The position of impacted canines reported by different authors varies, but in most studies, the canines are located palatally (41%-90%). Impacted maxillary canines have been shown to occur twice as commonly in females than males³. Different radiographic exposures, such as occlusal films, panoramic views, and lateral cephalometric radiographs, can aid in determining canine position. Due to superimposition issues, traditional radiographs can be somewhat limited in their ability to visualise impacted teeth. Three-dimensional (3D) volumetric imaging systems with excellent tissue contrast enable localization of impacted canines using spatial relationships. Cone beam computed tomography (CBCT) uses a cone shaped X-ray to acquire maxillofacial images with higher spatial resolution and lower radiation dose than conventional

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CT.⁴Root resorption (RR) of adjacent teeth, particularly the lateral incisors, is the most common undesirable, irreversible, and adverse sequela of maxillary canine impaction, causing irreversible damage and potentially leading to tooth loss.⁵Traditional methods of detecting resorption can be difficult; however, advances in (CBCT) have significantly improved the sensitivity and accuracy of the RR diagnosis.^{3,16} CBCT may influence treatment planning and may be a genuine method for correcting a suggested treatment for incisor RR, providing more reliable information than traditional methods.⁶

So this study was planned to evaluate the effect of different angulations of impacted maxillary canine on root resorption of Lateral incisor using cone-beam computed tomography.

Materials and Method

The study design:

In this retrospective study, Thirty CBCT scans of patients with unilateral or bilateral impacted maxillary canines ranging in age from 15 to 30 years old were collected from the archive of Oral Radiology Department, Faculty of Dentistry at Suez Canal University. The study was approved by the Research Ethics Committee of Suez Canal University. Using the same standard protocol, all CBCT scans were taken using Soredex SCANORA 3D* and handled by OnDemand Imaging Software.

Material and Method

- 1) Impacted maxillary canine localization (bucco-palatal position) :
From a CBCT axial view, and relative to the most central line of maxillary arch ; the buccolingual maxillary canine position is determined as : palatal (If more than half of the canine crown was located palatally), labial (If more than half of the canine crown was located labially) or in line with the arch (If the canine crown was located at central line).Hadler-Olsen et al (2015)⁷
- 2) Canine angulation relative to maxillary occlusal plane
 - o The occlusal plane was defined as the line from the mesiobuccal cusp of the maxillary first molar to the incisal edge of maxillary central incisor. Alqerban et al (2016)⁸
 - o From a clear panoramic view of the impacted canine, we measure the angle formed between the canine long axis and the occlusal plane.
- 3) Canine angulation relative to maxillary lateral incisor o From a clear panoramic view of the impacted canine, we measure the angle between long axis of the impacted canine and adjacent teeth .
- 4) Canine distance relative to maxillary lateral incisor
- 5) location of the lateral incisor root resorption due to impacted maxillary canine(Jawad et al., 2016)⁹
First the vertical position of the resorption relative to the long axis of the lateral incisor root, seen on CBCT images as follows: apical third, middle third and coronal third.
Second, horizontal position of the resorption relative to long axis of lateral incisor root was recorded as follows: buccal, palatal, mesial and distal.
- 6) severity of root resorption according to Ericson and Kurol (2000)¹⁰ graded as:
 - o no resorption
 - o slight: resorption up to half the dentine thickness

- moderate: resorption of the dentine midway to the pulp or more, the pulp lining being unbroken
- severe: resorption affecting the pulp

Results:

Thirty CBCT presenting with 34 impacted maxillary canine. Unilateral impaction was presented in 26 (86.6%) scan and 4 (13.3%) scan presented with bilateral impaction. The three-dimensional location analyses re-vealed that the majority of the impacted canines were located in the palatal position 15 (44.1%), 13 (38.2%) were located buccally and only 6 canines (17.6%) showed line of occlusion canine position. In this sample, 5 (14.7%) impacted maxillary canine caused no resorption. 20 (58.8%) caused slight resorption. 9 (26.5%) caused moderate resorption

Maximum root resorption presented in apical third (38.8%), middle third (32.4%) and coronal third (14.7%). According to root surface involved, maximum root resorption was in relation to the palatal surface (23.5%) followed by distopalatal (20.6%), distal (17.6%), buccal (8.8%), distobuccal (5.9%), mesial (5.9%) and mesiopalatal (2.9%) surfaces.

From table 1 it could be noted that the mean distance for no resorption was 1.3 ± 0.3 while the mean distance for slight resorption was 0.3 ± 0.4 . There is a negative significant correlation between distance and severity of resorption as revealed by Pearson's correlation ($r = -0.874$; $p < 0.001^{***}$). Accordingly, distance > 1.0 mm show a significant no resorption, however, distance (< 0.9) show a significantly slight resorption as revealed by one way ANOVA ($p = 0.002$).

Table 1: correlation between Severity of root resorption and distance between impacted maxillary canine and adjacent lateral incisor

Severity	Distance				
	N	%	Mean	SD	
No	5	45.5	1.36	0.36	
Slight	6	54.5	0.35	0.4	
Moderate	0	0	0	0	
Severe	0	0	0	0	
Total	11	100	1.71	0.763	
ANOVA	0.002**				
	$p < 0.001$				

From table 2 Regarding correlation between root resorption severity and angulation of impacted maxillary canine relative to the lateral incisor, There is a strong positive and highly significant correlation between the severity of root resorption and the angulation of the impacted maxillary canine with the lateral incisor.

Table 2 Regarding correlation between root resorption severity and angulation of impacted maxillary canine relative to the lateral incisor

Severity	Angulation with lateral incisor			
	N (%)	Mean	SD	Posthoc
No	5 (14.7)	10.0	3.1	A
Slight	20 (58.8)	38.5	8.2	B
Moderate	9 (26.5)	72.7	27.3	A
Severe	0 (0.0)	0	0	A
ANOVA	<0.001**			
Correlation	r= -0.279; p<0.112ns			

Regarding correlation between root resorption severity and angulation of impacted maxillary canine relative to the occlusal plane, there is a weak non-significant correlation between severity of root resorption and angulation of impacted canine with occlusal plane.

Table 3 The angulation with occlusal plane at different severity of resorption intact, slight, and moderate

Severity	Angulation with occlusal plane					
	n	%	Mean	SD	SE	DMRTs
Intact	5	14.7	52.2	25.5	11.4	a
Slight	20	58.8	46.9	13.8	3.1	a
Moderate	9	26.5	55.8	11.5	3.8	a
Sever	0	0	0.0	0.0	0.0	a
ANOVA	>0.05 ns					
Correlation	r= 0.167; p=0.345 ns					

Discussion:

Diagnosis and interpretation of canine impaction considered one of the greatest esthetic and functional challenge that face the orthodontist. Impacted maxillary canines are the second most impacted tooth after the third molar teeth because it has the longest path of eruption.⁸ Impacted canine is one of the most difficult malocclusions that face the orthodontist so some studies tried to understand the path of its eruption to early predict its impaction and hence early intervention to prevent impaction of the canine.^{10,11,12} Root resorption (RR) of adjacent teeth, particularly the lateral incisors, is the most common undesirable, irreversible, and adverse sequela of maxillary canine impaction, causing irreversible damage and potentially leading to tooth loss.^{6,13}

The goal of this study was to use cone-beam computed tomography to assess the effect of different angulations of an impacted maxillary canine on root resorption of adjacent teeth.

The age range in this study ranged from 15 to 30 years old. This was selected beyond the average eruption date of the canine to ensure its impaction. It was suggested that if the maxillary canine has not erupted at the age of 13.1 years in boys or 12.3 years in girls, it can be considered impacted. (Işık Aslan and Üçüncü, 2015)¹⁶

Two-dimensional radiographs may underestimate the problem because root resorption becomes clearly visible only when the entire thickness of the root surface is damaged, from the lingual to the buccal surface, or when it has progressed sufficiently to alter the mesio-distal profile of the root. Resorption is also difficult to detect on orthopantomograms due to incisor and canine overlapping, and because the degree of resorption should be compared to the initial thickness of the root.^{12,17} The CBCT has largely replaced other diagnostic techniques because of its accuracy in both localization of canine impaction and identification of any associated complications as root resorption, which may alter treatment plan for orthodontists. Moreover, CBCT radiographs have eliminated superimposed structures that may interfere with identifying reference points of measurements. (Botticelli et al., 2014).¹⁸

In this study, the samples were selected randomly and the CBCT scans that show Craniofacial anomalies or syndromes, Low resolution that precludes accurate measurements, Extraction cases or presence of supernumerary teeth and X-rays with limited field of view were precluded

The most common adverse effect of impacted maxillary canine is lateral incisor root resorption. Any level and surface of the tooth can be affected by root resorption. In this study, the apical one-third (38.2%) was the most involved level of root resorption, followed by middle one-third (32.4%). The least amount of root resorption was present in coronal third (14.7%). These findings agree with many other studies^{5,10,15}. It was observed that the palatal surfaces of the root were affected most severely (23.5%) followed by distopalatal (20.6%), distal (17.6%), buccal (8.8%), distobuccal (5.9%), mesial (5.9%) and mesiopalatal (2.9%) surfaces. **This was in agreement with Dogramaci et al. (2015)²²**

We correlated severity of root resorption and angulation of impacted maxillary canine with lateral incisor and angle between impacted maxillary canine and occlusal plane. Regarding angulation of impacted maxillary canine with lateral incisor, our study supported other researches which reported that severity of root resorption increase as angle between long axis of impacted maxillary canine and long axis of lateral incisor with mean angle 43.3. This was in agreement with, Alqerban et al (2015)⁸, Kalavritinos et al (2020)²¹, Guarnieri et al (2016)²³ and Simić et al (2021)²⁴

Regarding angulation between impacted maxillary canine and occlusal plane, our study reported that Angle of impacted maxillary canine with occlusal plane has no role in amount of root resorption of adjacent tooth. There may be another factor rather than angulation of impacted maxillary canine with occlusal plane affecting severity of root resorption. This was in agreement with Guarnieri et al (2016)²³ and Simić et al (2021)²⁴

The distance between impacted maxillary canine and lateral incisor was measured. There is a negative significant correlation between intact distance and severity of resorption as revealed by Pearson's correlation

($p < 0.001^{***}$) with mean distance 0.5 mm. Accordingly, distance > 1.0 mm show no resorption, however, small distance (< 0.9) show a significantly slight resorption as revealed by one way ANOVA ($p = 0.002$). Root resorption occurs due to proximity of impacted canines to adjacent teeth, indicating a relationship between resorption and pressure from an impacted canine. This was in agreement with Rafflenbeul et al (2019)¹⁵, Lai et al (2013)²⁰, Guarnieri et al (2016)²³, Ericson et al (2002)²⁵ and, Walker et al (2005)²⁶.

Finally, orthodontists can help the canine erupt in the proper location and reduce the risk of complications associated with an impacted maxillary canine by detecting it early, intervening in time, and providing well-managed treatment with proper direction of orthodontic traction.

Conclusions:

1. The most common adverse effect of impacted maxillary canine is lateral incisor root resorption.
2. Sight RR was the most frequent with highest incidence at the apical and palatal surface
3. The proximity of impacted canines to adjacent teeth causes root resorption, indicating a relationship between resorption and pressure from an impacted canine.
4. There is a negative correlation found between distance of impacted canine and lateral incisor and severity of resorption with mean distance 0.5 mm
5. There is a positive correlation between the appearance of resorption on the lateral incisor and the angle between the axis of canine and adjacent lateral incisor with mean angle of 43.3
6. Angle of impacted maxillary canine with occlusal plane can't be solely relied on determining the severity of RR

Reference:

- [1] Preda, L., La Fianza, A., Di Maggio, E. M., Dore, R., Schifino, M. R., Campani, R., Segù, C., & Sfondrini, M. F. (1997). The use of spiral computed tomography in the localization of impacted maxillary canines. *Dentomaxillo facial radiology*, 26(4), 236–241.
- [2] Liu, D. gao, Zhang, W. lin, Zhang, Z. yan, Wu, Y. tang and Ma, X. chen. (2008), "Localization of impacted maxillary canines and observation of adjacent incisor resorption with cone-beam computed tomography", *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology*, Vol. 105 No. 1, pp. 91–98.
- [3] Ericson, S. and Kurol, J. (1986), "Radiographic assessment of maxillary canine eruption in children with clinical signs of eruption disturbance", *European Journal of Orthodontics*, Vol. 8 No. 3, pp. 133–144.
- [4] Chung, H.K., Pan, P., Gallerano, R.L. and English, J.D. (2009), "A novel 3D classification system for canine impactions - The KPG index", *International Journal of Medical Robotics and Computer Assisted Surgery*, Vol. 5 No. 3, pp. 291–296.
- [5] Schroder, A.G.D., Guariza-Filho, O., de Araujo, C.M., Ruellas, A.C., Tanaka, O.M. and Porporatti, A.L. (2018), "To what extent are impacted canines associated with root resorption of the adjacent tooth?: A systematic References 109 review with meta-analysis", *Journal of the American Dental Association*, Vol. 149 No. 9, pp. 765-777.
- [6] Algerban, A., Jacobs, R., Fieuws, S. and Willems, G. (2011), "Comparison of two cone beam computed tomographic systems versus panoramic imaging for localization of impacted maxillary

- canines and detection of root resorption”, *European Journal of Orthodontics*, Vol. 33 No. 1, pp. 93–102.
- [7] Hadler-Olsen, S., Pirttiniemi, P., Kerosuo, H., BolstadLimchaichana, N., Pesonen, P., Kallio-Pulkkinen, S. and Lähdesmäki, R. (2015) “Root resorptions related to ectopic and normal eruption of maxillary canine teeth—A 3D study”, *Acta Odontologica Scandinavica*, Vol. 73, pp. 609–615.
- [8] Alqerban, A., Jacobs, R., Fieuws, S. and Willems, G. (2016) “Predictors of root resorption associated with maxillary canine impaction in panoramic images”, *European Journal of Orthodontics*, Vol. 38, pp. 292–299.
- [9] Jawad, Z., Carmichael, F., Houghton, N., & Bates, C. (2016), “A review of cone beam computed tomography for the diagnosis of root resorption associated with impacted canines, introducing an innovative root resorption scale”, *Oral surgery, oral medicine, oral pathology and oral radiology*, Vol. 122, No. 6, pp. 765–771.
- [10] Ericson, S. and Kurol, J. (2000), “Resorption of Incisors after Ectopic Eruption of Maxillary Canines: A CT Study”, *Angle Orthodontist*, Vol. 70 No. 6, pp. 415–423.
- [11] Lindauer, S.J., Rubenstein, L.K., Hang, W.M., Andersen, W.C. and Isaacson, R.J. (1992), “Canine impaction identified early with panoramic radiographs.”, *Journal of the American Dental Association*, Vol. 123 No. 3, pp. 91–92.
- [12] suyu, I. Ihan M.D., Kahraman, F. and ayan, R.O. (2018), “Threedimensional evaluation of angular, linear, and resorption features of maxillary impacted canines on cone-beam computed tomography”, *Oral Radiology*, Vol. 34 No. 1, pp. 66–72.
- [13] Andresen, A.K.H., Jonsson, M. V., Sulo, G., Thelen, D.S. and Shi, X.-Q. (2021), “Radiographic features in 2D imaging as predictors for References 107 justified CBCT examinations of canine-induced root resorption”, *Dentomaxillofacial Radiology*, Vol. 51 No. 1.
- [14] Almuhtaseb, E., Mao, J., Mahony, D., Bader, R. and Zhang, Z.X. (2014), “Three-dimensional localization of impacted canines and root resorption assessment using cone beam computed tomography”, *Journal of Huazhong University of Science and Technology - Medical Science*, Vol. 34 No. 3, pp. 425–430.
- [15] Rafflenbeul, F., Gros, C.I., Lefebvre, F., Bahi-Gross, S., Maizeray, R. and Bolender, Y. (2019), “Prevalence and risk factors of root resorption of adjacent teeth in maxillary canine impaction, among untreated children and adolescents”, *European Journal of Orthodontics*, Vol. 41 No. 5, pp. 447–453.
- [16] Aslan, B. I and Üçüncü, N. (2015), “Clinical Consideration and Management of Impacted Maxillary Canine Teeth”, *Emerging Trends in Oral Health Sciences and Dentistry*, pp. 465–491.
- [17] Kim, S.H., Kim, Y.M., Oh, S., Kim, S.S., Park, S.B., Son, W.S. and Kim, Y. Il. (2017), “How far is the root apex of a unilateral impacted canine from the root apices’ arch form?”, *American Journal of Orthodontics and Dentofacial Orthopedics*, Vol. 151 No. 2, pp. 351–356.
- [18] Botticelli S, Verna C, Cattaneo PM, Heidmann J & Melsen B. (2011), “Two- versus three-dimensional imaging in subjects with unerupted maxillary canines” *European journal of orthodontics*, Vol. 33 No. 4, pp. 344–349.
- [19] Alqerban, A., Jacobs, R., Fieuws, S. and Willems, G. (2011), “Comparison of two cone beam computed tomographic systems versus panoramic imaging for localization of impacted maxillary canines and detection of root resorption”, *European Journal of Orthodontics*, Vol. 33 No. 1, pp. 93–102.

- [20] Lai, C. S., Bornstein, M. M., Mock, L., Heuberger, B. M., Dietrich, T., & Katsaros, C. (2013). "Impacted maxillary canines and root resorptions of neighbouring teeth: a radiographic analysis using cone-beam computed tomography". *European journal of orthodontics*, Vol.35 ,No. 4,pp. 529–538.
- [21] Kalavritinos, M., Benetou, V., Bitsanis, E., Sanoudos, M., Alexiou, K., Tsiklakis, K. and Tsolakis, A.I. (2020), "Incidence of incisor root resorption associated with the position of the impacted maxillary canines: A cone-beam computed tomographic study", *American Journal of Orthodontics and Dentofacial Orthopedics*, Vol. 157 No. 1, pp. 73–79.
- [22] Dođramaci, E. J., Sherriff, M., Rossi-Fedele, G., & McDonald, F. (2015) . "Location and severity of root resorption related to impacted maxillary canines: a cone beam computed tomography (CBCT) evaluation". *Australian orthodontic journal*, Vol. 31, No 1,pp. 49–58.
- [23] Guarnieri, R., Cavallini, C., Vernucci, R., Vichi, M. and Leonardi, R. (2016), "Impacted maxillary canines and root resorption of adjacent teeth : A retrospective observational study", *Med Oral Patol Oral Cir Buca*, Vol. 21 No. 6, pp. 743–750.
- [24] Simić, S., Nikolić, P., StanišićZindović, J., Jovanović, R., StošovićKalezić, I., Djordjević, A., & Popov, V. (2022). "Root Resorptions on Adjacent Teeth Associated with Impacted Maxillary Canines". *Diagnostics (Basel, Switzerland)*, Vol.12, No. 2,pp. 380.
- [25] Ericson, S., Bjerklín, K., & Falahat, B. (2002) . " Does the canine dental follicle cause resorption of permanent incisor roots? A computed tomographic study of erupting maxillary canines". *The Angle orthodontist*, Vol. 72, No. 2, pp. 95–104.
- [26] Walker, L., Enciso, R. and Mah, J. (2005), "Three-dimensional localization of maxillary canines with cone-beam computed tomography", *American Journal of Orthodontics and Dentofacial Orthopedics*, Vol. 128 No. 4, pp. 418–423.



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