

Association Between Maxillary Impacted Canine Position and Root Resorption of the Adjacent Incisors: A CT Study

**Assist. Lect. Dr. Nadia Bassim Al-Ansari
B.D.S., M.Sc.**

nadiaansari81@yahoo.com

Al-Rafidain University College - Department of Dentistry

**Assist. Prof. Dr. Mohammed Nahidh
B.D.S., M.Sc.**

m_nahidh79@yahoo.com

University of Baghdad - College of Dentistry
Department of Orthodontics

Abstract

Background: *Resorption of permanent maxillary incisors is a common complication of ectopically positioned maxillary canines and when they occur they may drastically increasing both the cost and complexity of the orthodontic treatment, thus early diagnosis and corrective measures are imperative. This study aimed to investigate the association between the maxillary impacted canines labio-palatal and mesio-distal positions and the associated root resorption of adjacent maxillary incisors.*

Materials and Methods: *The sample included 46 patients with an age ranged between 12 and 30 years referred to the CT scan image to detect unilaterally or bilaterally impacted maxillary canines. The mesio-distal position of the canine cusp tip, the labio-palatal*

position of the impacted canines, contact and root resorption of permanent incisors were evaluated with CT scan image. The association between the impacted canines position and root resorption of permanent incisors were analyzed using Chi square test.

Results: *Labially and mid-alveolus impacted canines were more common in sectors I and IV, while palatally impacted canines were most frequent in Sector IV. Lateral incisors were more often affected than central incisors by root resorption. Root resorption of permanent incisors showed a high significant association with sector location [$p \leq 0.001$] and was observed in sectors III and IV.*

Conclusions: *When canine impactions are suspected in sectors III or IV, CT scan must be considered to disclose suspected incisor resorption.*

Keywords: *Impacted canines, computerized tomography, root resorption.*

Introduction

Maxillary canines are one of the most frequently impacted teeth secondly to the wisdom teeth [1,2]. They have the longest period of development, the most superior area of development and the most challenging path of eruption compared to any other tooth in the oral cavity so disturbances in their eruption are more frequent [3,4].

Serious complications such as displacement and root resorption of adjacent teeth, cystic degeneration, canine ankylosis, shortening of the dental arch or combinations of these factors are associated with impacted canines [5].

One of the most common sequel and most complicated problem that usually associated with ectopic eruption of the cuspids is root resorption of the adjacent teeth. Generally, the root of maxillary lateral incisor is the most commonly affected. Root resorption of the central incisors is documented as well [6-8].

Early detection of canine impaction, accurate diagnosis and evaluation of the severity of resorption is, therefore, of essential importance if preventive and early therapeutic interventions are to be taken in order to eliminate or reduce any subsequent complications that may lead to extractions, time-consuming and expensive orthodontic treatment, or both [9,10].

Traditionally, numerous radiographic techniques have been suggested, including periapical, occlusal, panoramic and cephalometric radiographs or a combination of these approaches for precise diagnosis and localization of the impacted canines [11]. Nevertheless, the appearance of the longitudinal axis and the relationship with the neighboring bony and dental structures are often inaccurate because these complex structures overlap in the maxillofacial region. In such cases, the usage of computed tomography [CT] particularly spiral CT was recommended for localization of the impactions and for assessment of resorption of incisors, due to the brilliant tissue contrast and precise three dimensional images afforded by this technique [12]. Using three dimensional dental CT scan, the diagnostic accuracy can be significantly enhanced. In an earlier cross-sectional study in patients with ectopically positioned maxillary canines, the number of the diagnosed resorbed incisors was three times than diagnosed by conventional 2D reconstructed panorama [13].

In this retrospective study, a computed tomography [CT scan] was used to determine whether maxillary lateral and central incisor root resorption can be predicted using the sector overlapping analysis and to find out if there is any association between the mesio-distal and labio-palatal position of the impacted canines and their contact to the adjacent incisors and the presence of resorption in the ipsilateral central and lateral incisor roots.

Materials and Methods

CT images were collected from 46 patients [39 females, 7 males] with an age ranged from 12 to 30 years and referred by specialty clinics to Al-Karkh General Hospital / Computerized Tomography department for localization of either unilateral or bilateral impacted or ectopically erupting canines between January and June 2013.

All patients had fully erupted maxillary permanent central and lateral incisors adjacent to the impacted canines. Patients with pathological lesions around impacted canines were excluded from the study.

A total of 54 impacted or ectopically erupted maxillary canines were studied, including 8 bilateral impactions, 32 left unilateral impactions and 6 right unilateral impactions.

The CT images were acquired using multi-detector computed tomography [Philips, Brilliance 64, Netherlands]. The scanning parameters were a tube voltage of 80 kV, a tube current of 30 mA, and a scanning time of 2.5 seconds. All images were prospectively reconstructed at 0.6 mm.

The CT images were collected from the workstation and the imaging data were secondary reconstructed using software from the manufacturer to produce many view points of the structures of interest which may include trans-axial, panoramic, and 3D volumetric views, then the images were analyzed, stored in the CT acquisition work station and retrospectively studied.

Depending on the relative position of the canine crown to adjacent teeth, the labio-palatal position of canines was classified as labial, mid-alveolus and palatal. Resorption of permanent incisors was classified as no resorption or resorption. No resorption means intact root surfaces. The mesio-distal position of the canine was determined using sector analysis of Lindauer and colleagues [14] [Fig. 1]:

- Sector I: cusp tip distal to a line tangent to the distal heights of contour of the lateral incisor crown and root.

- Sector II: mesial to sector I, with the cusp tip distal to a line bisecting the mesiodistal dimension of the lateral incisor along the long axis.
- Sector III: mesial to sector II, with the cusp tip distal to a line tangent to the mesial heights of contour of the lateral incisor crown and root.
- Sector IV: any position mesial to sector III.

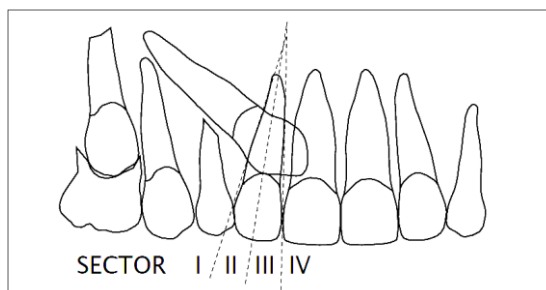


Figure 1: Mesio-distal position of canine cusp tip according to the Lindauer and colleagues sector location [14].

Statistical analyses

All the data of the sample was subjected to computerized statistical analysis using SPSS version 19. The associations of categorical data were studied using the chi-square test.

In the statistical evaluation, the following levels of significance are used:

Non-significant	NS	$P > 0.05$
Significant	S	$0.05 \geq P > 0.01$
Highly significant	HS	$P \leq 0.01$

Results

The positions of the ectopically erupting canines imaged on CT scans in relation to sector analysis were presented in table 1. Palatally impacted canines were most frequent and the majority of cases of sector IV showed palatal impaction 19 [63.33%]. Of the

total 54 impacted maxillary canines, 6 [11.1%] were impacted labially, 19 [35.19%] in the mid-alveolus and 29 [53.70%] palatally. Labially and mid-alveolus impacted canines were more common in sectors I and IV. Palatally impacted canines were most frequent in sector IV, however, statistically there was a non-significant association between the overlapping sectors of the impacted canines and their labio-palatal position [$p=0.377$].

Regarding the root resorption; lateral incisors were the teeth most affected and were more resorbed than the central incisors. On the 54 sides with ectopically positioned maxillary canines, 33 incisors were resorbed [26 lateral incisors and 7 central incisors]. The association between the mesio-distal position of the ectopically erupting canines and root resorption was significant for both the lateral and central incisors as shown in table 2 and 3 respectively.

Similarly, there was a highly significant association between crown-root contacts and resorption both for the lateral and central incisors as shown in table 4 and 5.

Tables 6 and 7 revealed non-significant associations between both lateral and central incisors root resorption and the labio-palatal position of the impacted canines.

Discussion

An accurate diagnosis of root resorption of the lateral and even the central incisors that are adjacent to an impacted maxillary canine can drastically change a treatment plan. It has become evident from many previous studies [15-17] that the three dimensional CT images has successfully overcome the limitations of conventional radiography and become superior to the conventional 2D radiographs for the localization of impacted canines and in the assessment of incisor root resorption.

Also, it is considerably outstanding for evaluating the positions of teeth and their mutual relationship compared to other diagnostic techniques which gives a good basis for clinical considerations when complications occur during eruption [18], so the use of computed tomography [CT] in such cases was recommended to be

more useful for planning treatment of a case involving unerupted canines including such factors as the volumetric size of the eruption follicle, the stage of root development, the amount of bone coverage, as well as the presence of root resorption [19]. However, considering the possibility of higher levels of radiation exposure from the routine use of CT restrict its recommendation indiscriminately in all cases.

In the current study, 54 CT images of maxillary impacted canines were analyzed to assess the association between the overlapping sector location of those impacted canines with their labio-palatal position and resorption possibility of the adjacent incisors.

It was found that most canines intended to become palatally impacted had cusp tips overlapping sector IV or mesial to the lateral incisor root. This could considerably increase both the treatment complexity and duration. Olive [20] reported that "canines impacted in sector IV commonly emerged after 21 months of treatment and canines in sectors II and III emerged after 8 months of treatment". Therefore, sector location of impacted canines could be helpful in treatment planning for impacted canines. However, the association between the labio-palatal position and the overlapping sectors was statistically non-significant suggesting that sector location could not be solely used as a predictor of the labio-palatal position of ectopically positioned canines. These results are inconsistent with Jung et. al. [21] who reported that sector location on the panoramic radiographs was significantly correlated with the labio-palatal position of impacted maxillary canines. These differences could be due to different radiographical imaging technique that was used.

Although the maxillary lateral-incisor root is the most commonly affected by ectopic eruption of the canine, there is also evidence that it can cause root resorption of the central incisors as reported by Bjerklín and Ericson [8].

In the present study, root resorption was associated with 33[66.1%] of 54 impacted canines, which are constant with the percentage of root resorption 66.7% reported by Walker et al.[22] and Ericson and Kurol [23]; however it was slightly higher than the

40.5% reported by Liu et al.[24] and 38% reported by Ericson and Kurol [12]. These differences may be related to the sampling and structure of the material, with many complicated cases, that may also have an impact on the results.

The mesio-distal position of the impacted canines on CT images showed a statistically high significant association with the lateral and central incisor root resorption in which there was nearly 60% chance that an impacted canine diagnosed in sector III or IV would be associated with lateral incisor root resorption suggesting a “root resorption threshold” between sectors III and IV. These results are supported by a previous study done by Schindel and Sheinis [19] who stated that sector analysis of a panoramic radiograph can be used to predict the presence of root resorption.

The high frequency of close contacts between the crowns of the ectopically positioned canines and the resorption cavities on the ipsilateral incisors found in this study indicates that the resorption is mainly caused by contact relations and physiological pressure after the eruption of the canine.

The CT method has been confirmed to be most efficient in revealing the presence and degree of root resorption on teeth adjacent to ectopically erupting maxillary canines. This technique facilitates interpretation of even slight loss of dentine on the roots of the teeth [25]. Although this study indicates that resorption cavities on maxillary incisors after ectopic eruption of maxillary canines is a common complication and is often underestimated by referring practitioners.

However, due to the high radiation dose of the CT, it cannot simply be justified for all ectopically located canines, but when maxillary cuspids are impacted or show delayed eruption in sectors III or IV on panoramic radiographs, CT scans should be recommended to localize the labio-palatal position of impacted canines and assess any root resorption.

Conclusion

In conclusion, the horizontal location of the impacted canines could guide the practitioner in determining whether a CT scan may be indicated when a potentially impacted canine is present, bearing in mind that the closer the impacted canine to the midline the higher probability that it is associated with resorption of permanent incisors.

References

- [1] Cooke J, Wang HL. "Canine impactions: incidence and management". *Int. J Periodontics Restorative Dent* 2006; 26(5): 483-91.
- [2] Abron A, Mendro RL, Kaplan S. "Impacted permanent maxillary canines: diagnosis and treatment". *N Y State Dent J* 2004; 70(9): 24-8.
- [3] Bishara SE. "Impacted maxillary canines: a review". *Am J Orthod Dentofac Orthop* 1992; 101(2): 159-71.
- [4] Bedoya MM, Park JH. "A review of the diagnosis and management of impacted maxillary canines". *J Am Dent Assoc* 2009; 140(12): 1485-93.
- [5] Alqerban A, Jacobs R, Lambrechts P, Loozen G, Willems G. "Root resorption of the maxillary lateral incisor caused by impacted canine: a literature review". *Clin Oral Investig* 2009; 13(3): 247-55.
- [6] Arens DE. "An alternative treatment for severely resorbed maxillary lateral incisor: A sequela of ectopic eruption". *J Endod* 1995; 21(2): 95-100.
- [7] Sameshima GT, Sinclair PM. "Predicting and preventing root resorption: Parts I and II". *Am J Orthod Dentofac Orthop* 2001; 119(5): 505-15.
- [8] Bjerklin K, Ericson S. "How a computerized tomography examination changed the treatment plans of 80 children with retained and ectopically positioned maxillary canines". *Angle Orthod* 2006; 76(1):43-51.

- [9] Williams BH. "Diagnosis and prevention of maxillary cuspid impaction". Angle Orthod 1981; 51(1):30-40.
- [10] Jacobs SG. "Reducing the incidence of unerupted palatally displaced canines by extraction of deciduous canines. The history and application of this procedure with some case reports". Aust Dent J 1998; 43(1): 20-7.
- [11] Mason C, Papadakou P, Roberts GJ. "The radiographic localization of impacted canines: a comparison of methods". Eur J Orthod 2003; 23(1):25-34.
- [12] Ericson S, Kurol PJ. "Resorption of incisors after ectopic eruption of maxillary canines: a CT study". Angle Orthod 2000; 70(6):415-23.
- [13] Al-Ansari NB, Ghaib NH, Al-Naimi SH. "Diagnosis and localization of the maxillary impacted canines by using dental multi-slice computed tomography 3D view and reconstructed panoramic 2D view". J Bagh Coll Dentistry 2014; 26(1): 159-65.
- [14] Lindauer SJ, Rubenstein LK, Hang WM, Anderson WC, Isaacson RJ. "Canine impaction identified early with panoramic radiographs". J Am Dent Assoc 1992; 123(3): 91-2.
- [15] Ericson S, Kurol J. "Incisor root resorptions due to ectopic maxillary canines imaged by computerized tomography: A comparative study in extracted teeth". Angle Orthod 2000; 70(4): 276-83.
- [16] Stewart JA, Heo G, Glover KE, Williamson PC, Lam EW, Major PW. "Factors that relate to treatment duration for patients with palatally impacted maxillary canines". Am J Orthod Dentofac Orthop 2001; 119(3): 216-25.
- [17] Heimisdottir K, Bosshardt D, Ruf S. "Can the severity of root resorption be accurately judged by means of radiographs? A case report with histology". Am J Orthod Dentofac Orthop 2005; 128(1):106-9.
- [18] Preda L, La Fianza A, Di Maggio EM, Dore R, Schifino MR, Campani R, Segu C, Sfondrini MF. "The use of spiral computed tomography in the localization of

- impacted maxillary canines". *Dentomaxillofac Radiol* 1997; 26(4):236-41.
- [19] Schindel RH, Sheinis MR. "Prediction of maxillary lateral-incisor root resorption using sector analysis of potentially impacted canines". *J Clin Orthod* 2013; 47(8): 490-3.
- [20] Olive RJ. "Factors influencing the non-surgical eruption of palatally impacted canines". *Aust Orthod J* 2005; 21(2): 95-101.
- [21] Jung YH, Liang H, Benson BW, Flint DJ, Cho BH. "The assessment of impacted maxillary canine position with panoramic radiography and cone beam CT". *Dentomaxillofac Radiol* 2012; 41(5): 356-60.
- [22] Walker L, Enciso R, Mah J. "Three-dimensional localization of maxillary canines with cone-beam computed tomography". *Am J Orthod Dentofac Orthop* 2005; 128(4): 418-23.
- [23] Ericson S, Kurol J. "Resorption of maxillary lateral incisors caused by ectopic eruption of the canines. A clinical and radiographic analysis of predisposing factors". *Am J Orthod Dentofac Orthop* 1988; 94(6): 503-13.
- [24] Liu DG, Zhang WL, Zhang ZY, Wu YT, Ma XC. "Localization of impacted maxillary canines and observation of adjacent incisor resorption with cone-beam computed tomography". *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008; 105(1): 91-8.
- [25] Freisfeld M, Dahl IA, Jäger A, Drescher D, Schüller H. "X-ray diagnosis of impacted upper canines in panoramic radiographs and computed tomographs". *J Orofac Orthop* 1999; 60(3):177-84.

Table 1: Association between the position of canine and overlapping

Overlap sector		Canine Position			
		Labial	Mid-alveolus	Palatal	Total
I	No.	2	7	5	14
	%	14.29	50	35.71	100
II	No.	1	4	3	8
	%	12.5	50	37.5	100
III	No.	0	0	2	2
	%	0	0	100	100
IV	No.	3	8	19	30
	%	10	26.67	63.33	100
Total	No.	6	19	29	54
	%	11.11	35.19	53.70	100

$X^2 = 5.642$, Likelihood ratio = 6.424, d.f. = 6, p-value = 0.377 [NS]

Table 2: Association between the lateral incisor resorption and overlapping

Overlap sector		Lateral incisor resorption		
		No	Yes	Total
I	No.	13	1	14
	%	92.86	7.14	100
II	No.	3	5	8
	%	37.5	62.5	100
III	No.	0	2	2
	%	0	100	100
IV	No.	12	18	30
	%	40	60	100
Total	No.	28	26	54
	%	51.85	48.15	100

$X^2 = 13.931$, Likelihood ratio = 16.615, d.f. = 3, p-value = **0.001 [HS]**

Table 3: Association between the central incisor resorption and overlapping

Overlap sector		Central incisor resorption		
		No	Yes	Total
I	No.	14	0	14
	%	100	0	100
II	No.	8	0	8
	%	100	0	100
III	No.	2	0	2
	%	100	0	100
IV	No.	23	7	30
	%	76.67	23.33	100
Total	No.	47	7	54
	%	87.04	12.96	100

$X^2 = 6.434$, Likelihood ratio = 9.057, d.f. = 3, p-value = **0.029 [S]**

Table 4: Association between the lateral incisor resorption and the contact

Lateral incisor contact		Lateral incisor resorption		
		No	Yes	Total
No	No.	17	0	17
	%	100	0	100
Yes	No.	11	26	37
	%	29.73	70.27	100
Total	No.	28	26	54
	%	51.85	48.15	100

$X^2 = 23.039$, d.f. = 1, p-value = **0.000 [HS]**

Table 5: Association between the central incisor resorption and the contact

Central incisor contact		Central incisor resorption		
		No	Yes	Total
No	No.	40	0	40
	%	100	0	100
Yes	No.	7	7	14
	%	50	50	100
Total	No.	47	7	54
	%	87	13	100

$X^2 = 22.979$, d.f. = 1, p-value = **0.000 [HS]**

Table 6: Association between the lateral incisor resorption and the position of the canine

Canine Position		Lateral incisor resorption		
		No	Yes	Total
Labial	No.	4	2	6
	%	66.67	33.33	100
Mid-alveolus	No.	11	8	19
	%	57.89	42.11	100
Palatal	No.	13	16	29
	%	44.83	55.17	100
Total	No.	28	26	54
	%	51.85	48.15	100

$X^2 = 1.379$, Likelihood ratio = 1.392, d.f. = 2, p-value = 0.499 [NS]

Table 7: Association between the central incisor resorption and the position of the canine

Canine Position		Central incisor resorption		
		No	Yes	Total
Labial	No.	5	1	6
	%	83.33	16.67	100
Mid-alveolus	No.	17	2	19
	%	89.47	10.53	100
Palatal	No.	25	4	29
	%	86.21	13.79	100
Total	No.	47	7	54
	%	87.04	12.96	100

$\chi^2 = 0.191$, Likelihood ratio = 0.191, d.f. = 2, p-value = 0.909 [NS]

العلاقة بين موقع الناب العلوي المظمور و نخر جذور القواطع العلوية الدائمة المجاورة - دراسة بأستخدام التصوير المقطعي

م.م.د. نادية باسم الانصاري

nadiaansari81@yahoo.com

كلية الرافدين الجامعة - قسم طب الاسنان

أ.م.د. محمد ناهض

m_nahidh79@yahoo.com

جامعة بغداد - كلية طب الاسنان - فرع تقويم الاسنان

المستخلص

ان نخر جذور القواطع العلوية الدائمة المجاورة للانياب الدائمة المظمورة هو احد المضاعفات الشائعة المصاحبة لوجود الانياب في غير مكانها الصحيح وخصوصا في الحالات المصاحبة لاحتباس أنياب الفك العلوي، وعندما يحدث النخر او التاكل في الجذور فإنه قد يزيد بشكل كبير كلا من تكلفة وتعقيد العلاج التقويمي لحالات الانياب المظمورة، وبالتالي التشخيص المبكر والتدابير التصحيحية أمران لا غنى عنهما. تهدف هذه الدراسة إلى التعرف على العلاقة بين مكان وجود الانياب المظمورة في عظم الفك العلوي وما قد يصاحبها بها من تاكل الجذور للقواطع العلوية المجاورة وذلك باستخدام الاشعة المقطعية ثلاثية الابعاد بواسطة جهاز المفراس الحلزوني.

لقد تمت في هذه الدراسة فحص وتشخيص ستة واربعون مريضاً تم تحويلهم الى مستشفى الكرخ العام في بغداد و باعمار تراوحت بين (12-30) سنة وبعد اجراء الاشعة المقطعية للمرضى تم دراسة كل حالة على حدة وتشخيص مكان الناب المظمور الامامي والخلفي بالاضافة الى مكانه الافقي نسبة الى القواطع المجاورة ومن ثم دراسة العلاقة بين موقع الانياب الامامية والخلفية ووجود النخر وايضا موقع الناب الافقي ووجود النخر، وكذلك تمت دراسة علاقة تماس الانياب المظمورة ووجود النخر في جذور الاسنان المجاورة.

أظهر البحث وجود علاقة احصائية ذات أهمية بين مكان وجود الناب الافقي وبين حدوث النخر في جذور القواطع المجاورة، علما ان القواطع الامامية الجانبية كانت أكثر تأثرا بنخر الجذور من القواطع الامامية الوسطية، كما لوحظ وجود علاقة ذات أهمية احصائية بين تماس الانياب بالاسنان المجاورة ووجود النخر في جذورها. ولم يتبين وفقا لنتائج هذه الدراسة وجود علاقة ذات دلالة احصائية بين مكان الناب المطمور الامامي والخلفي ووجود النخر في جذور القواطع المجاورة.

ان الاشعة المقطعية الحلزونية ثلاثية الابعاد تعد واحدة من افضل اجهزة الاشعة التشخيصية حيث انها توفر معلومات ذات قيمة ودقة تشخيصية عالية مما يساعد على تشخيص افضل ورسم خطط علاجية جراحية وتقويمية افضل لحالات احتباس الانياب العلوية الدائمة وما يصاحبها من مضاعفات.

الكلمات الرئيسية: أنياب مطمورة، التصوير المقطعي الثلاثي الابعاد، تناخر الجذور.