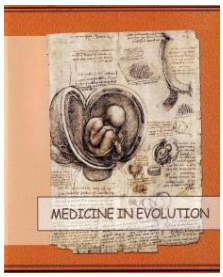
The CBCT evaluation of the resorption caused by impacted canines



Pop S.I.[1], Moldovan D.[2], Ghiman A.[2], Suciu V.[3], Contac L.R.[3], Pop R.V.[4], Popa G.[5], Bratu D.C.[5]

[1]Department of Orthodontics, Faculty of Dental Medicine, University of Medicine Pharmacy Science and Technology "George Emil Palade", Târgu-Mureş
[2]University of Medicine Pharmacy Science and Technology "George Emil Palade", Târgu-Mureş
[3]Department of Pedodontics, Faculty of Dental Medicine, University of Medicine Pharmacy Science and Technology "George Emil Palade", Târgu-Mureş
[4]Department of Dental Esthetic, Dental Clinic "Natural Smile by Dr Pop", Târgu Mureş
[5]Department of Orthodontics, Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy, Timişoara

Correspondence to:
Name: Moldovan Denisa Gabriela
Address: University of Medicine, Pharmacy, Science, and Technology of Târgu-Mureş George Emil Palade, Gheorghe Marinescu, nr. 38
Phone: +40 749053831
E-mail address: moldovan.denisa21@yahoo.com

Name: Contac Laura Roxana
Address: University of Medicine, Pharmacy, Science, and Technology of Târgu-Mureş George Emil Palade, Gheorghe Marinescu, nr. 38
Phone: +40 751439963
E-mail address: contac.roxana@yahoo.com

Abstract

Cone-beam computed tomography (CBCT) provides precise information regarding the position of the impacted canines, the presence and the degree of root resorption in adjacent teeth. This information is extremely important for surgeons and orthodontists in order to determine the correct diagnosis and the optimal interdisciplinary treatment plan.

The main goal of this study was the tridimensional evaluation of the position of impacted canines, as well as the frequency of the implicated factors in the root resorption of adjacent teeth. Using CBCTs, 20 impacted canines were diagnosed in 16 subjects. For the statistical analysis we used the Spearman rank correlation. In these patients, 10 canines had a palatal position (50%), 2 had a labial position (10%) and 8 had a medial position (40%). Root resorption was found in 11 lateral incisors (55%), 5 central incisors (25%), 1 first premolar (5%). Most statistically significant correlations were found in the central incisor resorption, dependent on the transversal position (-0.651 negative correlation, p=0.002). The second statistically significant correlation was found between the status of the deciduous canine and the central incisor resorption (0.457 positive correlation, p=0.043); the greater the lack of resorption of the deciduous canine, the higher the risk of resorption in the central incisor.

Keywords: maxillary impacted canines, mandibular impacted canines, CBCT, root resorption

INTRODUCTION

The CBCT (cone-beam computed tomography) pre-op examination is considered an important evaluation tool in choosing the most appropriate treatment of the impacted maxillary canines [1,2]. Amintavakoli and Spivakovsky [3] state in a study on the tridimensional position of the impacted canines that 2D images present a predisposition to errors and provide inadequate information about the position of the impacted teeth. CBCT is superior to conventional radiography because it provides tridimensional images and additional information on the dentofacial structures.

Many unidentified features of the impacted canines can be easily observed when using CBCT imagining [3]. The possibility of analysing a series of radiographic sections of the maxilla, enables the evaluation of the relationship between the impacted teeth and the neighboring teeth in all three spatial dimensions, as well as the position of the crown and the apex, and the inclination of the long axis of the tooth. This imaging method is, however, more expensive and it involves a higher dose of radiation than the conventional imaging techniques. The SEDENTEXCT studies conclude that, with respect to CBCT, there aren't solid evidence in favor of the CBCT usage as a primary imaging method in the diagnosis of root resorption [4].

Aim and objectives

The main goal of this study was the tridimensional evaluation of the position of impacted canines, as well as the frequency of the implicated factors in the root resorption of adjacent teeth. The second goal was to compare and to highlight possible correlations between these parameters. Moreover, this study endeavors to prove the importance of using CBCT in determining the correct diagnosis and establishing the most adequate treatment plan for each case.

MATERIAL AND METHODS

The study included a sample of 16 subjects, children and adults, with ages between 10 and 46 years, diagnosed with impacted maxillary and mandibular canines, with or without the suspicion of root resorption in adjacent teeth. Patients with palatal-lip cleft were not included in this study.

All the CBCT exams were performed on a limited area of the maxilla in order to maintain the radiation dose to a minimum, based on the A.L.A.R.A. principle (as low as reasonably achievable). Therefore, to achieve a correct diagnosis, the lowest dosage was used according to each particular case. In the cases where the position of the tooth was known, a 5x5 FOV (field of view) CBCT was performed. When the position of the tooth was unknown, we performed a 6x8 FOV CBCT with the following parameters: 90 kV and 6.3 mA with 27s exposure time.

The resulting sections were examined one by one in all three dimensions: sagittal, coronal and axial. When necessary, magnifying tools and digital rulers were used. The following analysis and measurements were performed for each subject:

A. The three-dimensional position of the impacted canine

Sagittal plane – position of the crown of the impacted canine with respect to neighboring teeth (usually the incisors) is classified as palatal, labial and medial. These examinations were performed in sagittal and/or coronal plane.

Vertical plane – position of the tip of the cusp of the impacted canine in relation to the long axis of the incisors. This is positioned on coronal level, in the cervical third, middle third, apical third or above the apex.

Axial plane – with the use of a ruler, we measured the distance between the tip of the canine cusp and the dental midline in mm.

B. Type of impaction – full bone impaction with or without soft tissue coverage.

C. Degree of development of the impacted canine root:

- canine with fully developed root with closed apex;
- canine with fully developed root with open apex;
- canine with ¾ developed root;
- canine with ½ developed root.

D. Size of dental follicle – using a ruler, we measured the largest diameter of the follicle, perpendicular to the impacted canine crown. These measurements were performed in the axial and the coronal plane.

E. Presence of the deciduous canine - the deciduous canine can be absent, present with in integral root or present with root resorption.

F. Impacted canine proximity or contact in relation to adjacent incisors or premolars. Proximity was defined as less than 0.5 mm from adjacent teeth. When the canines were in contact with the adjacent teeth, they were classified as follows: contact in cervical, middle or apical third of the impacted tooth.

G. Presence or absence of resorption in lateral incisors or adjacent teeth. Resorption level [5]:

- no resorption – the surface of the root is intact;
- mild resorption – half of the dentine thickness has been resorbed;
- moderate resorption – more than half of the dentine thickness has been resorbed;
- severe resorption – the resorption has determined the exposure of the pulp chamber.

The Spearman rank correlation test was used to determine the correlation between different parameters ($p<0.05$).

RESULTS

The results have been organized in Table 1 and Table 2.

Table 1. The morphology and position of the impacted canines (N=20)

Characteristics	n (%)
Canine	
Upper right	10 (50%)
Upper left	7 (35%)
Lower right	1 (5%)
Lower left	2 (10%)
Root development	
Fully developed, closed apex	14 (70%)
Fully developed, open apex	2 (10%)
¾ Developed root	3 (15%)
½ Developed root	1 (5%)
Follicle size	
<3 mm "no"	10 (50%)
>3 mm "yes"	10 (50%)
Deciduous canine	
Absent	7 (35%)

Present, resorbed	7 (35%)
Present, non-resorbed	6 (30%)
Sagittal position of the canine	
Labial	2 (10%)
Palatal	10 (50%)
Medial	8 (40%)
Vertical position of the canine	
Coronal	-
Cervical third	5 (25%)
Middle third	5 (25%)
Apical third	10 (50%)
Above the apex	-
Transversal position of the canine (mm)	
Average = 9.34; [Min-Max] = [2.5-17.2]	
Canine position in relation to the bone	
Full bone impaction	20 (100%)
Impaction with soft tissue coverage	-
Impaction without soft tissue coverage	-

Table 2. The resorption in adjacent teeth

	Central incisor	*Lateral incisor*	*First premolar*
Proximity / direct contact			
No	13 (65%)	5 (25%)	19 (95%)
Yes	7 (35%)	15 (75%)	1 (5%)
Proximity / direct contact position			
Cervical third	3 (15%)	5 (25%)	0 (0%)
Middle third	1 (5%)	3 (15%)	0 (0%)
Apical third	3 (15%)	7 (35%)	1 (5%)
Resorption			
No	15 (75%)	9 (45%)	19 (95%)
Yes	5 (25%)	11 (55%)	1 (5%)
Resorption position			
Cervical third	2 (10%)	5 (25%)	0 (0%)
Middle third	1 (5%)	2(10%)	0 (0%)
Apical third	2 (10%)	5 (25%)	1 (5%)
Resorption severity			
Mild	4 (20%)	9 (45%)	1 (5%)
Moderate	1 (5%)	3 15%)	0 (0%)
Severe	0 (0%)	1 (5%)	0 (0%)

This study was performed retrospectively on a sample of 16 subjects and it analyzed their respective CBCTs. The study evaluated 20 fully impacted canines (12 unilateral and 4 bilateral cases). The average age of the patients was 20 years, with a range between 10 and 46 years of age. Out of the 16 subjects, 7 (43.75%) were males and 9 (56.25%) were females. The three-dimensional position analysis confirms that the impacted canines are most frequently

found in palatal position (50%, 10 canines), closely followed by a medial position (40%, 8 canines) and less frequently found in labial position (10%, 2 canines).

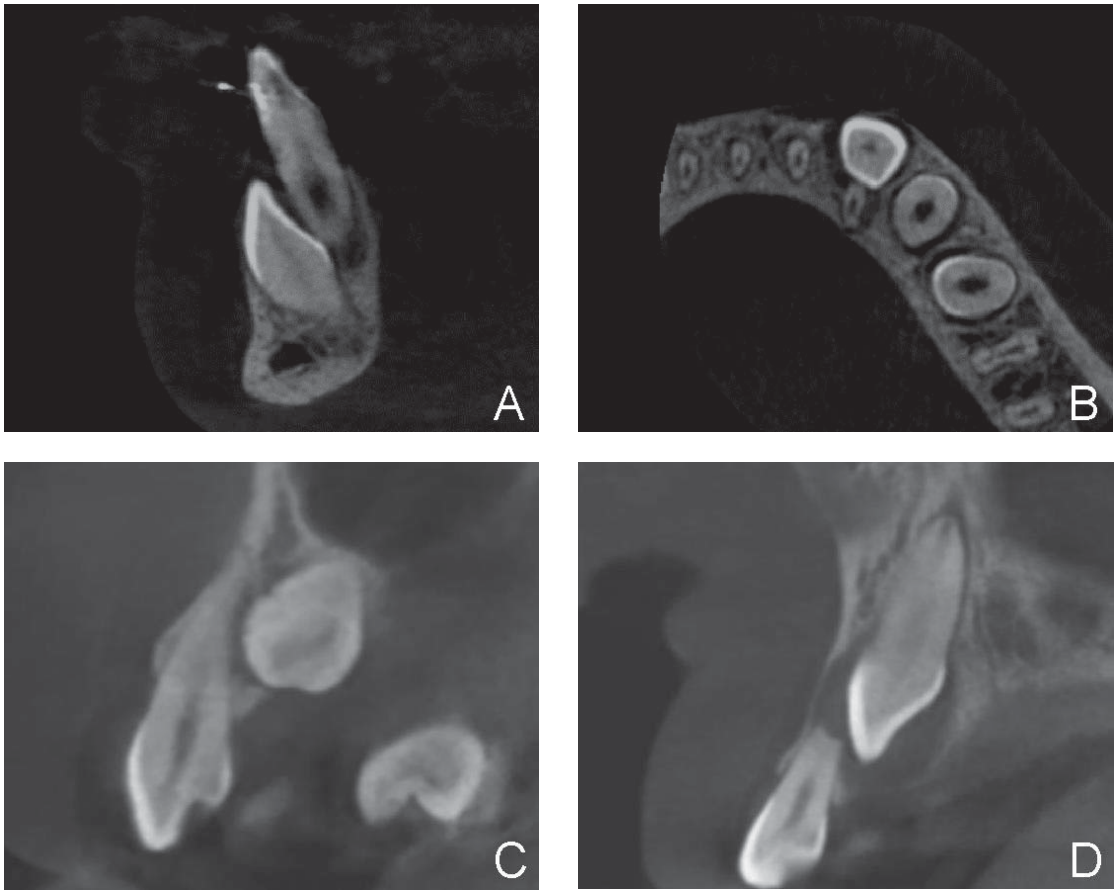


Figure 1. **D**ifferent examples of root resorptions: (A) – mild resorption of the lateral incisor; (B) – axial section, same patient as in image (A); (C) – moderate resorption of the central incisor; (D) – sagittal section, sever resorption of the lateral incisor.

Table 3. Spearman statistical analysis of the correlation between root resorption and different parameters

Parameters		Sagitt.	Vert.	Trans.	Decid.	Prox.	CI Res.	IL Res.	1PM Res.
	Sig. (2-tailed)		.102	.680	.187	.318	.852	.685	.456
Vertical position (Vert.)	Correlation Coefficient	-.376	1.000	.208	.210	-.064	-.109	.190	-.216
	Sig. (2-tailed)	.102		.378	.374	.790	.648	.424	.360
Transversal position (Trans.)	Correlation Coefficient	.098	.208	1.000	-.301	.080	-.651**	.044	.338
	Sig. (2-tailed)	.680	.378		.197	.738	.002	.855	.145
Deciduous canine (Decid.)	Correlation Coefficient	-.308	.210	-.301	1.000	-.247	.457*	.074	-.274
	Sig. (2-tailed)	.187	.374	.197		.294	.043	.757	.242
Proximity / contact with adjacent teeth (Prox.)	Correlation Coefficient	.235	-.064	.080	-.247	1.000	-.211	.359	.020
	Sig. (2-tailed)	.318	.790	.738	.294		.372	.121	.933
Central incisor resorption	Correlation Coefficient	-.044	-.109	-.651**	.457*	-.211	1.000	-.174	-.132

Parameters		Sagitt.	Vert.	Trans.	Decid.	Prox.	CI Res.	IL Res.	1PM Res.
(CI Res.)	Sig. (2-tailed)	.852	.648	.002	.043	.372		.463	.578
Lateral incisor resorption (LI Res.)	Correlation Coefficient	-.097	.190	.044	.074	.359	-.174	1.000	-.254
	Sig. (2-tailed)	.685	.424	.855	.757	.121	.463		.281
First premolar resorption (1PM Res.)	Correlation Coefficient	.177	-.216	.338	-.274	.020	-.132	-.254	1.000
	Sig. (2-tailed)	.456	.360	.145	.242	.933	.578	.281	

The strongest and most significant statistical correlation was observed in the central incisor resorption in transversal position (-0.651 negative correlation, p=0.002); the greater the value of the transversal position, the lower the risk of resorption in the central incisor.

The second statistically significant correlation was between the status of the deciduous canine and the resorption of the central incisor (0.457 positive correlation, p=0.043); the greater the lack of resorption of the deciduous canine, the higher the risk of resorption in the central incisor.

DISCUSSIONS

This study has revealed a greater prevalence in impacted canines in palatal position (50%), while the prevalence in medial (40%) and labial (10%) position was lower. Studies conducted in Switzerland and North America have shown the same increased prevalence in palatally impacted canines (51.49%-92.6%). Other studies conducted in Asia showed that the canine was more frequently impacted in labial position (45.2%) than in palatal position (40.5%). It was also postulated that enlarged dental follicles, as well as the pressure caused by erupted teeth can be determining factors for root resorption in adjacent teeth [6]. Even so, Ericson et al. [7], based on CT examination, reached the conclusion that dental follicle is not a cause for resorption in permanent teeth. Their conclusion was that the resorption of the permanent maxillary incisors is determined by the physical contact between the incisors and the canines and the pressure generated by the canines as part of their eruption process. Ectopic canines with a well-developed root, which erupt medially, on the long axis of the adjacent lateral incisors, with more than 25° angulation to the maxillary midline will determine the highest risk in root resorption of the lateral incisors [7]. Root resorption in premolars is rare [8].

This study supports previous conclusions that there is a correlation between prevalence in root resorption in permanent teeth and the proximity/contact with the affected canines. In the present study there are eleven resorbed lateral incisors, five resorbed central incisors and only one resorbed premolar.

Further observations were made on correlations between the position of the impacted canine to the midline (in transversal plane) and the resorption of the central incisor. These two parameters showed an inverse correlation (-0.651, p=0.002), namely the smaller the distance between the canine cusp and the midline, the greater the risk or resorption in the central incisor. Another correlation was observed between the presence of the non-resorbed deciduous canine and the resorption of the central incisor. This time a positive correlation, (0.457, p=0.043), namely, the greater the lack of resorption of the deciduous canine observed, the higher the risk of resorption in the central incisor.

A study conducted in Switzerland presented strong correlations with respect to the impaction of canines with full bone impaction with or without soft tissue coverage and the root resorption of adjacent teeth, the prevalence of the resorption being higher if the canine had full bone impaction (p=0.043). Moreover, there was a significant correlation between the

prevalence of root resorption and the position of the tip of the cusp in the vertical plane in relation to the long axis of the adjacent teeth [4-6].

CONCLUSIONS

It is important that the position of the impacted canines is precisely evaluated in the three special dimensions and the presence and degree of root resorption of adjacent teeth is carefully assessed, so that the surgeons and orthodontists can establish a correct diagnosis and an adequate interdisciplinary treatment plan. In addition to the clinical examination and the conventional radiography, CBCT imaging provides useful information regarding the position of the canine, the presence and the degree of root resorption in adjacent teeth. This study revealed a statistically significant correlation between the resorption of the central incisor and the position of the canine in transversal plane, as well as the resorption of the central incisor in relation with the presence of the non-resorbed deciduous canine.

REFERENCES

1. Schubert M, Proff P, Kirschneck C. Improved eruption path quantification and treatment time prognosis in alignment of impacted maxillary canines using CBCT imaging. Eur J Orthod. 2018;40(6):597-607.
2. Popa G, Borţun CM, Pop SI, Tas R, Simon CP, Bratu DC. The evaluation of an impacted maxillary canine before and during orthodontic traction using conventional and CBCT imaging: a case report. Medicine in Evolution. 2017;23(4):491-6.
3. Amintavakoli N, Spivakovsky S. Cone-beam computed tomography or conventional radiography for localising of maxillary impacted canines. Evid Based Dent. 2018;19(1):22-3.
4. Becker A. The orthodontic treatment of impacted teeth. Martin Dunitz Ltd; 1998. p. 1-23.
5. Lai CS, Bornstein MM, Mock L, Heuberger BM, Dietrich T, Katsaros C. Impacted maxillary canines and root resorptions of neighbouring teeth: a radiographic analysis using cone-beam computed tomography. Eur J. Orthod. 2013;35(4):529-38.
6. Marks SC, Schroeder HE, Andreasen JO. Theories and mechanism of tooth eruption. In: Andreasen JO, Kölsen-Pedersen J, Laskin DM (eds). Textbook and color atlas of tooth impactions. St Louis: Mosby; 1997. p. 20–65.
7. 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.
8. Postlethwaite KM. Resorption of premolar roots by ectopic canines. Br. Dent. J. 1989;167(11):397-8.