



Cone beam computed tomography for root resorption diagnosis

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Abstract

Background: Computed tomography (CT) is a non-invasive, rapid, reliable, and highly accurate diagnostic method. The frequency of impacted canines in the maxilla is 7 times greater than in the mandible and they are related to resorption of adjacent teeth.

Objective: The aim of this study was to evaluate and classify the degree resorption of teeth adjacent to upper canines with disturbance eruption by CT.

Materials and Methods: The images of 55 patients with 73 maxillary canines with eruption disorders were analyzed using a specific navigation software for cone beam CT scans in two planes, transverse and axial, looking for root resorption in maxillary incisors adjacent to canines with an eruption disturbance. For statistical analysis, the data were subjected to Student's t-test for paired samples and Pearson's correlation test ($P < 0.05$). The Kappa coefficient was used to evaluate the agreement between the first and second readings performed by the examiner (0.758).

Results: In the presence of retained canines observed increased risk of resorption in lateral incisors; most likely position of these elements is lingual; the reading of the cutting planes are indifferent diagnosis.

Conclusion: From the sample analyzed in this study, it is possible to conclude that when canines with eruption disorders exist, a tomographic analysis should be asked by the risk of reabsorption in surrounding tooth roots.

Introduction

Computed tomography (CT) is a non-invasive, rapid, reliable and highly accurate diagnostic method.^[1] The advantage of cone beam CT is that this method can capture full-size images in on the three spatial planes, unlike two-dimensional radiographs that project the image of structures onto a single plane, often in a distorted and superimposed manner.^[2]

The frequency of impacted canines in the maxilla is 7 times greater than in the mandible.^[3] The impacted maxillary canine is, in most cases, the second most common tooth in an ectopic position after the third molars, with an incidence ranging from 0.8% to 2.8% depending on the population examined.^[4,5] The incidence of impaction is twice as high in female patients.^[6]

The establishment and standardization of methods for locating canines with an eruption disturbance assist in orthodontic treatment planning and facilitate a more

conservative approaches.^[7] Late orthodontic treatment of impacted canines can have serious consequences, such as severe resorption of the central and lateral incisors.^[8,9] The use of cone beam CT has influenced the diagnosis and development of treatment plans in these cases.^[10] CT images are free of overlap and assist in making a diagnosis and decision regarding the best treatment to be offered to the patient.^[11]

Studies indicate that information obtained using three-dimensional (3D) imaging in patients with impacted canines can significantly influence changes in the treatment plan.^[12-14] The aim of this study was to evaluate and classify the degree resorption of teeth adjacent to upper canines with disturbance eruption by CT.

Materials and Methods

The tomographic images of 55 patients with 73 maxillary canines with eruption disorders were analyzed. The CT scans

were obtained between August 2008 and January 2012 from the databases of three different radiology clinical centers (Ethics Committee in Research of the University of Cuiabá – UNIC/2011-163).

The tomographic images were obtained with the same device, i-Cat Cone Beam 3D system (Imaging Sciences International, Hatfield, MN, EUA), were 0.20 mm × 0.20 mm × 0.20 mm voxels in size, 14 bits, and were examined using the XoranCat version 3.0.34 software (Xoran Technologies, Ann Arbor, MI, EUA) on a workstation with computers using Microsoft Windows XP professional SP-2 (Microsoft Corp., Redmond, WA, EUA). A senior, calibrated (Kappa 0.758) dental radiologist was asked to analyze the images using free navigation with the software in axial and transverse sections with 2-mm spacing and 1-mm-thick sections and to record the data regarding the presence or not of a canine with an eruption disorder, the position of the canine relative to the incisors, the presence or absence of resorption of the adjacent incisors, as well as the resorption score. The degree of resorption was evaluated using the index suggested by Estrela *et al.*, 2009^[15] with five scores as follows: 0 - Intact structures; 1 - Between 0.5 and 1 mm of resorption; 2 - Between 1 and 3 mm of resorption; 3 - Between 3 and 4 mm of resorption; 4 - Above 4 mm of resorption.

The data were tabulated and subjected to Student's *t*-test for paired samples, the Chi-square test, and Pearson's correlation. The Kappa test was used to verify the calibration of the examiner. A contingency table was created, and the relative risk of resorption was analyzed. The significance level used for all the tests was 5%.

Results

The results [Table 1] indicated that, of the 55 patients selected for the study, 29 (52.7%) were female and 26 (47.3%) were male ($P > 0.05$). The mean age of the patients was 15 years with a standard deviation of 3.4 years; the youngest subject was 11 years old, and the eldest subject was 24 years old. In total 73 canines with eruption, disorders were evaluated.

In assessing the frequency of the eruption area [Table 1], the results revealed that most of the canines were in the lingual maxilla region ($P < 0.05$), followed by the buccal surface ($P < 0.05$) and less often in other areas (apical and distal).

The tests using Pearson's correlation [Table 2] showed that the readings of the axial and transverse evaluation plans for teeth 11, 12, 21, and 22 were quite accurate regarding the degree of resorption in both of the two readings ($P < 0.05$).

In the case of canines with an eruption disorder, there was a 3.04-fold (1.97-4.67) increased the risk of resorption in the upper incisors. It was observed that the risk of resorption of the upper incisors increased by 1.52-fold (1.02-2.35) if the teeth erupted on the lingual surface. For the same variable regarding eruption on the buccal surface, the results were different; i.e., it appears that the risk of resorption on the buccal surface was reduced by 0.39 times (1.02-2.3). The presence of one or two

Table 1: Description of the sample

Analyzed variables	Research data	P value
Sample		
N (patients)	55	
N (canines with eruption disturbance)	73	
Age		
Mean±SD	15.81±3.4	
Min	11	
Max	24	
Gender, N (%)		
Male	26 (47.3)	$P > 0.05$
Female	29 (52.7)	
Teeth with eruption disturbance, N (%)		
Tooth 13	20 (27.40)	
Tooth 23	17 (23.28)	
Tooth 13 and 23	36 (49.32)	
Eruption position, frequency (%)		
Tooth 13		
Lingual	26(35.61)	$P < 0.05$
Buccal	8(10.95)	
Apical	3(4.10)	
Distal	1(1.36)	
Tooth 23		
Lingual	21 (28.76)	
Buccal	12 (16.43)	
Apical	1 (1.36)	
Distal	1 (1.36)	

The data are arranged by frequency and percentage. The Chi-square statistical test was used ($P < 0.05$). SD: Standard deviation

canines with eruption disturbances did not increase the risk of resorption of the incisors (0.932; 0.617-1.400).

In the case of canines with eruption disorders, the central incisors of the same hemimaxilla demonstrated an occurrence of resorption in 17.6% of the sample, $P < 0.05$. Under the same conditions, however, the lateral incisor exhibited a 47.3% resorption rate with the presence of a canine eruption disorder in the same hemimaxilla ($P > 0.05$).

Discussion

The study results show that resorption, in varying degrees of severity, in the adjacent teeth to canines with eruption disorder is relevant. It should be highlighted that retained upper canine in lingual side increased the risk of the presence and the severity of resorption in lateral incisor roots. Moreover, the two plans sections used in this study were able to diagnose the presence or absence of resorption in incisors.

Table 2: Different statistical tests for assessing resorption of maxillary incisors in the presence of canines with eruption disturbance

Correlations between the readings of the axial and transverse planes				
Teeth	12	11	21	22
Pearson's correlation	0.874*	0.765*	0.799*	0.751*
Risk of resorption in the central and lateral incisors in the presence of canines with eruption disturbance in the maxilla				
	OR value	Confidence intervals		
Resorption of incisors	3.04	1.97	4.67*	
Buccal eruption	0.398	0.187	0.848	
Lingual eruption	1.552	1.022	2.356*	
Presence of one or two canines	0.932	0.617	1.400	
Presence of resorption in the central and lateral incisors per hemi maxilla. (Chi-Square test)				
11 and 21 with resorption	13 (17.6%)*			
11 and 21 without resorption	60 (82.4%)			
12 and 22 with resorption	35 (47.3%)			
12 and 22 without resorption	39 (52.7%)			

11: Upper right central incisor, 12: Upper right lateral incisor, 21: Upper left central incisor, 12: Upper left lateral incisor, *Denotes statistical difference ($P < 0.05$). Statistical analyses were performed using Pearson's correlation, odds ratio or Chi-Square test (all of them with a significance level of 5%), OR: Odds ratio

Thus, our findings reinforce the need to request CT scans to assess the integrity of the roots of teeth surrounding canines with eruption disturbances.

In a sample of 255 patients who had canines with eruption disorders, severe root resorption of the permanent teeth adjacent to the canines occurred in 17.7% of the cases.^[16] In another study of the same type, root resorption of the maxillary lateral incisors was present in 66.7% of the cases and 11.1% of the cases had root resorption of the central incisors.^[17] Our results are close to those described in the literature. Root resorption was most frequently found in the lateral incisors (47.3%), followed by the central incisors (17.6%).

In many cases, root resorption of the lateral incisors may be diagnosed radiographically at an early stage, but the resorption process often remains asymptomatic, even in cases of dental pulp involvement.^[18,19] Therefore, early diagnosis and alerting the dental radiologist to the possible occurrence of resorption become even more important.^[20,21] Some findings have highlighted that axial sections are the most appropriate CT images for the diagnosis of root resorption caused by impacted teeth; parasagittal sections, known as transversal, do not always show the full cervicoapical extent of a tooth root, mainly due to the angles of the roots in the mesiodistal direction. This can lead to false positive tests of root resorption.^[22] The results of the present study indicate that interpretations of the images of both of the sections selected resulted in similar readings when the degrees of severity of resorption were compared.

Regarding the resorption scores, we used the 0, 1, 2, 3, and 4 index validated by Estrela *et al.*, 2009.^[15] These authors measured

root resorption in 40 patients using CT scans and compared the results with the resorption observed on periapical radiographs. Although validation could be performed on periapical radiographs, it appears that a CT scan is the gold standard for the diagnosis of resorption in such situations.

Although maxillary canine tooth germs develop labially compared to the adjacent teeth, the ratio of palatal impaction is 85% compared with buccally positioned canines.^[23] The results of our study corroborate these findings and also suggest a strong risk of resorption of the teeth adjacent to canines with lingual impaction. Another important observation in this study was that the presence of two impacted canine teeth did not increase resorption in the incisors. The large space taken by two teeth with eruption disturbances is expected to increase the degree of resorption, but the results indicated that these two variables were not correlated in a contingency table or in the correlation tests.

The presence or absence of root resorption determines the optimal treatment strategy.^[24] Root resorption may be difficult to diagnose, and its progress can be asymptomatic and rapid. In some situations, severe resorption of the incisors in children <10 years old can be found.^[25] In this study, the mean age of the patient sample was low. Nevertheless, soon after the first decade of life, a large number of resorptions in the adjacent teeth were observed. Unlike other studies^[26] reporting that canine impaction is twice as common in females, the gender variable did not influence the occurrence of resorption in our study.

Conclusion

From the sample analyzed in this study, it is possible to conclude that when canines with eruption disorders exist, a tomographic analysis should be asked by the risk of reabsorption in surrounding tooth roots.

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