Precise Assessment of Incisor Root Resorption Caused by Maxillary Impacted Canines

Peteris Sosars, Gundega Jakobsone

Rīga Stradiņš University, Institute of Stomatology,
Department of Orthodontics, Latvia
peteris.sosars@inbox.lv

Abstract

The objective of this study was with cone beam computed tomography (CBCT) to assess resorption of the lateral and the central incisors caused by upper maxillary impacted canines.

One hundred twenty six impacted maxillary canines in 104 patients were analysed using CBCT images in Osirix software. The severity of root resorption was assessed according to studies by Ericson and Kurol. Enlarged dental follicle and its association with the root resorption of the lateral and central incisors were evaluated.

In contact less than 0.5 mm with at least one adjacent tooth were 87.3% of all impacted canines. In contact with the lateral incisor were 83.3% of the impacted canines and with the central incisor – 24.6% impacted canines. Our reported rate of root resorption was 76.1% in the lateral incisors and 21.4% in the central incisors.

The results of our study show that root resorption of the lateral and the central incisor was common in patients, mostly affecting the lateral incisor to a mild degree. A wide dental follicle of impacted canine was not associated with a higher incidence of external root resorption of the lateral or the central incisors.

Keywords: impacted, canine, CBCT, resorption, incisors.

Introduction

Permanent maxillary canines are the second most frequently impacted teeth, and the prevalence of their impaction is 1–3% in general population. (Ericson, 1986; Aydin, 2004) Maxillary canines are important aesthetically and functionally, and impactions of these teeth are difficult and time consuming to treat. Moreover, the impaction of canines can lead to resorptions of neighbouring teeth, particularly the lateral incisors (Liu, 2008; Ericson, 2000).

The management of impacted canines requires accurate diagnosis and precise location of the teeth and their relation to the surrounding structures (Walker, 2005).

Diagnosis and treatment planning sometimes can be challenging with conventional radiographic methods, because of the two-dimensional (2D) representation of the three-dimensional structures (3D) that often are positioned at various angles (Walker, 2005; Tamimi, 2009).

Cone beam CT has become an increasingly popular diagnostic modality for impacted canines (Tamimi, 2009). And compared to conventional radiography, treatment plans are being altered after gaining additional information from 3D images (Bjerklin, 2006). Assessing root resorption and changes

in the root surface typically requires 3D information and reported rate of resorption to adjacent teeth have been markedly increased compared to conventional radiography (Liu, 2008; Yan, 2012; da Silva Santos, 2014; Mason, 2001; Alqerban, 2009).

Aim

The objective of this study was to assess resorption of the lateral and central incisors caused by upper maxillary impacted canines.

Material and Methods

The CBCT image database collected at the Institute of Stomatology, Rīga Stradiņš University, from March 2008 to December 2012 was reviewed on the subject of impacted maxillary canines. The study was approved by the Ethics Committee of Rīga Stradiņš University, Rīga, Latvia.

All CBCT scans were taken with an ICAT Scanner (Imaging Sciences International, Hatfield, Pa) as part of the initial orthodontic diagnostic records for the patients. The CBCT images were taken according to a standard protocol with the subject seated in a chair with the following parameters: 120 kV, 5 mA, 0.4 mm voxel, and scan time of 20 seconds. Orthodontic indication for CBCT other than palatinally impacted canines were excluded from this study (e.g. orthognathic or cleft patients).

The patients' records were revised and only those patients who came for the second consultation were included in the study. 136 patients were retrieved from the database and after exclusion criteria were applied, the study sample consisted of 104 patients (72 female, 32 male). The age range was 11 to 44 years with the mean age of 16.61 ± 5.96 years. A total of 126 impacted maxillary canines were studied, including 22 bilateral impactions, 42 left unilateral impactions, and 40 right unilateral impactions.

The cone beam generated DICOM files were imported into freeware Osirix software (v.5.7 32-bit) allowing assessment of the position of the canine and adjacent teeth in the multiplanar reconstruction (MPR) planes. MPR planes allow us precise assessment of the position of impacted maxillary canine and adjacent teeth in the three-dimensional space.

Proximity of the impacted canine to the adjacent teeth and resorption were assessed, and contact between the teeth was defined if the distance was less than 0.5 mm (Walker, 2005).

Resorption was graded in 5 slightly modified categories, based on the grading system suggested by Ericson and Kurol and also tried on CBCT by Liu et al. (Ericson, 2000; Liu, 2008):

- no contact (0);
- in contact, but intact root surfaces (no resorption) (1);
- mild resorption: resorption midway to the pulp or more, the pulp lining being unbroken (2);
- moderate resorption: the pulp is exposed by the resorption, the involved length of the root is less than one third of the entire root (3);
- severe resorption: the pulp is exposed by the resorption, and the involved length is more than one third of the root (4).

Each size of follicle was measured at the widest area and recorded. If dimension was greater than 2 mm, it was considered as enlarged follicle (Walker, 2005). Every measurement was screenshot for reference purposes.

Results

Most patients in this study with impacted canines were female (69%), and there was no significant difference between left and right impactions (42 left, 40 right, 22 bilateral impactions).

Statistical analysis was conducted using SPSS software (version 22.0). An intraclass correlation (ICCs) was used to assess the consistency of reproducibility of linear measurements. The coefficient of intraclass correlation (ICCs R value) was very high for reproducibility of linear measurements (ICC ranged from 0.992 to 0.999).

Of the 126 impacted canines in contact less than 0.5 mm were 110 canines (87.3%). In contact with the lateral incisor were 105 impacted canines (83.3%), and with the central incisor 31 – impacted canines (24.6%).

In total, 96 canines resorbed lateral incisor (76.1%) and 27 canines resorbed central incisor (21.4%) (Categories 2–4).

More detailed relationships between resorption categories and impacted canines have been represented in table 1.

107 impacted canines from 126 totally (84.9%) caused mild or worse resorption with at least one adjacent tooth (category 2–4).

Table 1. Contact and resorption relationship between impacted canine and incisors

Categories	Lateral incisor		Central incisor	
	N	%	N	%
0 (no contact)	24	19.05	94	74.60
1 (contact, no resorption)	4	3.17	4	3.17
2 (mild resorption)	78	61.90	25	19.85
3 (moderate resorption)	10	7.94	2	1.59
4 (severe resorption)	10	7.94	1	0.79

Discussion

To our knowledge, there are articles regarding three-dimensional impacted canine position and root resorption of adjacent teeth each with very different incidence of resorptions (Liu, 2008; Almuhtaseb, 2014; da Silva Santos, 2014; Walker, 2005; Oberoi, 2012). Adding a third-dimension to the radiographic information notably alters the prevalence of root resorption as it increases at least twice compared to studies with conventional x-rays (OPT, periapicals, occlusal x-rays or lateral cephalograms) (Ericson, 1987; Mason, 2001).

Osirix software allows precise and reproducible assessment of the impacted canine position and adjacent teeth root resorption by using linear measurements less than 0.1 mm which coincides with previous reports (Kim, 2012). That is more precise than in article mentioned by Walker et al. where they measured distances to the nearest 0.5 mm (Walker, 2005).

Most patients in this study with impacted canines were female (69%), and there was no significant difference between left and right impactions (42 left, 40 right, 22 bilateral impactions), which coincides with previous studies (Liu, 2008; Bjerklin, 2006; Rimes, 1997).

In our study most impacted canines (87.3%) were in contact (less than 0.5 mm) with at least one adjacent tooth. Mild, moderate or severe resorption (category 2–4) were observed in 76.1% of all lateral incisors and 21.4% of all central incisors. Although mostly mild resorption occurred in lateral and central incisors, the incidence is higher compared to other recent studies involving CBCT (Liu, 2008; Walker, 2005; da Silva Santos, 2014; Almuhtaseb, 2014; Oberoi, 2012; Oana 2013). Rate of resorption so high could be explained that we looked into palatally impacted canines where incidence of resorption is rated higher than buccally placed canines.

The mechanism of root resorption following impaction and the factors involved in the process are not yet clear. Ericson and Kurol mentioned the role of physical pressure due to the movement of the maxillary canine (Ericson, 2000). In our study, from 105 impacted canines in contact with lateral incisors, resorption occurred in 96 lateral incisors and from 31 impacted canines in contact with central incisors, 27 were resorbed. These findings support that resorption significantly correlated with contact between the adjacent tooth and impacted canine and coincides with previous studies (Ericson, 2000; Walker, 2005; Liu, 2008). During measurements, we noticed root dilacerations in impacted canines. Recently there was a CBCT study,

where reported root dilacerations were almost 60% (da Silva Santos, 2014). But it is still unclear why in some cases resorption occurs, and what the other factors are that influence resorption generation/creation after the contact of impacted canine with adjacent teeth has been established.

We did not find any association between follicle size and resorption and it coincides with previous studies (Ericson, 2002; Liu, 2008; Alqerban, 2009). In 8 cases (6.34%), follicles of the impacted canines were in contact with the adjacent teeth and four of them had a moderate or severe resorption.

The main weakness of the study is the relatively small sample size in specific resorption groups which could affect prevalence of specific resorption categories.

In conclusion, resorption of the incisors is very difficult to diagnose. Early diagnosis of impacted canine and root resorption might have further reduced complications during treatment and the presence or absence of root resorption will determine the treatment plan. Every dentist should palpate the maxillary permanent canines by the age of 9–10 and take necessary x-rays, if needed. The severity of lateral or central incisor root resorption cannot be accurately judged from two dimensional radiographs alone, as they fail to detect the exact localisation of the canines or any potential early or mild root resorption (Bjerklin, 2006; Mason, 2001; Ericson, 1987; Alqerban, 2009). Applying 'ALARA' (as low as reasonably available) principle to radiation dosage, field of view and assessing cost/risk/benefit ratio, a CBCT could be a reliable tool for diagnosing the position of the impacted canine and distance from adjacent structures to aid in further treatment planning.

Conclusions

The results of our study show that root resorption of the lateral and the central incisor was common in patients, mostly affecting the lateral incisor to a mild degree. In contact less than 0.5 mm with at least one adjacent tooth were 87.3% of all impacted canines. In contact with the lateral incisor were 83.3% of the impacted canines, and with the central incisor 24.6% impacted canines. Our reported rate of root resorption were 76.1% in the lateral incisors and 21.4% in the central incisors. A wide dental follicle of impacted canine was not associated with a higher incidence of external root resorption of the lateral or the central incisors.

References

1. Almuhtaseb E., Mao J., Mahony D., Bader R., Zhang Z. X. Three-dimensional localization of impacted canines and root resorption assessment using cone beam comptued tomography. *J Huazhong Univ Sci Technolog Med Sci*, 2014; Jun; 34 (3): 425–430.
2. 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; Sep; 13 (3): 247–255.
3. Aydin U., Yilmaz H. H., Yildrim D. Incidence of canine impaction and transmigration in a patient population. *Dentomaxillofac Radiol*, 2004; May; 33 (3): 164–169.
4. 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; Jan; 76 (1): 43–51.
5. da Silva Santos L. M., Bastos L. C., Oliveira-Santos C., da Silva S. J., Neves F. S., Campos P. S. Cone-beam computed tomography findings of impacted upper canines. *Imaging Sci Dent*, 2014; Dec; 44 (4): 287–292.
6. Ericson S., Bjerklin K. Does the canine dental follicle cause resorption of permanent incisor roots? A computed tomographic study of erupting maxillary canines. *Angle Orthod*, 2002; 72: 95–104.
7. Ericson S., Kurol J. Longitudinal study and analysis of clinical supervision of maxillary canine eruption. *Comm Dent Oral Epidemiol*, 1986; Jun; 14 (3): 172–176.
8. Ericson S., Kurol J. Radiographic examination of ectopically erupting maxillary canines. *Am J Orthod Dentofac Orthop*, 1987; Jun; 91 (6): 483–492.
9. Ericson S., Kurol J. Resorption of incisors after ectopic eruption of maxillary canines: a CT study. *Angle Orthod*, 2000; Dec; 70 (6): 415–423.

10. Kim G., Jung H. J., Lee J. S., Koo S., Chang S. H. Accuracy and reliability of length measurements on three-dimensional computed tomography using open-source Osirix software. *J Digit Imaging*, 2012; Aug; 25 (4): 486–491.
11. Liu D. G., Zhang W. L., Zhang Z. Y., Wu Y. T., Ma X. C. Localization of impacted maxillary canines and observation of adjacent incisor resorption with cone-beam computed tomography. *Oral Surg Oral Med Oral Path Oral Radio Endod*, 2008; Jan; 105 (1): 91–98.
12. Mason C., Papadakou P., Roberts G. J. The radiographic localization of impacted maxillary canines: a comparison of methods. *Eur J Orthod*, 2001; Feb; 23 (1): 25–34.
13. Oana L., Zetu I., Petcu A., Dragan E., Haba D. The essential role of cone beam computed tomography to diagnose the localization of impacted canine and to detect the austerity of the adjacent root resorption in the Romanian population. *Rev Med Chir Nat Iasi*, 2013; 117 (1): 212–216.
14. Oberoi S., Knueppel S. Three-dimensional assessment of impacted canines and root resorption using cone beam computed tomography. *Oral Surg Oral Med Oral Pathol Oral Radiol*, 2012; Feb; 113 (2): 260–267.
15. Rimes R. J., Mitchell C. N., Willmot D. R. Maxillary incisor root resorption in relation to the ectopic canine: a review of 26 patients. *Eur J Orthod*, 1997; Feb; 19 (1): 79–84.
16. Tamimi D., ElSaid K. Cone beam computed tomography in the assessment of dental impactions. *Semin in Orthod*, 2009; Mar; 15 (1): 57–62.
17. Walker L., Enciso R., Mah J. Three-dimensional localization of maxillary canines with cone-beam computed tomography. *Am J Orthod Dentofac Orthop*, 2005; Oct; 128 (4): 418–423.
18. Yan B., Sun Z., Fields H., Wang L. Maxillary canine impaction increases root resorption risk of adjacent teeth: a problem of physical proximity. *Am J Orthod Dentofac Orthop*, 2012; Dec; 142 (6): 750–757.