Lateral incisor root resorption and active orthodontic treatment in the early mixed dentition

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Abstract. Aim *To evaluate the presence of root resorption in the lateral incisor after active orthodontic treatment in the early mixed dentition.* ***Methods*** *Twenty-six children treated at the Children's Clinic of the Schulich School of Medicine & Dentistry at the University of Western Ontario were examined radiographically for lateral incisors root resorption before and after early active treatment to align upper incisors (2x4 appliance). In addition, canine inclinations to the midline and to the long axis of the lateral incisor as well as the most medial position of the canine crown were measured as potential risk factors for root resorption.* ***Results*** *8% (4) of the lateral incisors exhibited root resorption and the mean crown-to-root ratio of these teeth was significantly higher than that for lateral incisors not exhibiting root resorption. Similarly, mean canine inclinations to the midline and to the long axis of the lateral incisor were also significantly higher for the root resorption group. No association could be found between the most medial position of the canine crown and root resorption in the lateral incisor.* ***Conclusion*** *This study showed that active orthodontic treatment in the early mixed dentition does not increase the risk for root resorption in the lateral incisors as long as the clinician takes into consideration canine inclinations and their potential effect on root resorption. Limitations inherent to radiographic assessment are acknowledged.*

Keywords: *Mixed dentition, Orthodontics, Early treatment, Root resorption, Lateral incisors, Canine impaction.*

Introduction

Root resorption is a common consequence of orthodontics and active tooth movement [Brezniak, 1993a; Brezniak, 1993b; Copeland, 1986; Parker, 1997]. It is important to note, however, that root resorption is also found in patients who have not received orthodontic treatment [Goultshin, 1988]. Vlaskalic et al. [1998] in their review have found various potential risk factors for root resorption, such as genetic predisposition, age, gender, habits, root form, previous trauma, and canine impaction. The maxillary lateral incisors are the most commonly affected by root resorption [Brezniak, 1993a; Brezniak, 1993b]. In non-orthodontic patients, the presence of root resorption of upper lateral incisors has been reported due to the influence of ectopic erupting canines [Ericson, 1988; Ericson, 2000; Ericson, Bjerklin, & Falahat, 2002b; Ericson & Kurol, 1987; Ericson & Kurol, 2000b].

Active orthodontic treatment in the early mixed dentition is commonly employed by clinicians, followed by a second phase of treatment once the permanent dentition has erupted. According to the American Board of Orthodontists, early active treatment allows for earlier correction of anterior crowding, resulting in increased patient self-esteem and parent satisfaction, improved and more stable results, and less extensive treatment needed later [Dugoni, 2004]. However, one of the concerns regarding early active treatment is the increase in risk of initiation of root resorption in the incisors. In addition, one-phase treatment in the permanent dentition is easier to plan than two-phase treatment.

The children's SPEC clinic at the Schulich School of Medicine and Dentistry, University of Western Ontario, regularly performs active treatment in the early mixed dentition. The primary objective of this retrospective study was to investigate the occurrence of root

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resorption in the lateral incisors as a result of active treatment in the early mixed dentition. In addition, canine inclinations to the midline and to the long axis of the lateral incisor were investigated as potential risk factors for root resorption in the lateral incisor.

Methods

Twenty-six patients were found in the Children's Clinic at the Schulich School of Medicine and Dentistry, University of Western Ontario, that underwent active orthodontic treatment consisting of a 2x4 appliance with Ni-Ti wire to correct anterior crowding in the early mixed dentition. For each patient, pre-treatment panoramic radiographs and post-treatment periapical radiographs taken using the parallel technique, with a long spacer cone, were analysed. Due to a couple of missing radiographs, 50 lateral incisors and 50 canines were available for measurements. To avoid ethical issues irradiating non-treatment patients, no control group was set up, but all the findings were compared to those from Ericson and Kurol [Ericson, 1988] on a non-treatment sample.

For each patient, the presence of root resorption in the lateral incisors was qualitatively assessed in post-treatment periapical radiographs. The apex was observed for blunting and for abnormal shape. In addition, crown length and root length were measured for each lateral incisor using Image J© (Fig. 1). The cementum-enamel junction was marked in the centre of the tooth mesio-distally from which the crown length and root length was measured. Crown-to-root ratio was then calculated.

The methods described by Ericson and Kurol were used for canine measurements on pre-treatment panoramic radiographs [Ericson, 1987; Ericson, 1988]. Canine inclinations to the midline and to the long axis of the lateral incisor were measured (Fig. 2). Using Adobe Photoshop©, the midline was drawn using the nasal spine as a reference. A second line was drawn through the lateral incisor from its apex to mid-crown mesio-distally. A third line was drawn through the canine apex and canine cusp. Using Image J© the angle between the canine and the midline (A) and the angle between the canine and the long axis of the lateral incisor (B) were measured. Finally, the most medial position of the canine crown was assessed and the position was categorised into sectors 1 to 5 (Fig. 3). All measurements were repeated a week later by the same operator. Student's *t*-test for dependent samples was used to analyse the differences. Mean, standard deviation and p-value (through Student's *t*-test) were obtained.

Results

Non-significant differences were found between the first measurements and the repetitions taken one week later.

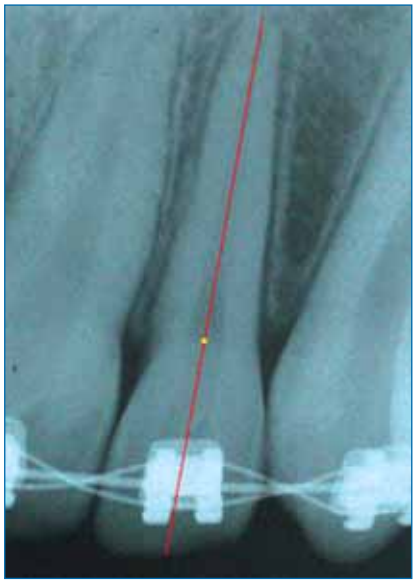

FIG. 1 - *Lateral incisor crown length and root length in the periapical radiograph.*

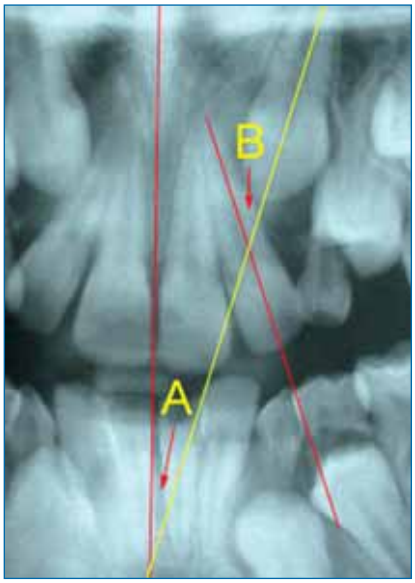

FIG. 2 - *Inclination of the maxillary canine to the midline (A) and long axis of the lateral incisor (B) in the panoramic radiograph.*

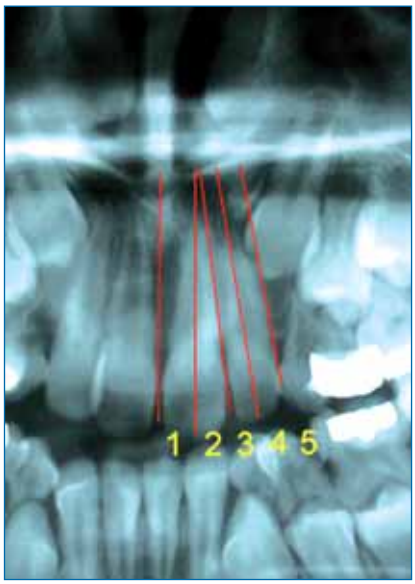

FIG. 3 - *Most medial position of the canine crown in sectors 1 through 5 in the panoramic radiograph.*

Root resorption was seen in 4 out of 50 (8%) lateral incisors (Table 1). Statistical analysis showed that the mean crown-to-root ratio of these lateral incisors was significantly higher than that for lateral incisors not exhibiting root resorption (p = 0.021) (Table 2, Fig. 4). Similarly, mean canine inclinations to the midline and to the long axis of the lateral incisor were significantly higher for those lateral incisors exhibiting root resorption than those not exhibiting root resorption (p = 0.0002 and p = 0.0040, respectively) (Table 3, Fig. 5).

No association was found between the most medial position of the canine crown and root resorption in the lateral incisor. The core of the sample in both the resorption group and the non-resorption group fell in sector 4.

Discussion

This study found a few cases demonstrating root resorption in the lateral incisors after active orthodontic treatment in the early mixed dentition. In addition, the mean crown-to-root ratio for these lateral incisors was significantly higher than for those not exhibiting root resorption. However, as is seen in Figure 4, one particular case in the resorption group is skewing the mean. We believe that this lateral incisor would have exhibited root resorption even in the absence of orthodontic treatment, based on the position of the canine over the lateral incisor, which falls in sector 2. Thus, this particular case is not a good representative of the root resorption subjects for this sample.

The results for canine inclinations to the midline and to the long axis of the lateral incisor are similar to

Resorption	Mean	S.D.	Significance
Y (n=4)	0.952	0.341	
N (n=46)	0.777	0.116	p = 0.021

TABLE 1 - *Lateral incisor crown-to-root ratio – Mean and standard deviation.*

Resorption	A		B	
	Mean	S.D.	Mean	S.D.
Y (n=4)	20.91	4.83	31.98	2.20
N (n=46)	8.94	5.70	18.45	8.74
Level of significance	p=0.0002		p=0.0040	

TABLE 2 - *Canine inclination (°) in the panoramic radiograph measured to the midline (A) and long axis of the lateral incisor (B) – Mean and standard deviation.*

Resorption	Canine position in sector				
	1	2	3	4	5
Y (n=4)	0	1	0	3	0
N (n=46)	0	0	1	39	6

TABLE 3 - *Distribution of the most medial position of the canine crown (sectors 1-5) as projected in the panoramic radiograph.*

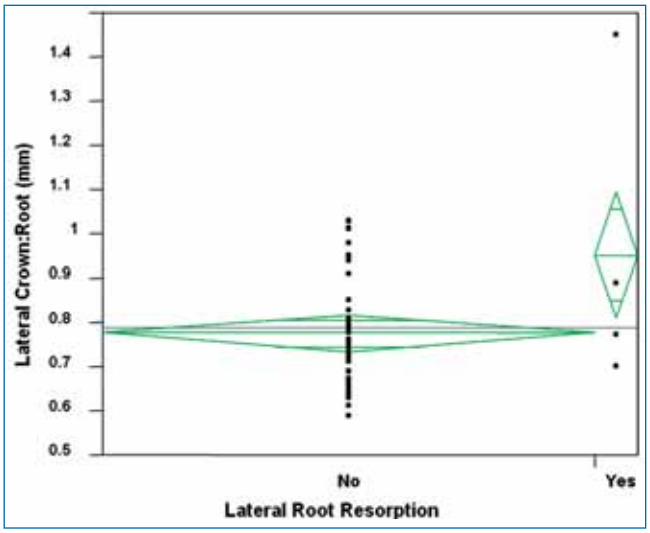

FIG. 4 - *Lateral incisor crown-to-root ratio and presence of root resorption.*

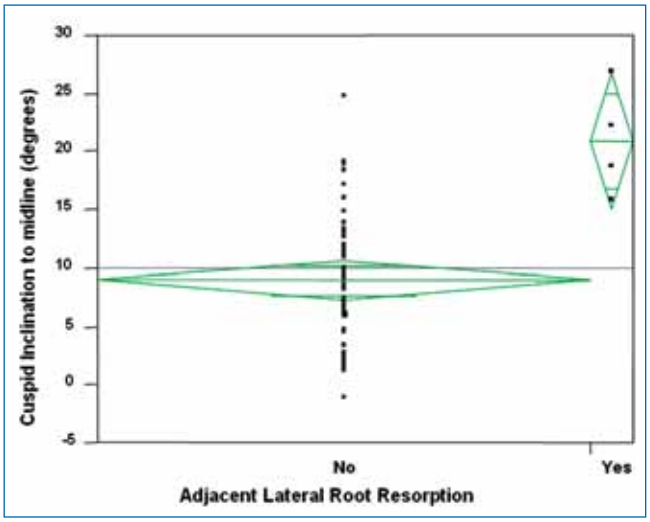

FIG. 5 - *Canine inclination (°) to the midline and presence of root resorption.*

results found by Ericson and Kurol [Ericson, 1988]. Lateral incisors exhibiting root resorption displayed on average a higher canine inclination to the midline (more than 25°) and to the long axis of the lateral incisor. It should be noted, however, that the data obtained by Ericson and Kurol has high standard deviations, so that there is considerable overlap between their resorption and non-resorption groups [Ericson, 1988]. Similarly, this study includes lateral incisors with canine inclinations in the resorption group range, yet the incisors are not displaying any resorption. Canine inclinations are thus potential risk factors for root resorption, but are not good predictors for resorption.

The core of this study's sample, both resorption and non-resorption groups, falls in sector 4 for the most medial position of the canine crown [Ericson, 1988]. We thus find it not suitable to conclude an association between the most medial position of the canine crown and lateral incisor root resorption, in contrast to Ericson and Kurol's findings.

Pre-treatment periapical radiographs were not available to compare with post-treatment periapicals in this study, as these are not standardised radiographs taken at the Children's Clinic at the Schulich School of Medicine and Dentistry. As a result, root resorption could not be measured quantitatively. Instead, the presence of root resorption was assessed qualitatively, by observing apex blunting and abnormal shape of the apex.

Similar qualitative assessments have been done in previous studies in which pre-treatment periapical radiographs were available, since changes in root length cannot be measured directly on radiographs [Beck, 1994; Malmgren, 1982; Remington, 1989].

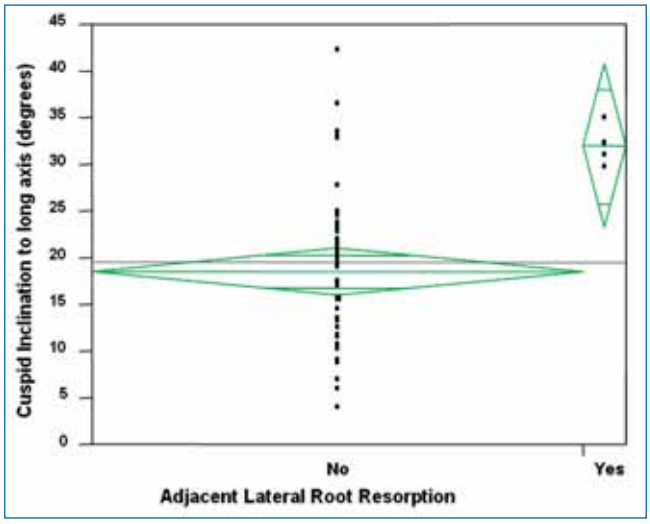

FIG. 6 - *Canine inclination (°) to the long axis of the lateral incisor and presence of root resorption.*

Although periapical radiographs have limitations in detecting root resorption, they are most available to a clinician in everyday practice. In addition, they provide the most appropriate information with the least irradiation to the patient when used for maxillary and mandibular incisors [Brezniak, 1993b].

Only 4 cases showed root resorption in this study, one of which had an impacted canine. These incisors had on average higher canine inclinations to the midline and to the long axis of the lateral incisor and thus had potential higher risks for root resorption. It is important to note that teeth exhibiting resorption after the first phase of treatment have a higher risk of developing more extensive areas of resorption in the second phase of treatment [Malmgren, 1982; Zachrisson, 1976].

Studies comparing diagnostic sensitivity have calculated it for conventional radiography (0.68) and CT scan (1.0), showing that the latter increases the detection of root resorption, making it the diagnostic tool of choice [Ericson, Bjerklin and Falahat, 2002a; Ericson and Kurol, 2000a], but on the other hand, although its availability is increasing, there is still a concern due to the substantially higher radiation exposure from CT scan, compared to conventional radiography [Lecomber et al., 2001; Ludlow et al., 2006; Ludlow, Davies-Ludlow and Brooks, 2003].

Conclusion

Within its limitations this study found that performing active orthodontic treatment in the early mixed dentition does not lead to root resorption if the case is properly chosen. The clinician however needs to take into consideration canine inclinations to the midline and to the long axis of the lateral incisor before planning treatment. Future investigations are however needed with larger sample sizes and if possible more precise technology, such as CT scans, to support this view.

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