ORIGINAL ARTICLE

Evaluation of Apical Root Resorption of Maxillary Incisors following Intrusion - A Clinical Study

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ABSTRACT

Objectives: The aim of this study was to investigate whether root resorption of the upper incisors occurs during intrusion of maxillary incisors is significant or not.

Materials and Methods: The sample of this study consisted of 10 patients with deep overbite with increased upper incisor display. The ratio of root length before and after the intrusion was compared in 10 patients. In 40 incisors with an intrusion period of 6 months and 25 g of constant force, intrusion was performed using a conventional method. The pre-intrusion (T_1) and post-intrusion (T_2) radiographs were measured using the measurement option in the RVG software.

Results: There were significant differences and were observed in root length changes between pre-intrusion and post-intrusion of central incisor, and lateral incisor with a t = 7.04 and 7.14, respectively. The relation between root lengths before and after intrusion indicates mean root resorption of 15.15%.

Conclusion: The result of this study shows that 25 g of intrusion forces is not within physiologic limit as it leads to a significant amount of apical root resorption.

Keywords: Intrusion, Maxillary incisors, Root resorption.

How to cite this article: Agrawal S, Kishnani R. Evaluation of Apical Root Resorption of Maxillary Incisors following Intrusion - A Clinical Study. Int J Oral Care Res 2018;6(2):S57-60.

Source of support: Nil

Conflicts of interest: None

INTRODUCTION

Root resorption is an essential phenomenon that plays a crucial role in the physiological and dynamic processes of tooth eruption. Resorption of deciduous roots during permanent tooth eruption is a necessary process that eventually results in the exfoliation of deciduous teeth in anticipation of the arrival of its permanent successor. However, as the saying goes "…to every coin, there are two sides," root resorption may not be a desirable process and is considered pathologic when occurring in permanent.

Apical root resorption is a serious iatrogenic problem associated with orthodontic treatment. It is believed to result from a complex combination of individual biology and the effects of mechanical forces. Bates[1] in 1856 was the first to discuss root resorption of permanent teeth. Ottolengui[2] in 1914, related root resorption directly to orthodontic treatment. Loss of apical root material is unpredictable and, when extending into dentin, irreversible.[3] It has also been described as the scar or the price to be paid for the treatment.

Although most root resorption studies attempt to investigate the etiologic factors and predictability of this phenomenon, its origin remains obscure. Individual susceptibility, hereditary predisposition, systemic, local, and anatomic factors associated with orthodontic mechanotherapy are commonly cited components.

Much controversy exists in the literature as to the exact definition of root resorption. In this study, external apical root resorption (EARR) was defined as any reduction in length of a maxillary incisor measured from the tip of the incisal edge to the apex of the root. Loss of clinical root length caused by periodontal disease was not considered nor was lateral external root resorption. Only the maxillary incisors were measured as they are considered by many authors to be among the most frequently affected teeth.[4-11]

Intrusion is one of the specific types of tooth movement that has been suggested as a possible cause of root resorption.[12-14] The tooth apex and associated periodontium can experience relatively high compression stresses when an intrusive force is applied to the crown. Due to the potential for these high-stress levels, intrusion is a technique that logically could increase the risk of apical root resorption.

Several problems with previous studies on root resorption have been identified. These include a subjective description of root resorption, i.e., mild, moderate, or severe, and a subjective nature of assessment with various scoring systems.

In this study quantitative measurements of the crown and root length of the incisors pre- and post-alignment were taken, and a correction factor was used.

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MATERIALS AND METHODS

The sample of this study consisted of 10 patients with deep overbite with increased upper incisor display. An informed consent was taken. The rights of the human subjects were protected, and approval was obtained from an identified institutional review board. These patients undergoing orthodontic treatment with pre-adjusted edgewise appliance using either Roth or MBT prescription. The inclusion criteria were:

1. Patients seeking orthodontic treatment having deep bite requires maxillary incisor intrusion as a part of treatment
2. Patients with complete root formation at the beginning of the treatment,
3. Patients have not undergone orthodontic treatment previously
4. Patients with maxillary incisors without having any abnormal tooth morphology (fusion, germination, emanel pearl, enamel/dentinal dysplasis, etc.)

The exclusion criteria were:

1. Patients with a history of generalized root resorption
2. Patients with endodontically treated maxillary incisors patients with a history of trauma to anterior teeth
3. Patients with parafunctional habits.
4. Patients with significant medical history.

Radiographs were taken at two stages - T_1- radiograph taken before activation of intrusion arch and T_2- radiograph taken after 6 months of intrusive force.

Pre-intrusion (T_1) and post-intrusion (T_2) digitalized intraoral periapical radiograph of the patients maxillary permanent central incisors were taken by paralleling cone by intraoral radiograph machine and digitalized by RVG Dent-America machine with DIGIREX Digital Dental Radiography System.

Intrusion was done by a conventional method using - Burstone's three-piece intrusion arch and Utility arch. Constant 25 g of force is applied to each incisor for 6 months as recommended by Burstone.

The crown and root length of the maxillary central and lateral incisors was measured in the pre-intrusion (T_1) and post-intrusion (T_2) radiographs using the measurement option in the RVG software.

In this study, measurements were made from the midpoint of incisal edge to the midpoint between the mesial cementoenamel junction (CEJ) and distal CEJ and from the apex to the midpoint between the mesial CEJ and distal CEJ.

During orthodontic treatment, the crown length of the tooth remains constant unless and until any fracture or attrition of the incisal surface occurs. Hence, crown length is constant pre- and post-alignment. This constant variable is used to correct any magnification difference between the pre-alignment and post-alignment radiographs. In this study, the formulae used for mathematical correction of magnification and to detect the amount of apical root resorption was: Actual root length (R_A) = C2×R1/C1; amount of root resorption (difference) = R_A-R2.

An equation was given by Linge and Linge[15] in which root length measurements in pre-treatment and post-retention radiographs were corrected for

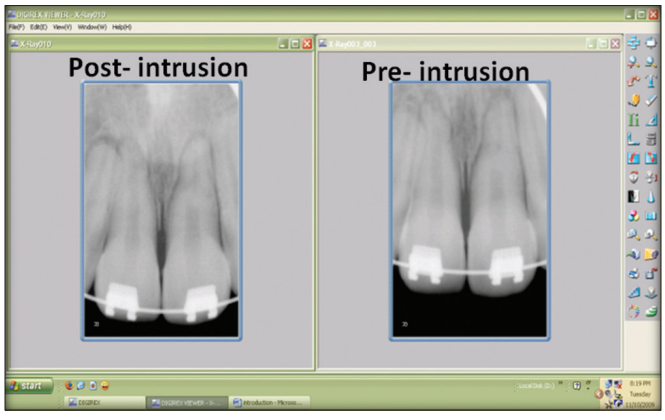

Figure 1: Digital imaging software (Digirex) showing pre-intrusion and post-intrusion radiographic images of maxillary central incisors

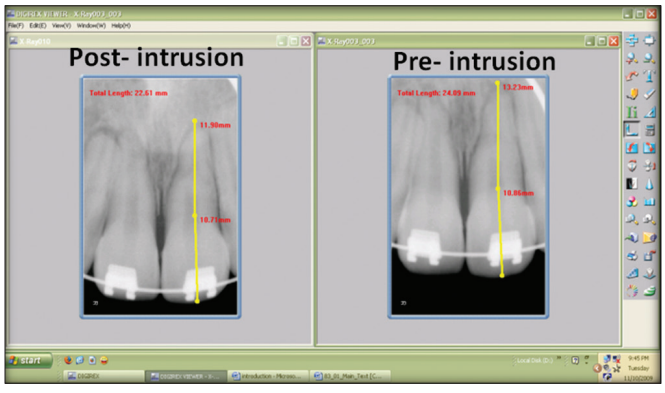

Figure 2: Digital imaging software (Digirex) showing measurement of incisors

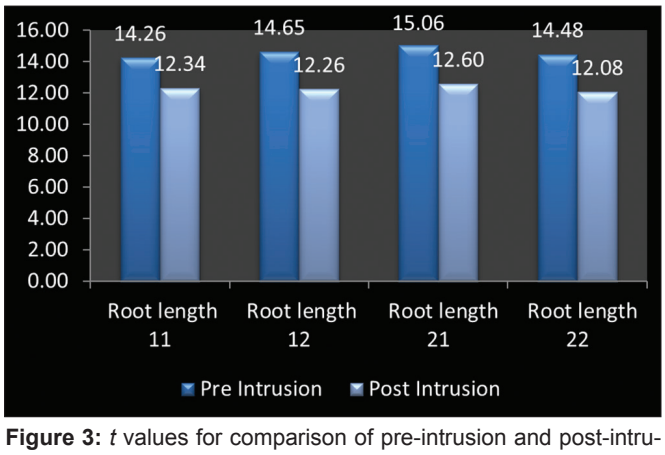

Figure 3: *t* values for comparison of pre-intrusion and post-intrusion root length (mm)

enlargement differences, revealing the values of apical root resorption in individual maxillary incisor teeth.

The teeth were measured in two parts: Pre-intrusion tooth length (T1): Incisal edge to CEJ (C1) and CEJ to the apex (R1), post-intrusion tooth length (T2): Incisal edge to CEJ (C2) and CEJ to the apex (R2) [Figures 1 and 2].

First, the actual root length (root length post-intrusion if no EARR would have occurred during intrusion) was calculated using the formula:

Actual root length (R_A) = C2×R1/C1

C1 - incisal edge to CEJ (T_1), C2 - incisal edge to CEJ (T_2), R1 - CEJ to the apex (T_1), and R_A - root length at T_2 if no root resorption would have occurred during the intrusion.

Further, the amount of root resorption was calculated by subtracting the root length (R2) measured in the post-intrusion radiograph (T2) from the actual root length (R_A) calculated as mentioned above.

Amount of root resorption (difference) = R_A - R2

R_A- Root length at T_2 if no root resorption would have occurred during the intrusion

R2- CEJ to the apex (T_2)

Finally, the percentage of the amount of root resorption was calculated from the root length pre-intrusion (R1).

Percentage of root resorption = amount of root resorption×100/R1

Statistical Analysis

Corrected root length and post-alignment root length were compared using paired *t*-test.

RESULTS

There were significant differences and were observed in root length changes between pre-intrusion and post-intrusion of central incisor, and lateral incisor with a $t = 7.04$ and 7.14, respectively [Table 1 and Figure 3].

The relation between root lengths before and after intrusion indicates mean root resorption of 15.15%. Starting from an average root length of 14.61 mm, mean resorption of 2.27 mm was found in this study.

No significant correlation in resorption could be found between the central and lateral incisors and also between right side and left side of incisors

DISCUSSION

EARR is a common iatrogenic consequence of orthodontics. It has long been recognized and postulated that intentional tooth movement, especially heavy intrusive forces increases the risk of EARR.

The conical shape of the apical portion of the roots concentrates axial forces at the tip or the apex of the root causing it to resorb under the intrusive forces.

Thus, the purpose of this study was to investigate whether root resorption of the upper incisors occurs during intrusion of maxillary incisors is significant or not. As the study done by Levander and Malmgren[16] on long-term effect of root resorption, it may lead to the mobility of teeth if the resorption leads to reduce the root length >9 mm, which is not acceptable as an acceptable side effect of esthetic correction of the tooth.

The relation between root lengths before and after intrusion indicates mean root resorption of 15.15%. Starting from an average root length of 14.61 mm, mean resorption of 2.27 mm was found in this study.

No difference in resorption could be found between the central and lateral incisors and also between right side and left side of incisors.

Comparing the study by Linge and Linge[15] with this study, intrusion seemed to cause more resorption than overall orthodontic treatment (torque, Class II elastics, and rectangular wire).

The results of this study can be appropriately compared with those of Goerigk *et al*.,[16] Dermaut and De Munck,[14] and Costopoulous and Nanda.[17] The type of intrusion mechanics used was very similar in all four studies.

When mean values are compared, Dermaut and De Munck found 2.9 mm of resorption of the upper incisors after 6.7 months, whereas patients in the present study had 2.27 mm of resorption after 6 months which is similar to this study.

Goerigk *et al*. and Costopoulous and Nanda, however, found 0.9 mm of resorption after 4.3 months and 0.6 mm of resorption after 4.6 months, respectively. The lesser amount of resorption reported by these authors is partly explainable by the duration of time that intrusion was performed (almost 50% lesser than the present study). However, given the low correlations found between root resorption and duration or extent of

Table 1: *t* values for comparison of pre-intrusion and post-intrusion root length mm

Character	Pre	Post	*t* value	*P*	Significance
Right central incisor	14.65	12.36	6.19	0.000	Highly sig.
Right lateral incisor	14.26	12.34	6.06	0.000	Highly sig.
Left central incisor	15.06	12.60	6.32	0.000	Highly sig.
Left lateral incisor	14.48	12.08	7.16	0.000	Highly sig.

intrusion (by Dermaut and De Munck), other factors may be responsible for the lesser extent of resorption. One such factor could be the intrusive force levels used by Costopoulous and Nanda were somewhat lesser, 15 g per tooth versus 25 g per tooth in the present study, and that of Dermaut and De Munck. It is daunting to consider that root resorptive processes might be sensitive to force differences on the order of 10 g per tooth. Perhaps a critical force threshold exists beyond which the normal protective role of the periodontal ligament at the apex breaks down.

As in study done by Costopoulous and Nanda and Dermaut and De Munck found no correlation with duration of intrusion and amount root resorption, thus by increasing the time and decreasing the intrusive force we can achieve effective overbite reduction while causing the negligible amount of apical root resorption.

CONCLUSION

From this study, we can conclude that the force used for the intrusion of maxillary incisors was not optimal as we have found the significant amount of apical root resorption. Hence, the lower forces are recommended for causing such tooth movements. We can increase the duration of intrusion and reducing the intrusive forces to achieve adequate intrusion thereby causing a less deleterious effect on teeth. Clearly, more studies investigating the optimum force levels for intrusion without resorption are needed.

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