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Research Article

Comparison of Amount of Root Resorption Seen in Incisors Radiographically During Active Orthodontic Treatment Using RVG and IOPA- An *In Vivo* Study

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Abstract

Objective: The aim of the present study was to measure the amount of external root resorption of incisors and also to evaluate which diagnostic tool is better for diagnosis of root resorption during active orthodontic treatment.

Materials and Methods: The study sample consisted of 30 patients (18 females and 12 males) with first premolar extractions. Retraction was done on 0.019 x 0.025 SS wire by active tie backs (intra-arch). The total sum of 120 teeth, the maxillary and mandibular right and left central incisors, of 30 patients were observed radiographically by using RVG and IOPA. To measure and compare the amount of root resorption of central incisors, all the peri-apical radiographs and radiovisiographs were obtained at: Pre-treatment (T0), after initial levelling and alignment (T1), after six months of retraction (T2). To measure the amount of root resorption, the difference of this length (L) among different stages i.e. pre-treatment (T0), after levelling and alignment (T1), after six months of retraction (T2) was calculated.

Results: On comparing the two methods statistically for both the arches, the difference between two methods was found to be significant at all the three time intervals ($p < 0.001$) with the IOPA and RVG. Root resorption during T0 - T1 of all the incisors measured by both IOPA and RVG was found to be statistically significant only between T0 and T2 and between T1 and T2 intervals ($p < 0.001$).

Conclusion: There was no statistically significant changes in root length from pre-treatment stage to the levelling and alignment stage in upper and lower incisors. Although, statistically significant amount of root resorption was found between the pre-treatment stage and after 6 months of retraction. Also, mean root length of upper and lower incisor by RVG was found to be statistically significantly higher than that measured by IOPA. Therefore, RVG is considered to be the better diagnostic tool for root resorption than IOPA.

Keywords: *External Root Resorption; Orthodontic Retraction; IOPA; RVG*

Introduction

The allure of aesthetics plays an important role in today's world, with dentistry and orthodontics as no exceptions. With increasing numbers of patients receiving orthodontic treatment and having higher expectations, proper diagnosis for effective treatment is of utmost importance. Evaluation of radiographs is a crucial step in the initial diagnostic process in orthodontics. The visualization of key structures, detection of pathology and assessment of developing teeth are some of the conditions that can be obtained only from radiographs.

Cephalometric films and panoramic films are routinely ordered as the primary pre-treatment radiographs [1]. When there is an imbalance between resorption and deposition of bone along with the loss of some of the protective mechanisms of cementum, osteoclasts and cementoclasts will be able to resorb portions of the root [2].

External apical root resorption is an undesirable sequel of orthodontic treatment that can result in permanent loss of tooth structure [3]. Much controversy exists regarding the exact definition of root resorption [4]. Prognosis is poor when resorption continues without diagnosis. Therefore, radiographic detection of external root resorption is important for clinician [5]. The upper incisors often show root resorption after orthodontic treatment and are used to determine root resorption during experimental studies. According to Parker and Harris (1998), incisors are the most common site of root resorption and undergo more displacement than any other teeth which can be easily visualized on the radiographs. They further stated that among the mechanical factors, the orthodontic techniques used may be related to root resorption and, in movement such as tipping, torque, and incisor intrusion, the root surface is directly compressed against the alveolar bone resulting in root resorption [6].

It is, however, difficult to isolate and evaluate specific tooth movements likely to enhance external apical root resorption because combinations of complex mechanical tooth movements, such as extrusion, intrusion, translation, tipping, torquing and rotations, are produced by a wide array of orthodontic appliances [7]. It has been said that root resorption process stops once the active appliances are removed [8,9].

Recent studies aim to elucidate the causal relationship between force application, tooth movement and root resorption [10]. Also, the apical tooth structure present cellular cement, that is less mineralized, more friable and easy to be injured. Morphopathological investigations show a hyalinization or aseptic necrosis of periodontal ligaments. In the first stages appear some lacunas that give an irregular contour to the root apex on radiographs. In more advanced phases, it will come to a surrounding apical root resorption, accompanied by tooth shortening. Severe root resorption (more than $1/4^{th}$ of root length or more than 5 mm) is rare, with prevalence between 1 - 5%. When this occurs, it has a negative effect on tooth implantation and it contributes to bad long term prognosis of the tooth [11,12]. The main aim of the present study was to measure the amount of root resorption of central incisors during active orthodontic treatment and also to evaluate which diagnostic tool is better for detection of root resorption RVG or IOPA.

Material and Methods

This study was approved by the Regional Ethical Committee of Research of Saraswati Dental College and Hospital Lucknow. The study sample consisted of 30 patients (18 females and 12 males), with a mean age of 19.5years (range 16 to 23 years) were selected from the pool of patients undergoing fixed orthodontic treatment in the Department of Orthodontics and Dentofacial Orthopedics, Saraswati Dental College, Lucknow. The following inclusion and exclusion criteria was used.

Inclusion Criteria

- Root development of incisors should be complete in all subjects at the beginning of the treatment.
- First premolar extraction cases.
- Teeth should be without any extensive fillings or prosthetic treatment or presence of wide palatal vault thus allowing correct positioning of film in a holder.

Exclusion criteria

- There should be no history of systemic diseases or metabolic anomalies, trauma or peri-apical inflammation of central incisors, endodontic treatment of the incisors, root resorption prior to orthodontic treatment, tumours and cysts in the examined area and nail biting or other habits.

The total sum of 120 teeth, the maxillary and mandibular right and left central incisors, of 30 patients were observed radiographically. RVG machine (Dr. Suni Digital Radiography System, SUNI Medical Imaging, Inc), RVG Xcp Positioner, XVa3 RVG software and standard IOPA films were used for the study All the patients were treated using MBT 0.022-inch bracket slots. Levelling and alignment of the teeth was done at 0.014, 0.016, 0.018 NiTi wires. Retraction was done on 0.019 x 0.025 ss wires by active tie backs (intra-arch). Sliding mechanics were used. To measure the amount and compare the amount of root resorption of central incisors, all the peri-apical radiographs and radiovisiographs were obtained at: Pre-treatment (T0), after initial levelling and alignment (T1), after six months of retraction (T2) by a paralleling device (Dr. Suni Digital Radiography System, SUNI Medical Imaging, Inc) and were analyzed in software for image analysis (XVa3 Version 3.5 (Build 21) copyright@1995 - 1999.Apteryx, Inc).

Point on incisal edge (a) and edge of apical foramen (b) were identified on all the stage peri-apical radiographs and radiovisiographs. A line (a-b) is drawn. Midpoint of the incisal edge (a) and apical foramen edge (b) were connected and measured. To measure the amount of root resorption, the difference of this length (L) among different stages i.e. pre-treatment (T0), after levelling and alignment (T1), after six months of retraction (T2) was calculated (Figure 1).

Figure 1: *Root length measurement on IOPA, a - point on incisal edge, b- point on apical foramen, L- total tooth length.*

Figure 2: *: Root length measurement on RVG.*

In the RVG images, the measurements were carried out using the electronic ruler tool incorporated into the software, Adobe Photoshop (version 7.0, MacApp, 1985-1993, Apple Computer, Inc). Horizontal points were noted similar to that of the IOPA, i.e, one at the root apex and the other at the incisal edge. The measurements were carried out by drawing a line perpendicular to the guides, to obtain the distance between them (Figure 2).

Statistical Analysis

A master file was created, and the data was analyzed statistically on a computer with Statistical Package for Social Sciences (SPSS) software (version 15). A data file was made under dBase and converted into a micro stat file. The data was subjected to descriptive analysis for mean, range, standard deviation and 95% confidence interval. Paired "t" test was used to compare the differences between the methods at two different intervals. To identify errors due to radiographic measurements, 20 radiographs were selected randomly. Their tracings and measurements were repeated 6 weeks after the first measurements were taken. A paired sample t-test was applied to the first and second measurements, the differences between measurements were insignificant.

Results

The upper and lower incisor measurements at T0, T1 and T2 intervals of both sides was not found to be significant statistically at any of the three time intervals ($p > 0.05$) (Table 1). Same was seen in the measurements with the RVG (Table 2). Collectively, for upper and lower incisors of both right and left sides, using IOPA mean root length on comparing the two methods statistically, the difference between two methods was found to be significant at all the three time intervals ($p < 0.001$) (Table 3). Root resorption during of Upper and lower incisors measured by IOPA was significant only between T0 and T2 and between T1 and T2 intervals ($p < 0.001$) (Table 4). Root resorption during T0 - T1 of Upper and lower incisors measured by RVG was significant only between T0 and T2 and between T1 and T2 intervals ($p < 0.001$) (Table 4). The amount of root resorption has been summarized.

Site of incisor	Time period	Right side (n = 30)		Left side (n = 30)		Statistical significance	
Upper	T0	27.43	2.23	27.23	2.04	1.235	0.227
	T1	27.43	2.21	27.22	2.04	1.281	0.210
	T2	27.23	2.22	26.96	1.99	1.866	0.072
Lower	T0	22.78	2.28	22.73	1.96	0.254	0.801
	T1	22.74	2.38	22.68	2.06	0.319	0.752
	T2	22.43	2.42	22.38	1.98	0.241	0.811

Table 1: *Comparison of Mean Root Length between Left and Right incisors by IOPA at different time intervals.*

Site of incisor	Time period	Right side (n = 30)		Left side (n = 30)		Statistical significance	
Upper	T0	31.45	2.27	31.44	2.32	0.076	0.940
	T1	31.39	2.32	31.45	2.34	-0.393	0.697
	T2	31.09	2.33	31.07	2.30	0.172	0.865
Lower	T0	26.39	2.48	26.29	2.31	0.699	0.490
	T1	26.36	2.56	26.22	2.38	0.898	0.376
	T2	25.93	2.54	25.80	2.28	0.918	0.366

Table 2: *Comparison of Mean Root Length between Left and Right incisors by RVG at different time intervals.*

Site of incisor	Time period	IOPA (n = 60)*		RVG (n = 60)*		Statistical significance	
Upper	T0	27.33	2.12	31.45	2.27	-22.697	< 0.001
	T1	27.32	2.12	31.42	2.31	-22.010	< 0.001
	T2	27.10	2.09	31.08	2.29	-21.317	< 0.001
Lower	T0	22.76	2.11	26.34	2.38	-33.707	<0.001
	T1	22.71	2.20	26.29	2.45	-33.527	< 0.001
	T2	22.41	2.19	25.86	2.39	-30.931	< 0.001

Table 3: *Comparison of Mean Root Length of Upper and Lower incisors by IOPA and RVG at different time intervals.*

Site of Incisor	Time period	IOPA (n = 60)					RVG (n = 60)				
		Mean resorption	SD	% resorption	't'	'p'	Mean resorption	SD	% resorption	't'	'p'
Upper	T0 - T1	0.01	0.22	0.04	0.415	0.680	0.03	0.26	0.08	0.780	0.438
	T1 - T2	0.23	0.24	0.83	7.253	< 0.001	0.34	0.28	1.08	9.249	< 0.001
	T0 - T2	0.24	0.26	0.87	7.106	< 0.001	0.37	0.33	1.17	8.710	< 0.001
Lower	T0 - T1	0.05	0.21	0.21	1.760	0.084	0.05	0.22	0.20	1.784	0.080
	T1 - T2	0.30	0.25	1.34	9.449	< 0.001	0.43	0.27	1.62	12.051	< 0.001
	T0 - T2	0.35	0.31	1.55	8.787	< 0.001	0.48	0.26	1.82	13.984	< 0.001

Table 4: *Root resorption in Upper and Lower Incisors by IOPA and RVG (Paired 't' test).*

Discussion

External apical root resorption is a common sequel of orthodontic treatment that is frequently discussed in the literature. The factors associated with this phenomenon are controversial. In 1982, Malmgren., *et al*. [13] created a quantitative evaluation index of apical root resorption made up of the following scores: score 1: irregular apical contour, score 2: apical root resorption less than 2 mm (minor resorption), score 3: apical root resorption from 2mm to a third of the original length (severe resorption), and score 4: apical root resorption exceeding a third of the original root length (extreme resorption). In the present study, selection of lower age limit was done to exclude the undesirable effect of residual root growth [14]. The higher age limit was defined in order to eliminate the unfavourable effect of age that may lead to increased external apical root resorption due to creation of more hyalinized areas, longer hyalinization duration, and lower healing activity in adults. Protesa., *et al*. [11] found higher prevalence of severe root resorption in older patients. This is also supported by other studies which reveal that patients at an older age are at higher risk of root resorption [15].

A study was done by Kamble., *et al*. [16] using finite element analysis indicated that the central incisors have the highest risk of root resorption. The chances of root resorption also increases with denuded root morphology. McNab., et al. [17] in 2000 found that the amount of root resorption is 3.72 times greater for extraction than non-extraction patients. They also found positive significant relationship between the amount of maxillary incisor retraction and root resorption, demonstrating that greater tooth displacement is associated with greater resorption. In 2012, Lund and Grondahl [18] said that almost all patients and between 55% and 91% of teeth showed some degree of root shortening but it is insignificant. A CBCT technique thus can provide more valid and accurate information about root resorption and may be of value in research. They also investigated the accuracy of CBCT and intraoral radiography for the detection of simulated root resorption cavities. Their findings verified the shortcomings of intraoral radiography and showed that these were overcome by CBCT. The degree of orthodontically induces inflammatory root resorption showed individual variation. Even though patients underwent similar

treatment schemes, there is variance in root resorption. According to Owman-Moll., *et al*. [22], individual reactions might even be more important than the increase in force or length of the tooth movement.

In the present study, 0.022 x 0.028 inch bracket slots were used. Among the mechanical factors investigated, the orthodontic technique used has been related to induced root resorption found that the Begg technique caused more root resorption than the edgewise technique [20,21]. In the present study root resorption during T0 - T1 of Upper incisor measured by IOPA was 0.04% from T0 while that during T1 - T2 was 0.83% from T1, total root resorption at T2 was found to be 0.87% from T0. Root resorption during T0 - T1 of Lower incisor measured by IOPA was 0.21 % from T0 while that during T1 - T2 was 1.34% from T1, total root resorption at T2 was found to be 1.55% from T0. Thus, it is clear from these readings that a significant change in root length was seen in both the upper and lower incisors. Root resorption during T0-T1 of Upper incisor measured by RVG was 0.08% from T0 while that during T1 - T2 1.08% from T1, total root resorption at T2 was found to be 1.17% from T0. Root resorption during T0 - T1 of Lower incisor measured by RVG was 0.20% from T0 while that during T1 - T2 was 1.62% from T1, total root resorption at T2 was found to be 1.82% from T0. Same inference can derived from these readings.

As stated, there was the insignificant change in root length when it is comparison is made between pre-treatment and after levelling and alignment. Although, it produces significant change when compared after six months of retraction. This is similar to studies done by other authors where they said root shortening is present after 6 months of orthodontic treatment in some percentage of patients [22-24]. Also, in 2013 Makedona., *et al*. [25] reported that root resorption can be seen in 25.6% of patients after 3 to 6 months of treatment. Ahn and Moon [26] found that during en-masse tooth movement, root length decreased more than the individual tooth movement. This is also supported by the study done by Liou and Chang in 2010 [27] Mohandesan., *et al*. [12] in 2007 measured the amount of root resorption in 40 patients undergoing orthodontic treatment and said clinically significant root resorption can be seen in 74% of central incisors after 6 and 12 months, which also support this result.

Artun., *et al*. [8] evaluated standardized periapical radiographs after 6 months and 12 months of orthodontic treatment and concluded that the patients with detectable root resorption during first six months of active treatment are more likely to experience resorption in the following six period than those without. Marques et al said that resorption could be easily noticed in peri-apical radiographs of the anterior teeth in first 6 months after beginning treatment [28]. The researches done by Protesa., *et al*. [11] and Artun., *et al*. [8] also support these findings. It is believed that the healing process of a resorption cavity takes place after the orthodontic force is removed. It starts as early as the first week of retention after treatment when the orthodontic treatment is discontinued or reduced below a certain level. As reported by the previous studies, repair occurs mainly when the orthodontic force is removed or reduced, but Han et al observed repair after intrusion for four weeks [10]. A limitation of this study was that the CBCT can be employed for further research on orthodontically induced root resorption as it is more sensitive than the peri-apical radiographs and radiovisiographs.

Conclusion

From this study, it was concluded that

- There are no statistically significant changes in root length from pre-treatment stage to the levelling and alignment stage in upper and lower incisors.
- Although, statistically significant amount of root resorption was found between the pre-treatment stage and after 6 months of retraction.

Mean root length of upper and lower incisor by RVG was found to be statistically significantly higher than that measured by IOPA. There-fore, RVG is considered to be the better diagnostic tool for root resorption than IOPA. Most root resorptions due to orthodontic treatment are not greater than 1 mm and do not impair tooth function, but its proper timely diagnosis is required for the successful orth-

odontic treatment. Because root resorption is usually asymptomatic, the only means to clinically detect and measure its severity is with radiographic images. Periapical radiography is the most common technique for the assessment of these lesions. Radiovisiographs (RVG) are also used for this and they have better sensitivity in the detection of root resorption.

Bibliograhy

1. Sameshina G T and Asgarifar O. "Assessment of root resorption and root shape: periapical vs panoromic films". *Angle Orthodontist* 71.3 (2001): 185-189.

2. Apajalahti S and Peltola JS. "Apical root resorption after orthodontic treatment—a retrospective study". *European Journal of Orthodontics* 29.4 (2007): 408-412.

3. Kocadereli I., *et al*. "Apical root resorption: A prospective radiographic study of maxillary incisors". *European Journal of Dentistry* 5.3 (2011): 318-323.

4. Copeland S and Green LJ. "Root resorption in maxillary central incisors following active orthodontic treatment". *American Journal of Orthodontics* 89.1 (1986): 51-55.

5. Kamburoğlu K., *et al*. "Diagnosis of artificially induced external root resorption using conventional intraoral film radiography, CCD, and PSP: an ex vivo study". *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 106.6 (2008): 885-891.

6. Ramanathan C and Hofman Z. "Root resorption during orthodontic movements". *European Journal of Orthodontics* 31.6 (2009): 578-583.

7. Parker RJ and Harris EF. "Direction of orthodontic tooth movements of external apical root resorption of maxillary central incisor". *American Journal of Orthodontics and Dentofacial Orthopedics* 114.6 (1998): 677-683.

8. Artun J., *et al*. "Apical root resorption six and twelve months after initiation of fixed orthodontics appliance therapy". *Angle Orthodontist* 75.6 (2005): 919-926.

9. Carrillo R., *et al*. "Intrusion of multiradicular teeth and related root resorption with mini-screw implant anchorage: a radiographic evaluation". *American Journal of Orthodontics and Dentofacial Orthopedics* 132.5 (2007): 647-655.

10. Han G., *et al*. "Root resorption after orthodontic intrusion and extrusion: an intraindividual study". *Angle Orthodontist* 75.6 (2005): 912-918.

11. Preoteasa CT., *et al*. "Orthodontically induced root resorption correlated with morphological characterstics". *Romanian Journal of Morphology and Embryology* 50.2 (2009): 257-262.

12. Mohandesan H., *et al*. "A radiographic analysis of external apical root resorption of maxillary incisors during active orthodontic treatment". *European Journal of Orthodontics* 29.2 (2007): 134-139.

13. Malmgren O., *et al*. "Root resorption after orthodontic treatment of traumatized teeth". *American Journal of Orthodontics* 82.6 (1982): 487-491.

14. Linge BO and Linge I. "Apical root resorption in upper anterior teeth". *European Journal of Orthodontics* 5.3 (1983): 173-183.

15. Weltman B., *et al*. "Root resorption associated with orthodontic tooth movement: a systematic review". *American Journal of Orthodontics and Dentofacial Orthopedics* 137.4 (2010): 462-476.

16. Kamble RH., *et al*. "Stress distribution pattern in a root of maxillary central incisor having various root morphologies: a finite element study". *Angle Orthodontist* 82.5 (2012): 799-805.

17. McNab S., *et al*. "External apical root resorption following orthodontic treatment". *Angle Orthodontist* 70.3 (2000): 227-232.

18. Lund H., *et al*. "Apical root resorption during orthodontic treatment. A prospective study using cone beam CT". *Angle Orthodontist* 82.3 (2012): 480-487.

19. Owman-Moll P., *et al*. "Continuous versus interrupted continuous orthodontic force related to early tooth movement and root resorption". *Angle Orthodontist* 65.6 (1995): 395-402.

20. Goldson L and Henrikson CO. "Root resorption during Begg treatment; a longitudinal roentgenologic study". *American Journal of Orthodontics* 68.1 (1975): 55-66.

21. Kaley J and Phillips C. "Factors related to root resorption in edgewise practice". *Angle Orthodontist* 61.2 (1991): 125-132.

22. Owman-Moll P., *et al*. "Repair of orthodontically induced root resorption in adolescents". *Angle Orthodontist* 65.6 (1995): 403-408;409-410.

23. Dimitrios Makedonas., *et al*. "Root resorption diagnosed with cone beam computed tomography after 6 months of orthodontic treatment with fixed appliance and the relation to risk factors". *Angle Orthodontist* 82 (2012): 196-201.

24. Makedonas D., *et al*. "Root resorption diagnosed with cone beam computed tomography after 6 months and at the end of orthodontic treatment with fixed appliances". *Angle Orthodontist* 83.3 (2013): 389-393.

25. Hansen K and Makedonas D. "Diagnosis, screening, and treatment of root resorption in orthodontic practices in Greece and Sweden". *Angle Orthodontist* 78.4 (2008): 248-253.

26. Ahn HW., *et al*. "Morphometric evaluation of changes in the alveolar bone and roots of the maxillary anterior teeth before and after en masse retraction using cone-beam computed tomography". *Angle Orthodontist* 83.2 (2013): 212-221.

27. Liou EJ and Chang PM. "Apical root resorption in orthodontic patients with en- asse maxillary anterior retraction and intrusion with miniscrews". *American Journal of Orthodontics and Dentofacial Orthopedics* 137.2 (2010): 207-212.

28. Marques LS., *et al*. "Severe root resorption and orthodontic treatment: clinical implications after 25 years of follow-up". *American Journal of Orthodontics and Dentofacial Orthopedics* 139.4: S166-S169.

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