Prevalence of Root Resorption in Patients of RSGM Universitas Sumatera Utara with Non-extraction Orthodontic Treatment

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Abstract: Root resorption is a side effect which cannot be prevented in orthodontic treatment. External apical root resorption (EARR) causes root shortening. The purpose of this study is to assess the prevalence of the degree of EARR in the incisors between maxillary and mandible before and after orthodontic treatment in patients with non-extraction cases. This research is an analysis of a cross-sectional study conducted on samples namely panoramic radiographs of patients before and after orthodontic by using the modification of Lavender and Malmgren index and Linge and Linge method. Wilcoxson test and Chi-square test was used for statistical analysis. Samples amounted to a total of 400 incisor teeth which have received orthodontic treatment. Results shows that of the 400 incisor teeth studied, the results found were 5 incisors (1.25%) with mild EARR (score 1), 368 incisors (92%) had moderate EARR (score 2) and as many as 27 incisors (6.75%) had severe EARR (score 3). The incisors with extreme EARR (score 4) is 0%. Conclusion, the EARR experienced by incisors is on score 2 as much as 92% and there are no incisors (0%) experienced extreme EARR (score 4).

1 INTRODUCTION

Orthodontic treatment has a positive effect but can have undesirable secondary effects. At the roots, undesirable side effects include severe root resorption (Preoteasa, 2012). Root resorption is the process of losing cementum and dentine from the roots (Bishara, 2001).

Apical resorption is an unavoidable complication and microscopic studies show a prevalence of 100%. This process can cause the shortening of root (Preoteasa, 2012]. Based on the research by Kapoor *et al.* (2014) when orthodontic force is given then receptor activator of the nuclear factor kappa-B ligand (RANKL) will increase in the gingival crevicular fluid. This increase stimulates the PGE2 pathway and initiates osteoclast activity leading to root resorption (Kapoor et al, 2014).

The degree of EARR is determined based on using the modification of Lavender and Malmgren index and Linge and Linge method. Linge and Linge introduced the crown length registration method by calculating the correction factor. This method can connect the radiography before and after. The Lavender and Malmgren index is a subjective method and EARR can't be evaluated by this index alone because distortions in panoramic radiography before and after treatment may occur which might make it difficult for researchers to evaluate EAAR. Therefore, these two methods are used to assess RAAE incisors before and after treatment (Jacobs et al, 2014).

Mohandesan *et al.* (2007) have found root resorption occurs in maxillary central incisive tooth as much as 74% and maxillary lateral incisors as much as 82% (Mohandesan et al, 2007). Agrawal *et al.* (2016) has observed root resorption in molar teeth and the results show extreme EARR especially in maxillary first molar (53.3-63.3%). This resorption is caused by the force applied on molars are larger compared to the premolars. In addition, the incidence of EARR in the case of extraction occurred 3.72 times greater than in non-extraction cases (Agarwal et al, 2016).

According to a study by Sunku et al (2011), the average EARR that occurred in maxillary central incisors were as much as 27.2% and the maxillary lateral incisors were 25.2% and the least root resorption occurred in the mandible lateral incisors right and left were as much as 19.1% and 17.4% (Sunku et al, 2011). Different results can also be found in several studies. According to the study of

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Savoldi *et al.* (2015), mandible central incisors and lateral mandible incisors experienced slight resorption and he concluded that patients with mild-crowding teeth and orthodontic treatment with low force might cause mild apical root resorption especially in the mandible incisors (Savoldi et al, 2015).

Jiang *et al.* (2010) gained a positive relationship between root resorption and the duration of treatment through the *Bivariate Correlation* analysis and concluded that the longer the duration of treatment the more severe the resorption of the roots (Jiang et al, 2010). A study conducted by Nanekrungsan *et al.* (2012) based on 564 periapical radiographs of the maxillary incisors have obtained results that EARR occurred as much as 59.6% mild, moderate EARR as much as 31.9% and severe EARR as much as 8.5% (Nanekrungsan et al, 2012).

2 METHOD

This research is an analytical research with a cross sectional approach. Samples were taken based on inclusion and exclusion criteria. The inclusion criteria of this study were patients who had completed orthodontic treatment, patients with non-extraction cases, medical records before and after treatment should be complete, patients with 17-40 years of age, patients with no systematic disease, radiography in good quality and from the same laboratory and patients with good oral hygiene. The exclusion criteria for this study were poor quality radiographs, patients who had received endodontic treatment in incisors, had a history of mechanical trauma in incisors and bad habits (tongue-thrusting, thumb sucking, bruxism).

2.1 Procedure

The agreement of ethical clearance was obtained from the Medical Ethics Commission of USU. The collection of panoramic radiography of patients before and after treatment. Then, tracing of the anatomic shape of the maxilla and mandibular incisors. Evaluation is done based on the modification of Lavender and Malmgren index and Linge and Linge method. Operator Test was conducted and the result of the measurement is then processed by computerized and the data is analyzed.

2.2 Data Analysis

The data will be computerized and using the Wilcoxon test because data was not distributed normally and data analysis followed by Chi-Square test used to know the difference in EARR between maxilla and mandibular incisors.

3 RESULTS AND DISCUSSIONS

Root resorption is evaluated in maxillary and mandible central incisors and lateral incisors. The number of teeth evaluated was 400 incisors which are 200 maxillary incisors and 200 mandible incisors.

Table 1: EARR distributions occurred in 400 incisors in non-extraction orthodontic patients.

	Score								Total	
	1		2		3		4			
	n	%	n	%	n	%	n	%	n	%
Incisor	5	1.25	368	92	27	6.75	0	0	400	100

Table 1 shows that of the 400 incisor teeth studied, the results found that there were 5 incisors (1.25%) with mild EARR (score 1), 368 incisors (92%) had moderate EARR (score 2) and as many as 27 incisors (6.75%) had severe EARR (score 3). The incisors with extreme EARR (score 4) is 0%.

Table 2: EARR distribution that occurred in 200 maxillary incisors.

Score / Tooth	1		2		3		4		Total	
	N	%	N	%	N	%	n	%	n	%
Maxillary right lateral incisor	-	-	50	25	-	-	-	-	50	25
Maxillary right central	-	-	50	25	-	-	-	-	50	25

incisor										
Maxillary left central incisor	1	0.5	49	24.5	-	-	-	-	50	25
Maxillary left lateral incisor	2	1.0	47	23.5	1	0.5	-	-	50	25
Total	3	1.5	196	98	1	0.5	-	-	200	100

Table 2 shows the EARR distribution that occurred in maxillary incisors in non-extraction orthodontic patients. A total of 196 maxillary incisors experienced moderate root resorption (score 2) of 98.0%. 0.5% (1 tooth) of maxillary left lateral incisor experienced severe root resorption (score 3) was and as much as 3 maxillary incisors which are maxillary left central incisor and maxillary left lateral incisors experienced mild root resorption of 0.5% and 1.0% each. The results show that samples with extreme EARR (score 4) are zero.

Table 3: EARR distribution that occurred in 200 mandible incisors.

Score / Tooth	1		2		3		4		Total	
	N	%	N	%	N	%	n	%	N	%
Mandible right lateral incisor	1	0.5	40	20	9	4.5	-	-	50	25
Mandible right central incisor	-	-	43	21.5	7	3.5	-	-	50	25
Mandible left central incisor	1	0.5	43	21.5	6	3	-	-	50	25
Mandible left lateral incisor	-	-	46	23	4	2	-	-	50	25
Total	2	1.0	172	86.0	26	13.0	-	-	200	100

Table 3 shows the EARR distribution that occurred in the mandible incisors in non-extraction orthodontic patients. A total of 172 maxillary incisors experienced moderate root resorption (score 2) of 86%. A total of 26 mandible incisor teeth experienced severe root resorption (score 3). Mandible right lateral incisors had the highest number of EARR samples (score 3) of 4.5%. A total of 2 mandible incisors which are mandible right lateral incisor and mandible left central incisors were subjected to mild root resorption of 0.5%. The results show that samples with extreme EARR (score 4) are zero.

Table 4: *Chi-square* test results

	Average (mm)	SD	*P-Value*
Maxillary Incisors	2.12	1.71	0.018
Mandible Incisors	2.77	2.35	

Chi-Square test results (table 4) showed that the average EARR occurred in the maxillary incisors were 2.12mm ± 1.71 while in the mandible were 2.77mm ± 2.35. The statistical analysis showed that there were significant EARR differences between maxillary and mandible incisors ($p = 0.018$). EARR occurred in the mandible incisors are higher than the maxillary incisors.

EARR is one of the most common iatrogenic problems with orthodontic treatment. This study has been conducted to observe the prevalence of root resorption before and after orthodontic treatment in patients who received non-extraction therapy. The number of teeth evaluated was 400 incisors which are 200 maxillary incisors and 200 mandible incisors.

The degree of EARR was measured using the Linge and Linge method modified with Lavender and Malmgren index. Linge and Linge introduced the crown length registration method by calculating the correction factor. This method could connect the radiography before and after.

The Lavender- Malmgren index is a subjective method. Assessment of the degree of root resorption does not depend on radiographic standardization before treatment. Distortion of panoramic radiography before and after treatment may occur and it may be difficult for researchers to evaluate EARR with the Lavender-Malmgrem index alone. Therefore, researchers used two methods to assess EARR of the incisors before and after treatment.

The results (Table 1) shows that of the 400 incisor teeth studied, the results found shows that 5 incisors (1.25%) with mild EARR (score 1), 368 incisors (92%) had moderate EARR (score 2) and as many as 27 incisors (6.75%) had severe EARR (score 3). The incisors with extreme EARR (score 4) is 0%.

The results of this study are similar to Chavez *et al.* (2015) study. He found that the teeth which experienced severe EARR the most are mandible central incisor teeth of 1.12mm (Chavez et al, 2015). Researcher Batool *et al.* (2010) got the result of mandible incisors (2.60%) having the greatest EARR and maxillary central incisors (1.52%) experienced the least EARR (Batool et al , 2010). Most studies show different results. Researcher Maues *et al.* (2015) found that maxillary central incisor had the highest percentage of EARR followed by maxilla lateral incisors and mandible lateral incisors. A total of 28 teeth (2.9%) out of 959 examined teeth experienced severe EARR (Maues et al, 2015). The Sunku *et al.* (2011) study showed the highest rate of root resorption occurred in 27.2% maxillary central incisors and maxillary lateral incisors as much as 25.2% and followed by right and left canines of 23.5% and 21.0% and the least EARR occurred in the right and left maxillary lateral incisors of 19.1% and 17.4% (Sunku et al, 2011).

Overall, the average EARR score which occurred in incisors were score 2. This is similar with Sunku *et al.* (2011) study that most patients receiving orthodontic treatment would have root resorption even if treatment was performed without extraction (Sunku et al, 2011). Agarwal *et al.* (2007) study showed that resorption in patients treated with extraction (55.9%) experienced higher EARR than treated patients without extraction (37.9%) (Agarwal et al, 2016). Researcher Mohandesan *et al.* (2007) found that in dental extraction patients, root resorption occurred in maxillary central incisors and maxillary lateral incisors are 11.1% and 12.7%. The root resorption occurred in patients with non-extraction treatment in maxillary central and lateral incisors was 8.4% and 9.2 %. This is because, extraction patients require more teeth movement and apical displacement than those treated without extraction to correct the malocclusion. This causes high EARR in patients treated with extraction (Mohandesan et al, 2007). There is a research that yielded the opposite result. Researcher Zahedani *et al.* (2013) found that there is no significant difference between the group of patients treated with dental extraction and the group treated without dental extraction (Zahed et al, 2013).

The intraoperator test showed that there were no significant differences between the first and second calculations. *Chi-Square* test results (table 4) showed that the average EARR that occurred in the maxillary incisors were 2.12mm ± 1.71 while the mandible incisors were 2.77mm ± 2.35. *Chi-Square* test shows that there is significant EARR difference between maxillary and mandible incisors ($p < 0.05$).

Based on the data analysis of table 4, the results showed that the number of mandible incisors that experienced severe EARR was higher than maxillary incisors. This is attributed to tooth morphology of mandible incisors. The morphology of apical mandible tooth is long, narrow and susceptible to deviation. Deformed root morphology is susceptible to increased root resorption as compared to normal root morphology in the application of orthodontic force (Pandey et al, 2015, Oyama et al, 2007). Researcher Pandey *et al.* (2015) obtained results that deviated apex teeth received more load than normal dental apex. This is due to the orthodontic force which is concentrated on the apex and apical structures such as the cellular cementum which is less mineralized and is easily traumatized (Pandey et al, 2015). In addition, researcher Batool *et al.* (2010) stated that mandible incisors experience greater EARR than maxillary incisors because they may be associated with denser alveolar bones in the mandible and the thinner root structures in the mandible incisors (Batool et al, 2010). The researcher in this study used panoramic or bidimensional radiographic image (2D) radiography and there is a disadvantage in the angulation of incisors and panoramic radiographic as it has an enlargement of 20% more magnification than periapical radiographic (Castro et al, 2010). Panoramic radiography is difficult to be measured and in determining the diagnosis because the degree of magnification in a particular area is unknown.

4 CONCLUSIONS

The prevalence of EARR occurred in incisors was 92% in score 2 (moderate RAAE). The average EARR that occurred in the maxillary incisors are 2.12mm ± 1.71 whereas the in the mandible incisors

are 2.77mm ± 2.35. Mandible incisors have a higher risk of EARR than maxillary incisors. Based on Chi-Square test results showed significant differences in EARR between the maxilla and mandibular incisors.

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