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A Radiographic Comparison of External Apical Root Resorption After Retraction and Space Closure in 022 & 018 Self Ligating Bracket Systems, A Retrospective Clinical Study

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KEYWORDS

External apical root resorption (EARR);

Self ligating brackets (SLB); IOPA (Intra oral periapical radiograph); OPG(Orthopantomogram)

ABSTRACT:

Objective: Comparative assessment of external apical root resorption from pretraction to postretraction and space closure with sliding mechanics, a retrospective clinical study comparing 0.022 and 0.018 self ligating MBT bracket systems.

Materials and Methods: Retrospectively 28 patients were divided into 2 groups of 14 each based on bracket slot size. Group I: Self ligating (0.022" slot), mean age 19.14 ± 2.12 years; Group II : Self ligating (0.018"slot), mean age 19.71 ± 1.80 years. IOPA & OPG radiographs were collected at two intervals of time. T1: Preretraction & T2 : Postretraction. The preretraction and postretraction IOPA and OPG x-rays, were studied for assessment of external apical root resorption (EARR).The data were analysed using SPSS 19.0 Version and an independent t test was utilized for comparing variance in mean score between two distinct groups.

Results: There was no statistically substantial variation between the two groups from T1 to T2 in terms of EARR in either of the arches. Group II: Self ligating (0.018"slot) showed more root resorption than Group I: Self ligating (0.022" slot) with maxillary lateral incisors showing the most in both the groups.

Conclusion: Statistically no significant difference was found in external apical root resorption, between 022 & 018 self ligating MBT bracket systems, from preretraction to postretraction & space closure with sliding mechanics.

Introduction

Orthodontic root resorption has been recognised as a clinical issue since 1920s[1]. Root resorption which occurs as an outcome of orthodontic treatment is irreversible. Because of external apical root resorption (EARR), orthodontic treatment might produce in less than ideal outcomes in certain circumstances[2]. To understand this phenomenon, we need to know as much as we can about its causes, impacts, and preventive measures. There are two ways to describe this phenomenon: surface resorption and transitory inflammatory resorption. The most often involved teeth

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are maxillary lateral incisors, which are highly vulnerable to EARR than mandibular ones.[3]

Multifactorial aetiology of root resorption may be separated into biological (genetic predisposition, systemic variables like hormonal changes, teeth agenesis as well as medication consumption) and mechanical (excessive tooth moving, root torque, movement kind, orthodontic force value, intensity as well as kind of force, also kind of bracket) elements.[4] Clinical treatment factors to be evaluated for root resorption include more factors like type of appliance, slot size, use of rigid archwires, use of large rectangular archwires, extraction pattern, surgical procedures, expansion, use of functional appliances, duration of treatment, amount of torque applied, displacement distance of the apex, removable vs fixed appliances.[5-8] The straight wire technique often uses a reverse curve of Spee in the upper archwire to assist with leveling, and many techniques use a high pull headgear to the upper molars, which show a high incidence of orthodontically induced inflammatory root resorption (OIIRR) compared with premolar teeth.[9]

Self-ligation brackets (SLB) in orthodontics means that the bracket has the design to hold the archwire itself[10] and is therefore assumed to reduce friction by eliminating the ligation force. Self-ligating brackets introduced in 1930s eliminate need for an elastic or wire ligature[11], their benefits claimed are reduced working time; better oral hygiene, less friction, as well as better treatment results[12-14]. However on assessment of tooth movement velocity and treatment outcome, studies and recent systematic reviews failed to report the significant superiority of SLBs over conventional brackets[15-17]. To close off the edgewise slot, SLB systems have a mechanical device built into the bracket . Two types have been developed : one having spring clip that presses against the archwire and another in which the SL clip just closes the slot, creating a tube, and does not actively press against the wire. The movable fourth part of the bracket is used to convert the slot into a tube with every SL bracket, whether active or passive.[18] The self ligating passive Smart Clip brackets (3M Unitek MBT), having 2C-shaped spring clip upon each side of bracket slot, were utilised in this study to hold arch wire. By applying instrumental or finger pressure to archwire, the clips are opened up for insertion or removal of archwire.[19]

Most studies use IOPA (Intra oral periapical x-ray) or OPG (orthopantomogram) to assess EARR in maxillary as well as mandibular incisors only [20,21], while few do so in incisors and molars together[22]. In addition, usage of various self-ligating bracket slots as well as sizes hasn't been compared with EARR evaluation.

Purpose of this retrospective controlled clinical study was evaluating EARR on incisors & molars using IOPA & OPG, from preretraction (after leveling and alignment) to postretraction (till space closure), with sliding mechanics comparing 0.022 & 0.018 self ligating MBT bracket systems.

Materials & Methods

This study was conducted retrospectively on 28 patients undergoing orthodontic treatment. Treatment planned was fixed appliance therapy with all four extraction.The inclusion criteria were good general health, no systemic disease, permanent & periodontally sound dentition-probing depth less than 3mm, with no radiographic or computed tomographic evidence of bone loss.The exclusion criteria were root resorption, endodontic treatment, dilacerated incisor roots, anodontia, impacted canines, incomplete root formation and decayed or carious teeth.

Approval was obtained from the Institutional ethics board as also individual consent for treatment and study was obtained from all selected patients.

The sample size was based on a power of 90% and α of 0.05.[23]

The patients having earlier dental/skeletal relation of Class I, mild Class II after leveling and alignment were allocated to two groups of 14 patients each.

1. Group I: 14 patients of self ligating 0.022” slot, mean age 19.14 ± 2.12 years, in which space closure was carried out with 0.019x0.025 inch stainless steel archwire with sliding mechanics (Fig 1 and 2).

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Fig 1: Preretraction Group I, subject treated with 0.022" self ligating bracket system (sliding mechanics) 0.019″ x 0.025″ SS

Fig 2: Postretraction Group I, subject treated with 0.022″ self ligating bracket system (sliding mechanics) 0.019″ x 0.025″ SS

2. Group II: 14 patients of self ligating 0.018"slot, mean age 19.71 ± 1.80 years in which space closure was carried out with 0.017x0.025 inch stainless steel archwire with sliding mechanics (Fig 3 and 4).

Fig 3: Preretraction Group II, subject treated with 0.018″ self ligating bracket system (sliding mechanics) 0.017″ x 0.025″ SS

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Fig 4: Postretraction Group II, subject treated with 0.018" self ligating bracket system (sliding mechanics) 0.017″ x 0.025″ SS

En masse retraction on SS wire after leaving *in situ* for 4 weeks to express itself, was performed by steel hooks mesial to canine utilizing NiTi closed coil springs which delivered a force of 100 g on either side.

IOPA (Dentsply Italia, Italy Model: Gendex, Dens-O-Mat Type: Oralix AC) & OPG (Kodak Dental Systems, France Model: 8000 C Type: CG 810) radiographs were taken on all selected individuals during the following stages:

T1: Preretraction in Group I - after levelling and alignment upto 0.019x0.025 inch SS wire in 0.022" slot and in Group II - after leveling and alignment upto 0.017x0.025 SS wire in 0.018" slot (Fig 1 and 3).

T2: Postretraction in Group I - after retraction and space closure on 0.019x0.025 inch SS wire in 0.022" slot and in Group II - after retraction and space closure on 0.017x0.025 SS wire in 0.018" slot (Fig 2 and 4).

The same IOPA & OPG machines were used for all radiographs, facilitated with standardization of head positioning. Single experienced radiographer carried out all the images & were studied by single orthodontist to examine root resorption. The

author was blinded to group allocation and analysis, as also the intraexaminer errors were eliminated by randomly selecting 50 percent of IOPA & OPG radiographs 30 days after initial recording and repeating their measurements. Crown as well as root lengths of incisors and molars were measured quantitatively as well as correction factor was used for both IOPA as well as OPG values in this research. Root resorption in IOPA and OPG can be accurately measured using this technique after orthodontic treatment.[21]

The left as well as right side data of both the arches and both the groups were pooled with their average being taken.

The under mentioned teeth were evaluated for EARR:

i. Maxillary central and lateral incisors: Incisal edge till root tip.
ii. Mandibular central and lateral incisors: Incisal edge till root tip.
iii. Maxillary first molars: a) Mesiobuccal cusp tip till mesiobuccal root tip, b) Distobuccal cusp tip till distobuccal root tip.
iv. Mandibular first molars: a) Mesiobuccal cusp tip till mesial root tip, b) Distobuccal cusp tip till distal root tip.

A) Intraoral Periapical Radiograph (IOPA): The IOPA's were standardized with x-ray positioning device-XCP (TPC, Advanced technology ,USA, Model: FPS 3000, blue anterior, yellow posterior, Fig 5 & 6) and taken with the paralleling cone technique.

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Fig 5: X ray positioning device –XCP, blue anterior

Fig 6: X ray positioning device- XCP, yellow posterior

The tooth lengths of maxillary (Fig 7) and mandibular incisors and permanent maxillary and mandibular first molars were compared before and after space closure.

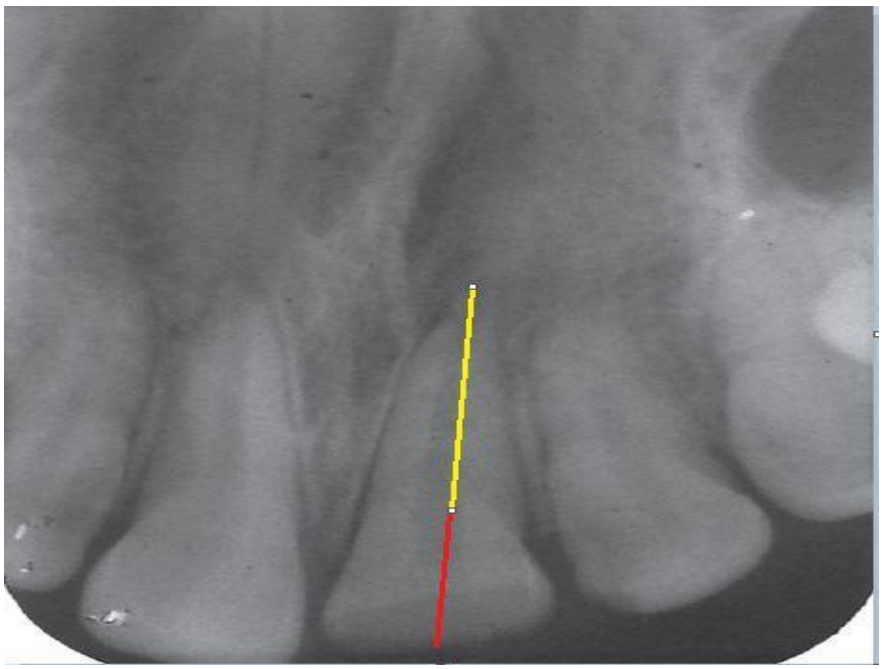

Fig 7: Crown length (red) and root length (yellow) on maxillary anterior IOPA

Crown length registrations were used to determine any image distortion that may have occurred during the preretraction and post-space closure IOPA exposures. It was proposed by Linge B and Linge L (1983).[24] In order to correlate IOPA at preretraction and postretraction, correction factor was determined.[21] (Fig 8)

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Fig 8: (I) Preretraction, (II) postretraction - correction factor

Correction Factor (CF) = C_1/C_2 Here: C_1= preretraction crown length, C_2= post retraction crown length. The apical root resorption in millimetres per tooth was evaluated.

Apical root resorption (ARR) = R_1-(R_2xCF), Here: R_1 = preretraction root length R_2 = postretraction root length, percentage root resorption per tooth was deliberated as: Percentage resorption (%) = ARRx100/R_1. Percentage shortening per tooth was chosen to represent root resorption. Difference in root lengths of different teeth make it difficult to compare root resorption values in millimetres, hence this percentage number is a preferable one to use it as a comparative metric.[21]

B) Orthopantomogram (OPG): In panoramic radiographs to evaluate magnification, permanent maxillary as well as permanent mandibular central incisors on right side of mouth were marked with 10mm 0.019″×0.025″inch stainless steel wire which was placed temporarily from incisal edge towards gingiva parallel to tooth long axis (Fig. 9).

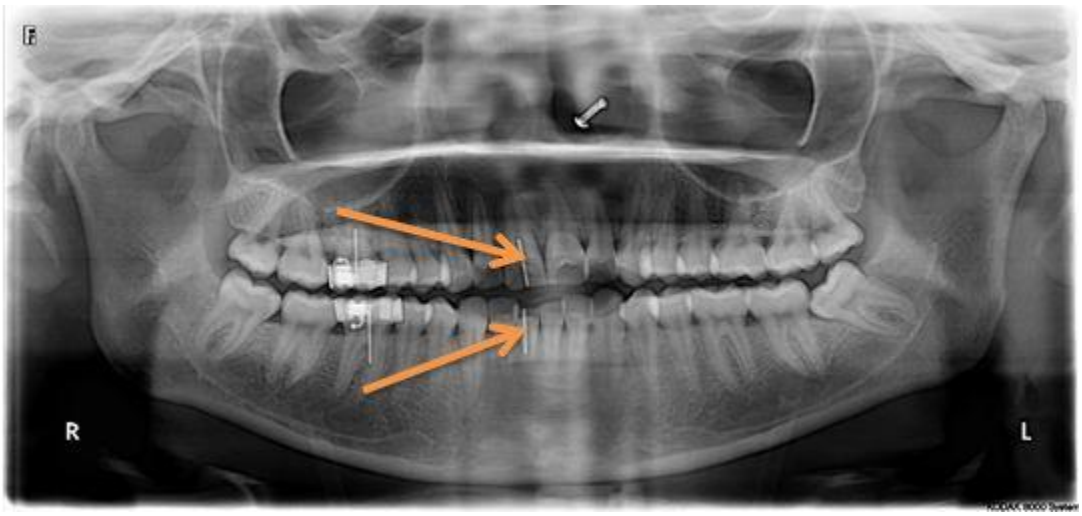

Fig 9: 10 mm 0.019 x 0.025 inch stainless steel wire marker to the permanent maxillary central incisor and permanent mandibular central incisor of right side respectively

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Magnification was shown by comparing real lengths of stainless steel markers to radiographic lengths.[25]

Crown as well as root outlines of all permanent incisors and permanent first molars were traced. For incisors tooth length was calculated from incisal edge to root apex and for molars from cusp tip to root apex following which comparisons were made before and after space closure (Fig 10).

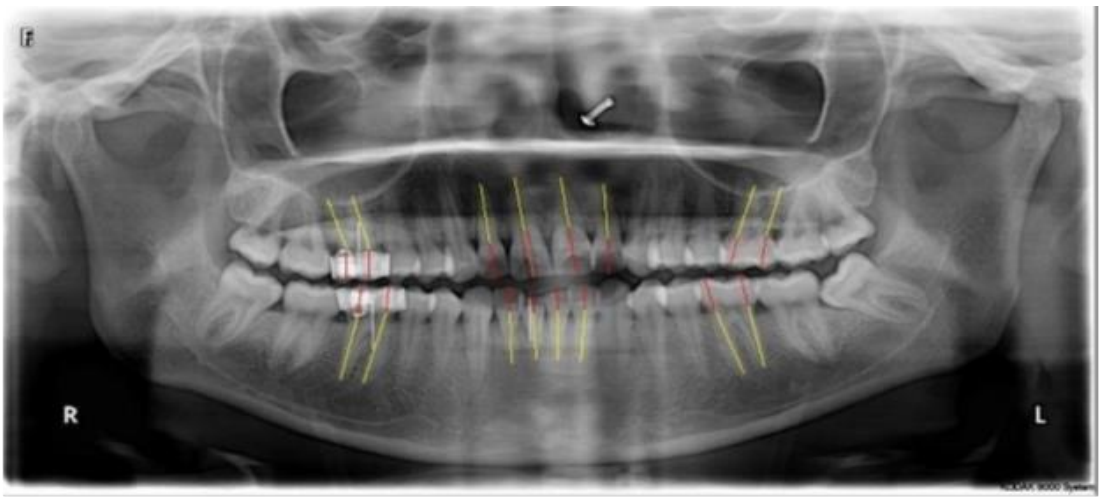

Fig 10: Crown length (red) and root length (yellow) on OPG

Preretraction and postretraction OPG images were compared using crown length registrations to determine any image distortion. Linge BO and Linge L described this approach (1983).[24] A correction factor was derived to link preretraction with post retraction OPG.[21] Correction Factor (CF) = C_1/C_2 Here: C_1 = preretraction crown length, C_2 = postretraction crown length, apical root resorption per tooth in mm was evaluated. Apical root resorption (ARR) = R_1 - (R_2xCF) Here: R_1 = preretraction root length, R_2 = postretraction root length, percentage root resorption per tooth was derived as: percentage resorption (%) = ARRx100/R_1[21]

RESULTS

The preretraction and postretraction (after space closure) IOPA & OPG radiographs were evaluated for the assessment of EARR. The records were analyzed and data were transferred to excel sheets.

Statistical Analysis: For the given below stages, statistical analysis was carried out:

T_1- Preretraction; T_2- Postretraction

By Microsoft Excel 2007 along with SPSS (statistical package for social sciences) statistical software 19.0 Version, data for this research was input. Descriptive statistics included the standard deviation and the mean.

Independent t test was utilized for comparing the variance into average scores between the two groups. Threshold of significance in this investigation was set on $p \leq 0.05$, which is considered substantial.

Independent t-test : Used whenever test statistic would be expected to emulate normal distribution to assess whether two sets of data are statistically different. Independent samples t-test is employed when two sets of independent identically distributed samples are collected, one for every population studied, and results are compared.

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\left(\frac{(N_1 - 1)s_1^2 + (N_2 - 1)s_2^2}{N_1 + N_2 - 2}\right)\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$$

Where X1 = first Group Mean , X2 = Second Group Mean

SD = standard deviation

X = scores obtained

$\overline{X}$ = mean score of data

N =number of scores

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Right and left-side data were gathered, as well as average was calculated from this pooled information.The mean of data of root resorption percentage from *T*1 to *T*2 for incisors and first molars of all selected patient is presented in Table 1 & 2.

TABLE 1 : EXTERNAL APICAL ROOT RESORPTION OF MAXILLARY AND MANDIBULAR FIRST MOLARS AND INCISORS ON IOPA IN PERCENTAGE, AVERAGE OF BOTH LEFT + RIGHT

Tooth	Group I Mean Change ±SD (% Change)	Group II Mean Change ±SD (% Change)	P value
Maxillary CI	0.69±0.42 (5.16%)	0.96±0.57 (5.29%)	0.650
Maxillary LI	0.58±1.31 (5.47%)	0.85±0.54 (6.44%)	0.486
Maxillary Molar (Mesiobuccal)	0.52±0.43 (4.10%)	0.57±0.43 (5.63%)	0.325
Maxillary Molar (Distobuccal)	0.44±0.35 (3.46%)	0.60±0.44 (5.82%)	0.125
Mandibular CI	0.32±0.41 (2.37%)	0.74±0.59 (4.27%)	0.287
Mandibular LI	0.38±0.60 (3.10%)	0.80±0.65 (4.13%)	0.562
Mandibular Molar (Mesial)	0.23±0.64 (3.65%)	0.83±0.41 (5.56%)	0.142
Mandibular Molar (Distal)	0.30±0.70 (4.19%)	0.81±0.48 (6.03%)	0.129

Statistical analysis done using Independent t test at $p \leq 0.05$

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TABLE 2 : EXTERNAL APICAL ROOT RESORPTION OF MAXILLARY & MANDIBULAR FIRST MOLARS AND INCISORS ON OPG IN PERCENTAGE, AVERAGE OF BOTH LEFT + RIGHT

Tooth	Group I – 022" Mean Change ±SD (% Change)	Group II – 018" Mean Change ±SD (% Change)	P value
Maxillary CI	0.75±1.15 (5.02%)	0.87±0.56 (7.27%)	0.215
Maxillary LI	0.67±1.20 (5.85%)	0.75±0.60 (8.01%)	0.123
Maxillary Molar (Mesiobuccal)	0.41±1.02 (5.56%)	0.53±0.45 (6.15%)	0.683
Maxillary Molar (Distobuccal)	0.41±0.97 (5.50%)	0.54±0.36 (6.10%)	0.361
Mandibular CI	0.42±1.27 (5.12%)	0.56±0.74 (6.92%)	0.361
Mandibular LI	0.49±1.28 (4.70%)	0.66±0.58 (6.34%)	0.385
Mandibular Molar (Mesial)	0.27±1.30 (5.58%)	0.79±0.47 (6.72%)	0.550
Mandibular Molar (Distal)	0.23±1.51 (5.34%)	0.76±0.41 (6.92%)	0.404

Statistical analysis done using Independent t test at $p \leq 0.05$

Both groups had variations in external apical root resorption. In group I on IOPA & group II on OPG maxillary incisors showed more root resorption than other teeth whereas in group II on IOPA & group I on OPG maxillary incisors showed root resorption comparable to molars however maxillary lateral incisors showed highest resorption in both the groups on both IOPA & OPG. More external apical root resorption was

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observed in retraction by sliding mechanics in self ligation group II with 0.018" slot while less was observed in self ligation group I with 0.022" slot, which can be attributed to less clearance angle (4.1 degree) after insertion of 0.017"×0.025" stainless steel wire in 0.018" slot.[26]

Finally when comparing between the two groups using independent t test, no significantly substantial variance (p=0.325) was noticed.

Discussion

This study had been carefully planned with strict inclusion and exclusion criteria configured to exclude all potential sources of incorrect data. Selected patients had good oral and general health without any systemic disease and had been advised for following good oral hygiene practices throughout the study period. In orthodontic therapy, resorption of the apical root is common and unwelcome side effect. In spite of this, advancements in orthodontic procedures as well as materials have been made to alleviate this issue.[27] EARR has been connected to variety of parameters including age, gender, systemic diseases, malocclusion type, tooth anatomy, treatment duration, tooth movement type, quantity of orthodontic force, hereditary disposition, as well as the kind of orthodontic appliance.[28-30] According to Becks H[31] endocrine problems such as hypothyroidism, hyperthyroidism, and hyperpituitarism are related to root resorption. Root resorption may be exacerbated by hormonal abnormalities also. No significant differences between the two sexes have been noted in literature.[32] Research has shown that certain shapes are more prone to post orthodontic root resorption. Teeth with pipette-shaped roots experience the most resorption out of all the root types.[33] Dilacerated roots are also more susceptible to resorption. Therefore patients having severely dilacerated incisor roots were excluded from the study.

There's been increasing use of IOPA & orthopantomogram (OPG) to better see root resorption and to provide more precise diagnosis of its extent and location. Periapical radiographs are more accurate than extraoral x-rays when it comes to determining prevalence of EARR. In 2001, Sameshima GT with Asgarifar KO[3] found that on panoramic films the quantity of EARR might be overestimated up to 20%. Furthermore, it was shown that head positioning with respect to tilting is significant cause of inaccuracy in panoramic radiography. Linear measurements for panoramic radiographs recorded at various periods are reliable if occlusal plane is in same position and tilting doesn't surpass 10°, according to Stramotas S et al (2002)[34]. Dental panoramic tomography (OPG) has a narrow focal trough in incisor area, making sometimes apices and palatal structures difficult to see. This is as laid by British Orthodontic Society Radiography Guidelines[35]. When there is a clinical reason, like probable inherent midline or developmental pathology, periapical images should be obtained in additional to dental panoramic tomograph.[36] Furthermore, since IOPA has higher resolution than OPG, so both were employed here. In the present study on IOPA & OPG linear measurements, external apical root resorption was observed from T1 to T2 in both groups, more in group II with 0.018" slot and less in group I with 0.022" slot but in statistical analysis with intergroup comparison using Independent t test it was non-significant. Maxillary lateral incisors have most root resorption in entire dentition.[3,37] They showed highest root resorption in the current investigation also. This might be due to variety of factors. Many researchers -Segal GR et al[38] and Jolien T and Zachrisson BU[39] think that the more a tooth is displaced, the more the root resorption will be. To relocate maxillary lateral incisors to right position they have to move significantly distally because roots of maxillary lateral incisors are commonly shifted mesially. As result of their narrow or curved roots also, maxillary lateral incisors are at increased risk of resorption. Pandis N et al (2010)[40] used panoramic radiographs for comparing volume of EARR between traditional edgewise appliance and passive self-ligating bracket systems and reported no difference in quantity of EARR among different appliance systems. He found that age, gender and extraction treatment just weren't accurate indicators of EARR, although there was a significant relationship between EARR and treatment duration.

Letie EF et al (2012)[41] using cone beam CT (CBCT), determined that although EARR occured throughout all teeth; yet bracket designing made no difference in amount of EARR. Our findings are corroborated by this research. Furthermore there is no significant link between orthodontically induced inflammatory root resorption (OIIRR) and variation in bracket slot and size

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as revealed by retrospective research by Sameshima and Sinclair[42], who looked at several treatment parameters for prediction and prevention of OIIRR. Our investigation also discovered no significant or substantial variation in EARR between 0.022" and 0.018" self-ligating bracket systems during retraction and space closure phase.

To gather further meaningful data in this area of subject more studies are invited as presently few are there comparing EARR between 0.022" and 0.018" self ligating bracket systems.

Conclusion

More EARR was observed in 0.018" slot and less in 0.022" slot but it wasn't statistically substantial, maxillary lateral incisors had highest resorption.

There was statistically no significant difference in external apical root resorption with sliding mechanics when comparing 0.022" and 0.018"self ligating MBT bracket systems from preretraction to postretraction and space closure.

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Nil.

Conflicts of interest

Nil.

Data Availability Statement

The data pertaining to this article is within the manuscript and its supplementary material.

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