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RESEARCH ARTICLE

INCIDENCE OF APICAL ROOT RESORPTION IN SEGMENTAL CANINE RETRACTION USING FRICTION AND FRICTIONLESS MECHANICS

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ABSTRACT

Aim: To evaluate the incidence and amount of periapical root resorption of maxillary and mandibular canines during fixed orthodontic treatment using friction and frictionless mechanics. **Materials and Methods:** The study population included patients aged in between 14 to 20 years undergoing orthodontic treatments in the Dept. Of Orthodontics and Dentofacial Orthopaedics. Twenty samples were selected by convenience sampling method and were divided into two groups namely, Group A (n=10): Segmental canine retraction using frictionless mechanics .Group B (n=10): Segmental canine retraction using friction mechanics. The group A and B patients underwent first pre molar extraction, 0.022 MBT brackets were bonded. The pre retraction radiographs and post retraction radiographs of maxillary and mandibular canines was obtained by standardized technique and external apical root resorption was evaluated using SOREDEX DIGORA imaging software. **Result:** The between group comparision i.e pre retraction and post retraction of frictionless mechanics and friction mechanics showed Z value of -1.250 and P value of 0.211 for pre retraction values and Z value of -1.402 and P value of 0.161 for post retraction values. The comparison of pre retraction values of two groups showed there is no statistically significant difference between two groups and hence they can be compared after intervention. The comparison of post retraction values of two groups showed there is no statistically significant difference between two groups. In within the group comparison the mean difference, Z value and P value of frictionless mechanism is 0.5, 0.00 and 1.00 respectively. The mean difference, Z value and P value of friction mechanism is 0.5, -1.0 and 0.310 respectively. **Conclusion:** Segmental canine retraction using friction and frictionless mechanics produces the same amount of apical root resorption.

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INTRODUCTION

External apical root resorption (EARR) is a common clinical condition of orthodontic treatment. EARR is the permanent shortening of the end of the tooth root that can be seen on routine dental radiographs. Although EARR is seen in any or all teeth, it is most commonly seen in maxillary incisors. For many orthodontic patients maxillary central incisors EARR can average 1 to 2 mm from the original tooth root length, with essentially no effect on function (Parker, 1998). In apical resorption, an assessment of the radiographic outline of the apex serves as a useful tool regarding the risk during orthodontic treatment (Levander E, Malmgren O. 1988). A root resorption index permits quantitative assessment of root conditions before treatment and can be used for further resorption (Goldson L, 1975). Experiments have revealed that the anatomic environment constitutes an important factor during tipping movement and intrusion (Reitan K, 1974).

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The degree of root damage is often stated as being a function of the appliances used. Linge and Linge (Linge, 1983) compared root resorption resulting from fixed and removable appliances and they concluded that fixed appliances are more detrimental to the roots. Many authors measured the effect of the apical root resorption with various orthodontic therapies with lack of measuring in different mechanics used for tooth movement. Mostly all of the authors investigated the rate of external root resorption by the means of intraoral periapical radiographs. In recent trends, digital radiography seems to be playing a vital role in diagnosis and treatment due to many advantages like accuracy, exposure of radiation. The term digital in digital imaging refers to the numeric format of the image content and its discreteness. Digital images are numeric and discrete in two ways: 1) different shades of grey with their pixels and 2) spatial distribution of the picture elements. Production of a digital image requires a process called analog to digital conversion (ADC). Photostimulate phosphor (PSP) tends to be one of the useful distinct digital image receptor (Heinz Von Seggern, 1992).

There is no robust evidence of digital radiography in measuring the EARR in maxillary and mandibular canines. Thus, the idea of interest of this study is to evaluate the apical root resorption in maxillary and mandibular canine with friction and frictionless mechanics during segmental canine retraction using intraoral imaging plates (PSP).

Aim: To evaluate the incidence and amount of periapical root resorption of maxillary and mandibular canines during fixed orthodontic treatment using friction and frictionless mechanics.

Objectives: The present study was conducted with the following objectives,

- To assess the amount of periapical root resorption in frictionless mechanics of segmental canine retraction.

To assess the amount of periapical root resorption in friction mechanics of segmental canine retraction.

MATERIALS AND METHODS

The present cross sectional study was conducted in the Department of Orthodontics and Dentofacial Orthopedics. The study was planned and organized to evaluate the incidence of apical root resorption in segmental canine retraction using Friction and Frictionless mechanics. The study design and protocol was analyzed and approved by the Institutional Review Board and Institutional Ethics. A written consent in mother tongue was also obtained from the patients who participated in the study.

Armentarium used

- Diagnostic instruments – Mouth Mirror, Straight Probe in kidney tray
- Disposable mouth masks.
- Disposable gloves.
- Stainless steel ligature wire
- 17 X 25 TMA Wire
- 19 X 25 Stainless steel wire
- 3M Alastik modules
- Bird beak plier
- Distal end cutter
- Light wire cutter
- Mathieu ligating plier
- X Ray unit (Make: X-mind DC/ Model: Satelec Acteon)
- Dentsply film holder
- Digital Radiography (Soredex digora optime, Imaging plate system)
- Soredex digora imaging software

Sample Selection: The study population included patients aged in between 14 to 20 years undergoing orthodontic treatments in the Dept. Of Orthodontics and Dentofacial Orthopaedics.

Inclusion Criteria

- Patients undergoing fixed orthodontic treatment.
- Cases undergoing first premolar extraction.

Exclusion criteria

- Patients with special health care needs.
- Patients with other dental defects like amelogensisimperfecta, turner's hypoplasia.
- Patients with medical illness.
- Patients who are not willing for the study.

Study Samples: Twenty samples were selected by convenience sampling method and were divided into two groups namely,

Group A (n=10): Segmental canine retraction using frictionless mechanics.

Group B (n=10): Segmental canine retraction using friction mechanics.

Data collection: The group A and B patients underwent first pre molar extraction, 0.022 MBT brackets were bonded. The pre retraction radiographs and post retraction radiographs of maxillary and mandibular canines was obtained by following the standardized technique. The patients were seated in upright position in the dental chair and were subjected to dental intraoral periapical radiographs of maxillary and mandibular canine. The radiographs were taken with the digital radiography by Sordex Digora Optime intraoral imaging plate (size1)for the entire study. To avoid errors associated with positioning of the plate, Dentsply x-ray film holder (model No:540861) was used. The X-ray unit used was X-mind DC (Model: SATELEC Acteon). The exposure time, kilovoltage peak and tube current used were 0.125seconds, 70kVp and 4mA respectively. The samples of group A and B were first taken pre retraction Intraoral periapical radiograph using Sordex Digora Optime intraoral imaging plate. The image collected was stored in the computer. Group A and B underwent orthodontic treatment by extraction of first pre-molars. Group A patients were subjected to frictionless mechanics using T-loops for segmental canine retraction.Group B patients were first aligned using 0.016" copper Niti wire in 0.022 slot, Pre adjusted edgewise appliance, MBTmechanotheraphy. After 6-8 weeks of alignment was followed by 0.017x0.025" TMA and 0.019x0.025" SS wire.The Group B individuals were subjected to frictional mechanics of canine retraction by Benett method.

Post retraction Intraoral periapical radiograph were taken after retraction using Sordex Digora Optime intraoral imaging plate. By using Sordex Digora software, the degree of root resorption was assessed by measuring the length of canine from incisal tip to the apex of the root using scaler tool grids. The Pre retraction and post retraction radiographs were assessed and investigated each twice by one investigator. The values were noted as observation1 and observation2. The average of all the readings were noted and subjected to the calculation formula to note the difference in external apical root resorption between friction and frictionless mechanics. The values obtained are tabulated in the following tables.

Statistical analysis: Statistical analysis was performed using software statistical package for social sciences (spss,version 22,IBM Crop.2013). The descriptive statistics was done to evaluate the mean and standard deviation of pre and post retraction canine length in friction and frictionless mechanics. The statistical analysis was performed using Mann- Whitney U test to describe between group comparision i.e, friction and frictionless mechanics. P value lesser than 0.05 is considered statistically significant. The Wilcoxon signed ranks test was performed to describe comparison within the group and P value lesser than 0.05 is considered statistically significant.

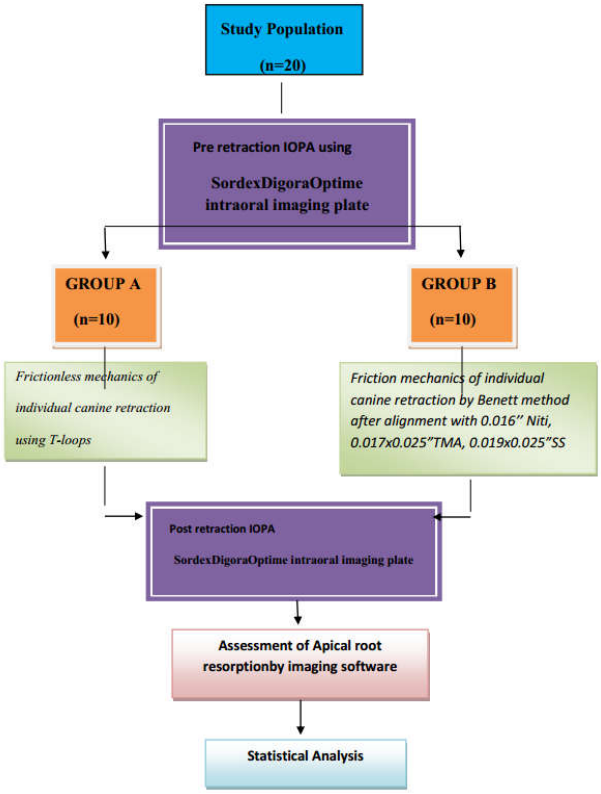


Chart 1. Flowchart of the Methodology

The formula used to evaluate the mean of the sample is

($\sum xi/n$),

The formula used to evaluate the standard deviation is

$\sqrt{\sum(x-x)^2/n-1}$,

The formula used to evaluate Mann- Whitney U test is

U1=R1 – n1(n1+1)/2 and

The formula used to evaluate Wilcoxon test is **σ:**

$\sqrt{((n(n+1)(2n+1))/24)}$

RESULTS

In frictionless mechanics the mean of pre retraction, observation 1 is 23.380 and standard deviation is 1.3315. The mean of pre retraction, observation 2 is 23.390 and standard deviation is 1.4325 and hence the mean and standard deviation of pre retraction frictionless mechanics is 23.385 and 1.3806 (Table 3). In frictionless mechanics the mean of post retraction, observation 1 is 23.340 and standard deviation is 1.3401. The mean of post retraction, observation 2 is 23.330 and standard deviation is 1.2482 and hence the mean and standard deviation of post retraction frictionless mechanics is 23.335 and 1.2873 (Table 3). In friction mechanics the mean of pre retraction, observation 1 is 22.970 and standard deviation is 2.7484. The mean of pre retraction, observation 2 is 22.930 and standard deviation is 2.5188 and hence the mean and standard deviation of pre retraction friction mechanics is 22.950 and 2.6287 (Table 4). In friction mechanics the mean of post retraction, observation 1 is 22.910 and standard deviation is 2.7819.

Fig. 1. Basic Armentarium

Fig. 2. Group A Materials

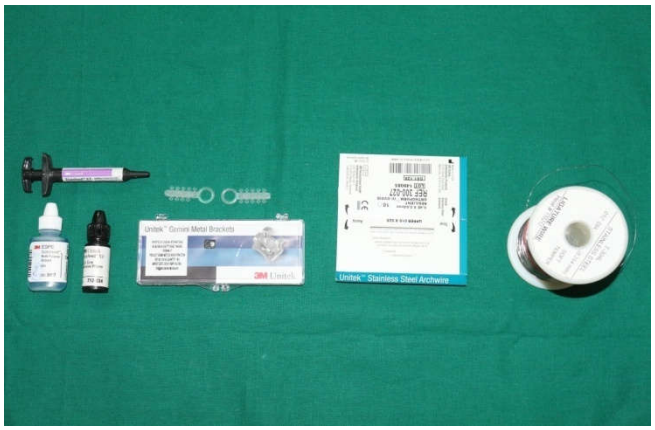


Fig. 3. Group B Materials

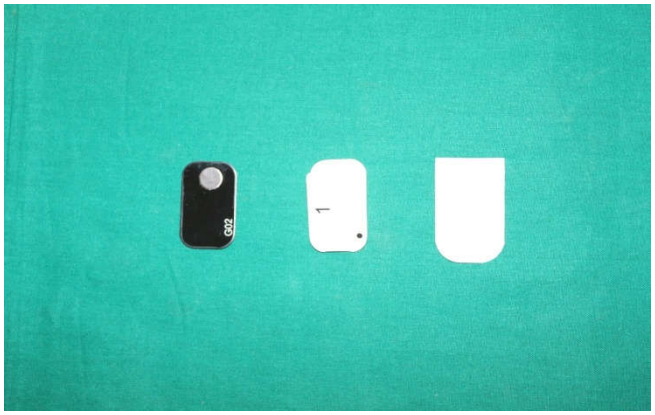


Fig 4. Soredex Digora Optime, Imaging pla

Table 1. The pre retraction length and post retraction length in frictionless mechanics

S.No	Op.No	Name	Tooth. No	Pre. Length 1	Pre. Length 2	Post. Length 1	Post. Length 2
1	505540	Jeevitha	13	23.2	23	23	23.4
2	505540	Jeevitha	23	25.2	25.3	25.4	25
3	442569	Krishnadarshini	13	24.4	24.4	24.4	24.6
4	442569	Krishnadarshini	23	25.2	25.6	25	24.5
5	442569	Krishnadarshini	33	21.4	21.3	21.4	21.3
6	442569	Krishnadarshini	43	23.4	23.3	23.2	23.5
7	518053	Sasirekha	13	24	24	24	24
8	518053	Sasirekha	23	23	23	23	23
9	518053	Sasirekha	33	22	22	22	22
10	518053	Sasirekha	43	22	22	22	22

Table 2. The pre retraction length and post retraction length in friction mechanics

S.No	Op.No	Name	Tooth. No	Pre. Length 1	Pre. Length 2	Post. Length 1	Post. Length 2
1	344923	Ajith kumar	13	21.6	21.5	21.3	21.5
2	344923	Ajith kumar	23	22.2	22.2	22.1	22.3
3	440491	Gowsika	13	28	28	28	28
4	440491	Gowsika	23	28	27	28	28
5	447533	Ashwin	13	23	23	23	23
6	447533	Ashwin	23	22	22.5	22	22
7	442363	Sureka	13	22	22	21.9	21.3
8	442363	Sureka	23	21.7	21.5	21.7	21.5
9	442363	Sureka	33	20.3	20.6	20.3	20.4
10	442363	Sureka	43	20.9	21	20.8	20.9

Table 3. Descriptive statistics showing the mean and standard deviation of frictionless mechanics

	Mean	STD. Deviation
Pre – Observation 1	23.380	1.3315
Pre – Observation 2	23.390	1.4325
Mean Pre – Observation	23.385	1.3806
Post – Observation 1	23.340	1.3401
Post – Observation 2	23.330	1.2482
Mean Post – Observation	23.335	1.2873

Table 4. Descriptive statistics showing the mean and standard deviation of friction mechanics

	Mean	Std. Deviation
Pre – Observation 1	22.970	2.7484
Pre – Observation 2	22.930	2.5188
Mean Pre – Observation	22.950	2.6287
Post – Observation 1	22.910	2.7819
Post – Observation 2	22.890	2.7875
Mean Post - Observation	22.900	2.7821

Table 5. Between group comparison (frictionless mechanism & friction mechanism)

	Z Value	P Value
Pre – Retraction	-1.250	.211
Post – Retraction	-1.402	.161

Table 6. Within the group comparison (pre and post retraction root length)

	Mean Difference	Z Value	P Value
Frictionless Mechanics	0.5	0.00	1.OO
Friction Mechanics	0.5	-1 .0	.310

The mean of post retraction, observation 2 is 22.890 and standard deviation is 2.7875 and hence the mean and standard deviation of post retraction frictionless mechanics is 22.900 and 2.7821 (Table 4). The between group comparision i.e pre retraction and post retraction of frictionless mechanics and friction mechanics showed Z value of -1.250 and P value of 0.211 for pre retraction values and Z value of -1.402 and P value of 0.161 for post retraction values. The comparison of pre retraction values of two groups showed there is no statistically significant difference between two groups and hence they can be compared after intervention.

The comparison of post retraction values of two groups showed there is no statistically significant difference between two groups. This infers is no difference between two types of mechanics (Table 5). In within the group comparison the mean difference, Z value and P value of frictionless mechanism is 0.5, 0.00 and 1.00 respectively. The mean difference, Z value and P value of friction mechanism is 0.5, -1.0 and 0.310 respectively. Hence comparison of Pre and post value of two groups showed that there is no statistically significant difference between pre and post retraction canine length (Table 6).

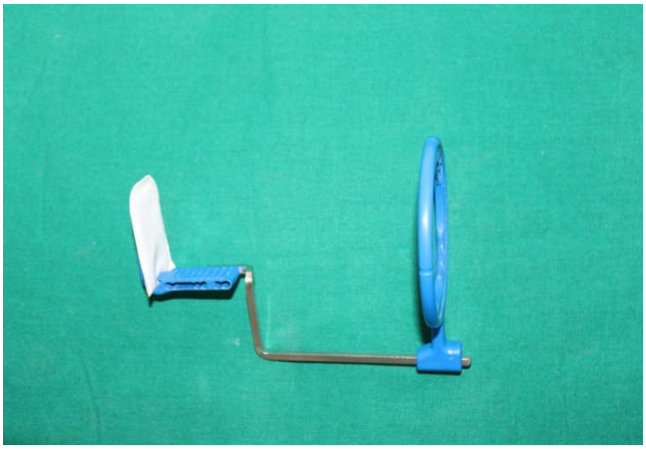


Fig. 5. Dentsply film holder

Fig. 6. X Ray unit (Make: X-mind DC/ Model: SATELEC Acteon)

Fig 7. Patient positioning

Fig. 8. Soredex digora optime Image Processor

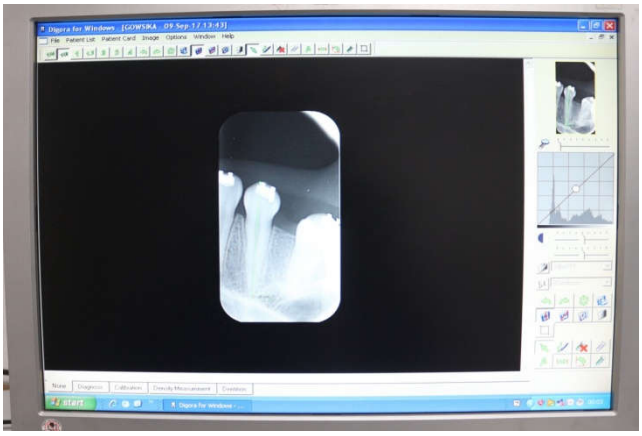


Fig. 9. Soredex Digora imaging software

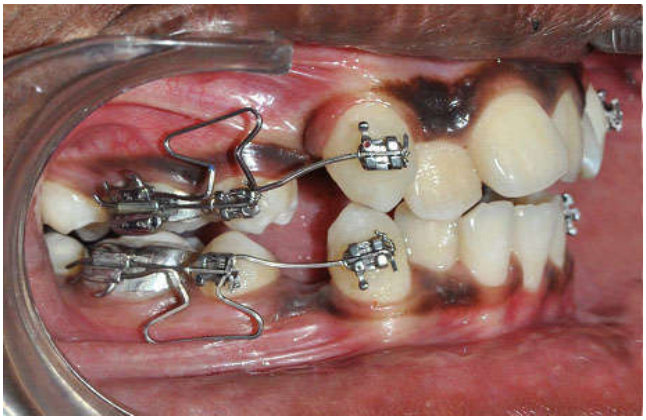


Fig. 10. An example of Group A image

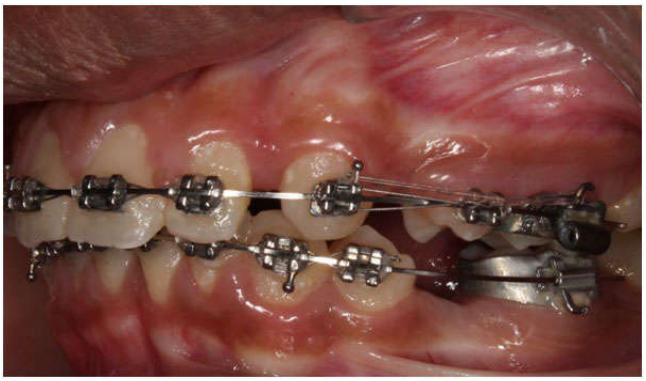


Fig. 11. An example of Group B image

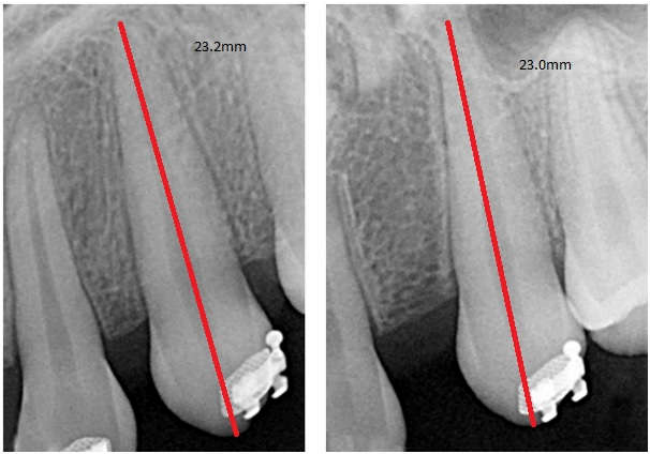
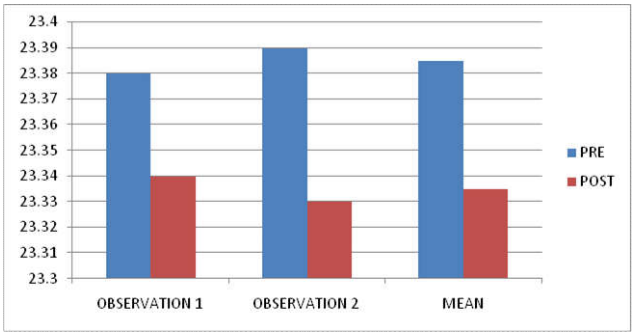
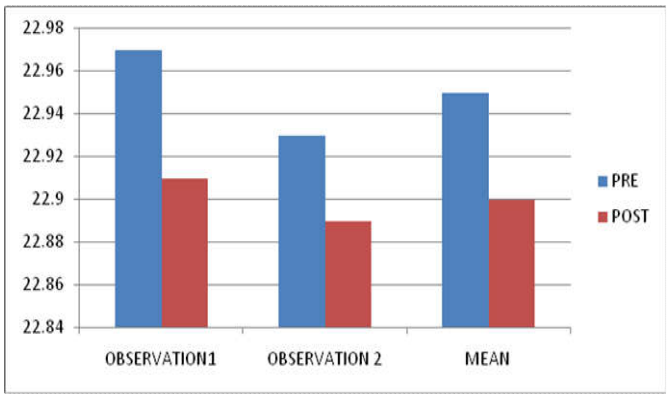


Fig. 12. An example of Pre- Retraction and Post-Retraction radiograph



Graphical representation 1 Mean and standard deviation of frictionless mechanics



Graphical representation 2. Mean and standard deviation of friction mechanics

DISCUSSION

External apical root resorption is the permanent shortening of the end of the tooth root that can be seen on routine dental radiographs. Although EARR is seen in any or all teeth, it is most commonly seen in maxillary incisors. EARR is the most common sequelae following orthodontic force application. Odontoclasts are multinucleated cells responsible for the resorption of dental hard tissues by doing the damage. These cells are morphologically and functionally similar to osteoclasts (Edward, 1997). Root resorption is a condition being related and not related to orthodontic treatments. Ketcham (Ketcham, 1929), Becks (Beck, 1994), and Hemley (Henry, 1951) found in their study that 21% of their orthodontically treated individuals had root resorption. Rudolph, Malone, Massler and Phillips (Brezniak, 1993) found that 100% of their patients had external apical root resorption. Study by Jon Artun (Jon Artun, 2005) showed that risk of EARR is more in first and second month of fixed orthodontic treatment. Thus this study provides the information on the incidence of apical root resorption in orthodontically managed patients.

According to previous study by Brita Ohm Linge and Leif Linge (Ohm, 1973) the possible etiologic or risk factors of external apical root resorption are individual predisposition; hormonal, genetic and nutritional factors, trauma, age of the patient, onset of root formation stage of treatment, type of tooth movement and treatment duration. Sex distribustion of the individuals is not a reliable predictor for external apical root resorption. Odenrick and Brattstrom, (1983) found a higher degree of external apical root resorption before and after treatment among nail bitters. The permanent shortening of end of the tooth root is seen on routine dental radiographs but most of this does not decrease the functional capacity of the involved tooth. Though external apical root resorption is a common sequelae of fixed orthodontic treatment, it does not affect the functional capacity or vitality of a affected tooth. There are certain drugs like bisphosphonates, doxycycline, celrbrex[60] reduces the risk of external apical root resorption without affecting the tooth movement. Previous study by Bailey TE, Shamy IE and Graber TM (Tarek, 2004) showed that low intensity pulsed ultrasound (LIPUS) minimized root resorption and accelerated healing of the resorption by formation of reparative cementum over 4 weeks of LIPUS application. Shaza Abass and James Hartsfield stated that although EARR can occur in many or all teeth, it most often involves the maxillary incisors. For many other orthodontic patients maxillary central incisor EARR can average 1 to 2 mm from the original pre treatment root length with essentially no effect on function (Shaza, 2007). Approximately 1 to 20 patients undergoing orthodontic treatment can have upto 5mm of tooth root loss, potentially endangering the longevity of the tooth[59] and it may also occur in the absence of orthodontic treatment. A total of 7 to 13% of individuals who have not had orthodontinc treatment show 1 to 3mm of EARR radiograghically (Shaza, 2007). Most of all literatures include the region of incisors and there is more lack of literature associated with canine region. In a study by Pandis N,et.al,[44] showed that there is no difference in root resorption as expected between self ligating and conventional edgewise brackets with respect to root resorption, our study was done to elict the incidence of root resorption in fixed appliance of same mechanotheraphy with different techniques of canine retraction.

Fixed orthodontic appliances using pre-adjusted edgewise mechanics usually involves segmental canine retraction by friction and frictionless mechanics. Thus this study attempted to include the canine region by using friction and frictionless mechanics. In friction and frictionless mechanics the force exerted in the direction of orthodontic tooth movement leads to compression of periodontal ligament between tooth and alveolar bone. Due to heavy force over long duration, periodontal ligament is injured following hylanized tissue formation. The process of resorption is associated with the remodeling of periodontal ligament as a result of its injury and necrosis. The various friction mechanics (sliding mechanics) of individual canine retraction are; elastomeric chains, elastic modules with ligature, closed coil springs and various methods in frictionless mechanics (loop mechanics) are PG canine retraction spring, opus loop, Burstone T loop, mushroom loop and rectangular loop (Ruchi Sharma, 2015). According to study by Claire Nattrass, Anthony J. Ireland, Elastomeric chain was affected by both temperature and environment. The Closed coil springs seems to be relatively unhygienic comparing to elastic system (Ruchi Sharma, 2015) and hence Elastic modules with ligature is used in this study for individual canine retraction by frictional mechanics. The Burstone T loop is considered to be highly standardized universal loop for segmental canine retraction, it has lower load deflection rate, it delivers a more constant force and M/F ratio[54] and hence it is used for individual canine retraction by frictionless mechanics. Clinically, radiography is the only method of diagnosing root resorption. The various methods used in literatures to determine the amount of apical root resorption are periapical radiographs, panoramic radiographs, cephalometric radiographs used along with various measuring methods.

Study by Sameshmia and Asgarifar (Glenn, 2001) showed that amount of external apical root resorption might be overestimated up to 20% on OPG and the source of error associated in association in OPG is head positioning with respect to tilting. Hence periapical radiograph is used in this study to determine the incidence of apical root resorption. Alexander dudic and Catherine Giannopoulou (Alexander Dudic, 2008) showed that use of digital radiograph in long cone paralleling technique results in lesser image magnification and distoration, lesser measuring errors comparing with conventional periapical radiograph. Since there is no standardized long cone paralleling technique using RVG, PSP imaging plate is used and PSP imaging plates are flexible and thin than RVG sensor (Van Der Stelt, 2005).

In this study, to eliminate the errors associated with operator bias, two observations were taken. The operator variability is determined by taking two observations by observer over an interval period of 15days for both friction and frictionless methods. In frictionless mechanics, the mean±SD of pre-op is about 23.38±1.33 for observer 1 and 23.39±1.43 with a mean difference of 23.38±1.38. The mean±SD of post-op is about 23.34±1.34 for observer 1 and 23.33±1.24 with a mean difference of 23.33±1.28. Whereas in friction mechanics, the mean±SD of pre-op is about 22.97±2.74 for observer 1 and 22.93±2.51 with a mean difference of 22.95±2.62. . The mean±SD of post-op is about 22.91±2.78 for observer 1 and 22.89±2.78 with a mean difference of 22.9±2.78. Comparison of pre value of between two groups showed there is no statistically significant difference between friction and frictionless mechanics with p value of 0.211 and 0.161 with pre-op and post-op respectively.

The results showed there is no statistically significant difference between two groups so there is no difference between two types of mechanics. On comparison of pre and post retraction canine length, the mean difference, Z value and P value for friction (p= 0.310) and frictionless (p=1.00) mechanics have no statistically significant difference suggesting that the root resorption caused by friction and frictionless mechanics are nearly equal. EARR is a varied and dynamic defect highly influencing the management of orthodontic movements. The findings of this study may increase the level of knowledge amongst orthodontists towards the appropriate management strategies regarding EARR

Conclusion

- Segmental canine retraction using friction and frictionless mechanics produces the same amount of apical root resorption.
- The intraobserver error noted is also insignificant.

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