IMPACT: International Journal of Research in Applied, Natural and Social Sciences (IMPACT: IJRANSS)
ISSN (P): 2347–4580; ISSN (E): 2321–8851
Vol. 9, Issue 12, Dec 2021, 19–36

ROOT RESORPTION IN MAXILLARY & MANDIBLAR ANTERIOR SEGMENT DURING ACTIVE ORTHODONTIC TREATMENT – A CBCT STUDY

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Received: 24 Dec 2021 **Accepted:** 29 Dec 2021 **Published:** 31 Dec 2021

ABSTRACT

'What we do not see does not mean it does not exist.... ' (Graber)

Root resorption is defined as the loss of root structure that involves mineralized and non-mineralized cementum and dentine. It can be part of a physiological process during the exfoliation of the deciduous teeth or it can imply a pathology. Pathological root resorption can be either internal or external depending on the part of the root that is affected (Bishara, 2001).

In internal root resorption, the process is originated from the cells in the pulp and affects the internal wall of dentin while in external root resorption the process starts from the periodontium and affects the external and lateral surfaces of the root (Tronstad, 1988a)

KEYWORDS: *Root Resorption, Orthodontic Treatment*

INTRODUCTION

Root resorption is a common complication associated with orthodontic treatment. Physiological and pathological factors are responsible for a destruction of root structure. The consequences of root resorption range from slight tooth mobility due to small amounts of root loss to complete tooth loss from excessive amounts of resorption. Radiographically, the resorption may appear as either an apical root blunting, lateral root resorption or in rare cases excessive root loss. Root resorption may be pathologic or physiologic in nature and it may also occur in association with orthodontic tooth movement. Physiological resorption occurs during the exfoliation of the primary dentition and mesial drifting in the permanent dentition. The mineralized tissues of the permanent dentition are not normally resorbed. Pathological resorption occurs subsequent to a traumatic injury, pathological disease process or iatrogenic causes.

External apical root resorption is an undesirable as well as least predictable sequel of orthodontic treatment. It can occur during treatment or post-treatment, raising questions about the longitivity of therapy &the stability of treatment results. It has been proven beyond doubt that along with other factors, orthodontic force application can act as a stimulus for initiating the iatrogenic response. [1,2]

Resorption of root apices is a ubiquitous occurrence in orthodontic treatment. Although most occurrence of resorption during orthodontic treatment is clinically inconsequential, a small percentage of patients have a severe amount of root structure that is lost. There are factors that are widely accepted as responsible for root resorption (RR), such as heavy compressive forces on the periodontal ligament (PDL). Unfortunately, it is still largely unpredictable if one patient

will experience more root loss than what is considered normal. Thus, it is of clinical interest to further study what factors play a role in RR.[3]

Many parameters such as type of malocclusion, extraction verses non-extraction, the type of appliance used weather removable, fixed or functional, the type of tooth movement performed and the duration of force application further complicate the methodology of research. Of various tooth movements, intrusion and torque are most commonly associated with the resorption process. Also on the evaluation of the type of the force applied- continues verses interrupted on the resorption pattern showed less severe apical blunting and smaller resorption affected areas when interrupted forces are applied.[3]

Apical root resorption (RR) is an irreversible iatrogenic effect that can occur with orthodontic treatment. Although most RR during orthodontic treatment is clinically inconsequential, severe RR, although rare, is problematic. For those with severe RR, avoidance of further root loss becomes a primary objective, leading to limitations of treatment and possibly an esthetic compromise. After treatment the patient remains at risk for tooth loss for those teeth affected.[4-7]

Orthodontic force applied to the biologic system act similarly on bone and cementum which are separated by periodontal membrane. Since cementum is more resistant to resorption as compared to the more vulnerable bone, applied force usually causes tooth resorption which leads to bone resorption. Resorption of the cementum and the dentin is thus an untoward sequel. Root resorbing i.e. odontoclasts has similar cytogenic and functional characteristics as that of osteoclasts. Recently published articles [1,8,9] demonstrate that resorbing activity as a response to mechanical and chemical stimuli by the periodontal ligament cells, is characterized by synthesizing prostaglandin E with concomitant release of cAMP. This process is regulated by hormones such as parathyroid and calcitonin, neurotransmitters e.g substance P, vasoactive intestinal peptide, cytokines such as interlukin 1 alpha, 1 beta & tumor necrosis factor.

It is widely accepted that heavy compressive forces on the periodontal ligament (PDL) create hyalinized zones which lead to the destruction of the protective cementum layer covering the root.[10,11,12.] However, magnitudes of force that the clinician delivers are often unknown and certain directions of tooth movement may increase the incidence of root resorption. However, there are areas of controversy regarding which directions of tooth movement or orthodontic appliances are associated with more resorption.11 Most previous studies regarding RR have been limited to the use of periapical films, panoramic radiographs, and lateral cephalograms to measure root length and tooth position changes. Image distortion and image superimposition make these radiographic 12 images unreliable for measuring root resorption. Conversely, cone-beam computed tomography (CBCT) has been shown to be superior for diagnosing and measuring RR.[13,14,15.]

Quantitative as well as qualitative resorption process is required to prevent the occurrence of the most common iatrogenic damage following orthodontic tooth movement. Of the various method employed e.g. clinical, histological, radiographic, & biologic markers, radiographs remain the most important tool for evaluation of pre-treatment, in process and post-treatment status of tooth roots. The grading criteria's of Sharpe et a and scoring criteria of Levander & Malmgren are the most commonly used. [6,7,8]

So there were many studies done to highlight the various aspect associated with the orthodontic root resorption mainly the etiology, patho-physiology, histopathilogy, methods of assessment and the treatment modalities employed in addition to a overview of current genetic and molecular research related to the resorptive process.

AIMS AND OBJECTIVES

Aim

To evaluate amount of root resorption in maxillary and mandibular permanent anterior teeth during fixed orthodontic treatment.

Objectives

The objectives of this study is to accesses the root resorption in maxillary and mandibular anterior teeth at the end of leveling and alignment phase.

MATERIAL AND METHOD

Material

The sample consists of 30 patients with full complement of teeth in both maxillary and mandibular arch .Cone Beam Computed Tomographic (CBCT) images of 30 patients undergoing fixed orthodontic treatment with their maxillary and mandibular segments.

Method

Cone beam computed tomographic images (CBCT) would be taken at their pre- treatment after extraction of the 1st premolarand at the post CBCT I taken at the end of levelling and alignment i.e. 0.016X0.022 NiTi in maxillary and mandibular anterior teeth of 30 patients from the department of orthodontic who were willingly undergoing orthodontic treatment and the treatment plan which was formulated was all premolar extraction. The following parameter was analysed.

CBCT will be taken during two stages

- T_0 - pre-treatment CBCT of maxillary and mandibular anterior teeth.
- T_1 - CBCT at the end of levelling and alignment stage.

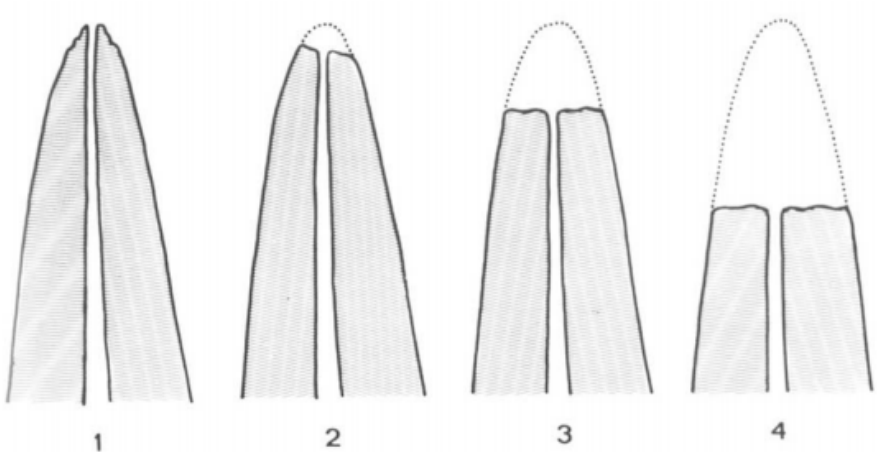

Figure 1

Parameters to Included in the Study are

- Region of root resorption:- Apical 1/3rd

  Middle 1/3rd

  Coronal 1/3rd

- Teeth included in root resorption:- central incisors,

  lateral incisors

  canine

- Extent of root resorption:- extending upto cementum

  extending upto dentin

  involving pulp

The treatment protocol for the purpose of the study will be standardized using an MBT pre adjusted appliances with 0.018 slot

- Stage I - Initial levelling and alignment would be done using
  - 0.016" Niti in upper and lower arch for 4 weeks,
  - 0.016"X 0.022" Niti in upper and lower arch for 4 weeks,
  - 0.016 X 0.022 SS in upper and lower arch for 3 weeks.

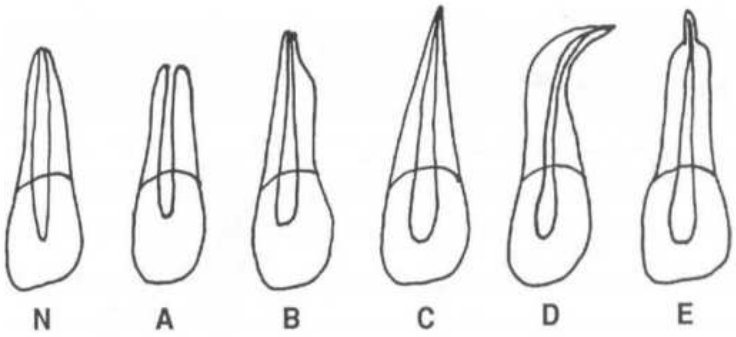

Fig 3. Criteria for subjective scoring of root form. **N**, normal; **A**, blunt; **B,** eroded; **C,** pointed; **D,** deviated; **E,** bottle shaped. Adapted from Mirabella and Årtun.[11]

Figure 2

The CBCT of each patient was evaluate by using a CBCT software CS 3D imaging3.5.18.0 tool I used for evaluation of the root resorption of the upper and the lower anterior. The measurement was evaluated by using the measurement tool given in that software for measurement. A bisecting line was drawn from the centre of the central, lateral, and canine of both the side. The root is divided into three part from the root tip to the cemento-enamel (CEJ) i.e. the apical one third, the middle one-third and the coronal one-third. The extent of the root resobtion is divided into three part .i.e. extending upto cementum, extending upto dentin, and involving pulp.The mean is taken for the left and the right in both the pre-cbct & pot-cbct.

INCLUSION CRITERIA

- Patient age - 16-25 years..
- Permanent Dentition with full complement of teeth and fully developed roots in anterior segments.
- In all the cases who are undergoing therapeutic extraction of all 1st premolars
- Patients with crowding in anterior region.
- Patients with no signs of previous root resorption
- No history of previous orthodontic treatment.

EXCLUSION CRITERIA

- Patients with amelogenesis imperfect, mesiodense, tourodontism, dentinogenesis imperfecta.
- Patients with syndrome.
- Patients with history of trauma
- Patients wit periapical pathology
- Patients with periodontally compromised teeth.
- Patients with caries
- Patients with supernumerary teeth.
- Patients with oligodontia, impacted canines, multiple unerupted tooth.

STATISTICAL ANALYSIS

Method of Data Analysis

SPSS Inc. Released 2007. SPSS for Windows, Version 16.0. Chicago, SPSS Inc software was used to analyse the data.

Statistical analysis was done by using tools of descriptive statistics such as Mean, and SD for representing quantitative data (e.g. root length)

Probability $p<0.05$, considered as significant as alpha error set at 5% with confidence interval of 95% set in the study. Power of the study was set at 80% with beta error set at 20%

Paired t test was used for intra -comparison of each group before and after a study duration.

Paired "t" Test

A paired t-test is used to compare two population means where you have two samples in which observations in one sample can be paired with observations in the other sample. Examples of where this might occur are:

- Before-and-after observations on the same subjects (e.g. students' diagnostic test results before and after a particular module or course).

- A comparison of two different methods of measurement or two different treatments where the measurements/treatments are applied to the same subjects (e.g. blood pressure measurements using a stethoscope and a dynamap).

Let x = test score before the module, y = test score after the module

To test the null hypothesis that the true mean difference is zero, the procedure is as follows: 1. Calculate the difference (di = yi − xi) between the two observations on each pair, making sure you distinguish between positive and negative differences.

- Calculate the mean difference, d.
- Calculate the standard deviation of the differences, sd, and use this to calculate the standard error of the mean difference, SE(¯ d) = √ sd n
- Calculate the t-statistic, which is given by T = ¯ d SE(¯ d) . Underthe null hypothesis, this statistic follows a t-distribution with n − 1 degrees of freedom.
- Use tables of the t-distribution to compare your value for T to the tn−1 distribution. This will give the p-value for the paired t-test.

The test statistic is calculated as:

$$t \quad \frac{\bar{d}}{\sqrt{s^2/n}}$$

Where d bar is the mean difference, s^2 is the sample variance, n is the sample size and t is a Student tquantile with n-1 degrees of freedom.

Power is calculated as the power achieved with the given sample size and variance for detecting the observed mean difference with a two-sided type I error probability of (100-CI%)%

RESULT

Table 1: Comparison of Maxillary Root Length Pre and Post Orthodontic Treatment

MAXILLARY	TIME INTERVAL	n	Mean	Std. Deviation	Std. Error Mean	Paired t test	p value , Significance
CENTRAL INCISOR - RIGHT	PRE	30	0.2437	0.0049	0.00089	t= 0.0	p =1.0, not significant
	POST	30	0.2437	0.0049	0.00089		
CENTRAL INCISOR – LEFT	PRE	30	0.2557	0.00504	0.00092	t= 0.255	p =0.799, not significant
	POST	30	0.2553	0.00507	0.00093		
LATERAL INCISOR - RIGHT	PRE	30	0.2163	0.0049	0.00089	t= 0.00	p =1.0, not significant
	POST	30	0.2163	0.0049	0.00089		
LATERAL INCISOR – LEFT	PRE	30	0.211	0.00607	0.00111	t= 0.404	p =0.688, not significant
	POST	30	0.2103	0.00669	0.00122		

Table 1: Contd.,

CANINE – RIGHT	PRE	30	0.2793	0.00691	0.00126	t = 10.802	p < 0.001, highly significant
	POST	30	0.26	0.00695	0.00127		
CANINE – LEFT	PRE	30	0.2967	0.01028	0.00188	t =5.336	p<0.001,Highly significant
	POST	30	0.279	0.01494	0.00273		

p> 0.05 – not significant p < 0.05 significant p < 0.001 –highly significant

Table 1 is showing the root resorption in the maxillary anterior segment (mean of both right & the left side) of 30 sample (n-30), with a mean value of each tooth, showing both the standard deviation as well as error. It is also showing the paired t- test and the weather the root resorption is seen or not.

Mean of the central incisor is 0.2437 in the pre-cbct & post cbct standard deviation of 0.0049 and the error of 0.0089 which is showing no significant result on right side & 0.2557 mean(t0), & 0.2553 (t1); with a standard deviation of 0.00504(t0) & 0.00507(t1)which is not significant on the left side.

Mean of the lateral incisor on right side in the pre-test& post-test is 0.2163 with a standard deviation of 0.0049& error of 0.0089 which is not significant; & 0.2111 mean(t0), & 0.2103 (t1); with a standard deviation of 0.00607(t0) & 0.00669(t1) and an error of 0.0011(t0) & 0.0122 (t1) which is not significant on the left side.

Mean of the canine on right side in the mean I 0.2793(t0) & 0.2600(t1) with a standard deviation of 0.00691 (t0) & 0.00695(t1); error of 0.00126(t0) & 0.00127(t1) which is highly significant; & mean of 0.2967 (t0)& 0.2790 (t1); with a standard deviation of 0.01028 (t0) & 0.01494 (t1) and an error of 0.00188(t0) & 0.00273 (t1) which is highly significant on the left side.

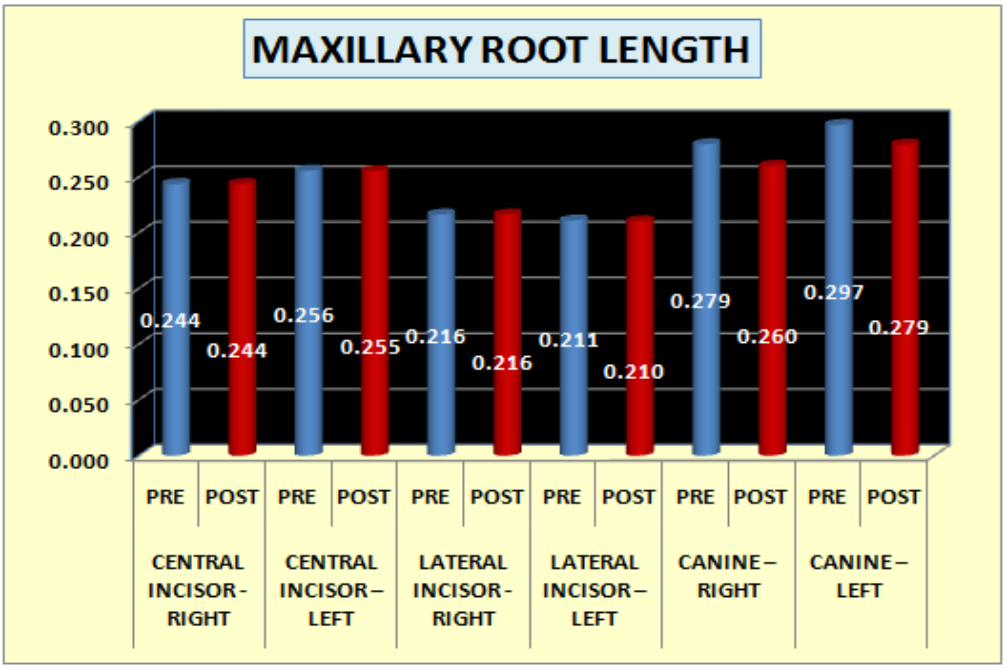

Figure 3

Table 2: Comparison of Mandibular Root Length Pre and Post Orthodontic Treatment

MANDIBULAR	TIME INTERVAL	N	Mean	Std. Deviation	Std. Error Mean	Paired t Test	p value , Significance
CENTRAL INCISOR -RIGHT	PRE	30	0.1387	0.00681	0.00124	t = 1.151	p = 0.254, not significant
	POST	30	0.136	0.0107	0.00195		
CENTRAL INCISOR – LEFT	PRE	30	0.147	0.00466	0.00085	t = 1.444	p = 0.154, not significant
	POST	30	0.1443	0.00898	0.00164		
LATERAL INCISOR -RIGHT	PRE	30	0.143	0.00466	0.00085	t = 1.034	p = 0.305, not significant
	POST	30	0.1417	0.00531	0.00097		
LATERAL INCISOR – LEFT	PRE	30	0.1557	0.00626	0.00114	t = 0.825	p =0.413, not significant
	POST	30	0.1543	0.00626	0.00114		
CANINE – RIGHT	PRE	30	0.2157	0.00626	0.00114	t = 0.00	p =1.00, not significant
	POST	30	0.2157	0.00626	0.00114		
CANINE – LEFT	PRE	30	0.2057	0.00774	0.00141	t = 0.00	P =1.00, not significant
	POST	30	0.2057	0.00774	0.00141		

p> 0.05 – not significant p < 0.05 significant p < 0.001 –highly significant

Mean of the central incisor is 0.1387 (t0) & 0.136 (t1) with a standard deviation of 0.00681(t0) & 0.0107 (t1) and the error of 0.00124(t0) & 0.00195 (t1) which is showing no significant result on right side mean; & on left side mean is 0.147 (t0), & 0.1143 (t1); with a standard deviation of 0.00466 (t0) & 0.00898 (t1); error of 0.00085 (t0) & 0.00164 (t1) which is not significant on the left side.

Mean of the lateral incisor is 0.1430 (t0) & 0.136 (t1) with a standard deviation of 0.00466 (t0) & 0.00531 (t1) and the error of 0.00085(t0) & 0.00097 (t1) which is showing no significant result on right side mean; & on left side mean is 0.1157 (t0), & 0.1543 (t1); with a standard deviation of 0.00626 (t0) & 0.00626 (t1); error of 0.00114 (t0) & 0.00114 (t1) which is not significant on the left side.

Mean of the canine on right side iz 0.2157 (t0) & 0.2157(t1) with a standard deviation of 0.00626 (t0) & 0.00626 (t1); error of 0.00114 (t0) & 0.00114(t1) which is not significant; & mean of 0.2057 (t0) & 0.2057 (t1); with a standard deviation of 0.00774 (t0) & 0.00774 (t1) and an error of 0.00141 (t0) & 0.00141 (t1) which is not significant on the left side.

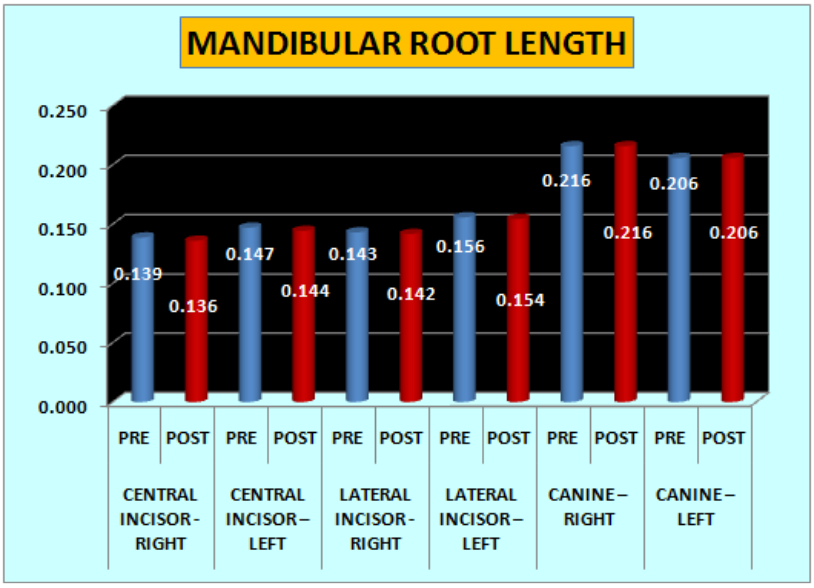

Figure 4

DISCUSSION

Number of the patient's seeking orthodontic treatment, because now a days they are more conscious of their appearance. The esthetic being there major concern for which they are coming to an orthodontist. So in order to fulfill their chief complaint, in some patient it is mandatory for them to undergo orthodontic extraction of 1st or 2nd pre-molar depending upon the space required. In that extraction space we need to either de-crowd the anterior teeth or reduce the proclination of the teeth by taking them back. There are various mechanics which can be used to take to bring the tooth movement with-in the bone.

(5)There was a direct correlation seen with the orthodontic treatment and the root resobtion. It was first observed as early as 1914 were some clinician suspected that there is a direct correlation between the orthodontic tooth movement and root resorption. Later in 1920's scientists have noticed the change in the roots in the post-treatment x-rays when compared it with the pre-treatment x-rays. Since then there are numerous study going on in order to know the actual cause of the root resorbtion.[66]

Apical root resorption is been the most common abiogenic problem associated with the orthodontic tooth movement. Loss of apical root due to orthodontic treatment is un-predictable. Thereare various etiological factor for it, but once extended into the dentin it become irreversible. A better understanding of this important clinical problem requires controlled studies that are designed to examine the association between a limited set of variables and root resorption. Various investigation are to be done in order to evaluate the amount of root resorption. Various investigation came into picture through which root resorption can be well appreciated.

According to Naphtali Bernaiak And Atalia Wasserstein (1993) radiographs are commonly used for diagnosis of root resorption. The investigations which are been used were the intra oral peri-apical radiographs (IOPA) the orthopantomogram (OPG) then came up with the computed tomography (CT) and now the latest being the cone beam computed tomography (CBCT). All these investigations the CBCT being the most accurate in diagnosing the root resorption. CBCT imaging has made it possible to examine the various aspects of the maxillofacial complex in relation to time and dental applications. It was recently shown using cadaver heads that CBCT can be used to quantitatively assess buccal bone height and buccal bone thickness with high precision and accuracy.(10)

Radiographic detection of apical root shortening require a cetain degree of resorption. It is difficult to develop a standardize technique to compare the same teeth at different time. Tooth movement makes it more difficult to assess the exact amount of root loss especially when the tooth is torque or tipped. Root resorption seen on radiographs could offen only detect root shortening. Resorption seen on the Mesial and distal surface of the tooth i.e. when the cone beam is right angle to the tooth which is too be seen.

Sameshima and Asgarifa (2001)compared the use of peri-apical radiographs and OPG to assess the morphology and quantify the amount of root resorption present in the sample. They found that the description of root morphology differ greatly between two detecting modes. It was found that OPGs over-estimated the amount of root loss by 20% or more when compared with peri-apical radiographs.

According to M. Ali Darendiler (2004), OPG normally show super-imposed structure of radio-opaque o radiolucent shadows over one-another, also the root may get magnified or foreshortened over the teeth. According to

Naphtali Bernaiak And Atalia Wasserstein (2002), because of the limitations of the radiographic technique might obscure major defect in the root surface, so more modern imaging technique such as CT should be used routinely. CT is an expensive procedure and need special equipments.CBCT images can provide 3D information on tooth movement, including both the amount and orientation of the movement, which can minimize errors caused by incorrect projection and magnification. In addition, the availability of 3D data provides information on all teeth, and not only on the movement of the center incisor as obtained by lateral cephalograms.

All permanent tooth show microscopic level of root resorption that is clinically in-significant and radiographically undetectable. Root resorption of permanent tooth is a probable consequence of orthodontic treatment and active orthodontic tooth movement. Usually, extensive resorption does effect the functional capacity or the effective life of the tooth. Most study has stated that the root resorption ceases once the active treatment is terminated. In light of the orthodontics liability of what is basically an unacceptable phenomenon, it is necessary that the speciality defines this uncertainity and establishes criteria of diagnosis, records, and informed consents to protect its members against un-necessary and unjustified ligitation.

Melsen observed that most resorption activity occurs in areas that are subjected to compression, and that less activity occurs in the tension zone. Because our study group consisted of growing children, some increase in labial bone width would be expected during lingual movement of the incisors. One might also speculate that, as bone increase in the labial direction would be expected if retraction had not been applied, perhaps the thickness of the original labial alveolar bone was actually reduced because of retraction, despite previous evidence that apposition takes place in the tension zone.(14)

Durack et al. 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. When investigating the accuracy and reliability of root length measurements. Compared with most other studies on OIIRR, the present trial is based on a more homogeneous patient sample in terms of age and the reason for orthodontic treatment. Because of this and methodological differences, it is difficult to make direct comparisons with previous studies on root resorption and percentage of affected teeth. Difficulties in making comparisons between studies of OIIRR were pointed out by Brezniak and coworkers.4

Each tooth is attached to and separeated from the adjacent bone by a heavy collageneous supporting structure and the periodontal ligament (PDL). Under normal circumstances PDL occupies a space of approximately 0.5mm in width around all the parts of the root. By far the major component of the ligament is a network of collagen fibers inserting into the cementum of the root surface on one side and into a relatively dense bony plate, lamina dura on the another side. So when-ever there will be any force acting on the tooth there will be compression and tension zone created in the PDL ligament. The heavier the sustained force, the greater should be the reduction in the blood flow through the compressed area of the PDL.

It is apparent that the optimum force levels for the orthodontic tooth movement should be just high enough to stimulate cellular activity with-out completely occluding blood vessels in the PDL. Both the amount of force delivered to a tooth and also the area of the PDL over which the force is distributed are important in determining the biological effect. The PDL response is determined by the amount of force acting per unit area. Orthodontic treatment require resorption and apposition of the bone adjacent to the root structure of the teeth and the recognized PDL.

Thomas M. Graber has mentioned that according to Rygh &his coworkers, cementum adjacent to hylinized area of the PDL is marked by a contact and the clast cells attack this marked cementum when the PDL areas are repaired. This observation helps why heavy continues orthodontic force can lead to severe root resorption. Even with the most careful control of orthodontic force, however, it is difficult to avoid creating some hyalinized areas in the PDL. It is not surprising therefore, that careful examination of the root surfaces of the teeth that has been moved reveals repair areas of resorption of both cementum and dentin of the root. It appear that cementum and dentin are removed from the root surface, and then cementum is restored in the same way that of alveolar bone is removed and replaced.

Root resorption of the deciduous dentition is normal, essential, and physiological process. Usually it is a necessary precursor to the eruption of the permanent tooth. But root resorption of the permanent tooth is a complex biological process of which many aspects remain unclear.As stated by Tomes M. Graber, root resorption, unlike alveolar bone is unpredictable. Many of the resorption lacunae are small and insignificant. They soon get repair by cellular cementum. Periodontal fibers are incorporated in the new cementum layer, and the tooth remain in normal function.

Slanted surface resorption was found to be relatively common at buccal and palatal root surfaces—an interesting finding because these surfaces are not displayed on intraoral radiographs, and because such resorption eventually may result in root shortening. In attempts to identify patients at risk for severe root shortening, slanted surface resorption could be a relevant research topic in future studies of OIIRR with CBCT.

Patel and coworkers [8] reviewed the literature on CBCT applications to endodontics and found CBCT to be clinically superior to periapical radiography for the detection of periapical lesions. They cited an interesting study by Lofthag-Hansen and coworkers, in which CBCT was found to result in 62% more periapical lesions on individual roots being identified, when compared with periapical examinations. In addition, Patel and colleagues found CBCT to be efficacious in endodontic surgery, periapical surgery treatment planning, identification of root canals not seen on 2D images, identification of dentoalveolar trauma, and the management of external cervical root resorption.

The relationship between the longevity of the teeth and root resorption is generally associated with the root shortening. Zachrisson reported that 2-mm apical root shortening is not detrimental to the function of the dentition. Phillips28 claimed that 2-mm root shortening reduced the total attachment area of 5–10%. Barber and Sims10 attracted attention to the periodontal fiber reattachment to the repaired root surface after resorption. They found very few periodontal fiber reattachments up to 8 months of fixed retention. Langford and Sims7 investigated anchor teeth under retention periods of 14 to 53 weeks. They showed sparse and inconsistent Sharpey's fibers depressions into the cellular cementum, which was different from that of normal cellular cementum.(9)

En masse retraction of the six anterior teeth, instead of step-by-step retraction of the canine and four incisors can reduce treatment time and allow an early change of the facial profile. This increases patient cooperation in treatment. The important aspect of this approach is that teeth can be moved to their exact treatment goal. The amount of maxillary retraction or teeth movement can be controlled by continuing or discontinuing the retracting force. The decision of when to discontinue the maxillary retraction force is determined after evaluating the facial profile and occlusal relationships.(12)

DeShields, in contrast, found significant correlations between EARR and sagittal apical movements of the maxillary central incisor. Mirabella and Årtun stated, "movement of the roots in either an anterior or posterior direction, is associated with apical root resorption." Although Mirabella and Årtun found no statistically significant association between

vertical movement of the incisor apex and root resorption, they did caution about interpretation because few patients in their study experienced as much as 1 mm of extrusion or intrusion. Jacobson suggested that a loss of a millimeter at the apex is trivial because the apical end of the root has the smallest diameter, but Kalkwarf et al showed that there is a nearly linear relationship between root length and percentage of periodontal attachment, so minor loss in root length may be important. In addition, loss of root length moves the center of resistance coronally, so the same amount of torque on the tooth will have a greater effect than if the root were intact.(11)

DeShields found a significant, positive correlation between EARR and how far the root was transposed horizontally. Sharpe et al showed that cases requiring premolar extraction experienced more resorption than those requiring less retraction of the maxillary incisors. Harris and Butler and Kaley and Phillips also reported that the horizontal amount the maxillary incisors needed to be retracted was positively correlated with EARR. External apical root resorption (EARR) can be a significant sequel of orthodontic treatment and in the most severe cases may threaten the longevity of the teeth. Identification of the factors contributing to EARR during orthodontic treatment is therefore essential in order to minimize the incidence and severity of root resorption.(13)

It is widely accepted that whenever orthodontic tooth movement occurs, the bone around the alveolar socket remodels to the same extent. However, non-orthodontic tooth movements do not follow this rule. During eruption of the dentition, teeth emerge from the alveolar process, and alveolar ridge augmentation occurs simultaneously. In this process, tooth movement exceeds bony apposition. It is not clear whether the bone remodeling-to-tooth movement ratio is actually 1:1 in all orthodontic tooth movements. During orthodontic extrusion, bone increase in the vertical dimension usually does not match tooth movement. When transverse movement is attempted, dehiscence and fenestration in the buccal and lingual cortical plate have been reported.(14)

Duterloo observed a definite shortening of the marginal aspect of the palatal cortex after orthodontic treatment but did not note any repair or remodeling even several years after treatment. In our study, we waited an average of 3 months after loading the teeth before we did the T2 scans. The aim was to allow osteoblastic activity to start the repair process, if any repair was to occur. It would be valuable to assess these same patients years from now to determine whether repair takes place. Remmelink and van der Molen investigated Ten Hoeve and Mulie's patients several years after the original study and found well-defined dense cortical plate in association with relapse of torque of the anterior teeth. Perhaps complete repair can take place only if relapse occurs, as Wainwright, Duterloo, Edwards, and Meikle have suggested.

Proximity of the root apex to the palatal cortex has been associated with apical root resorptioil, x6,a6,a7 Kaley and Phillips concluded that the risk of clinically significant apical root resorption increased 20 times when the maxillary incisors were in close proximity to the lingual or cortical plate£ 7 Our results are in agreement with an experimental study in monkeys, 2 finding no increase in root resorption in such cases(15).Levander and Malmgren,17 we confirmed that most orthodontic patients develop visible signs of apical root resorption of the maxillary incisors during the initial stages of fixed appliance therapy. However, the resorption is typically expressed only as a slight change in apical contour without actual root shortening. Although we judged 24.0% of the teeth to express root shortening, only 3.6% had shortening of more than 2 mm. Comparable figures by Levander and Malmgren17 were 34.4% and 1.3%, respectively. However, the wide range in severity of resorption among teeth with subjective score 3, which is from 2 mm to one third of initial tooth length, 21 makes direct comparisons of severity.

Studies based on random measurements of tooth lengths (TL) on standardized periapical radiographs made before and after active orthodontic treatment conclude that the sample mean of the averaged amount of resorption of all six maxillary anterior teeth,1 of the four maxillary incisors, or of each pair of maxillary central and lateral incisors,1–4 is less than 1.5 mm. Accordingly, apical root resorption is of limited clinical significance for the average patient. However, about 4% of the patients experience generalized resorption of more than three mm, and about 5% of adults1 and 2% of adolescents are likely to have one or more teeth that undergo more than five mm of resorption during appliance therapy. Similarly, simultaneous subjective scoring of pre- and post-treatment panoramic radiographs of a large representative patient sample5 suggests that about 3% experience resorption of more than one fourth of the root length of both maxillary central incisors during fixed appliance therapy. Although the resorption process stops once the active appliances are removed, severely resorped teeth may be lost prematurely in patients who are also susceptible to marginal periodontal breakdown.(17)

There are plenty of scientists saying about the root resorption but none of them told properly the etiological factor. Although they stated multiple factor that causes root resorption like biological factor, mechanical factors, biological and mechanical factors and other consideration. Becks suggested that endocrine problem including hypo-thyroidism, hypo-pituitarism, and other diseases related to root resorption. It was first suspected in 1940 that the deficiency of the thyroid hormone could lead to generalized root resorption.

Marshall suggested that mal-nutrition can cause root resorption. Becks demonstrated root resorption in animals deprived of dietary calcium &vitamins D. During growth, root development can be affected by tooth movement; dilacerations decreases expected root length and root resorption. Nail biting and tongue thrusting associated with the open bite and increased tongue pressure have been related to increased root resorption. According to Harris and Butler (1992) open bite cases have seen the presence of root resorption.

SUMMARY AND CONCLUSION

The study was conducted in order to evaluate the amount to root resorption which is the most common sequel of active orthodontic treatment and the measure taken to overcome the amount of root resorption. In this study we have carried a CBCT for evaluation of the root resorption. CBCT is the most effective tool for evaluation of root resorption. The study was conducted in the patient who were undergoing orthodontic treatment and require all 1st pre-molar extraction in order to achieve the esthetic demand of the patient.

The pre-test (t0) and post-test (t1) CBCT of the patient was evaluated after 3 month .i.e after leveling and alignment stage. The pre-test was after extraction and after appropriate anchorage element placed and the post test was immediately after removal of 0.016X0.022 NiTi wire and the appropriate statistical analysis was performed.

Conclusion Derived from the Study are

- The CBCT of the maxillary arch there was root resorption in the maxillary central and lateral incisors both of right and the left side.
- The canine showed a significant amount of root resorption during leveling and alignment stage.
- The CBCT in the mandibular arch did not show any significant change.

BIBLIOGRAPHY

1. Brezniak N,Wasserstein A.Root resorption after orthodontic treatment – Part I – Literature review.Am J Orthod Dentofacial Orthop 1993;103:62-66.
2. Brezniak N,Wasserstein A.Root resorption after orthodontic treatment – Part II – Literature review.Am J Orthod Dentofacial Orthop 1993;103:138-146.
3. Acar A,Canyurek V,Kocaaga M,Erverdi N.Continuous vs discontinuous force application and root resorption.Angle Orthod 1999;69:159-163.
4. Becker A, Chaushu S. Long-term follow-up of severely resorbed maxillary incisors after resolution of an etiologically associated impacted canine. Am J Orthod Dentofacial Orthop 2005;127:650-654; quiz 754.
5. Jonsson A, Malmgren O, Levander E. Long-term follow-up of tooth mobility in maxillary incisors with orthodontically induced apical root resorption. Eur J Orthod 2007;29:482-487.
6. Levander E, Malmgren O. Long-term follow-up of maxillary incisors with severe apical root resorption. Eur J Orthod 2000;22:85-92.
7. Remington DN, Joondeph DR, Artun J, Riedel RA, Chapko MK. Long-term evaluation of root resorption occurring during orthodontic treatment. Am J Orthod Dentofacial Orthop 1989;96:43-46.
8. Daryl I. Boekenoogen,Pramod K Sinha.The effects of exogenous prostaglandin E2 on root resorption in rats.Am J Orthod Dentofacial Orthop 1996;109:277-86.
9. Vinod Krishnan,Ze'ev Davidovitch.Cellular,molecular and tissue level reactions to orthodontic force.Am J Orthod Dentofacial Orthop 2006;129:469e-460e.32.
10. Roscoe MG, Meira JB, Cattaneo PM. Association of orthodontic force system and root resorption: A systematic review. Am J Orthod Dentofacial Orthop 2015;147:610-626.
11. Bartley N, Turk T, Colak C, Elekdag-Turk S, Jones A, Petocz P et al. Physical properties of root cementum: Part 17. Root resorption after the application of 2.5 degrees and 15 degrees of buccal root torque for 4 weeks: a microcomputed tomography study. Am J Orthod Dentofacial Orthop 2011;139:e353-360.
12. Chan E, Darendeliler MA. Physical properties of root cementum: part 7. Extent of root resorption under areas of compression and tension. Am J Orthod Dentofacial Orthop 2006;129:504-510.
13. Tieu LD, Normando D, Toogood R, Flores-Mir C. Impact on perceived root resorption based on the amount of incisal inclination as determined from conventional panoramic radiography. Am J Orthod Dentofacial Orthop 2015;148:685-691.
14. Dudic A, Giannopoulou C, Leuzinger M, Kiliaridis S. Detection of apical root resorption after orthodontic treatment by using panoramic radiography and conebeam computed tomography of super-high resolution. Am J Orthod Dentofacial Orthop 2009;135:434-437.

15. *Ponder SN, Benavides E, Kapila S, Hatch NE. Quantification of external root resorption by low- vs high-resolution cone-beam computed tomography and periapical radiography: A volumetric and linear analysis. Am J Orthod Dentofacial Orthop 2013;143:77-91.*
16. *Wendy Sharpe,Brian Reed.Orthodontic relapse,apical root resorption and crestal alveolar bone levels.Am J Orthod Dentofacial Orthop 1987;91:252-6.*
17. *Scott McNab,Diana Battistutta.External apical root resorption following orthodontic treatment.Angle Orthod 2000;70:227-232.*
18. *Olle Malmgren,Eva Levander.Minimizing orthodontically induced root resorption:guidelines based on a review of clinical studies.World J Orthod 2003;4:19-30.*
19. *Philips J.R. Apical root resorption under orthodontic therapy.Angle Orthod 1955; 25:1-22.*
20. *De Shields RW. A study of root resorption in treated class II Division I malocclusion. Angle Orthod 1969; 39: 231-45.*
21. *Rygh P. Orthodontic root resorption studied by electron microscopy. Angle Orthod 1977; 47: 1-16.*
22. *Langford. Root resorption extremes resulting from clinical RME.Am J Orthod 1982; 41:371 – 377.*
23. *Malmgren, Goldson, Hill, Orwin, Petrini, and Lundberg. Root resorption after orthodontic treatment of traumatized teeth. Am J Orthod 1982; 82:487 - 491.*
24. *Harry MR, Sims MR. Root resorption in bicuspid intrusion: A SEM study. Angle Orthod 1982; 52:235-238.*
25. *Brita Ohm Linge and Leif Linge. Apical root resorption in upper anterior teeth. Eur J Orthod 1983; 5:173-183.*
26. *Goldie and King. Root resorption and tooth movement in Orthodontically treated, calcium-deficient, and lactating rats. Am J Orthod 1984; 85: 424-430.*
27. *Dr.E.M.l'abee and Dr.G.C.H. Sanderi. Apical root resorption during Begg treatment. J Clinical Orthod 1985; 19: 60-61.*
28. *Scott Copeland and Larry J. Green. Root resorption in maxillary central incisors following active orthodontic treatment. Am J Orthod Dentofac Orthod 1986; 89:51-55.*
29. *L.R. Dermaut and A.De Munck. Apical root resorption of upper incisors caused by intrusive tooth movement: A radiographic study. Am J Orthod Dentofac Orthop 1986; 90: 321-326.*
30. *Engström, Granström, and Thilander. Effect of orthodontic force on periodontal tissue metabolism. Am J Orthod Dentofac Orthod 1988; 93:486-95.*
31. *Ericson and Kurol. Resorption of maxillary lateral incisors caused by ectopic eruption of the canines. Am J Orthod Dentofac Orthod 1988; 94:503-13.*
32. *Remington, Joondeph, Årtun, Riedel, and Chapko. Long-term evaluation of root resorption during orthodontic treatment. Am J Orthod Dentofac Orthod 1989; 96:43-6.*

33. *McFadden, Engstrom, Engstrom, and Anholm. Relationship between incisor intrusion and root shortening. Am J Orthod Dentofac Orthod 1989; 96:390-396.*
34. *Steven W. Spurrier. A comparison of apical root resorption during orthodontic treatment in endodontically treated and vital teeth. Am J Orthod Dentofac Orthod 1990; 97:130 – 134.*
35. *Harris and Baker. Root resorption in adolescents and adults. Am J Orthod Dentofac Orthod 1990; 98:463-9.*
36. *Linge and Linge. Patient characteristics and treatment variables associated with apical root resorption during orthodontic treatment. Am J Orthod Dentofac Orthod 1991; 99: 35 – 43.*
37. *Edward F. Harris, PhD, and Monte L. Butler, DDS. Patterns of incisor root resorption before and after orthodontic correction in cases with anterior open bites. Am J Orthod Dentofac Orthod 1992; 101:112 – 119.*
38. *A.D. Vardimon, T.M.Graber and S.Pitarus. Repair process of external root resorption subsequent to palatal expansion treatment. Am J Orthod Dentofac Orthod 1993; 103:120-130.*
39. *Hendrix, Carels, Kuijpers-Jagtman, and Van ' T Hof. Radiographic study of posterior apical root resorption. Am J Orthod Dentofac Orthod 1994;105:345-349.*
40. *Barry W. Beck and Edward F. Harris. Apical root resorption in orthodontically treated subjects: Analysis of edgewise and light wire mechanics. Am J Orthod Dentofac Orthod 1994; 105:350-61.*
41. *Kjaer I. Morphological characteristics of dentitions developing excessive root resorption during orthodontic treatment. Eur J Orthod 1995; 1: 30-38.*
42. *David Mirabella and Jon Årtun. Risk factors for apical root resorption of maxillary anterior teeth in adult orthodontic patients. Am J Orthod Dentofac Orthod 1995; 108:48-55.*
43. *Blake, Woodside, and Pharoah. Apical root resorption compared after treatment. Am J Orthod Dentofac Orthod 1995; 108: 76-84.*
44. *Rachanee Taithongchai, Kemmatat Sookkorn, and Dennis M. Killiany. Facial and dentoalveolar structure and the prediction of apical root shortening. Am J Orthod Dentofac Orthod 1996; 110: 296-302.*
45. *Jüri Kurol. Time-related root resorption after application of a controlled continuous orthodontic force. Am J Orthod Dentofac Orthod 1996; 110:303 – 310.*
46. *Stanley A Alexander. Levels of root resorption associated with continuous arch and sectional arch mechanics. Am J Orthod Dentofac Orthod 1996; 110: 321-324.*
47. *Edward Harris, Stephen Kineret and Elizabeth Tolley. A heritable component for external apical root resorption. Am J Orthod Dentofac Orthod 1997; 111: 301-309.*
48. *Eva Levender, Rusalin Bajka and Olle Malmgren. Early diagnosis of apical root resorption during orthodontic treatment: a study of maxillary incisors. Eur J Orthod 1998; 20:57-63.*
49. *Tulin Taner, Semra Ciger, Yesin Sencift. Evaluation of apical root resorption following extravtion therapy in subjects with class I and class II malocclusions. Eur J Orthod 1999; 21:491-496.*

50. *Maria Mavragani, Andrea Vergariet, Nils Jorgen, Olav Egil and Per Johan. A radiographic comparison of apical root resorption after orthodontic treatment with standard edgewise and a straight-wire edgewise technique. Eur J Orthod 2000; 22:665-674.*
51. *F. Weiland. Constant versus dissipating forces in orthodontics: the effect on initial tooth movement and root resorption. Eur J Orthod 2003; 25:335-342.*
52. *Massoud Seifi. Effect of prostaglandin E2 and calcium gluconate on orthodontic tooth movement and root resorption. Eur J Orthod 2003; 25:199-204.*
53. *Riyad Al-qawasmi, James K. Hartsfeild and Eric T. Everett. Genetic predisposition to external apical root resorption. Am J Orthod Dentofacial Orthod 2003; 123:242-252.*
54. *Yoon Ah Kook, Sohee Park. Peg shaped and small lateral incisors not at higher risk of root resorption. Am J Orthod Dentofacial Orthod 2003; 123:253-258.*
55. *Maltha JC, Van Leeuwen. Incidence and severity of root resorption in orthodontically moved premolars in dogs. Journal of orthodontics and craniofacial research 2004; 7:115-121.*
56. *M. Ali Darendeliler, Daniel C.S. Ngan, Om P. Kharbanda. The genetic contribution to orthodontic root resorption: A retrospective twin study. Aust Orthod 2004; 20:1-9.*
57. *Guangli Han, Shengfu Huang. Root resorption after orthodontic intrusion and extrusion: An intraindividual study. Angle Orthod 2005;75:912-918.*
58. *Marcos Roberto de Freitas,Rejane Targino Soares Beltrao.Evaluation of root resorption after open bite treatment with and without extractions.Am J Orthod Dentofacial Orthop 2007;132:143.e15-143.e22.*
59. *Jon Artun,Ron Van't Hullenaar.Identification of orthodontic patients at risk of severe apical root resorption.Am J Orthod Dentofacial Orthop 2009;135:448-55.*
60. *Leandro Silva Marques,Maria Leticia Ramos Jorge. Severe root resorption in orthodontic patients treated with the edgewise method: Prevalance and predictive factors. Am J Orthod Dentofacial Orthop 2010;137:384-8.*
61. *Juan I.Ramirez-Echave,Peter H.Buschang. Histologic evaluation of root response to intrusion in mandibular teeth in beagle dogs. Am J Orthod Dentofacial Orthop 2011;139:60-9.*
62. *Carmen Gonzales,Hitoshi Hotokezaka.Effects of fluoride intake on orthodontic tooth movement and orthodontically induced root resorption. Am J Orthod Dentofacial Orthop 2011;139:196-205.*
63. *Stacy N. Ponder, Erika Benavides, Sunil Kapila. Quantification of external root resorption by low vs high resolution cone beam computed tomography and periapical radiography: A volumetric and linear analysis.Am J Orthod Dentofacial Orthop 2013;143:77-91.*
64. *Marina G. Roscoe, a Josete B. C. Meira,b and Paolo M. Cattaneoc. Association of orthodontic force system and root resorption: A systematic review. Am J Orthod Dentofacial Orthop 2015;147:issue 5.*
65. *Furkan Dindaroğlu, Servet Doğan. Root Resorption in Orthodontics. Turkish J Orthod 2016; 29: 103-8*

DISCUSSION

66. *Naphtali Breznlak, Atalta Wassersteln. Root resorption after orthodontic treatment: Part 1. Literature review.Am. J. Orthod. Dentofac. Orthop. January" 1993-Volume 103 Number 1*
67. *Naphtali Breznlak, Atalta Wassersteln. Root resorption after orthodontic treatment: Part 1. Literature review.Am. J. Orthod. Dentofac. Orthop. January" 1993-Volume 103 Number 2*
68. *Eva Levander and Olle Malmgren. Evaluation of the risk of root resorption during orthodontic treatment: A study of upper incisors. European Journal ofOrthodontics 10 (1988) 30-3*
69. *Henrik Lunda; Kerstin Gro¨ndahlb; Ken Hansenc; Hans-Go¨ran Gro¨ndahld. Apical root resorption during orthodontic treatment A prospective study using cone beam CTAngle Orthodontist, Vol 82, No 3, 2012.*
70. *Sunil Kapila, Gregory J. King. Biological mechanics in orthodontic tooth movement. Esthetics and Biomechanics in Orthodontics (Second Edition), 2015.*
71. *Alexander Dudic,a Catherine Giannopoulou,b Michael Leuzinger,c and Stavros Kiliaridisd. Detection of apical root resorption after orthodontic treatment by using panoramic radiography and cone-beam computed tomography of super-high resolution. Am J Orthod Dentofacial Orthop 2009;135:434-7*