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Evaluation Of Lateral Root Resorption In Maxillary Teeth Among First Premolar Extraction Cases After Space Closure- A CBCT Study.

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Abstract:
Background*: Orthodontic treatment usually involves usage of light continuous forces but when heavy forces are used it leads to apical root resorption. External apical root resorption refers to reduction in root structure involving the apices. This resorption is of transient inflammatory type. 2D images are commonly used for diagnostic purposes in orthodontics but it cannot detect root resorption on lingual or buccal surfaces thus cannot measure the volume of root loss. Cone beam computed tomography which can provide 3D images was introduced in late 1990s. Images provided by CBCT are more more accurate than panoramic and periapical radiographs . Therefore in this study , CBCT is used to evaluate lateral root resorption in maxillary teeth after after space closure among first premolar extraction cases .*
Materials and Methods: *CBCTs of 20 patients fulfilling inclusion and exclusion criteria were taken before the start of orthodontic treatment and after space closure. Post treatment root width was substracted from the pre treatment root width at three levels from CEJ (3mm,6mm,9mm). The normality test (Shapiro-Wilk Test) was performed to analyze the data, and the results were expressed as frequency with percentage and mean with standard deviation. Difference between means were assessed using paired t test for before and after the procedure. All the statistical analyses were carried out at a 5% level of significance, and results with a P value < 0.05 were considered statistically significant.*
Results*: Considering all the three levels the least tooth resorption was observed in the case of central incisor (0.1750 ± 0.0444, p <0.001) and highest in the canine tooth (5.900± 0.0000, p <0.001) .*
Conclusion: When root resorption is detected, it is recommended to pause the treatment for about 6 months to allow for root repair. Intermittent forces, which provide rest periods between applications, are more tissue-friendly and can help reduce the risk of further resorption.
Key Word: *CBCT, Root resorption, Lateral root resorption.*

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I. Introduction

Orthodontics is a branch of dentistry that focuses on adjusting both the hard and soft tissues in the facial and jaw area to meet the aesthetic needs of the patient. While enhancing aesthetics is a key goal, it is of utmost importance to improve or preserve the health and function of the dental apparatus throughout and after orthodontic treatment. The roots of the teeth are not clinically observable, so changes in them can go unnoticed[1]

Root resorption is a dental condition where the root structure of a tooth undergo deterioration. It can be categorized into external and internal types. External root resorption affects the outer surface of the root, often due to trauma, orthodontic treatment, or infection. In contrast, internal root resorption begins inside the tooth, typically caused by chronic pulp inflammation or injury.[1] Symptoms may be absent initially, but as the condition progresses, it can lead to pain, swelling, or tooth mobility.

Various radiographic examination methods, such as periapical radiographs, panoramic radiographs, cone beam computed tomography (CBCT), and CT scans, are utilized to detect root resorption.[2] While two-dimensional radiography techniques like panoramic and periapical radiographs have limitations in accurately measuring root resorption due to its three-dimensional nature, CBCT has shown higher accuracy in diagnosis and measurements.

This study employs CBCT to assess root resorption mesiodistally, at three levels from CEJ following orthodontic treatment in maxillary teeth, focusing on cases involving extraction of first premolars. The maxilla

is chosen due to its less dense bone density compared to the mandible.[3] First premolar extraction cases are selected based on research indicating greater resorption in such cases compared to second premolar extractions.[2] Moreover, it is noted that root resorption is more common following extraction of all four first premolars compared to non-extraction or single premolar extraction cases. It is also noted that bodily movement is associated with lower risk of root resorption than tooth tipping,[11] and continuous force application without allowing time for repair of periodontal tissues may lead to higher levels of resorption.[3] There are plenty of studies measuring apical root resorption. However there are insufficient studies that measure lateral root resorption. Therefore, this study evaluates lateral root resorption in maxillary teeth among first premolar extraction cases after space closure.

II. Material And Methods

The study was carried out on patients who reported for fixed orthodontics treatment to the Department of Orthodontics and Dentofacial Orthopaedics, PSM Dental College, Thrissur. The approval for the study was acquired from the institutional research ethical committee under reference No.511/Ethic/PSMCDR/2021. Informed consent was duly signed by the patient. CBCTs of 20 patients fulfilling the inclusion and exclusion criteria were taken before the start of orthodontic treatment. CBCTs of the same patients were taken after closure of first premolar extraction space.

The cone beam computed tomography (NewTom, 13.1, India) images of 20 Patients, pre and post treatment were analyzed. Subjects were scanned standing with the head oriented in natural head position . For all scans , the minimum field of view used was 13 X 10 , and scan time of 5.2 seconds with original axial thickness of 0.30 mm .

Inclusion criteria:

1) Age : 19 – 30 years
2) Full complement of permanent teeth excluding third molars
3) First premolar extraction cases
4) Periodontally healthy cases

Exclusion criteria:

1) History of previous orthodontic treatment
2) Congenital anomalies
3) Use of continuous medication
4) Gross decay
5) Systemic diseases including diabetes mellitus
6) Craniofacial anomalies
7) History of facial trauma

Procedure methodology

The CBCT images were analysed and measurements were taken from the sagittal view as shown in fig 1 and 2. The cemento enamel junction was identified for each tooth and mesiodistal width of each root was measured and recorded at three levels from CEJ (3mm, 6mm, 9mm) before the start of treatment (T1) and after the space closure (T2) . In case of first molars the measurements were taken from mesiobuccal, distobuccal and palatal roots. The post treatment values of each tooth at each level were subtracted from it's corresponding pre treatment values to obtain the amount of resorption that has taken place at that level.

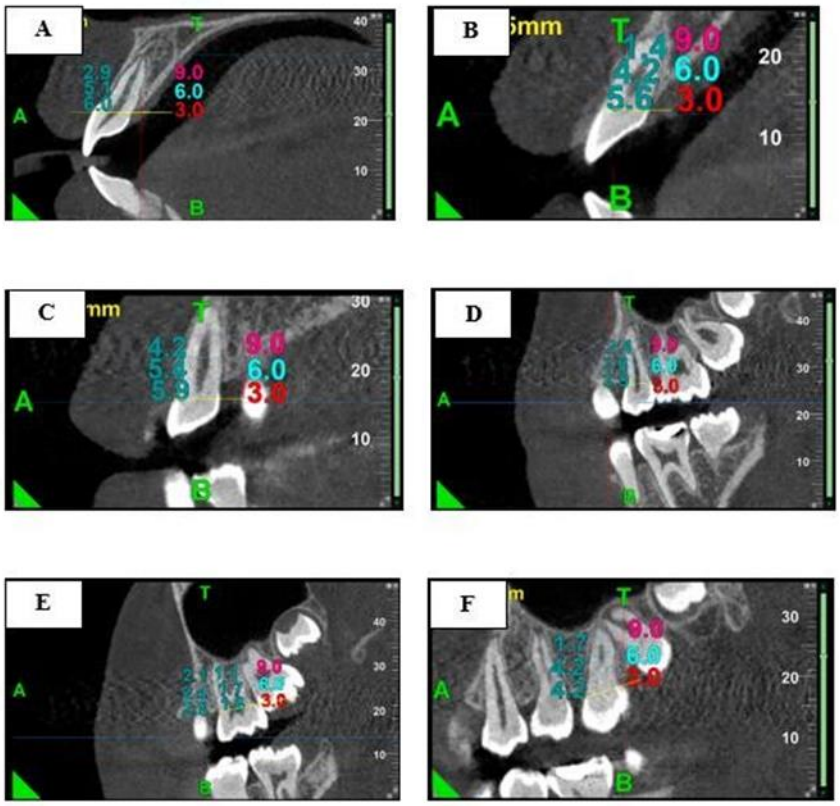

Fig 1: The cemento enamel junction was identified for each tooth and mesiodistal width of each root was measured and recorded at three levels from CEJ (3mm, 6mm, 9mm) before the start of treatment (T1).
A- central incisor, B- lateral incisor, C- canine, D- premolar, E and F – molar.

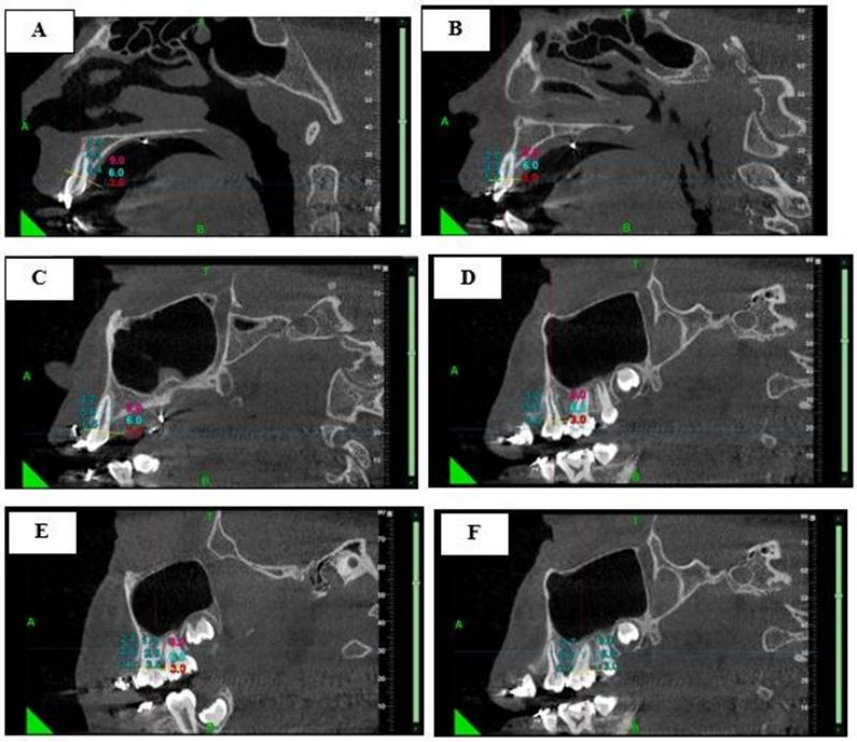

Fig 2: The cemento enamel junction was identified for each tooth and mesiodistal width of each root was measured and recorded at three levels from CEJ (3mm, 6mm, 9mm) after the closure of extraction space (T2).
A- central incisor, B- lateral incisor, C- canine, D- premolar, E and F – molar.

Statistical analysis

The data was collected using Microsoft 365 Excel and analyzed using SPSS v21.0. The normality test (Shapiro-Wilk Test) was performed to analyze the data, and the results were expressed as frequency with percentage and mean with standard deviation. Difference between means were assessed using paired t test for before and after the procedure. All the statistical analyses were carried out at a 5% level of significance, and results with a P value < 0.05 were considered statistically significant.

III. Result

All the teeth showed greatest resorption at 9mm, that is at apical level than at 3mm and 6mm (Table 1). At 3 mm level, the mean tooth resorption was highest in canine (4.375 ± 0.1832, p < 0.05) and the least was found in case of the distobuccal root of first molar (1.125 ± 0.0444, p value <0.05, Table 1).

At 6 mm level, the resorption was found to be increased than that at 3mm for all the teeth. The mean tooth resorption at this level was highest in the canine (5.400± 0.0000m, p <0.001). The least was in case of distobuccal root of first molar (1.675± 0.0444, p <0.001, Table 2).

At 9 mm level the resorption was found to be increased from what it was at 6mm level for most of the teeth. The mean tooth resorption at this level was found to be highest in the canine tooth (5.900± 0.0000, p <0.001). The least was found in case of the mesiobuccal root of first molar (3.100± 0. 1777, p <0.001, Table 2) .

Considering all the three levels the least tooth resorption was observed in the case of central incisor (0.1750 ± 0.0444 , p <0.001) and highest in the canine tooth (5.900± 0.0000, p <0.001, Table 2) .

Table 1: Mean values of variables

TOOTH	MEAN RESORPTION VALUE		
	at 3mm	at 6mm	at 9mm
Central incisor	1.850 ± 0.0513	4.450 ± 0.0344	5.400± 0. 0000
Lateral incisor	1.625 ± 0.2337	4.675± 0. .0444	5.325± 0. 1333
Canine	4.200 ± 0.0000	5.400± 0.0000	5.900± 0.0000
Premolar	2.700 ± 0.3078	3.550± 0. 0513	4.075± 0. 1832
Molar			
Mesiobuccal root Distobuccal root Palatal root	2.100 ± 0.0000 1.125 ± 0.0444 1.850 ± 0.1539	2.400 ± 0.0000 1.675± 0.0444 4.300± 0. 1026	2.800± 0.0000 1.875± 0. 4887 4.700± 0. 5130

Table 2: Paired t test between the variables

TOOTH	MEAN RESORPTION VALUE					
	at 3mm		at 6mm		at 9mm	
		p value		p value		p value
Central incisor	0.1750 ± 0.0444	<0.001*	0. 5250± 0. 3024	<0.001*	0. 5750± 0. 0444	<0.001*
Lateral incisor	0.3750 ± 0.2337	<0.001*	0. 2250 ± 0. 0444	<0.001*	0. 2750 ± 0. 1333	<0.001*
Canine	0.1750 ± 0.1832	<0.001*	0. 2250 ± 0. 0444	<0.001*	0. 3500 ± 0. 2565	<0.001*
Premolar	0.5000 ± 0.3078	<0.001*	0. 0500 ± 0. 0513	<0.001*	0. 3250 ± 0. 1832	<0.001*
Molar						
Mesiobuccal root Distobuccal root Palatal root	0.3250 ± 0.0444 0.2250 ± 0.0851 0.8500 ± 0.1539	<0.001* <0.001* <0.001*	0. 1500 ± 0. 0513 0. 5750 ± 0. 3354 0. 3000 ± 0. 1026	<0.001* <0.001* <0.001*	0. 3000 ± 0. 1777 1.3250± 0. 7122 0. 6500 ± 0. 4674	<0.001* <0.001* <0.001*

*p value <0.05; Hence statistically significant

IV. Discussion

Root resorption is a potential complication in orthodontics. It can occur during or after orthodontic treatment due to the pressure applied by braces or other orthodontic devices. Apical Root Resorption is the most typical form seen in orthodontic cases, wherein the apex (tip) of the root is resorbed.[1] Lateral Root Resorption affects the sides of the root but is less common.

Root resorption is detected by radiographic assessment, which include 2D and 3D methods. Usually, there are no symptoms, but in severe cases, teeth might become mobile. Studies that evaluate apical root resorption are plenty in number however there are very less studies conducted to evaluate the lateral root

resorption.

Therefore in this study , Cone Beam Computed Tomograpghy (CBCT) was used to evaluate lateral root resorption in maxillary teeth at three levels (3mm,6mm and 9mm) after closure of first premolar extraction spaces . Lateral root resorption at cervical , middle and apical thirds of root where thus compared and it was found that the degree of root resorption is highest at the apical third for all the maxillary teeth. The highest rate of root resorption was found to be in canine at all the three levels and the least was found in the distobuccal root of first molar. This can be attributed to the fact that, canine had to move first through maxillary bone while the other anterior teeth merely had to follow canine, and the molar (anchorage tooth) had not undergone any movement. This was in agreement with the study conducted by Ramos et al.[6] Lindskog-Stokland et al reported that some lateral root resorption is an inevitable occurence with orthodontic movement.[7]

The distobuccal root of first molar as well as the root of central incisors were found to have the least amount of resorption in this study. Studies by Remington[8] confirms the same. The prevalence of ARR in this study was found to be be consistent with other studies widely, ranging from 20 to 100%. Severe cases of ARR, where resorption exceeds 5 mm or one-fourth of the root length, are rare, with an incidence of 1 to 5%. While root resorption may often be clinically insignificant, excessively shortened roots can result in tooth loss or mobility.

Krishnan et al[10] suggested that when root resorption is detected during orthodontic treatment, it's advised to stop the treatment for about 6 months. This break allows the roots to start repairing themselves. Using intermittent forces, which provide breaks between pressure applications, is better for the tissues than continuous forces, as it gives the roots time to heal during these rest periods.[4]

This study does not compare root resorption that occurs with different retraction mechanics. It also does not include various factors that affect resorption like age, sex, duration of treatment etc. Segal et al[9] in their study concluded that root resorption is highly corelated with the age and duration of treatment. In this study it was found that the maximum lateral root resorption took place at the apical thirds of the teeth, compared to the cervical and middle thirds. Thus this study can be used as an awareness on lateral root resorption and for patient education so as to highlight the importance of use of light continuous force during orthodontic treatment.

V. Conclusion

n conclusion, root resorption is a potential complication of orthodontic treatment, primarily caused by the mechanical forces used to move teeth. It is more commonly seen as external root resorption, with the apical third of the root being the most affected area, particularly in canines. The risk of root resorption increases with the duration and intensity of the treatment, especially when continuous forces are applied. When root resorption is detected, it is recommended to pause the treatment for about 6 months to allow for root repair. Intermittent forces, which provide rest periods between applications, are more tissue-friendly and can help reduce the risk of further resorption. While root resorption may not always be clinically significant, severe cases can lead to tooth mobility or loss, highlighting the importance of careful monitoring during orthodontic treatment.

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