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Comparison of the Extent of Root Resorption in Maxillary Anterior Teeth Retracted using Regular Temporary Anchorage Devices (TADS) Versus Conventional Anchorage Methods: A Retrospective Study

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Abstract:-

- ***Aim***

The aim of this study will be to compare the amount of root resorption of maxillary anterior retracted with anterior TADs,regular TADs and without skeletal anchorage.

- ***Materials and methods:***

Samples for the study will be the patients undergone orthodontic treatment at the Department of Orthodontics,K.V.G. Dental College and Hospital, Sullia Sample size of 45 patients will be divided in to 3 groups . ,Group 1 consists of patients treated with anterior TADs, Group2 consists of patients treated with regular TADs and Group 3 consists of patients treated without skeletal anchorage for retraction of maxillary anteriors. Root resorption will be measured by comparing pretreatment and post treatment intraoral periapical radiographs (IOPAR) radiographs.

- ***Result-***

The study meticulously compared root resorption levels among three groups: Conventional, Anterior Temporary Anchorage Devices (TADs), and Posterior TADs. Anterior TADs exhibited the highest mean root resorption, significantly higher than both Conventional and Posterior TADs. Statistical analyses confirmed these differences, highlighting the impact of anchorage method on root resorption. Pairwise comparisons and confidence intervals further supported the findings, emphasizing the nuanced variations observed.

I. INTRODUCTION

Orthodontic root resorption is one of the most frequently reported side effects of orthodontic Movement. Orthodontic root resorption is related to various factors, while long orthodontic treatment time and a large amount of apical displacement pose great risk factors for root resorption.[1]

Maximum retraction of the anterior teeth with premolar extraction is necessary to improve Occlusion and facial aesthetics in patients with lip protrusion or severe skeletal/dental discrepancies. The application of temporary anchorage devices (TADs) has improved the efficiency and the predictability of 3-dimensional management of tooth movement and anchorage control; thus, incorporating TADs in comprehensive treatment, especially for premolar extraction cases, is well-accepted in clinical orthodontics.[2]

External apical root resorption (EARR) is the result of a sterile inflammatory process that leads to an ischemic necrosis localized in the periodontal ligament, and is the most commoniatrogenic complication of orthodontic treatment. The onset and progression of root resorption is associated, to variable degrees, with multiple risk factors related to the patient such as genetic susceptibility and root morphology, and to the orthodontic treatment such as duration of treatment, magnitude of force applied, method of force application (continuous versus intermittent), and direction and type of tooth movement. 3 The greatest damage is observed with intrusive movements since they concentrate pressure at the root apex. There is the risk of permanent tooth mobility in a maxillary incisor that undergoes severe root resorption during orthodontic treatment, if the remaining total root length≤9 mm.[4]

Several studies have demonstrated that maxillary incisors are the most affected teeth by external apical root resorption and that horizontal displacement of the tooth root during orthodontic treatment is positively associated with incisor root shortening mainly in extraction patients. Anterior retraction anchored on mini-implants can produce greater incisor displacement and less anchorage loss when compared with orthodontic mechanics with conventional anchorage.[1,5,6]

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A temporary anchorage device (TAD) is a device that is temporarily fixed to bone for the purpose of enhancing orthodontic anchorage either by supporting the teeth of the reactive unit or by obviating the need for the reactive unit altogether, and is subsequently removed after use. They can be located trans-osteally, subperiosteally, or endosteally; and they can be fixed to bone either mechanically (cortically stabilized) or biochemically (osseointegrated). Importantly, the incorporation of dental implants and TADs into orthodontic treatment made possible infinite anchorage, which has been defined in terms of implants as showing no movement (zero anchorage loss) as a consequence of reaction forces.[7,8,9]

Possible insertion sites include, in the maxilla: the area below the nasal spine, the palate, the alveolar process, the infrazygomatic crest, and the retromolar area; in the mandible: the alveolar process, the retromolar area, and the symphysis.[10]

Hence the present study will be undertaken to compare the root resorption of maxillary central incisors after anterior retraction with regular TADs and without skeletal anchorage.

II. AIM AND OBJECTIVES

➢ *Aim:*

The aim of this study will be to compare the amount of root resorption of maxillary anterior retracted with TADs and without skeletal anchorage.

➢ *Objectives:*

- To determine the amount of root resorption of maxillary anterior with anterior TADs placed in-between the roots of maxillary central incisors.
- To determine the amount of root resorption of maxillary anterior with posterior TADs placed in-between the roots of maxillary first molars and second premolars.
- To determine the amount of root resorption of maxillary anterior retracted with without skeletal anchorage.
- To compare the amount of root resorption of maxillary anteriors with anterior TADs,regular TADs and without skeletal anchorage.

III. METHODOLOGY

➢ *Study Design:*

A Retrospective study.

➢ *Data Source:*

The orthodontic records will be obtained from the files of the Department of Orthodontics at KVG Dental College and Hospital,Sullia.

➢ *Inclusion Criteria*

- Patients who already underwent treatment for Class II Division 1 malocclusion or Class I bi-maxillary protrusion with extraction of maxillary first premolars.
- No history of trauma to the maxillary incisors.
- No endodontic treatment or pre-existing resorption on the initial periapical radiographs.
- Maxillary crowding smaller than 3 mm.

➢ *Exclusion Criteria*

- History of trauma.
- Patients with supernumerary or impacted teeth, malformed roots, tooth shape and size anomalies

➢ *Data Collection:*

The orthodontic records for this retrospective study will be obtained from the files of the Department of Orthodontics at KVG Dental College and Hospital, Sullia.

This study will be divided into 3 groups, Group 1 consists of patients treated with anterior TADs, Group2 consists of patients treated with regular TADs and Group 3 consists of patients treated without skeletal anchorage for retraction of maxillary anteriors.

In Group 1-the records will be collected from the patients who underwent orthodontic treatment with 1st premolars extraction and maximum retraction of maxillary anterior with the help of temporary anchorage devices placed in the anterior region in-between the roots of maxillary central incisors.

In Group 2- the records will be collected from the patients who underwent orthodontic treatment with 1st premolars extraction and maximum retraction of maxillary anterior with the help of temporary anchorage devices placed in the posterior region in-between the roots of maxillary first molars and second premolars

In Group 3- the records will be collected from the patients who underwent conventional orthodontic treatment with 1st premolars extraction and maximum retraction of maxillary anterior without temporary anchorage devices.

➢ *Measurement of Root Resorption :*

Root resorption will be measured by comparing pretreatment and post treatment intraoral periapical radiographs (IOPAR) radiographs.

To minimize the standardization problem between the periapical radiographs, the scoring system proposed by Malmgren et al; will be used to quantify root resorption degree instead of metrical evaluation. The classification will consist of 5 score:

- 0 - no root resorption.
- 1 - mild resorption,with only an irregular outline and the root showing normal length.
- 2 - moderate resorption, with little loss of root apex showing an atmost straight outline.
- 3 - sharp resorption, with great root loss, reaching almost a third of its length.

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- 4 - extreme resorption, with loss greater than a third of the root length.

➢ *Statistical Analysis*

All statistical analysis will be performed by using the SPSS 27 software. The mean and the standard deviation will be calculated for each variable. t test will be used to measure the level of significance between the groups. P < 0.05 was considered as statistically significant.

IV. RESULTS

The study aimed to meticulously investigate and compare the degree of root resorption among three distinct groups: Conventional, Anterior Temporary Anchorage Devices (TADs), and Posterior TADs. The mean and standard deviation of root resorption for each group provided insightful numerical data, revealing a nuanced pattern. Notably, Anterior TADs exhibited the highest mean root resorption at 2.66, indicating a potentially more substantial impact on root structures compared to the Conventional (mean = 1.6) and Posterior TADs (mean = 1.733) groups. To evaluate the significance of these observed differences, a robust statistical approach was employed, including analysis of variance (ANOVA) and post hoc tests.

The ANOVA results unveiled a highly significant difference between the groups ($F=9.732$, $p<0.001$), signifying that the choice of method significantly influenced the degree of root resorption. Post hoc tests delved deeper into these group distinctions. The pairwise comparisons between Conventional and Anterior TADs, as well as Anterior TADs and Posterior TADs, demonstrated statistically significant mean differences ($p=0.001$ and $p=0.003$, respectively). These results suggest that the use of Anterior TADs is associated with a significantly higher degree of root resorption compared to both Conventional and Posterior TADs. In contrast, the comparison between Conventional and Posterior TADs yielded no significant difference ($p=0.869$), implying similar effects on root resorption.

The inclusion of 95% confidence intervals for the significant differences further strengthened the robustness of these findings. The intervals for Conventional vs. Anterior TADs (-1.70 to -0.42) and Anterior TADs vs. Posterior TADs (0.29 to 1.57) did not encompass zero, substantiating the reliability of the observed discrepancies. The meticulous examination of these statistical parameters underscores the nuanced variations in root resorption among the three groups.

Table 1: Comparison of Mean Degree and Standard Deviation of Root Resorption among Different Orthodontic Treatment Methods

SL.NO	Method	Mean	Standard Deviation
1	Conventional	1.6	0.611
2	Anterior tads	2.66	0.86
3	Posterior tads	1.733	0.57

Table 2: Comparison of Movement Across Different Groups in Orthodontic Treatment (ANOVA)

Movement	Sum of Squares	df	Mean Square	F	P value
Between Groups	10.133	2	5.067	9.732	0.000
Within Groups	21.867	42	.521		

**The table shows that the difference between the groups is statistically significant.*

Table 3: Pair Wise Comparison of Mean Differences in Movement between Orthodontic Treatment Groups with Tukey's Honestly Significant Difference (HSD) Test

(I) Group	(J) Group	Mean Difference (I-J)	P Value	95% Confidence Interval	
				Lower Bound	Upper Bound
Conventional	Anterior tads	-1.06*	0.001	-1.70	-0.42
	Posterior tads	-0.13	0.869	-0.77	0.50
Anterior tads	Conventional	1.06*	0.001	0.42	1.70
	Posterior tads	0.93*	0.003	0.29	1.57
Posterior tads	Conventional	0.13	0.869	-0.50	0.77
	Anterior tads	-0.93*	0.003	-1.57	-0.29

**The mean difference is significant at the 0.05 level.*

** The table shows that the difference between the groups is statistically significant.*

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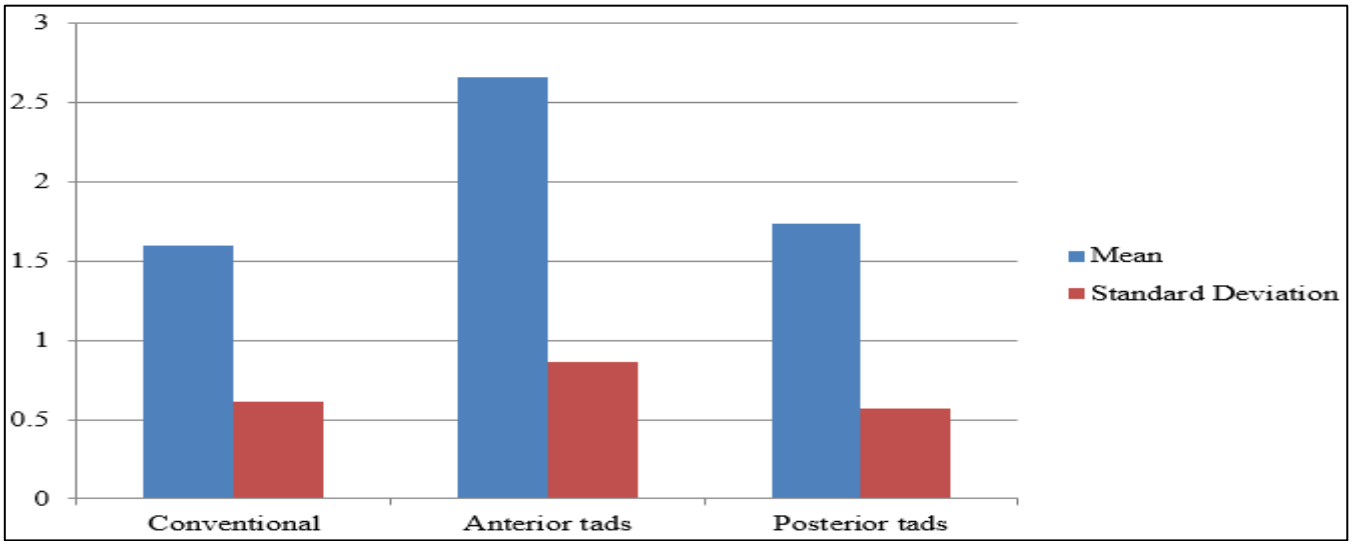

Fig 1: Comparison of the Amount of Root Resorption among the Three Groups.

V. DISCUSSION

The retrospective study sheds light on variances in root resorption among orthodontic patients subjected to different anchorage methods, stimulating a comprehensive discourse informed by existing research. It juxtaposes conventional anchorage against anterior and posterior Temporary Anchorage Devices (TADs), unveiling subtle distinctions in root resorption rates. Building upon these insights, the ensuing discussion will delve deeper into the implications of these findings, synthesizing additional research to offer a holistic grasp of the subject matter.

The increased occurrence of root resorption observed in the anterior TADs cohort aligns with several studies indicating that the placement and mechanics of TADs can influence the extent of root resorption. Park et al. (2011) found a similar trend, reporting elevated levels of root resorption in cases where anterior TADs were utilized for maxillary incisor intrusion. The proximity of the anchorage devices to the teeth undergoing retraction can lead to concentrated forces, thereby exacerbating root resorption, particularly in scenarios involving intrusive movements. Additionally, Wilmes et al. (2014) underscored the potential hazards associated with positioning TADs between the roots of maxillary central incisors, echoing the findings of the present study.

On the other hand, the similar rates of root resorption observed in both the conventional and posterior TADs groups are consistent with the concept of selective anchorage. Baumgaertel et al. (2014) conducted a study exploring the application of TADs in the posterior palate to reinforce anchorage, which demonstrated effective control over anchorage while mitigating the likelihood of excessive root resorption. The idea of employing posterior TADs to distribute forces more uniformly and alleviate pressure on individual tooth roots has garnered support from multiple studies, highlighting the advantages of strategic placement of anchorage devices.

While this study primarily examined maxillary anterior retraction, it's crucial to consider the broader impact of anchorage methods on treatment outcomes. Liou and Pai (2007) conducted a study investigating TAD utilization across various maxillary regions, underlining the significance of choosing the optimal anchorage site based on planned tooth movements. Their findings indicated that placing TADs in the infrazygomatic crest or retromolar area could yield effective anchorage control with reduced risk of root resorption. This underscores the necessity for a tailored approach in selecting anchorage methods, taking into account the specific biomechanical demands of each case.

This retrospective study's strengths are evident in its specific examination of three distinct anchorage techniques (conventional, anterior TADs, and posterior TADs) for maxillary anterior retraction, offering valuable insights into the varying degrees of root resorption associated with each method. The employment of a standardized scoring system for assessing root resorption and the incorporation of multiple anchorage groups bolster the study's internal consistency. Moreover, the application of robust statistical analyses, such as ANOVA and post hoc tests, enhances the statistical integrity of the results, thereby substantiating the reliability of observed discrepancies among the groups.

Nevertheless, it's important to recognize several constraints. The retrospective design introduces potential biases like selection bias and the inability to control all treatment variables. The absence of randomization and blinding could undermine internal validity. Relying on orthodontic records for data collection may result in variations in radiograph quality and availability. The relatively small sample size and single-center setting might limit generalizability. Moreover, the lack of information on factors such as patient age, skeletal maturity, and treatment duration could hinder a comprehensive understanding of the intricate relationship between orthodontic anchorage methods and root resorption. Future prospective studies with larger, more diverse samples, controlling additional variables, are needed to confirm and extend these findings.

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VI. CONCLUSION

In conclusion, this retrospective study provides valuable insights into the nuances of root resorption associated with different orthodontic anchorage methods. It highlights the impact of anchorage device placement and mechanics on root resorption rates, with anterior TADs showing increased occurrence of root resorption compared to conventional anchorage. Conversely, posterior TADs demonstrate comparable root resorption rates to conventional methods, supporting the concept of selective anchorage.

While the study's strengths lie in its focused examination of distinct anchorage techniques and robust statistical analysis, limitations such as potential biases inherent in retrospective design and the lack of comprehensive patient data must be acknowledged. Future prospective studies with larger, more diverse samples and controlled variables are necessary to validate and extend these findings.

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