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Comparative Evaluation of Anchorage Loss with Implant-Aided Retraction and Frictionless Mechanics with Conventional Anchorage in Bimaxillary Protrusion Cases

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ABSTRACT: Management of anchorage and good control of molars in all three planes of space is necessary for optimal results. It is of paramount importance for the clinician to select the appropriate anchorage control. The aim of the study was to compare the anchorage loss from implant-aided retraction and frictionless mechanics retraction in bimaxillary protrusion cases. Cephalograms of 40 patients were evaluated in this retrospective study, segregated into two groups based on their retraction mechanics. Anchorage loss was determined from measurements made on pretreatment and postretraction lateral cephalograms. Mean and standard deviation from independent sample *t*-tests were used to analyze the anchorage loss between the two groups. Statistical analysis was carried out using SPSS version 20.0. In the implant-aided group, mean anchorage loss was 0.95 ± 0.36 mm; in the frictionless mechanics with conventional anchorage group, the mean anchorage loss was 2.44 ± 0.46 mm. The average interincisal angle in the frictionless mechanics group and the implant-aided retraction group was 99.45 ± 5.41° and 100.15 ± 4.85°, indicating similar incisor inclinations in the pretreatment group. Pretreatment interincisal angle measurement ensured that both groups had similar anchorage demands. Anchorage loss was greater in frictionless mechanics with conventional anchorage (2.44 m) when compared to implant-aided retraction mechanics (0.95 mm). Implant-aided retraction can thus be considered for cases requiring absolute anchorage.

KEY WORDS: miniscrews, anchorage loss, lateral cephalograms, frictionless mechanics

I. INTRODUCTION

Protrusion of the maxillary and mandibular incisors with incompetency of the lips, known as bimaxillary dentoalveolar protrusion, is one of the most common chief complaints of patients seeking orthodontic correction.[1,2] The treatment plan for these patients mostly involves the extraction of the first premolars followed by retraction of the anterior teeth to reduce the protrusion. In this situation, when maximum retraction of the anterior teeth is essential, anchorage control of the posterior teeth becomes critical to good treatment results.[3,4] In other words, the better the anchorage, the better the retraction and the better the improvement of the patient's profile.[5,6]

With the development of implants, there has been an increase in the use of miniscrews/mini-implants to achieve absolute anchorage during retraction of anteriors.[7,8] There are different opinions on how to achieve maximum retraction in first premolar extraction cases.[9] Profitt and Fields recommended individual canine retraction followed by incisor retraction for maximum anchorage, hypothesizing that this would decrease anchorage strain on the posteriors.[10] Staggers and Germane argued that anchorage is taxed excessively with a two-step retraction method.[11] This debate was brought to an end by Hain et al., who stated that there was no significant difference between the two retraction modes.[12,13]

Space closure can be carried out by either friction or frictionless mechanics. In friction mechanics, the extraction site is closed using elastomeric chains or NiTi coil springs to allow sliding of the wire with resultant space closure.[14] In frictionless mechanics, loops and bends are used to generate forces and moments to close the extraction site with both active and reactive units.[15] Despite the large number of studies dealing with space closure, evidence is scattered regarding the best technique for anterior retraction. A recent systematic review suggested additional trials to determine the best method of anterior retraction.[16] Our team has conducted numerous clinical trials[17–23] and lab studies with animals[24–28] as well as *in vitro* studies[29–31] over the past 5 years. Now, we are focusing on anchorage loss, which is a topic of current interest in our community. Not enough is known about the relative merits of frictionless mechanics and implant-aided mechanics during en-masse retraction. Only properly designed trials will provide conclusive answers. Our department has published extensive research on various aspects of prosthetic dentistry.[32–41] This experience inspired us to explore anchorage loss in bimaxillary protrusion cases through cephalograms comparing the effectiveness of frictionless mechanics with conventional anchorage (FMCA) and that of implant-aided friction mechanics (IAFM) by assessing the anchorage loss.

II. MATERIALS AND METHODS

This study was conducted in the Department of Orthodontics at Saveetha Dental College, Chennai, India, using the PICO format—P: patients requiring orthodontic treatment presenting with bimaxillary protrusion; I: retraction with IAFM; C: retraction with FMCA (including transpalatal arch and bonding of second molars); O: outcomes assessed (molar anchorage loss, interincisal angle changes). The null hypothesis was that the methods have the same efficiency in en-masse anterior retraction in patients with class I bimaxillary protrusion. Preinterincisal angles were assessed in both groups and kept as close to each other in size to ensure that the difficulty of treatment in both the groups was the same. Thus, the anchorage demands were equal.

A. Inclusion/Exclusion Criteria and Sample Size

Inclusion criteria included (1) Male or female patients with aged 18–30 years; (2) Class I bimaxillary protrusion; (3) full permanent dentition; (4) good oral hygiene; (5) maximum anchorage requirements; and (6) healthy bone between first molars and second premolars. Exclusion criteria included (1) systemic diseases, (2) severe crowding, (3) extracted/missing upper permanent tooth/teeth, and (4) previous orthodontic treatment.

Our sample size calculation followed Ziegler et al. in comparing effects of friction and frictionless mechanics on maxillary canine retraction.[42] A sample size of 20 cases per group was considered. Pretreatment and postretraction lateral cephalograms of 40 patients with bimaxillary protrusion, showing 20 cases of IAFM and 20 of FMCA. All the patients had undergone extraction of all four first premolars and retraction of the anterior teeth by one or the other retraction method.

Space closure by FMCA was carried out with a continuous T-loop fabricated with 17 × 25 TMA wire and 15 degrees of alpha bend and 35 degrees of beta bend to augment anchorage. Additionally, a transpalatal arch between the first molars was placed along with the inclusion of second molars to the anchor unit. Space closure with IAFM was carried out with conventional retraction mechanics on a 19 × 25 SS wire. Retraction was carried out with power chains given directly from the implants placed between upper second premolars and upper first molars to the retraction hooks placed on the wire between the lateral incisor and the canines.

B. Cephalometric Analysis

The pretreatment and postretraction lateral cephalograms were traced and the discrepancies in landmark location and measurements were resolved by agreement with the principal guide. The cephalograms were manually superimposed to measure anchorage loss. Maxillary bone, upper first molar, upper central incisor, and pterygomaxillary fissure were traced. Two reference axes were constructed and required variables were identified. The x-axis connected the ANS to the PNS. The y-axis was perpendicular to the x-axis and tangent to the posterior border of the pterygomaxillary fissure. The reference axes were used to superimpose the pretreatment and postretraction lateral cephalograms and establish anchorage loss.

C. Statistical Analysis

Paired and unpaired *t*-tests were used to compare intra- and intergroup changes. The results were regarded as significant at $p < 0.05$. All statistical analyses were performed with SPSS version 17.0

III. RESULTS

Table 1 gives the values of the preinterincisal angle in the FMCA and IAFM groups. The preinterincisal angle in the FMCA group was 99.45°; the preinterincisal angle in the IAFM group was 100.15°. There was no statistically significant difference ($p = 0.717$) between the groups. This test was carried out to verify the similarity in sample size collection. Similar preinterincisal angles place identical anchorage demand on both groups and help in preventing bias.

Table 2 gives the values of anchorage loss in the FMCA and IAFM groups determined by an independent *t*-test. There was a significant difference between the two. In the IAFM group, the anchorage loss was 0.95 ± 0.36 mm; in the FMCA, the anchorage loss was 2.44± 0.46 mm (Fig. 1).

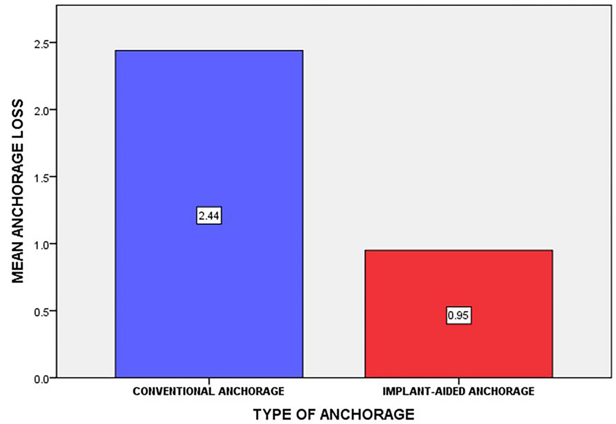

FIG. 1: Rate of anchorage loss

IV. DISCUSSION

Premolar extraction in orthodontics is performed primarily to resolve moderate to severe crowding and retracting anteriors.[5,43] The goal of space closure is to retract the maxillary anterior teeth while maintaining posterior anchorage control. We compared anchorage loss between implant-aided and frictionless retraction to determine which was the more efficient.

To accurately measure anchorage loss, measurement should occur after the alignment phase, just before the space closure phase. Most studies report on initial and final molar position based on lateral cephalometric radiographs taken at those points in treatment.[44,45] Thiruvenkatachari et al. measured molar anchorage loss with differential moments after alignment and completion of space closure, finding about 2.55 mm of molar mesialization.[46] This is in agreement with our study, which determined anchorage loss FMCA group to be 2.44 mm.

A significant difference in anchorage loss is noted between the two retraction mechanics

TABLE 1: Paired *t*-test to determine preinterincisal angle

Mechanics	*N*	Mean	Standard deviation	Significance ($p > 0.05$)
FMCA	20	99.45	5.41	0.717
IAFM	20	100.15	4.86	

TABLE 2: Independent sample *t*-test to determine anchorage loss during retraction

Method	*N*	Mean	Standard deviation	Significance ($p > 0.05$)
FMCA	20	2.44	0.46	0.000
IAFM	20	0.95	0.36	

The mean anchorage loss in frictionless mechanics with conventional anchorage was 2.44 mm and mean anchorage loss in implant-aided frictional mechanics group was 0.95 mm. There was a statistically significant difference $p = 0.000$ ($p < 0.05$) between the two groups included in the study.

methods. Considering the increased anchorage loss in FMCA patients, IAFM is recommended for patients requiring maximum/absolute anchorage.[47] Our results are similar to those obtained by Naik et al., who reported better anchorage control with IAFM.[48] Basha et al. had similar findings.[49] Considering the greater amount of anchorage loss seen with FMCA, it may be tempting to see IAFM as a solution for anchorage loss. However, the various confounding factors in play must be considered. Frictionless mechanics involves distal tipping of molars to compensate for the moments generated, and this may also be responsible for increased anchorage loss. Also, implant placement is an invasive procedure and its stability is questionable in young children and adolescents.

A. Limitations and Future Directions

The limitations of this study include verification of anchorage loss through lateral cephalograms, which can be doubtful and subject to error.[50] A better method would have been using palatal rugae in digital models. Other limitations include the small sample size, variations in tooth size and bone density, and the samples being of the same race. These limitations can be overcome with more advanced methods like CT/CBCT imaging to ascertain changes in bone density, root length, inclination of the teeth, and so forth. Future studies might include assessment of root resorption with different anchorage and retraction mechanics, variation in implant placement height and its effect on intrusion and root resorption, assessment of implant failure, and implant migration within the bone with application of force.

V. CONCLUSION

Anchorage loss is greater in FMCA when compared to IAFM. IAFM is a viable option in patients requiring absolute anchorage.

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