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CHANGES IN THIRD MOLAR POSITION AFTER EN-MASSE RETRACTION IN BIMAXILLARY DENTOALVEOLAR PROTRUSION CASES

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ABSTRACT

Introduction: This study aimed to evaluate the changes in the space available for eruption of third molars as well as their angulation after treatment of bimaxillary dentoalveolar protrusion cases with 1st premolars extractions implementing maximum anchorage.

Methods: The sample of the current study comprised 41 adult females (mean age of 20.8 ±2.03) having bimaxillary dentoalveolar protrusion. All participants received the same treatment protocol where TADs were used for direct maximum anchorage followed by 1st premolars extraction and en-masse retraction of the anterior teeth over 0.019” × 0.025” main working archwire. Third molar angulation and its available space pre-and post-treatment was assessed via panoramic radiographs using IC Measure 2.0.0.161 software. Paired t tests were used for intragroup comparison between pre and post-treatment data.

Results: Analysis of the linear variables demonstrated a non-statistically significant difference between the 2 groups for all third molar eruption spaces. The mean differences in the third molar angulation between the pretreatment and posttreatment values revealed a decrease in the angulation yet these changes were non-significant.

Conclusion: This study suggests that orthodontic treatment comprising extraction of first premolars and en-masse retraction utilizing maximum anchorage doesn’t lead to a significant improvement in the angulation nor the space available for third molar eruption by the end of treatment.

KEYWORDS: Third molar, En-masse retraction, Premolar extraction

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INTRODUCTION

The third molar is considered the most unique tooth in the entire human dentition. It's variability in the time of its formation, eruption, and eruption path has been a concern for dentists and dental specialists alike. This is mainly due to the fact that 3rd molars are considered the most commonly impacted tooth in the entire dentition [(1)]. The risk of impaction is highly correlated to reduced eruption space in the dental arch. There are various factors described in the literature which contribute to this lack of space, such as the alteration in the longitudinal growth of the mandible, or distal eruption pattern of teeth [(2, 3)].

Some studies in the orthodontic literature associate extraction therapy with mesialization of molars, which would increase the amount of space in the retromolar region [(4, 5)]. Meanwhile, other studies have correlated the extraction of 1st or 2nd premolars, during orthodontic treatment, to improved vertical position of third molars and increased eruption space [(6)] without any significant effect on the third molar angulation [(6, 7)].

Extraction therapy is commonly advocated in orthodontics to mask skeletal problems as well as solve many dental problems such as crowding or anterior teeth proclination which is known as bimaxillary dentoalveolar protrusion. These cases are usually managed through the extraction of first premolars and retraction of the anterior teeth. The first premolars are usually the main choice for extraction for maximum retraction of anterior teeth into the extraction space, hence, achieving the best facial and smile esthetics.

Two main methods of extraction space closure and anterior teeth retraction are usually adopted; either two-step retraction or en-masse retraction. In two-step retraction the canines are retracted first, followed by anterior segment retraction whereas, in en-masse retraction, the six anterior teeth are retracted as one unit. Each technique has its pros and cons which are still debatable, however, en-masse retraction is more superior regarding the esthetics, as less extraction space is evident upon smile during retraction which makes it preferable for patients.

Some studies have recommended the two-step retraction as they might be less taxing on anchorage and hence might result in more anterior teeth retraction [(8)]. On the other hand, it was hypothesized that this technique might cause double loading on the anchorage as retraction is done twice, one time during separate canines' retraction and another during incisors' retraction [(9)]. Despite the debate, the advent of orthodontic miniscrews has simplified the anchorage control and hence allowed for better functional and esthetic results [(10, 11)]. Thus, en-masse retraction with proper anchorage control could be advocated with better and faster treatment outcomes.

Although the literature is rich in a plethora of studies which aimed to assess the efficiency of retraction techniques and mechanics, yet the improvement in the functional outcomes after orthodontic treatment couldn't be overlooked. Increasing the chances of 3rd molar eruption could be one of the important benefits of extraction therapy in orthodontic treatment, yet no solid conclusion regarding the effect of 1st premolars extraction and anterior teeth retraction on the 3rd molars could be detected due to the heterogeneity of the retraction mechanics and sample in most of the retrospective studies [(12)]. Accordingly, the aim of this study was to assess the effect of en-masse retraction with maximum anchorage application on the space available for 3rd molar eruption as well as its angulation in adult female patients having bimaxillary dentoalveolar protrusion.

MATERIAL AND METHODS:

For the current study, sample size calculation was done using the comparison of URD (the distance between the most distal point of the upper right second molar and the Z point on the ramus (mm)) between pre- and post-treatment. As reported in a previous study (5), the mean ± SD of pre-treatment URD was 3.56 ± 3.61 mm, while in post-treatment it was 11.78 ± 4.27 mm. Using the highest SD (4.27 mm), we calculated that the minimum proper sample size was 11 participants to be able to detect a real difference of 4 mm in URD with 80% power at $\alpha = 0.05$ level using Paired *t* test for matched samples. Sample size calculation was done using PS Power and Sample Size Calculations Software, version 3.1.2 for MS Windows (William D. Dupont and Walton D., Vanderbilt University, Nashville, Tennessee, USA).

Despite the sample size calculation, a larger sample was retrospectively selected from the files of 2 previous randomized clinical trials conducted at the Orthodontic Department, Faculty of Dentistry, Cairo University. The records of 41 adult females having bimaxillary dentoalveolar protrusion, treated by four 1st premolar extraction and maximum anchorage using miniscrews were gathered. All recruited panoramic radiographs were ensured to be done at the same radiology center with the same specs. Subjects with missing 3rd molars, missing records, or treated with a different pattern of extraction or different mechanics were excluded.

Treatment mechanics comprised fixed straight wire appliance, ROTH prescription, with 0.022 × 0.028-inch brackets' slot (American orthodontics, Sheboygan, Wis). All participants started levelling and alignment using 0.014" Nickel-titanium (NiTi) archwire, followed by sequential wires till reaching 0.019 × 0.025-inch stainless steel S.S) archwire. Maximum anchorage was implemented via insertion of 1.6 × 8 mm miniscrews (bracket head design; Dual Top Anchor System, Jeil Medical Corporation, Seoul, Korea) between the 2nd premolars and the 1st permanent molars followed by ligation of the 2nd premolar to the miniscrews to ensure anchorage. First premolars were then extracted and en-masse retraction phase commenced.

En-masse retraction was done by crimping hooks distal to lateral incisors and attaching elastomeric chain (Short Power chain, American orthodontics, Sheboygan, Wis) extending between the miniscrews and the hooks delivering a force of 200 gm/ quadrant. After the retraction phase panoramic radiographs were captured for each participant.

The space available for third molars and their mesiodistal angulation were assessed at pre-(T1) and post-treatment stages (T2) in panoramic radiographs using IC Measure 2.0.0.161 software. Treatment changes were calculated as (T2-T1). All landmarks' demarcation and measurements were done by a single investigator (H.D) (Table I & figure 1). Although panoramic radiographs were captured with a 1:1 magnification, further confirmation was done by measuring the mesiodistal width of the 1st molar and compared with its radiographic width. After one month, 20% of the enrolled sample were re-calibrated and measured by the same investigator as well as by another colleague (L.S) to evaluate the intra-observer and inter-observer reliability.

TABLE (1): Reference lines, linear and angular measurements used

Reference lines:	**Definition**
Infraorbital line	Line tangent to the right and left orbitale points (most inferior point on the lower border of the inferior orbital rim)
Inter-mentonian foramina line	Line connecting between the middle of the right and left mental foramina
P-Line_ RT	Line perpendicular to the infraorbital line tangential to the right maxillary tuberosity.
P-Line_ LT	Line perpendicular to the infraorbital line tangential to the left maxillary tuberosity.
Linear measurements:	**Definition**
Sp.UR8/mm	Space available for the upper right third molar measured between the distal contact point of the upper right 2nd molar's crown and P-Line_RT
Sp.UL8/mm	Space available for the upper left third molar measured between the distal contact point of the upper left 2nd molar's crown and P-Line_LT

Sp.LR8/mm	Retromolar space available for the lower right third molar, measured as the distance between the distal contact point of the lower right 2nd molar's crown and the anterior border of the ramus of the mandible
Sp.LL8/mm	Retromolar space available for the lower left third molar, measured as the distance between the distal contact point of the lower left 2nd molar's crown and the anterior border of the ramus of the mandible
Angular measurements:	**Definition**
UR8*/deg	Exterior angle between the long axis of upper right third molar and the infraorbital line
UL8*/deg	Exterior angle between the long axis of upper left third molar and the infraorbital line
LR8*/deg	Exterior angle between the long axis of lower right third molar and the Inter-mentonian line
LL8*/deg	Exterior angle between the long axis of lower left third molar and the Inter-mentonian line

Two main reference lines were used in the current study, the infra-orbital and the inter-mentonian foramina lines as references for the maxillary and the mandibular arches respectively. The space available for the mandibular 3rd molars was assessed via linear measurements extending from the anterior border of the ramus to the distal contact point of the mandibular second molar's crown following the occlusal plane. Meanwhile, the distance between the distal contact point of the maxillary second molar's crown and a constructed line which is drawn perpendicular to the infraorbital line tangential to the maxillary tuberosity denotes the space available for the maxillary 3rd molars. (Figure 1)

Third molar's angulation was measured by measuring the exterior angle between the 3rd molar's long axis and the inter-mentonian foramina plane or the infra-orbital plane for the mandibular and maxillary arches respectively (Figure 1). In maxillary 3rd molars, the pre-treatment is usually an acute angle (for mesio-angular molars), thus any increase in this angulation denotes a more favorable angulation with better chances for maxillary 3rd molar eruption. On the other hand, the pre-treatment angulation of mandibular third molar is usually an obtuse angle, hence, any decrease in this angulation denotes a more favorable angulation for these teeth eruption.

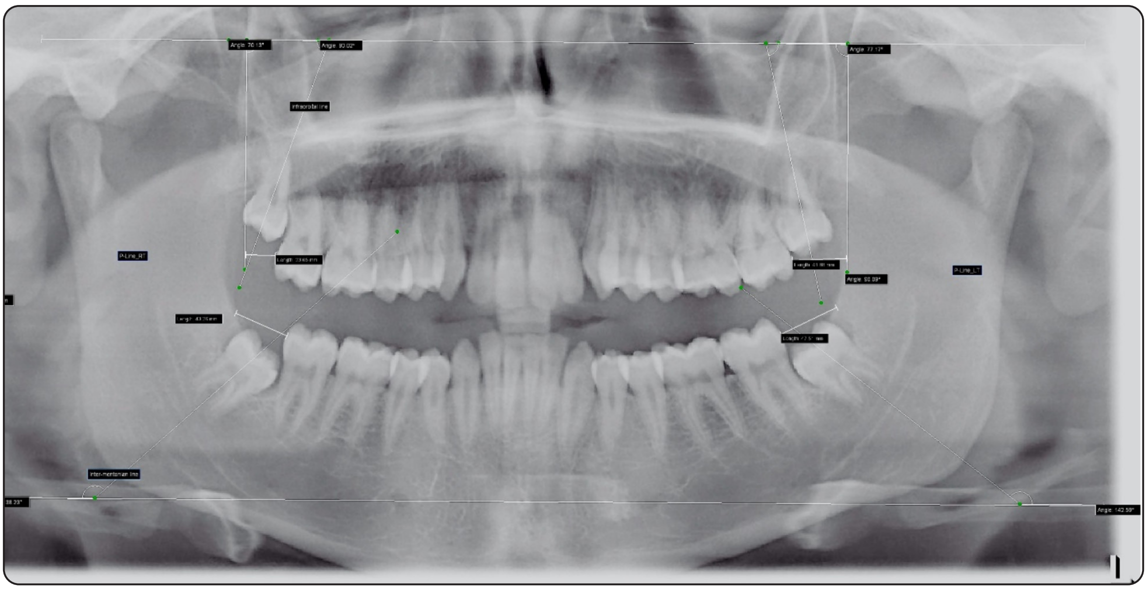

Fig. (1): Reference planes and measurements done in the study

Statistical Analysis

Data were statistically described in terms of mean ± standard deviation (± SD). Reliability was tested using Cronbach's alpha and interclass correlation coefficient (ICC) statistics. Comparison between the study groups was done using Paired *t* test for matched samples. Two-sided *p* values less than 0.05 was considered statistically significant. IBM SPSS (Statistical Package for the Social Science; IBM Corp, Armonk, NY, USA) release 22 for Microsoft Windows was used for all statistical analyses.

Error Study

All panoramic radiographs were assured to be of 1:1 ratio and captured in the same radiographic center to avoid any magnification error. Additionally, 20% of the studied radiographs were re- calibrated and measured by the same investigator as well as by another investigator to assess the intra and inter- observer reliability. Cronbach α was used for assessing such reliability via the intraclass correlation coefficient [13, 14]. The results were evaluated at 95% confidence intervals (CIs) and the levels of significance were $p < 0.05$ and $p < 0.01$.

RESULTS

Assessment of intra and inter-observer reliability revealed non statistically significant difference between both measurements assuring a good reproducibility and reliability of the measurement process where no significant systematic errors were observed (tables 2 & 4).

The average time taken for en-masse retraction was 9.2 ±1.5 months. Analysis of the linear variables for the maxillary 3rd molars showed a slight increase in the space available for their eruption following extraction and anterior teeth retraction. However, this increase was statistically non-significant upon comparing the pre and post retraction data. Similarly, the mean differences in the mandibular 3rd molars eruption spaces at T1 and T2 revealed a slight increase at T2, yet no statistically significant difference could be detected. (Table IV)

Maxillary 3rd molars showed a decrease in their angulation upon comparing T2 and T1 denoting an unfavorable change in these teeth angulations. Similarly, a decrease in the post- treatment angulation of the mandibular 3rd molars was detected in comparison to the pre-treatment angulations, yet this denoted a more favorable change in the mandibular 3rd molar angulation. However, analysis of all angular changes of both maxillary and mandibular 3rd molar angulation showed no statistically significant difference between T1 and T2. (Table V).

TABLE (2): Intra-observer reliability

Measurement	Cronbach's Alpha	ICC
UR8*/deg	0.880	0.799
UL8*/deg	0.870	0.772
LR8*/deg	0.917	0.845
LL8*/deg	0.976	0.959
Sp.UR8/mm	0.851	0.762
Sp.UL8/mm	0.916	0.853
Sp.LR8/mm	0.941	0.843
Sp.LL8/mm	0.927	0.879

TABLE (3): Inter-observer reliability

Measurement	Cronbach's Alpha	ICC
UR8*/deg	0.996	0.994
UL8*/deg	0.961	0.917
LR8*/deg	0.976	0.958
LL8*/deg	0.981	0.954
Sp.UR8/mm	0.976	0.948
Sp.UL8/mm	0.908	0.849
Sp.LR8/mm	0.991	0.976
Sp.LL8/mm	0.978	0.964

TABLE (4): Comparison between pre and post distance measurements

	PRE (N = 13)	POST (N = 13)	MEAN DIFF.	95%CI	P VALUE
	Mean (SD) (mm)	Mean (SD) (mm)			
SP.UR8-/MM	6.6(2.6)	6.6(3.5)	0.08	-0.59 , 0.75	0.806
SP.UL8/MM	7.2(2.7)	7.5(3.3)	0.27	-1.05 , 0.51	0.489
SP.LR8/MM	11.5(2.6)	11.6(2.8)	0.17	-0.69 , 0.35	0.509
SP.LL8/MM	11.1(2.7)	11.5(3.4)	0.44	-1.12 , 0.25	0.205

TABLE (5): Comparison between pre and post angular measurements

	PRE (N = 13)	POST (N = 13)	MEAN DIFF.	95%CI	P VALUE
	Mean (SD) (º)	Mean (SD) (º)			
UR8*/DEG	66.8(14.5)	65.2(15.5)	-1.52	-1.59 , 4.62	0.33
UL8*/DEG	69.0(14.0)	67.9(15.3)	-1.12	-1.85 , 4.10	0.448
LR8*/DEG	134.4(20.9)	133.1(23.1)	1.24	-1.49 , 3.96	0.363
LL8*/DEG	134.6(19.9)	133.6(19.2)	1.04	-0.78 , 2.86	0.252

DISCUSSION

Different tools were introduced for proper diagnosis of the position and angulation of impacted 3rd molars. Panoramic radiographs and Cone Beam Computed Tomography (CBCT) images are the most popular diagnostic tools for 3rd molar's assessment and evaluation [7]. Despite the supreme reliability of the CBCTs, their high costs and radiation dose make its use more confined to complicated impacted 3rd molars rather than general screening and evaluation of 3rd molar position [5].

The literature is full of debate on whether the panoramic radiographs represent a reliable tool for the diagnosis and evaluation of 3rd molars. Some studies reported that using such a tool has presented some distortions, magnifications and limited representation of the accurate clinical condition [15, 16]. On the other hand, other researches stated that panoramic radiographs show reliable and accurate linear as well as angular measurements where its specificity ranged from 96% to 98% [17, 18] and its low cost makes its use more common and versatile [19].

In the current study, several steps were followed to reduce the risk of data inconsistency and magnification. The gathered panoramic records were all ensured to be captured at the same radiology center, with the same machine specs and 1:1 magnification. Moreover, linear mesiodistal first molar width measurements were compared between the casts and the radiographs to avoid any magnification error. All measurements were applied by the same investigator and re-measured after month to assess the intra-observer reliability as well as measured by a colleague for inter-observer reliability.

The effect of extraction therapy in orthodontic treatment on the eruption of third molars was markedly studied in the literature bearing in mind the logical sequence of orthodontic extraction which might result in mesial movement of the posterior teeth, hence increasing the chance of 3rd molar uprighting and eruption [7]. Most of the available studies have assessed the effect of premolars extraction and compared the effect of extraction vs non-extraction therapy on the position of 3rd molars [20-25]. Other studies evaluated the impact of unusual extraction patterns, such as 1st molar extraction and asymmetric extractions, on the third molars [5, 19]. Yet, the findings of the available literature were inconclusive with limited evidence that orthodontic extractions could significantly improve the 3rd molar angulation [7, 12].

Systematic analysis of the available studies has spotted some shortcomings in the published literature. Among these, the young age of the recruited subjects, unclear length of the reported follow up period as well as lack of full description of the malocclusion of the recruited subjects, anchorage needs, details of the appliances used [7]. This has shed the light on the importance of data homogeneity and standardization within all studies even if they were retrospective.

Accordingly, the current study was designed to minimize the defects within the previous retrospective studies as it was based on the data of homogenous sample with detailed description of the mechanics and anchorage used based on 2 previously conducted RCTs. Additionally, despite the popularity of 1st premolar extraction in the orthodontic profession, the effect of maximum anchorage application for en-masse retraction and its questionable effect on the 3rd molar position and angulation was not previously investigated.

In the current study, evaluation of the changes in the third molars was accomplished by linear and angular measurements in relation to reference planes based on stable cranial structures (orbits and mental foramina) [19, 21]. However, several authors have used measurements in reference to occlusal, mandibular planes and 2nd molar long axis which are less reliable as they are prone to growth changes as well as alterations due to the orthodontic treatment [7]. The effect of growth as a confounder was negated in this study by using records for adult females, without the fear of absence of 3rd molar movement as it could still occur in patients beyond the age of 25 years [7].

The space available for eruption of both maxillary and mandibular 3rd molars showed a slight increase upon comparing pre and post treatment data, yet, these changes were statistically non-significant. Similar findings were reported by Miclotte *et a*l. (2017) where a significant change in the retromolar space and position of third molars occurred, but the recruited sample was for growing individuals which might explain the significant effect [26]. However, these changes in the 3rd molar space do not guarantee the successful eruption of 3rd molars in extraction cases [27].

Changes in the third molar angulation in the current study denoted an unfavorable effect of treatment on the maxillary 3rd molars, while a favorable effect was observed on mandibular 3rd molars, however, such findings were statistically non-significant. Likewise, Saysel *et al*. (2005) detected significant improvement in mandibular 3rd molar angulation relative to the occlusal plane when extraction of 1st premolars was applied, while no significant changes could be detected for maxillary 3rd molars [20]. Likewise, a reduction in the maxillary 3rd molar angulation was noticed by Janson et al. (2006) denoting an improvement in their angulation [21]. Despite the comparable sample size, the results of that study showed significant improvement which was not revealed in our current study. This could be attributed to the young age of their recruited sample which wouldn't be reliable enough to evaluate third molar eruption because of the variations in the eruption time and incomplete root formation making the exact tracing of the 3rd molar long axes inaccurate [28].

CONCLUSION

This study suggests that orthodontic treatment comprising extraction of first premolars and en-masse retraction utilizing maximum anchorage doesn't lead to a significant improvement in the angulation nor the space available for third molar eruption by the end of treatment. Hence, extra care should be taken in treatment planning of extraction cases taking into consideration the effect of anchorage selection not only on the anterior teeth and esthetics, but on the 3rd molar position and eruption as well, which in turn would significantly aid in the functional improvement of the orthodontic care delivered to our patients.

Recommendation

Prospective assessment of the third molar angulations as well as the space available for their eruption post-retention with a long term follow up.

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