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THREE DIMENSIONAL EVALUATION OF MAXILLARY ANTERIOR TEETH INTRUSION FOR TREATMENT OF ANTERIOR DEEP BITE ACCOMPANIED WITH GUMMY SMILE USING TWO DIFFERENT BIOMECHANICAL TECHNIQUES.

(DOUBLE ARMED RANDOMIZED TRIAL)

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Abstract

Objective: this clinical study was designed to three dimensionally evaluate maxillary anterior teeth intrusion for treatment of anterior deep bite combined with Gummy Smile using TMA arch wire supported on two posterior miniscrews versus direct intrusion on two anterior miniscrews.

Materials and methods: A clinical trial was conducted on 20 deep bite and gummy smile patients, divided into two groups. Group A had two miniscrews inserted in between upper second premolars and upper first molars, while Group B had two miniscrews inserted in between upper canines and upper lateral incisors. In group A, 80 gm force was applied from the TMA intrusion arch to the anterior segment, while in group B, an equivalent magnitude of force was exerted by the use of an elastomeric chain, the measurement of intrusion was conducted utilizing CBCT.

Results: results showed significant decrease in intrusion measurements with mean difference in incisal edge to horizontal plane 2.72 ± 0.33mm for group A and 2.92 ± 0.17mm for group B. While with mean difference in apex to horizontal plane 2.61 ± 0.4mm for group A and 2.76 ± 0.31mm for group B.

Conclusion: The comparison between group A and group B showed no significant difference in intrusion measurements. As both groups used intrusion mechanics near to the center of resistance of the anterior segment and the same amount of force, allowing for similar intrusive effects.

Introduction:

Anterior deep bite can be treated orthodontically by anterior teeth intrusion or posterior teeth extrusion. Choosing the best treatment plan depends on multiple factors like, incisal show at rest, anterior facial height and mandibular plane angel.[5-7]

Anterior deep bite cases accompanied with gummy smile are best treated by upper anterior teeth intrusion. Many techniques can be used to perform upper anterior teeth intrusion as usage of traditional intrusive arch. However, there were some disadvantages with the use of conventional intrusive arch such as flaring of anterior teeth and loss of anchorage. [24]

Usage of orthodontic temporary anchorage devices (TADs) facilitated correction of many malocclusion types. In addition, many disadvantages could be prevented by the use of intrusive forces in proximity to the center of resistance, therefore miniscrews are depended

upon to correct deep bite and gummy smile cases.[15]

Bilateral posterior (TADs) may be used as anchor for anterior intrusive arch to avoid reactor forces on posterior teeth. [23] Also, usage of anterior (TADs) to perform anterior teeth intrusion directly was considered to be an available technique. [3]

The application of the TMA intrusive arch by lying it to posterior miniscrews on both sides and comparing it with the direct anterior segment intrusion with anterior miniscrews seemed to be a point of worthy investigation. Accordingly, the study was conducted to highlight this aim.[16]

Patients & methods:

This trial was designed as a double armed randomized Clinical trial following the CONSORT (Consolidated Standards of Reporting Trials) 2010 criteria for randomized controlled trials explanation and elaboration.

The sample included 20 patients who were selected from the Department of Orthodontics outpatient clinic, Faculty of Dentistry, Minia University.

Participants:

The selected subjects met the following:

Inclusion criteria:

- Patients with deep bite and gummy smile.
- Patients are in permanent dentition.
- Patients with good oral hygiene.
- No previous orthodontic treatment.
- gummy smile measuring at least 3 mm, as determined through clinical examination.
- Increased overbite diagnosed by clinical examination.

Exclusion Criteria:

- Patient who underwent prior orthodontic treatment.
- Patient with root resorption in the anterior teeth.
- Patient with sever periodontal disease.

Ethical regulation:

- The study received approval from the Research Ethics committee of the Faculty of Dentistry, Minia University, Egypt.
- The research, therapies, and any adverse effects were fully explained to the patients and/or parents.
- Either the patients or their parents submitted an informed consent.
- During the application of Miniscrews, all safety procedures were taken.

Material and methods:

Preclinical stage:

a. Complete patient records were obtained [fig. 1:20].

b. Scaling, polishing, and oral hygiene instructions were given to all patients who matched the inclusion criteria.

Figure 1 presents extraoral photograph (Frontal).

Figure 2 presents extraoral photograph (smiling).

Figure 3 presents extraoral photograph (profile).

Figure 4 presents intraoral photograph (Frontal).

Figure 5 presents intraoral photograph (right side).

Figure 6 presents intraoral photograph (left side).

Figure 7 presents intraoral photograph (lower occlusal).

Figure 8 presents intraoral photograph (upper occlusal).

Figure 9 presents panoramic radiograph.

Figure 10 presents lateral cephalometric radiograph.

Figure 11 presents extraoral photograph (Frontal).

Figure 12 presents extraoral photograph (smiling).

Figure 13 presents extraoral photograph (profile).

Figure 14 presents intraoral photograph (Frontal).

Figure 15 presents intraoral photograph (right side).

Figure 16 presents intraoral photograph (left side).

Figure 17 presents intraoral photograph (lower occlusal).

Figure 18 presents intraoral photograph (upper occlusal).

Figure 19 presents panoramic radiograph.

Figure 20 presents lateral cephalometric radiograph.

Initial leveling and alignment was done by bonding brackets that were used to create a full arch from the first molar of one side to the first molar on the other side, using two different levels vertically. Segmented mechanics were used distal to the lateral, and sequential archwires were used from 0.012-inch NiTi to 0.019 x 0.025-inch NiTi and then stainless steel, preparing for intrusion with an average duration of 6-8 months.
A cone beam computed tomography (CBCT) was performed on each patient after leveling and alignment, using parameters such as field of view 120x90, voxel size 0.200, voltage 85kvp and current 9.5mA.

The study consists of two groups: one using two posterior miniscrews and the other using two anterior miniscrews. Before mini-screw insertion, a pre-intrusion CBCT was performed to assess the available space in-between the roots of the lateral incisor and canine on both sides, as well as in-between the roots of the second premolar and first molar. Patients were anesthetized bilaterally and a topical anesthetic drug was administered to alleviate needle discomfort.
The site of insertion was detected using a probe to detect the level of attached mucosa and ensure symmetry between the two sides. Miniscrews were inserted in interradicular areas with 45^{o} to the teeth to avoid root injury and midpoint between the roots. The insertion direction was gradually shifted to 90 degrees to the labial surface.
80gm force was applied to the miniscrews using force gauges. In the first group, the 0.016 x 0.022 TMA wire was inserted in the miniscrew slot, marked, preactivated, and cinched back. The wire was ligated to the main archwire at level to give 80gm intrusive force.
In the second group, the 80 gm force was applied from the elastomeric power chain that was extending directly from the segmented arch wire between upper lateral incisors and canines to the miniscrews bilaterally.
Follow-up intervals were made every three weeks for an overall follow-up time of six months and photographs are taken after intrusion [fig. 21:26].

Fig21: Intraoral photograph after intrusion using TMA wire extending from the two posterior minscrews (frontal).

Fig.22: Intraoral photograph after intrusion using TMA wire extending from the two posterior minscrews (right side).

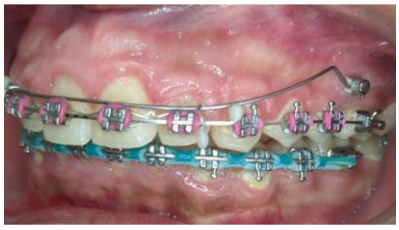

Fig.23: Intraoral photograph after intrusion using TMA wire extending from the two posterior minscrews (left side).

Fig.24: Intraoral photograph after intrusion using power chain extended from the two anterior minscrews (frontal).

Fig.25: Intraoral photograph after intrusion using power chain extended from the two anterior minscrews (right side).

Fig.26: Intraoral photograph after intrusion using power chain extended from the two anterior minscrews (left side).

A cone beam computed tomography (CBCT) was taken to assess intrusion and resorption in patients. Digital software was used to localize points and construct planes for measurements. Data were collected and analyzed to detect intrusion amount and root resorption. The study was made to compare amount of intrusion and root resorption between groups and identify techniques with less resorption. CBCT measurements involved landmark identification [fig. 27-28], reference planes [fig. 29:32], reference lines, and measurements.

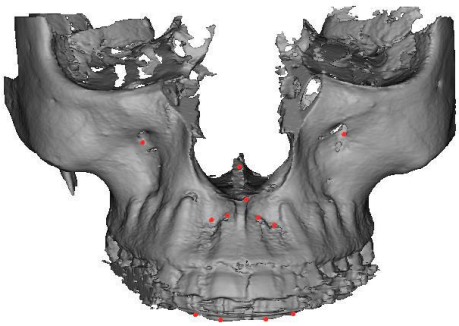

Fig.27: 3D Model showing the identification of landmarks.

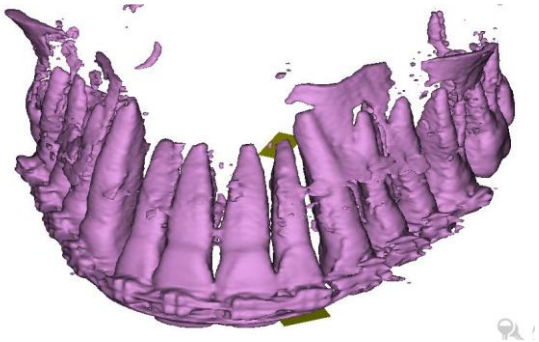

Fig.28: 3D Model showing the land mark used.

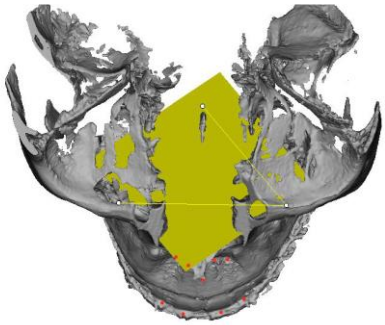

Fig.29: 3D Model showing the transverse plane.

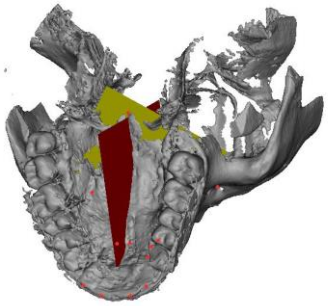

Fig.30: 3D Model showing the sagittal plane.

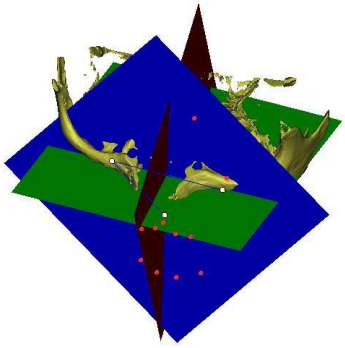

Fig.31: 3D Model showing the frontal plane.

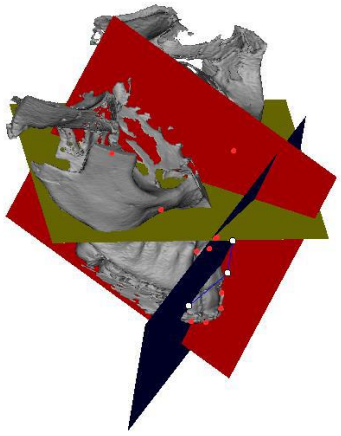

Fig.32: 3D Model showing the merging of three planes.

Results: The statistical analysis was conducted using software programs (SPSS 20®, Graph Pad Prism®, and Microsoft Excel 2016). The normality of all quantitative data was assessed using the Shapiro-Wilk and Kolmogorov Normality tests, and the results were reported as means and standard deviation (SD) values.

Tests used:

- The Shapiro-Wilk and Kolmogorov tests were used to assess the normality of the data.
- paired t-test was used to compare the before and after measures within each group.
- An independent t-test was conducted to compare the two groups.

I. Normality test:

The data was analyzed using the Shapiro-Wilk test and the Kolmogorov-Smirnov test to assess its normality. The analysis suggested that the observed level of significance (P-value) was found to be statistically insignificant, as the calculated P-value was more than 0.05. This suggests that the data followed a normal distribution (parametric data), resembling a typical bell curve, for all measures in both groups.

II. Descriptive results:

Group A: The mean and standard deviation values for the pre and post intrusion measures in group A, as well as the difference between them, were reported in Table 1 and Figure 33, respectively. A comparison was conducted between the pre and post measures using a Paired t test, which indicated a statistically significant reduction in all intrusion measurements (P<0.0001).

Table 1: presents the mean and standard deviation values for the pre, post, and difference in intrusion measures of group A.

Intrusion	Group A				Paired Differences (Paired t test)					P value
	Pre		Post		MD	SD	SEM	95% CI		
	M	SD	M	SD				L	U	
UR2-Apex to HP	29.110	3.914	26.097	3.547	-3.013	1.091	0.315	2.320	3.707	0.0001*
UR1-Apex to HP	27.663	2.830	25.108	2.791	-2.556	1.298	0.375	1.731	3.381	0.0001*
UL1-Apex to HP	27.577	3.195	25.289	2.435	-2.288	1.385	0.400	1.408	3.167	0.0001*
UL2-Apex to HP	29.250	3.835	26.634	2.626	-2.616	1.498	0.433	1.664	3.568	0.0001*
IE-UR2 to HP	51.740	1.453	49.143	0.929	-2.597	1.321	0.381	1.757	3.436	0.0001*
IE-UR1 to HP	54.347	1.659	51.292	1.595	-3.055	1.140	0.329	2.330	3.780	0.0001*
IE-UL1 to HP	54.130	2.158	51.436	1.820	-2.694	1.598	0.461	1.679	3.709	0.0001*
IE-UL2 to HP	51.173	2.142	48.593	1.593	-2.580	1.090	0.315	1.888	3.272	0.0001*

M: mean SD: standard deviation MD: mean difference SEM: standard error mean
CI: confidence interval L:Lower arm U:upper arm
**Significant difference as P<0.05.*

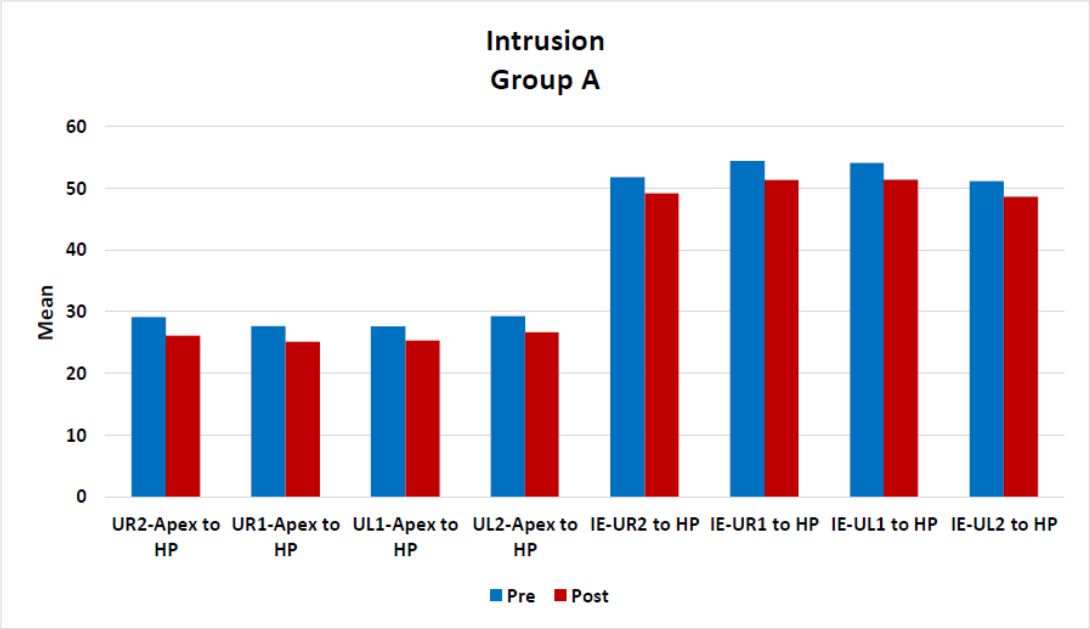

Figure 33: presents a bar chart that illustrates the pre and post intrusion measures of group A.

Group B: The mean and standard deviation values for the pre and post intrusion measures in group A, as well as the difference between them, were reported in Table 2 and Figure 34, respectively. A comparison was conducted between the pre and post measures using a Paired t test, which indicated a statistically significant reduction in all intrusion measurements (P<0.0001).

Table 2: presents the mean and standard deviation values for the pre, post, and difference in intrusion measures of group B:

Intrusion	Group B				Paired Differences					P value
	Pre		Post		MD	SD	SEM	95% CI		
	M	SD	M	SD				L	U	
UR2-Apex to HP	26.349	2.502	23.300	2.879	-3.049	0.771	0.223	2.559	3.539	0.0001*
UR1-Apex to HP	25.761	1.753	22.978	2.438	-2.783	0.933	0.269	2.190	3.376	0.0001*
UL1-Apex to HP	25.366	2.118	22.916	3.169	-2.450	1.194	0.345	1.691	3.209	0.0001*
UL2-Apex to HP	25.900	2.853	23.095	3.269	-2.805	0.682	0.197	2.371	3.239	0.0001*
IE-UR2 to HP	47.844	2.644	44.869	3.153	-2.975	1.134	0.327	2.255	3.695	0.0001*
IE-UR1 to HP	48.640	3.884	45.544	4.236	-3.096	1.047	0.302	2.430	3.761	0.0001*
IE-UL1 to HP	47.583	4.604	44.713	5.029	-2.869	1.113	0.321	2.162	3.576	0.0001*
IE-UL2 to HP	46.598	3.176	43.825	3.747	-2.773	1.004	0.290	2.134	3.411	0.0001*

M: mean SD: standard deviation MD: mean difference SEM: standard error mean
CI: confidence interval L:Lower arm U:upper arm
**Significant difference as P<0.05.*

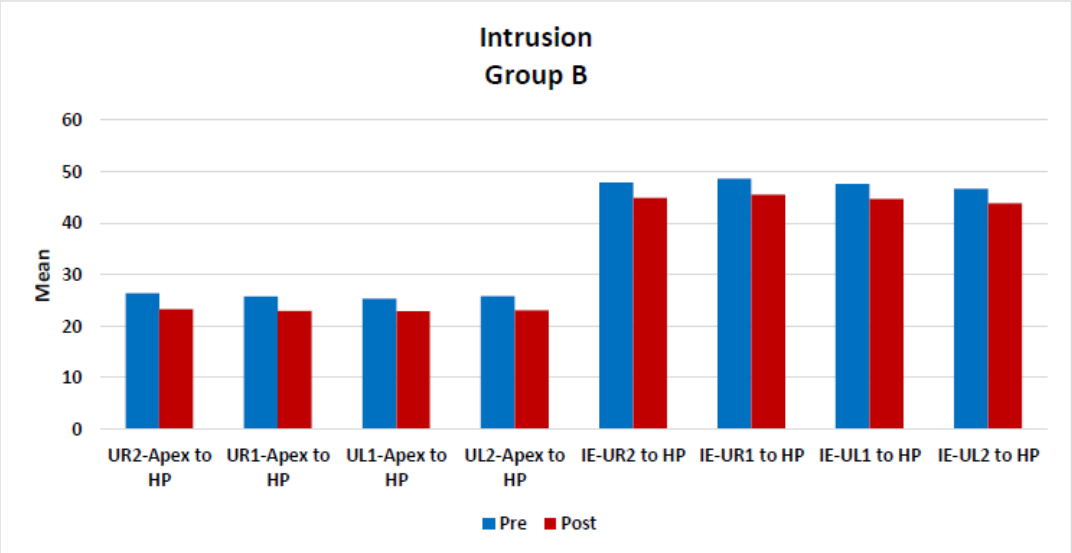

Figure 34: presents a bar chart that illustrates the pre and post intrusion measures of group B.

III. Analytical results (Comparison between group A & B): The mean difference and standard deviation of the difference between pre and post intrusion measures for both groups were presented in table. 3 and fig. 35. A comparison was conducted between group A and group B using an Independent t test. The results indicated that there was no significant difference between the two groups since the p-value was more than 0.05.

Table. 3: Mean difference and standard deviation of difference between pre and post regarding intrusion measurements in both groups and comparison between them:

Intrusion	Group A		Group B		Difference (Independent t test)				
					MD	SD	95% CI		P value
	MD	SD	MD	SD			L	U	
UR2-Apex to HP	-3.013	1.091	-3.049	0.771	0.036	0.386	-0.764	0.836	0.927
UR1-Apex to HP	-2.556	1.298	-2.783	0.933	0.228	0.461	-0.730	1.185	0.627
UL1-Apex to HP	-2.288	1.385	-2.450	1.194	0.163	0.528	-0.932	1.257	0.761
UL2-Apex to HP	-2.616	1.498	-2.805	0.682	0.189	0.475	-0.797	1.175	0.694
IE-UR2 to HP	-2.597	1.321	-2.975	1.134	0.378	0.503	-0.664	1.421	0.460
IE-UR1 to HP	-3.055	1.140	-3.096	1.047	0.041	0.447	-0.886	0.968	0.928
IE-UL1 to HP	-2.694	1.598	-2.869	1.113	0.175	0.562	-0.991	1.341	0.758
IE-UL2 to HP	-2.580	1.090	-2.773	1.004	0.193	0.428	-0.695	1.080	0.657

M: mean SD: standard deviation MD: mean difference SEM: standard error mean
CI: confidence interval L:Lower arm U:upper arm

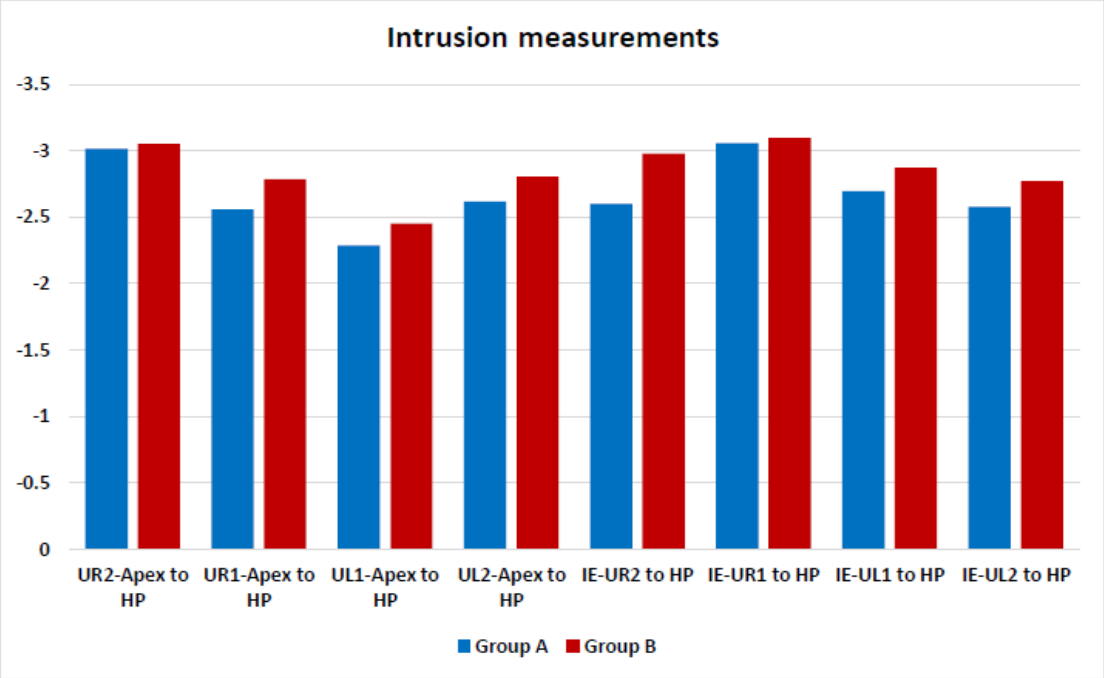

Fig. 35: Bar chart showing mean difference between pre and post intrusion measurements in both groups.

Discussion:

Deep bite is a complicated orthodontic condition that may cause functional and aesthetic concerns such as TMJ disorders, aesthetics, periodontium, attrition, anterior gingival loss, clenching, migraines and tinnitus difficulties[11].

Deep overbite affects around 49% of the general population[1].Deep bite therapy is a biomimetic treatment of orthodontics that mimics an individual's typical development pattern to prevent incisor overgrowth and molar undergrowth[12].

Treatment options include surgical and non-surgical interventions, with non-surgical interventions involving a range of treatments, such as shifting the development pattern from horizontal to vertical, causing excessive dental display, anterior movement of teeth, and upward displacement of molars[2].

The treatment of choice for individuals with excessive gingival show and normal vertical dimension is maxillary incisor intrusion, which may not always yield satisfactory results unless necessary[15].

The position of maxillary incisors, especially around the upper lip, is crucial in determining treatment for patients with inadequate incisor display[8].

Various types of intrusive arches, including Rickett's utility arch, vertical loop, K-SIR loop, segmental intrusion arches (such as Burstone and Connecticut), and three-piece intrusion arch, use intraoral arches as a means to anchor posterior teeth and facilitate the intrusion of anterior teeth[9-17].

The utility arch is often inserted into the bracket slot located on the anterior teeth, while segmental intrusion arches are cinched to a base arch wire positioned on the anterior teeth. The efficacy of these arches in the treatment of anterior teeth has been shown to be superior than that of utility arches, which have a tendency to cause more extrusion of anchorage teeth[19].

Temporary Anchorage Devices (TADs) have been used since 1983, with miniscrews becoming more popular due to their advantages, such as reducing the need for complex mechanics and avoiding potential

adverse effects associated with traditional approaches[6-22].

our study aimed to evaluate maxillary anterior teeth intrusion using mini-screws for treatment of anterior deep bite combined with Gummy Smile using TMA arch wire supported on two posterior miniscrews versus direct intrusion on two anterior miniscrews.

Twenty participants were divided into two groups, with miniscrews positioned between the upper second premolars and upper first molars and between canines and upper lateral incisors[10].

Randomization was used to eliminate selection bias and conduct statistical tests[20]. The orthodontic treatment involved obtaining comprehensive patient records, applying brackets, and bonding to the first molars. The brackets were bonded using segmented mechanics, allowing simultaneous control of tooth movement in both vertical and anteroposterior planes[18].

The patient underwent a cone beam computed tomography (CBCT) scan after alignment, using parameters such as 120x90 field of view, 0.200 voxel size, 85kvp voltage, and 9.5mA current.

The first group received miniscrews with a diameter of 1.6mm and a length of 8mm, and with a diameter of 1.6mm and a length of 6mm for the second group.

The miniscrews have been inserted into interradicular regions, positioned perpendicular to the teeth and at the halfway between the roots. the buccal premolar and molar regions had greater thickness compared to the cortical region of the maxillary anterior alveolar bone. In cases where the palatal vault exhibits significant depth, it is advisable to use miniscrews of around 6-7mm in length as a viable means of anchoring implants inside the U1-U2 and U2-U3 regions. It is advisable to maintain a minimum bone clearance of 1mm around the miniscrew implant in order to ensure safety[4].

80 gm force was applied to group A from a 0.016 x 0.022 TMA arch wire to the main arch wire to direct intrusive force in close proximity to the center of resistance (CR) of the anterior segment[21].

The TMA wire is secured in the main arch wire, directing intrusive force near the anterior segment's center of resistance (CR), located within two-thirds of the distance between lateral incisor and canine brackets [14]. While in group B 80 gm force was applied from an elastomeric power chain, extending from the segmented arch wire between upper lateral incisors and canines to the miniscrews bilaterally.

follow-up intervals were made every three weeks to assess the condition of miniscrews. Force reactivation was achieved by replacing the previous power chain and TMA arch wire and visually evaluating intrusion extent.

Post-intrusion cone-beam computed tomography (CBCT) scans were taken for each patient, and the Materialise Mimics software was used to compare intrusion amounts. Three reference planes were constructed to confirm dental movements.

Overbite correction measurements were taken through intrusion of maxillary incisors. Results showed significant decreases in intrusion measurements for group A and group B. The amount of intrusion found to be coincident with the amount of intrusion that reported by Manal M. El Namrawy [8].

Comparison between group A and group B was performed which revealed insignificant difference between both groups regarding the intrusion measurements, this can be explained as the used intrusion mechanics was near the center of resistance of the anterior segment and the usage of the same amount of force which allowed for similarly intrusive effects between the 2 groups.

Conclusions:

Based on the circumstances of this study, it is apparent that the following conclusions can be drawn:

1. The achievement of true intrusion of upper incisors can be facilitated with the utilization of miniscrew anchorage and avoidance of any unwanted movement in the posterior segment.
2. The utilization of miniscrews and a segmental archwire to intrude the maxillary incisors proved advantageous in reducing incisor protrusion and achieving true intrusion in patients with deepbite.
3. No statistically significant distinction was seen between the two groups, as the intrusion mechanics in both groups were found to be similarly located near to the center of resistance of the anterior segment.

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