

THREE-DIMENSIONAL EVALUATION OF THE INTRUSIVE EFFECTS OF USAGE OF SINGLE MINISCREW VERSUS TWO IN CORRECTING ANTERIOR DEEP BITE WITH GUMMY SMILE: DOUBLE ARMED RANDOMIZED TRIAL

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Abstract:

Deep over bite with gummy smile can be treated with orthodontics only or combination with orthognathic surgery. the use of miniscrews is a treatment option that offers an effective method for obtaining maxillary dento- alveolar intrusion and correction of the gummy smile.

Aim of the study

This study aimed to compare one anterior miniscrew versus two anterior miniscrews for correcting deep overbite with gummy smile using cone beam computerized tomography.

Methods

thirty-two adults with deep overbite and gummy smile were divided into two groups: group A was treated with one miniscrew between upper central incisors and group B with two miniscrews between upper lateral incisors and canines. Incisor intrusion was measured from CBCT before treatment and six months after intrusion. Forces were applied ranged from (60 to 80 g) from the miniscrews to the archwire using elastomeric chains.

Results

Significant intrusion in both groups was observed. Average intrusion of upper incisors in group A was almost 1.5 mm. while in group B the average intrusion was almost 3.5 mm.

Conclusions

- Both single and double mini-screws are significant to perform incisor intrusion
- The amount of intrusion while using two mini-screws more than the amount of intrusion while using single mini-screw

Introduction

A gummy smile is caused by a changeable combination of factors including vertical maxillary excess, increased overjet, and increased overbite. In addition to short upper lip and excessive lip muscular activity have been reported to be contributory factors. (Allen, 1988)¹

Deep over bite with gummy smile can be treated with orthodontics only or combination with orthognathic surgery.² The approach depends on the etiology and severity of the problem, such as the extent of gummy

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smile.²When surgical treatment is not an option because of the patient's refusal to undergo surgery, or because no maxillary vertical excess is present, the use of miniscrews is a treatment option that offers an effective method for attaining maxillary incisor intrusion and correcting the gummy smile.³ Intrusion of upper and lower incisors, reducing deep overbite, can be easily achieved by placing miniscrews in anterior interradicular areas and applying the proper orthodontic mechanics. One or two miniscrews may be placed between central incisors^{4,5}, central and lateral incisors⁵, or lateral incisors and canines^{6,7,8,9,10}. The miniscrew (or screws) has to be correctly located¹¹, As often a good outcome with minimal incisor protrusion can be obtained. Other auxiliary methods can be used to intrude upper incisors. Most of them use posterior teeth for anchorage, although this may produce unwanted reciprocal effects. An intrusive archwire is often used for overbite correction.^{12, 13,14,15} Comparing intrusion archwires with miniscrews, some authors had reported significantly more incisor proclination when using intrusive archwires.¹³ Others found significantly more intrusion and generally better results using miniscrews.¹⁵ Most of the studies quantifying upper incisor intrusion

depended on lateral cephalograms to perform measurements, while a few had evaluated root resorption using CBCT sagittal sections.^{12,16} Although the efficacy of anteriorly versus posteriorly located miniscrew-assisted intrusion mechanics had been investigated, together with the resorptive root damage derived from miniscrew placement in different locations^{16,17,18,19} However no clinical trials had compared the effects (including root resorption) of treatment with single or double miniscrews placed in the anterior area. As both the forces applied and the vector position are different depending on whether one or two miniscrews are used, differences in the displacement pattern may occur, which could affect root resorption and treatment stability. Therefore, the purpose of this study was to compare one anterior miniscrew versus two anterior miniscrews for correcting deep overbite with gummy smile using cone beam computerized tomography.

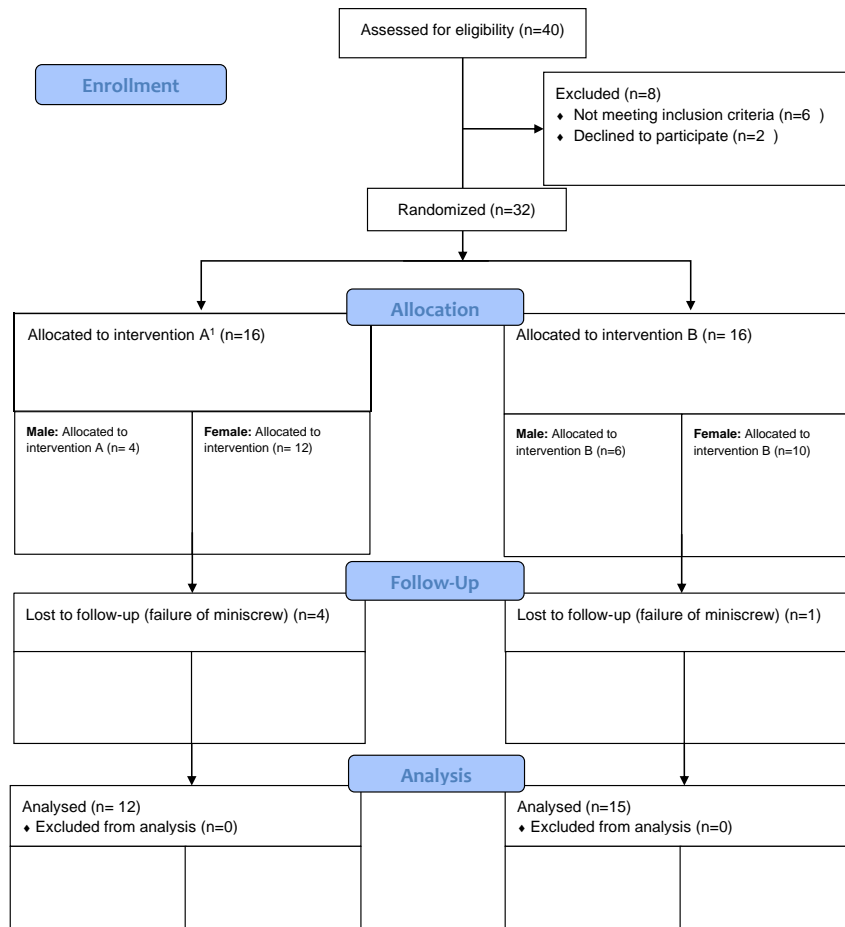
Patients and Methods:

4 Study Design:

A randomized double armed clinical trial according to CONSORT guidelines was established according to the following steps:



CONSORT 2010 Flow Diagram²



¹ Intervention A and Intervention B denote experimental and comparator arms.

1-Ethical Regulations:

- **This study design was approved by the Research Ethics Committee of faculty of dentistry, Minia university, Minia, Egypt.**
- **Standard informed consent of Research Ethics Committee of faculty of dentistry, Minia university was used**
- **All steps were explained to the patients.**

2-Patients:

Data from 32 patients selected from the outpatient clinic of department of orthodontics, faculty of dentistry, Minia university, Minia, Egypt; all these patients had been diagnosed with deepbite and gummy smile.

Inclusion criteria were as follows:

- All patients free from any systemic diseases, bad oral hygiene and pathological conditions
- All patients are in permanent dentition.

-No previous orthodontic treatment was carried out.

-Did not take any medication that affects the bone quality.

-The patient had Deep over bite with gummy smile.

Exclusion criteria were as follows:

-Patients with a history of any kind of trauma or endodontic treatment of the maxillary incisors.

-Patients presenting systemic disease or taking periodic medication.

-Patients exhibiting poor oral hygiene.

preparatory phase:

Diagnostic records were performed for all patients:

- Digital photographs (fig:1,3):
- These included:
 - Extraoral photographs
 - Intraoral photographs
- Radiographs (fig:2,4): These included
 - Panoramic x-ray
 - Lateral cephalometric x-ray
- Study cast (fig:5)

Fig 1.3: Extraoral photographs





Fig 1.4: Intraoral photograph (right side View)



Fig 1.5: Intraoral photograph left side View)



Fig 1.6: Intraoral photograph (frontal View)



Fig 1.7: Intraoral photograph (Upper occlusal View)



Fig 1.8: Intraoral photograph (lower occlusal View)

Fig 1: Digital photographs



Fig 2.1: Lateral cephalometric x-ray



Fig 2.2: Panoramic x-ray



Fig 3.1: Extraoral photograph (Frontal View)



Fig 3.2: Extraoral photograph (Smile)



Fig 3.3: Extraoral photograph (Profile View)



Fig 4.1: Lateral cephalometric x-ray

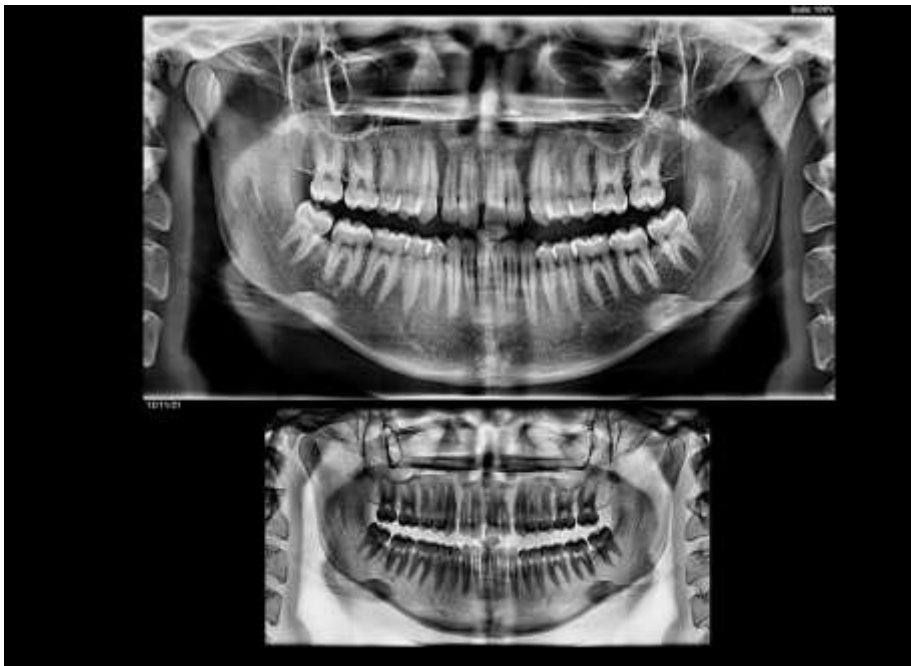


Fig 4.2: Panoramic x-ray

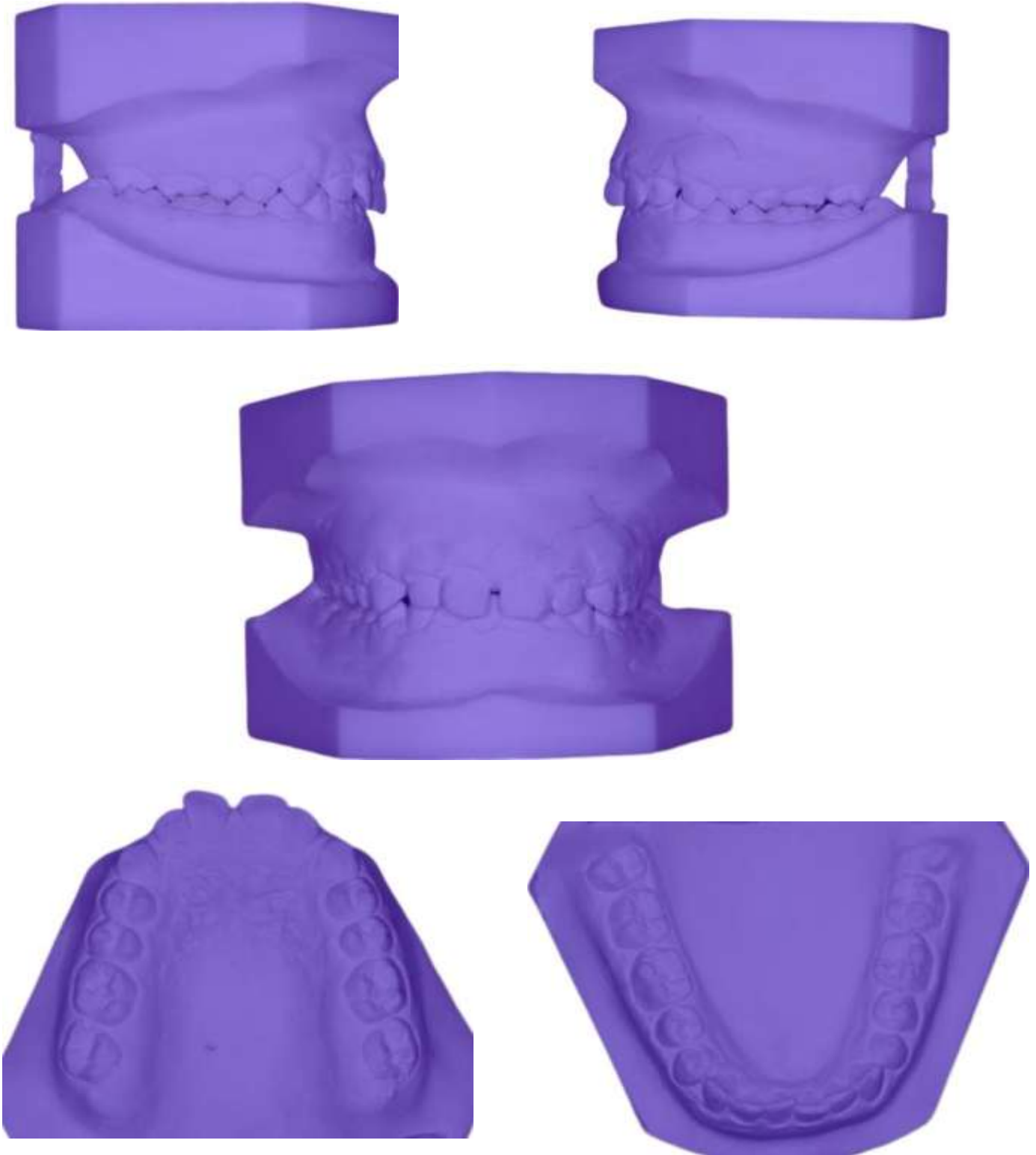


Fig 5: Study cast

Method

Buccal tubes were bonded on the upper first and second permanent molars and the brackets* (Roth Mini-master with 0.022×0.028 slot) were bonded to the other permanent teeth. The following archwires were sequentially used for initial leveling and alignment: 0.012 to 0.017 \times 0.025-inch NiTi arch wire and reached 0.019 \times 0.025-inch stainless steel arch wire.

Anchorage preparation:

In order to ensure maximum anchorage, mini-screws* (fig: 6) were inserted in interradicular areas perpendicular to the teeth and midpoint either between the roots of Central incisors (fig: 7) or between the roots of lateral incisors and the canine in both sides in order to endure the intrusion (fig: 8). A mini-screw with 6 mm length and 1.4 mm head diameter was used for each patient.



Fig 6: mini-screw kit

* American Orthodontics USA /metal-twin-brackets/ Mini-master series/

• KMCT orthodontic miniscrew. OA.



Fig 7.1: Diagrammatic representation of the mini-screw in midpoint between the roots of Central incisors

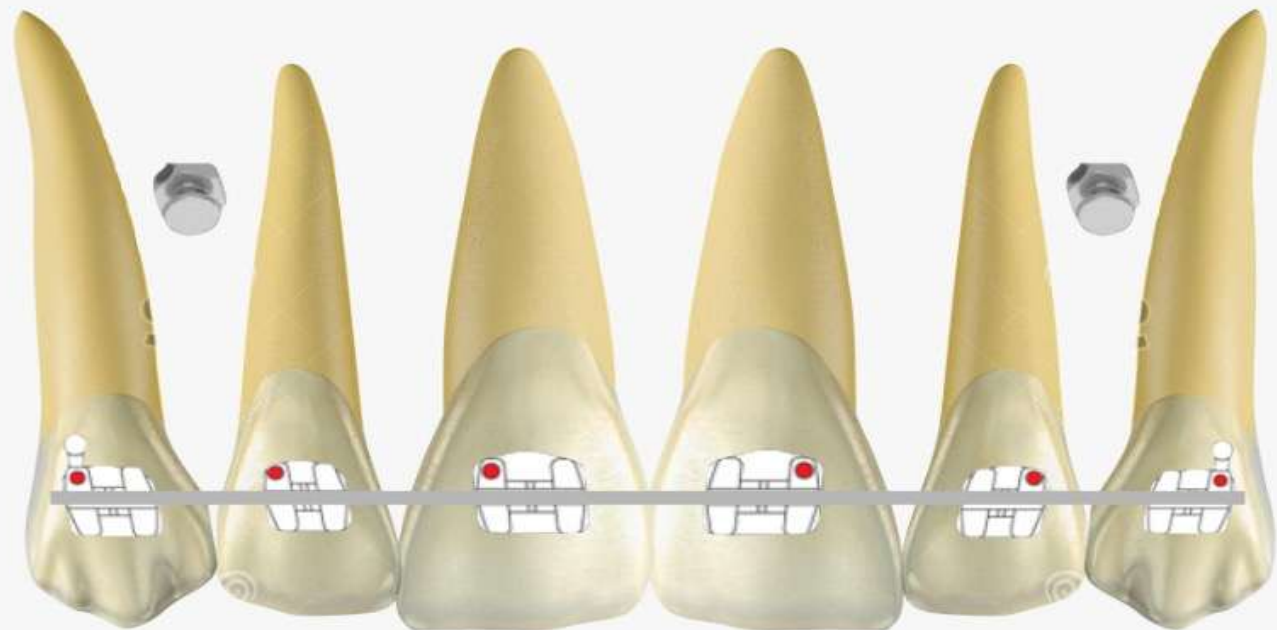


Fig 8.1 Diagrammatic representation of two mini-screws between the roots of lateral incisors and the canine



fig 7.2: Mini-screw was inserted in midpoint between the roots of Central incisors



Fig 8.2: Mini-screws were inserted between the roots of lateral incisors and canine

CBCT analysis

Two CBCT radiographs were obtained for each patient: before intrusion (T0) and after intrusion t (T1) Eight landmarks were identified on each radiograph: ANS, PNS, IE-UR1, IE-UR2, IE-UL1, IE-UL2, UR1-Apex, UR2-Apex, UL1-Apex, UL2-Apex and Inf. Or-Foramen (Table 1 and Fig. 9), three constructed reference planes: TP, SP and FP

(Table 2 and Fig. 10), four reference lines: UR1-LA,UR2-LA,UL1-LA,UL2-LA (Table 3 and Fig. 11) and eight measurements were taken (Table 4 and Fig. 12) DICOM files were obtained from the radiology center and **DDS-Pro version 1.6_2016© JST Sp.** Software was used to perform the CBCT measurements.

Table 1. Landmarks Identification

Landmark		Abbreviation	Definition
1	Anterior nasal spine	ANS	Most anterior point on the tip of the anterior nasal spine.
2	Posterior nasal spine	PNS	Most posterior point on the hard palate at the tip of the post nasal spine.
3	Incisal edge of maxillary right central incisor	IE-UR1	The most incisal point on the maxillary right central incisor.
4	Incisal edge of maxillary lateral incisor	IE-UR2	The most incisal point on the maxillary right lateral incisor.
5	Incisal edge of maxillary left central incisor	IE-UL1	The most incisal point on the maxillary left central incisor.
6	Incisal edge of maxillary left lateral incisor	IE-UL2	The most incisal point on the maxillary left lateral incisor.
7	Root apex of maxillary right central incisor	UR1-Apex	The most apical point at the apex of maxillary right central incisor

8	Root apex of maxillary right lateral incisor	UR2-Apex	The most apical point at the apex of maxillary right lateral incisor
9	Root apex of maxillary left central incisor	UL1-Apex	The most apical point at the apex of maxillary left central incisor
10	Root apex of maxillary left lateral incisor	UL2-Apex	The most apical point at the apex of maxillary left lateral incisor
11	infraorbital foramen	Inf. Or- Foramen	one of two small holes in the skull's upper jawbone (maxillary bone), located below the eye socket and to the left and right of the nose. In anatomical terms, it is located below the infraorbital margin of the orbit

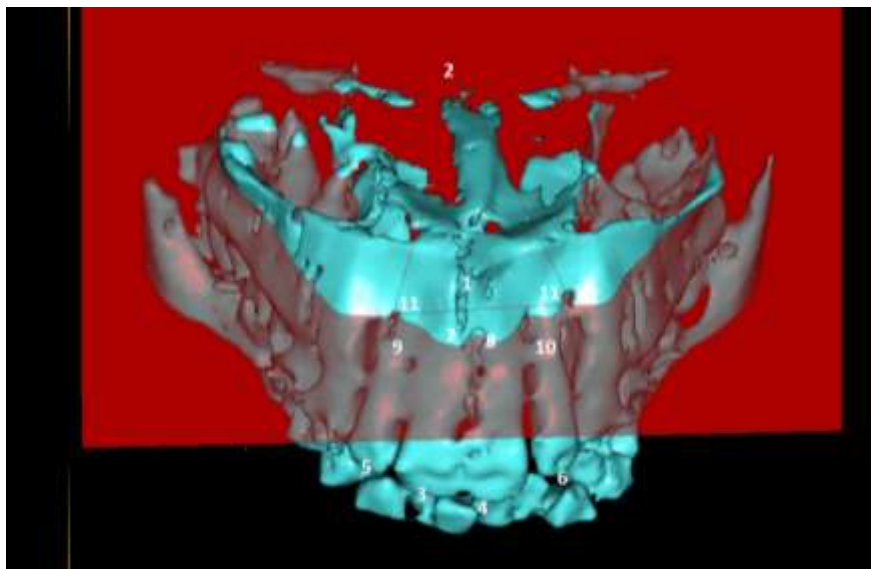


Fig 9. Landmarks Identification

(Table 2): Constructed planes

Reference		Abbreviation	Definition
1	Transverse plane	TP	Plane connecting right infra orbital foramen, left infra orbital foramen, and PNS
2	Sagittal plane	SP	ANS, PNS perpendicular to Transverse plane
3	Frontal plane	FP	ANS perpendicular to Sagittal and Transverse plane

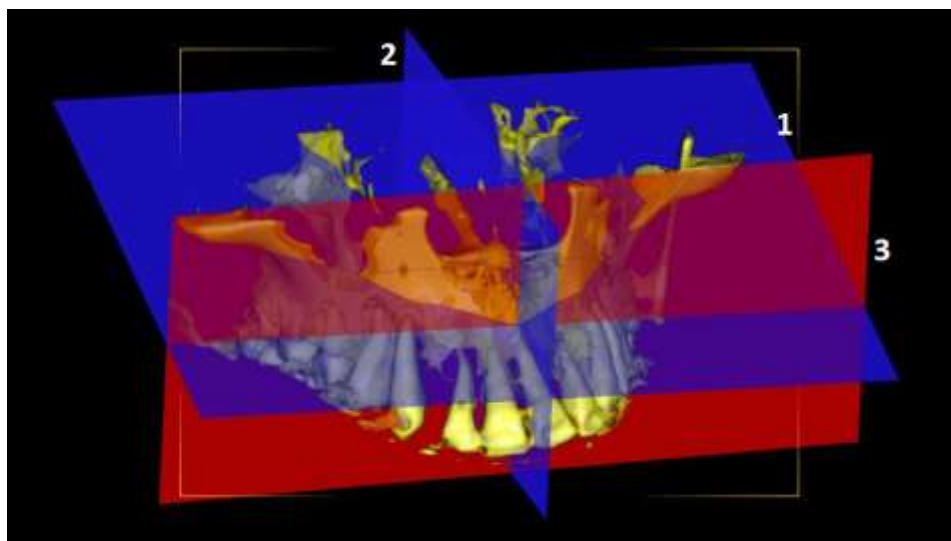


Fig 10. Constructed Planes

(Table 3): Reference lines

Reference		Abbreviation	Definition
4	Maxillary right central incisor long axis	UR1-LA	Line connecting UR1-TIP and UR1- Apex
5	Maxillary left central incisor long axis	UL1-LA	Line connecting UL1-TIP and UL1- Apex
6	Maxillary right lateral incisor long axis	UR2-LA	Line connecting UR2-TIP and UR2- Apex
7	Maxillary left lateral incisor long axis	UL2-LA	Line connecting UL2-TIP and UL2- Apex

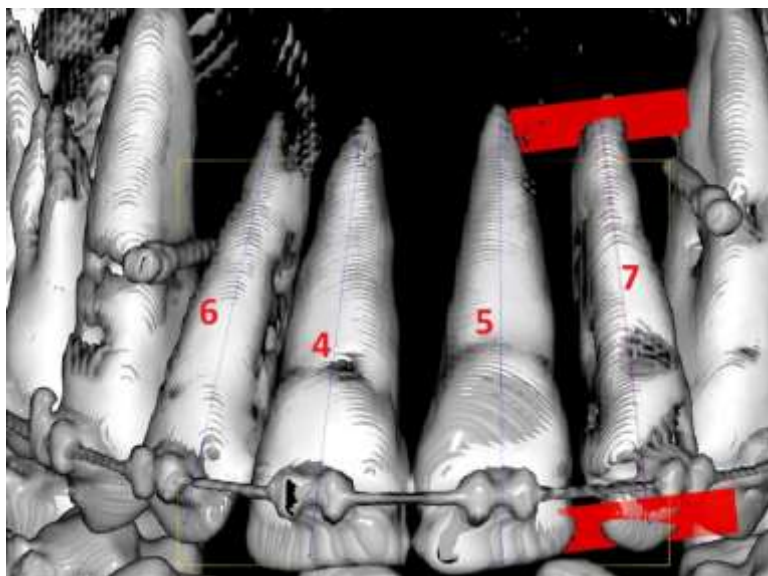


Fig 11. Reference lines

Table 3: CBCT Measurements

Measurement		Abb.	Definition
1	Apex of upper right central incisor to horizontal plane (mm)	UR1-Apex to HP	Linear measurement from the most root apex of the maxillary right central incisor to horizontal plane.
2	Apex of upper left central incisor to horizontal plane (mm)	UL1-Apex to HP	Linear measurement from the most root apex of the maxillary left t central incisor to horizontal plane.
3	Apex of upper right lateral incisor to horizontal plane (mm)	UR2-Apex to HP	Linear measurement from the most root apex of the maxillary right latera incisor to horizontal plane.
4	Apex of upper left lateral incisor to horizontal plane (mm)	UR2-Apex to HP	Linear measurement from the most root apex of the maxillary left t lateral incisor to horizontal plane.
5	Incisal edge of maxillary right central incisor to horizontal plane (mm)	IE-UR1 to HP	Linear measurement from the most incisal point on the maxillary right central incisor to horizontal plane.
6	Incisal edge of maxillary left central incisor to horizontal plane (mm)	IE-UL1 to HP	Linear measurement from the most incisal point on the maxillary left central incisor to horizontal plane.
7	Incisal edge of maxillary right lateral incisor to horizontal plane (mm)	IE-UR2 to HP	Linear measurement from the most incisal point on the maxillary right lateral incisor to horizontal plane.
8	Incisal edge of maxillary left lateral central incisor to horizontal plane (mm)	IE-UL2 to HP	Linear measurement from the most incisal point on the maxillary left lateral central incisor to horizontal plane.

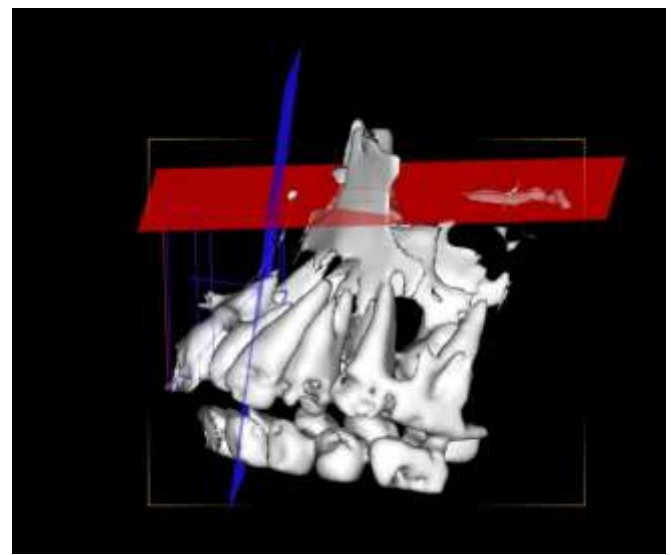
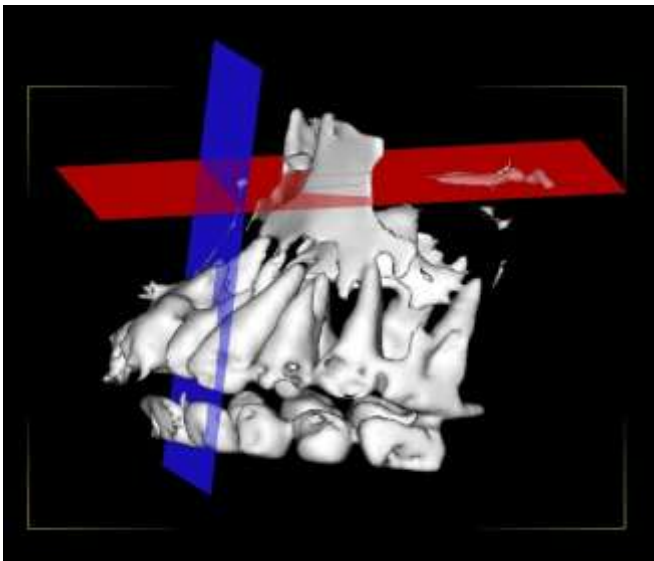


Fig 12. Measurements

Outcomes

The following variables were examined:

- **Results of orthodontic movement by one or two anterior miniscrews for upper incisor correction of overbite and angulation in adult patients.**
- Upper incisors intrusion deriving from 1 or 2 miniscrews and their locations.
- **The stability of both treatment options**

Results

Statistical analysis was performed with SPSS 20®, Graph Pad Prism® and Microsoft Excel 2016.

All quantitative data were explored for normality by using Shapiro Wilk and Kolmogorov Normality test and presented as means and standard deviation (SD) values.

Tests used:

- Shapiro Wilk and Kolmogorov were used for normality exploration.
- Independent t test to compare between both groups.
- Paired t test to compare between pre and post treatment measurements

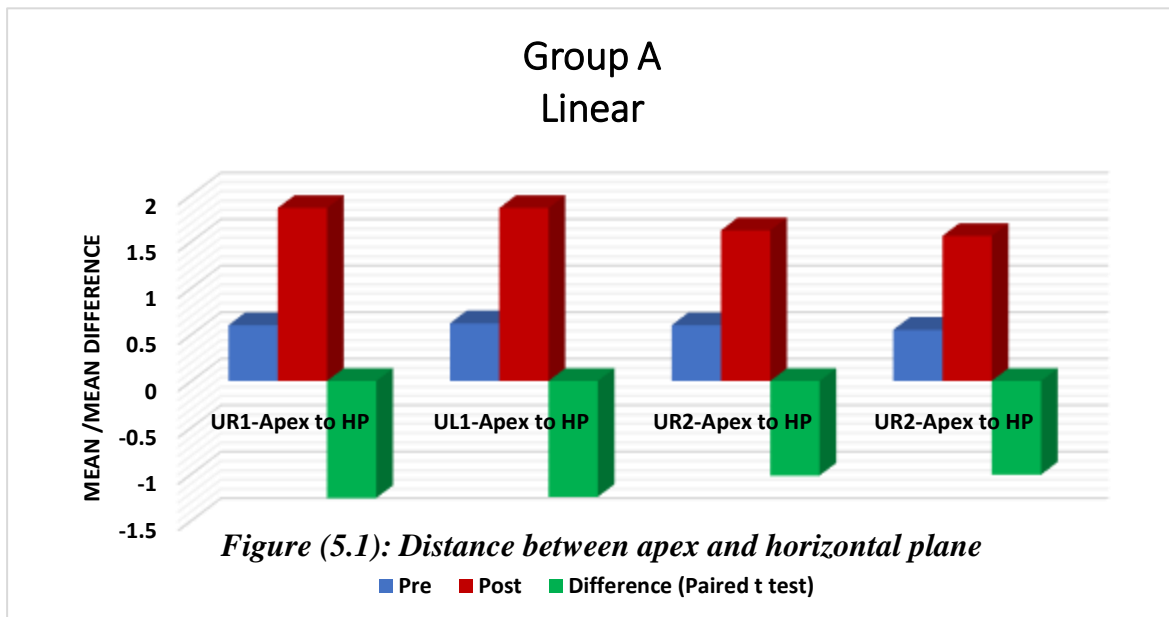
All results were presented as:

1-Group A (single miniscrew):

Concerning intrusion of incisors in group A (Table 5) there was a decrease in the distance between both the incisal edge and the apex to the horizontal plane. The detected difference was statistically significant (fig. 5.1, 5.2)

Table (5): Distance between apex and incisal edge to horizontal plane

Group A		Pre		Post		Difference (Paired t test)		
		Mean	MD	Mean	MD	MD	SD	P value
Linear (intrusion)	UR1-Apex to HP	0.6	0.31	1.86	0.31	-1.260	0.038	0.000*
	UL1-Apex to HP	0.62	0.3	1.86	0.32	-1.246	0.044	0.000*
	UR2-Apex to HP	0.6	0.29	1.62	0.33	-1.017	0.107	0.000*
	UL2-Apex to HP	0.55	0.29	1.56	0.3	-1.007	0.107	0.000*
	IE-UR1 to HP	22.94	0.68	21.6	0.42	1.346	0.318	0.000*
	IE-UL1 to HP	23.11	0.48	21.79	0.48	1.320	0.276	0.000*
	IE-UR2 to HP	21.01	0.74	19.93	0.48	1.078	0.611	0.000*
	IE-UL2 to HP	21.18	0.67	20.16	0.63	1.012	0.181	0.000*



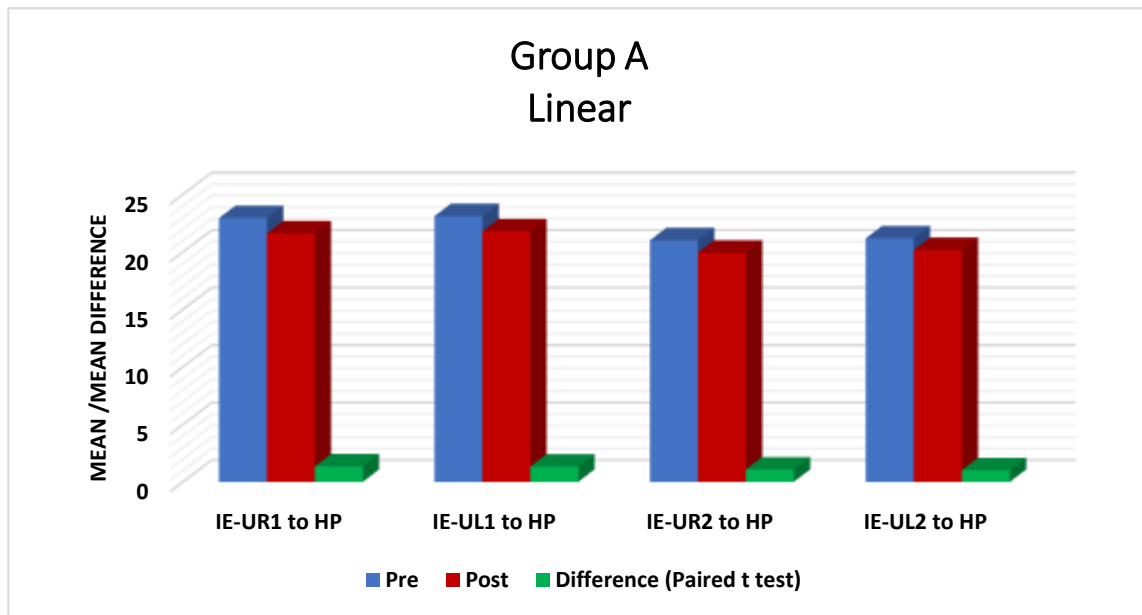


Figure (5.2): Distance between incisal edge and horizontal plane

2. Group B (Two miniscrews)

Concerning intrusion of incisors in group B (Table 6) there was a decrease in the

distance between both the incisal edge and the apex to the horizontal plane. The detected difference was statistically significant (fig. 6.1, 6.2)

Table (6): Distance between apex and incisal edge to horizontal plane

Group B		Pre		Post		Difference (Paired t test)		
		M	SD	M	MD	MD	SD	P value
Linear (intrusion)	UR1-Apex to HP	1.61	.34	5.12	0.37	-3.505	0.135	0.000*
	UL1-Apex to HP	1.56	.33	5.02	0.36	-3.463	0.124	0.000*
	UR2-Apex to HP	1.15	.29	4.44	0.39	-3.297	0.156	0.000*
	UL2-Apex to HP	1.15	.29	4.45	0.37	-3.300	0.147	0.000*
	IE-UR1 to HP	22.70	.31	26.21	0.33	-3.505	0.135	0.000*
	IE-UL1 to HP	22.70	.31	26.16	0.33	-3.463	0.124	0.000*
	IE-UR2 to HP	21.43	.35	24.73	0.39	-3.297	0.168	0.000*
	IE-UL2 to HP	21.44	.34	24.71	0.35	-3.270	0.163	0.000*

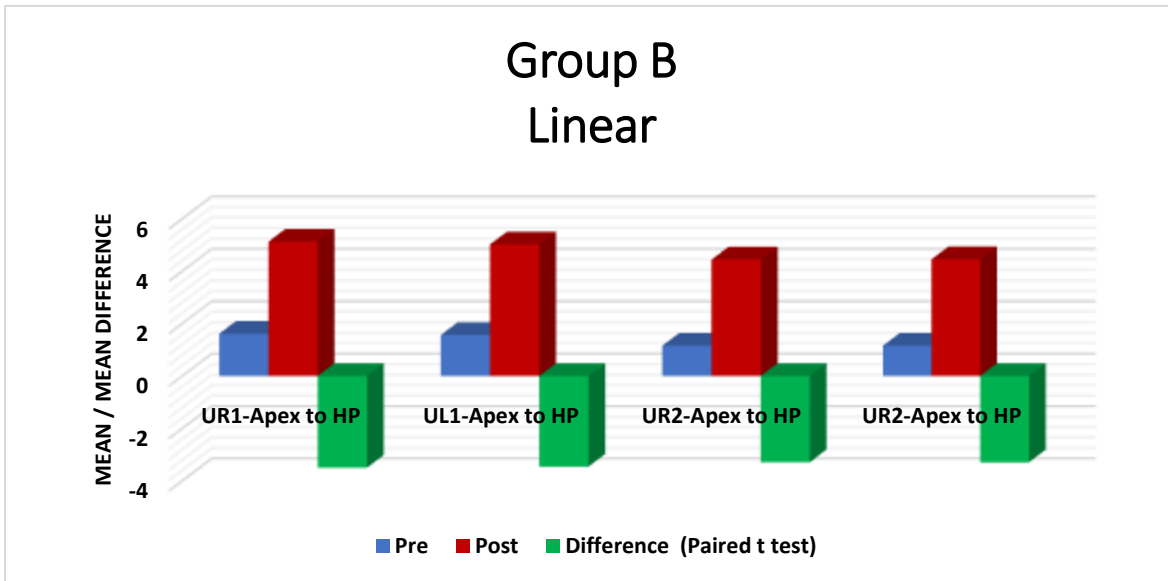


Figure (6.1): Bar chart representing pretreatment and post treatment UR1-Apex to HP, UL1-Apex to HP, UR2-Apex to HP and UR2-Apex to HP measurements in group B.

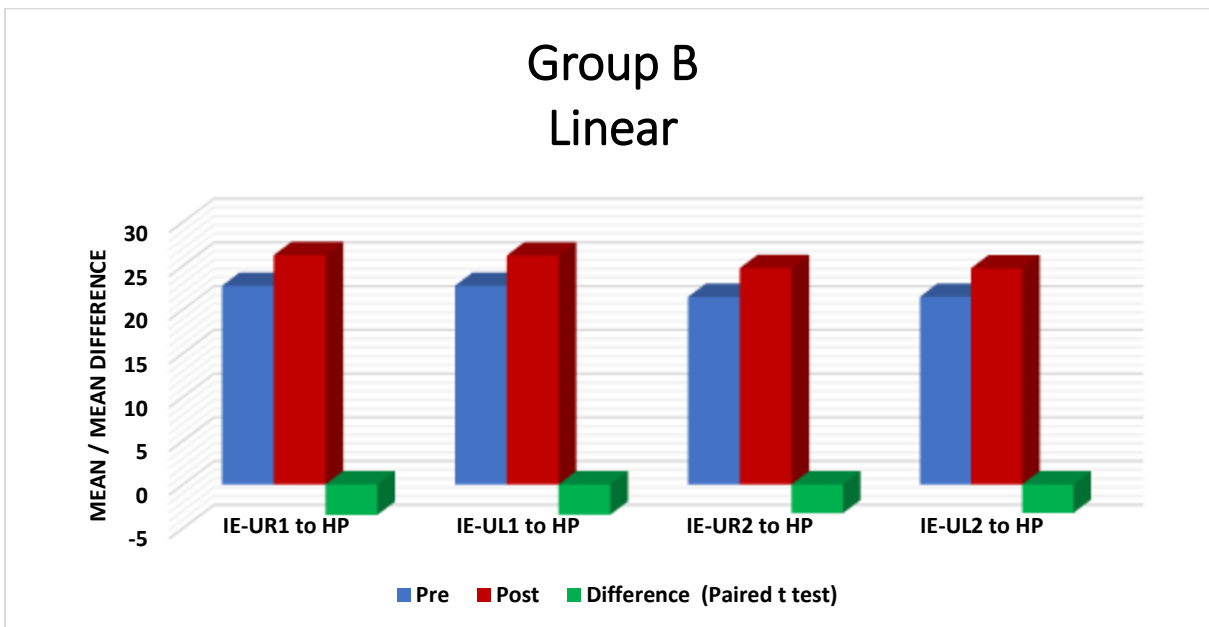


Figure (6.2): Bar chart representing pretreatment and post treatment of IE-UR1 to HP, IE-UL1 to HP, IE-UR2 to HP and IE-UL2 to HP measurements in group B.

I. Comparison between group A & B regarding difference between pre and post treatment records:

Mean difference and standard deviation of difference between pretreatment and post treatment measurements in intrusion measurements in group A and group B were presented table (7) and figure (7,8).

Comparison between both groups was performed by using independent t test which revealed significant difference as P=0.000 in all measurements

- **Group A were significantly lower than Group B measurements in UR1-Apex to HP, UL1-Apex to HP, UR2-Apex to HP, UR2-Apex to HP, IE-UR1 to HP, IE-UL1 to HP, IE-UR2 to HP and IE-UL2 to HP. Denoting that the amount of intrusion in group A (single miniscrew) lower than the amount of intrusion in group B (two miniscrews) (fig.7,8)**

• Table (7): Difference between pre and post in both intrusion measurements in group A & B and comparison between them using Independent t test (Analytical results)

		Group A		Group B		Difference (Independent t test)		
		MD	SD	MD	SD	MD	SED	P value
Linear (intrusion)	UR1-Apex to HP	1.26	0.04	3.51	0.14	-2.245	0.037	0.000
	UL1-Apex to HP	1.24	0.06	3.46	0.12	-2.221	0.036	0.000
	UR2-Apex to HP	1.01	0.09	3.30	0.16	-2.294	0.049	0.000
	UL2-Apex to HP	1.01	0.11	3.30	0.15	-2.293	0.049	0.000
	IE-UR1 to HP	1.36	0.31	3.51	0.14	-2.145	0.095	0.000
	IE-UL1 to HP	1.32	0.28	3.46	0.12	-2.143	0.086	0.000
	IE-UR2 to HP	0.91	0.22	3.30	0.16	-2.392	0.075	0.000
	IE-UL2 to HP	1.01	0.18	3.30	0.15	-2.288	0.064	0.000

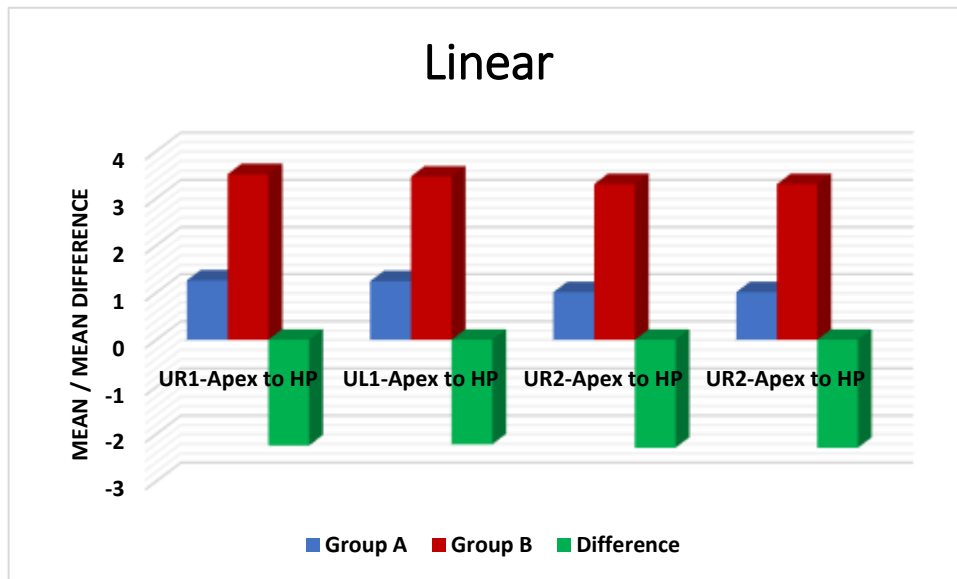


Figure (7): Bar chart representing difference between pretreatment and post treatment of UR1-Apex to HP, UL1-Apex to HP, UR2-Apex to HP and UR2-Apex to HP measurements in both groups.

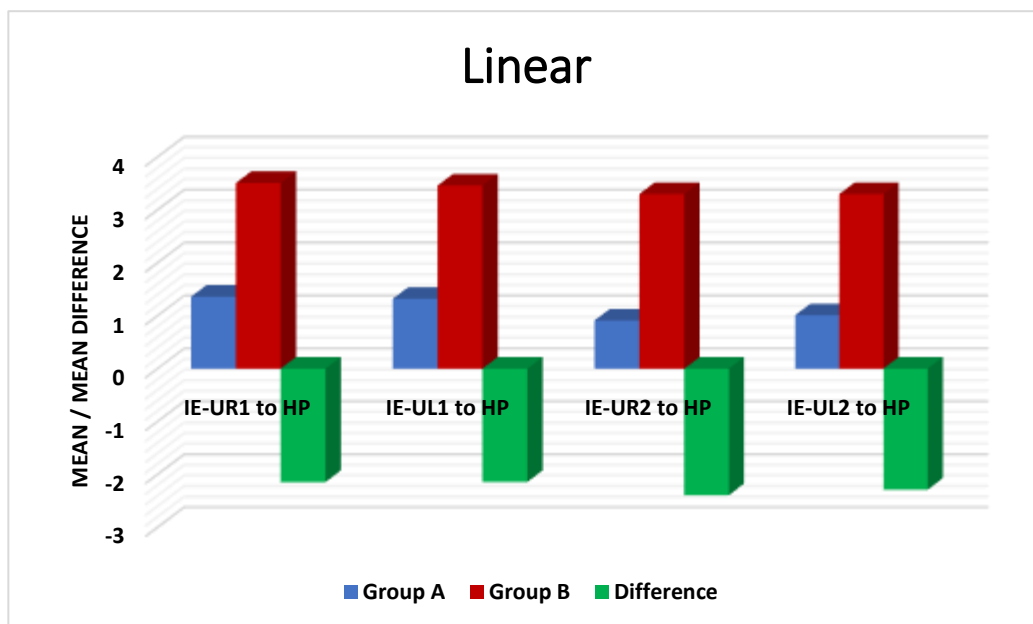


Figure (8): Bar chart representing difference between pretreatment and post treatment of IE-UR1 to HP, IE-UL1 to HP, IE-UR2 to HP and IE-UL2 to HP measurements in both groups.

Discussion

True intrusion of upper incisors can be achieved using miniscrew anchorage. miniscrews reduce the need for complicated mechanics and avoid the side effects of more conventional methods. During the application of intrusive force, the axial inclination of the upper incisors showed minimal change, which was considered to be clinically acceptable. Root resorption was not seen as a consequence of incisor intrusion.⁹ this study analyzed the changes produced during miniscrew-assisted orthodontic treatment focusing on intrusion pattern, while the other factors assessed were a consequence of this intrusion. As shown in this study, deep overbite with gummy smile can be corrected within a short period of time. Understanding the mechanisms, measurements changes through CBCT and adverse effects related to overbite reduction using different treatment approaches can help clinicians make treatment planning more precise. In the present study, patients presenting maxillary incisors with a history of some kind of trauma, endodontic treatment, or patients with any systemic disease or periodic medication were excluded since there is a relationship between these disorders and root resorption.^{20,21,22,23} the measurements were taken from CBCT.¹⁴ Vertical incisor movement was measured using two different reference points (incisal edge and root apex), making it possible to compare the results with a wider range of studies. Several authors¹⁵ have used two landmarks to assess incisor intrusion. The study was constructed from two groups (each group contained 17 patients). The decision of whether to place one

miniscrew or two depended on the root inclination and position of the labial frenum. In group A, one miniscrew was placed in the interradicular space between the two central incisors, this location being anterior to the CR. In this way, the force applied produced less intrusion but more buccal tipping. In group B, two miniscrews were inserted between the roots of canines and lateral incisors. In this way, force was applied more posteriorly but still anterior to the CR, producing less labial tipping but more intrusion. These effects have already been described by Lindauer and Isaacson¹³, who demonstrated that the different effects that obtained during intrusion and extrusion movements depend on the point where force is applied in relation to the CR of the anterior teeth. The result showed that the average intrusion of upper incisors in group A was almost 1.5 mm. while in group B, average intrusion was almost 3.5 mm which is accepted with Ohnishi et al⁴. Although buccal tipping produced by miniscrew mechanics could be considered an undesirable effect, this is often not the case as many of the patients presenting overbite and gummy smile may present retroclination of the upper incisors, making buccal inclination a favorable effect leading to better and more stable outcomes. It should be noted that in group B, the total force applied from the miniscrews was greater than that applied in group A (120-180 g and 60-80 g respectively), which could alter the velocity of movement and the amount of root resorption. Intrusion values were found to be higher in the present study than those reported by other authors using conventional methods, such as utility arches or Burstone intrusion arches.⁷

Although differences between groups were found for all the factors analyzed, most of them did not show statistical significance despite the major differences in force vectors. This fact may be due to other factors affecting orthodontic movement, such as the level of crowding present or archwire effects. The results of the present study showed that the use of miniscrews for incisor intrusion provided good stability for all measurements in both groups. But the stability results cannot be compared to any other studies since none of the published works on incisor intrusion with miniscrews have reported this data, as noted in the single systematic review conducted to date²⁴

Conclusions

- **Overbite correction may be achieved successfully by a combination of upper incisor intrusion and lower incisor proclination with no rotation of the mandibular plane using one or two miniscrews.**
- **The use of light and dissipating force prevents the root resorption.**
- **Stability is satisfactory when using either one or two miniscrews.**

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