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Original Article

Comparison of cephalometric changes resulting from different upper incisor intrusion methods

Demet Süer Tümen[1], Orhan Hamamcı[2]

[1] Diyarbakır Oral and Dental Health Hospital, Department of Orthodontics, Diyarbakır, Turkey
[2] Dicle University, Faculty of Dentistry, Department of Orthodontics, Diyarbakır, Turkey

Abstract

Aim: The aim of this study was to provide intrusion of upper incisors with applying Connecticut Intrusion Arch (CIA) and Miniscrew and to evaluate the dental and skeletal cephalometric effects of these intrusion methods on individuals with deep bite caused by supraocclusion of upper incisors.
Methodology: The study includes 40 adults, without making sexual distinction, who have at least 4 mm deep bite caused by supraocclusion of upper incisors. Two study groups each consisting 20 individuals formed as CIA and Miniscrew groups. Skeletal, dental, soft tissue measurements were done on lateral cephalograms and apical root resorption measurements were done on standard periapical radiographs that were taken from upper four incisor teeth. Statistically, Paired Student's t-test was used in intragroup comparements and independent Student's t-test was used in the investigation of differences between groups. Nevertheless, the concern of variables that seen as risk factors with the amount of resorption was investigated with Pearson correlation analysis.
Results: Successful intrusion of four upper incisor teeth with CIA and Mini screw methods and in-significant difference was determined between two methods. Protrusion of upper and lower incisor teeth decrease in interincisal angle and overbite and increase in overjet was stated by intrusion at both of the methods. The decline of the mesiobuccal cusp of the upper first molar was observed in the CIA method. In soft tissue evaluation, decrease of upper lip length, upper lip thickness and distance of upper and lower lip to the Rickett's plane was observed.
Conclusion: The methods used for intrusion showed to cause similar ratio of root resorption.

Keywords: deep overbite, CIA, miniscrew, maxillary incisor intrusion

Correspondence:

Dr. Demet SÜER TÜMEN
Diyarbakır Oral and Dental Health Hospital, Diyarbakır, Turkey.
E-mail:demetsuer@gmail.com

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Introduction

In recent years, the aesthetic needs of individuals have been increasing; thus, facial and dental aesthetics have become very important. Facial aesthetics is an important variable in social life and relationships. One of the primary purposes of orthodontic treatment is to improve dental aesthetics (1). A beautiful and attractive smile is known to have a positive effect on individuals. It also improves self-confidence, communicative success, careers, and private life. Thus, smile design aims to give a beautiful, healthy, ideal smile through a combination of medicine and art. In smile design, the relationship between the teeth and surrounding soft tissues is well known (2). Less visible gums during a smile are considered more aesthetically pleasing (2–4).

Deep bite is defined as the amount and percentage of excessive overlap of the lower incisors by the upper incisors (5, 6). Deep bite can be functional, skeletal (morphological), or dental. It must be corrected to achieve a harmonious facial profile, a balanced intraoral bite relationship, and good function (7). Correcting a deep bite with orthodontic treatment is very difficult. Generally, three treatment methods have been used: (a) true incisor intrusion, (b) posterior tooth extrusion, and (c) a combination of posterior extrusion and incisor intrusion (8). Orthognathic surgery is a further option (7, 9). The ideal deep bite treatment is incisor intrusion because it does not change the vertical facial dimensions. If an intrusion greater than 4 mm is required, lower incisor intrusion is recommended besides the upper incisors (10, 11).

A review of the literature indicates that the following appliances have been used in intrusion: anterior bite planes, functional appliances, J-hook headgear (J-HG), intrusion arches (three-piece base arch, utility arches [UIAs], Connecticut intrusion arches [CIAs]), reverse curve archwire, interarch elastics, clear aligners, and miniscrews. The CIA, which is manufactured from a nickel titanium alloy, has the advantages of shape memory, springback, and light, continuous force distribution. It has the characteristics of not only the utility arch but also the conventional intrusion arch. The CIA is fabricated with the types of bends that facilitate easy insertion and use (12).

Miniscrews recently gained popularity because they provide maximum anchorage in incisor intrusion, reduce the need for patient cooperation, and simplify further treatment. Experimental and clinical studies have demonstrated that miniscrews provide effective and stable anchorage for orthodontic treatment (13-20). Their advantages include easy application, small size, simple surgery, immediate loading, minimal anatomic limitations, high patient comfort, no laboratory procedure, easy post-treatment removal, and low cost (21).

The aim of this study was to evaluate the effects of the CIA and miniscrews on skeletal, dental, and soft tissues. For patients with deep bites, the CIA and miniscrew are most commonly used methods for upper anterior incisor intrusion.

Materials and Methods

The study included 40 adult patients with upper incisor supraocclusion, deep bites, and complete growth. Participant selection was based on the following criteria: (1) at least 4 mm overbite, (2) dental angle Cl-I or angle Cl-II relationship, (3) optimum SN-GoMe angle of 28–38°, and (4) excessive gingival display when smiling. Detailed information was given to the patients and their parents about the treatments to be performed. They were then asked to sign a treatment consent form. The study was approved by the Dicle University Faculty of Dentistry Ethics Committee (July 27, 2008; Issue 2008 / 0006-821).

For all the patients, intraoral and extraoral photography, lateral cephalometric radiography, and panoramic radiography were performed at the beginning of treatment. Plaster models were also made. The 40 participants were placed into two groups: CIA and Miniscrew (Table 1).

Table 1. The distribution of gender, and mean of age in study groups

Gender	Group	
	CIA	Miniscrew
Female	12	13
Male	8	7
Mean Age	17,9±4.54	18,9±3.42

In the first group, a 0.016 × 0.022 in CIA (Intranol, GAC, USA) was used. First, a three-tube molar band was placed on the upper right and left first molars. Roth brackets (Omni-Roth, GAC, USA) with 0.018 × 0.025 in slots were attached to the upper four incisors, which were then connected with a 0.010 in ligature wire to form a block. The transpalatal arch was used to improve molar anchorage. Next, 0.016 × 0.022 in stainless steel wire was placed on the incisors, and the intrusion arch was placed in the auxiliary tubes. The front part of the intrusion arch was connected to a 0.016 × 0.022 in steel wire from the area between the central and lateral teeth (Fig. 1a, b). The CIA applied an average of 35–40 g of intrusion force. In cases of the application of insufficient force by the CIA, the force was increased to the desired level (70–80 g) by increasing the bends in the molar region. The patients were recalled for control at 4-week intervals.

For the Miniscrew group, two 1.6 mm wide × 8 mm long miniscrews (DualTop Anchor System, Jeil Medical, South Korea) were selected. They were placed bilaterally between the maxillary central and lateral incisors with a long hand driver. After the induction of local anesthesia, a screwdriver was used to insert the miniscrews at a 45° angle to the occlusal plane without removing the flap. For standardization, the miniscrews were inserted by the same dentist (DST). Roth brackets (Omni-Roth, GAC, USA) with 0.018 × 0.025 in slots were placed in the upper four incisors, which were connected as a block with a 0.010 in ligature wire. After the placement of 0.016 × 0.022 in stainless steel wire, 70–80 g of force was applied between the central and lateral incisors with a closed coil spring (Closed Coil Spring, GAC, USA) (Figure 2a, b).

To determine the effect of intrusion during deep bite treatment, no orthodontic mechanics were applied to the posterior region or lower jaw. After the application of force to the two groups for 6 months, the intraoral and extraoral photographs and cephalometric radiographs were retaken. The patients were checked every 4 weeks for signs of mobility or infection around the screws.

a b

Figure 1 a,b. Intraoral views of intrusion mechanics with the CIA: (a) Frontal view and (b) Upper occlusal view

a b

Figure 2. Intraoral views of intrusion mechanics with the Miniscrew: (a) Frontal view and (b) Upper occlusal view

Statistical analysis

Descriptive statistics, such as the mean, standard deviation, and minimum and maximum values, were calculated. The suitability of continuous variables for normal distribution was assessed with the Kolmogorov-Smirnov test, and homogeneity was determined by Levene's test. The paired Student's t-test was used for the in-group comparisons of the pre-intrusion [T1] and post-intrusion [T2] values. The differences between the two groups were assessed with the independent Student's t-test. The chi-square test was used to measure frequencies. Systematic errors were not detected in the analysis ($p > 0.05$). A systematic error analysis performed with the Dahlberg formula yielded an acceptable level (0.018–0710) in the cephalometric measurements (Table 2). The data were found to be homogenous and normally distributed. The tests were performed with IBM SPSS Statistics. A 95% confidence interval was used, and significance was set at $p < 0.05$.

Results

Lateral cephalometric radiographs were obtained at T1 and T2 from the 40 participants in the CIA and Miniscrew groups. A total of 84 measurements, including skeletal, dental, and soft tissue, were made (Fig. 3-7).

Table 2. Dahlberg values related to cephalometric measurements used in the study

Measurements	Dahlberg	Measurements	Dahlberg	Measurements	Dahlberg	Measurements	Dahlberg
SNA	*0.043*	*HRP-B*	0.274	U1-HRP(cr)	0.329	U6MxP(cr)	0.144
SNB	*0.072*	*VRP-A*	*0.303*	*U1-HRP(tip)*	*0.423*	*U6MxP(tip)*	0.214
ANB	0.034	VRP-B	0.323	U1-VRP(cr)	0.323	Upper lip thickness	0.039
SNGoMe	*0.323*	*ANS-PNS*	*0.211*	*U1-VRP(tip)*	*0.354*	Upper lip length	0.061
NSAr	0.325	Co-Gn	0.289	U6-HRP(cr)	0.204	A'-HRP	0.047
HRP-MxP	0.710	Pog-HRP	0.204	U6-HRP(tip)	0.233	A'-VRP	0.258
HRP-MnP	0.233	Pog-VRP	0.316	U6-VRP(cr)	0.245	B'-HRP	0.204
Gonial angle	*0.251*	*Go-HRP*	*0.258*	*U6-VRP(tip)*	*0.169*	*B'-VRP*	0.233
Facial axis angle	0.289	Go-VRP	0.266	L1-HRP	0.258	Ls-HRP	0.266
OP-HRP	*0.281*	*ANS-HRP*	*0.296*	*L1-VRP*	*0.194*	*Ls-VRP*	0.242
SN-Pog	0.184	PNS-HRP	0.242	U1-APog	0.112	Li-HRP	0.129
N-ANS	*0.536*	*ANS-VRP*	*0.316*	*L1-APog*	*0.183*	*Li-VRP*	0.183
ANS-Me	0.148	PNS-VRP	0.266	OJ	0.047	Sn-HRP	0.266
S-Ar	*0.365*	*U1-MxP*	*0.108*	*OB*	*0.032*	*Sn-VRP*	0.065
Ar-Go	0.089	U1-HRP	0.061	Pr-HRP	0.376	Pog'-HRP	0.296
S-Go	*0.323*	*U1-NA*	*0.232*	*Pr-VRP*	*0.233*	*Pog'-VRP*	0.194
N-Me	0.371	L1-NB	0.048	U1-NA	0.187	E-ULA	0.144
Jarabak	*0.296*	*L1-MnP*	*0.193*	*L1-NB*	*0.129*	*E-LLA*	0.183
S-N	0.188	U6-HRP	0.548	L6m.k HRP	0.266	Nasolabial angle	0.393
Wits	*0.275*	*U6-MxP*	*0.018*	*L6m.k VRP*	*0.059*	Labiomental *angle*	0.266
HRP-A	0.258	U1ˆL1	0.111	U1-MxP(cr)	0.204	Sn-Me'	0.145

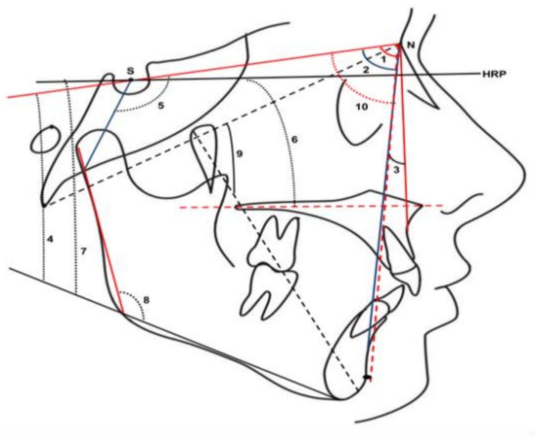

Figure 3. Angular skeletal measurements used in the study

1. SNA: Angle formed between sella nasion and nasion point A planes, **2. SNB:** Angle formed between sella nasion and nasion point B planes, **3. ANB:** Angle formed between nasion point A and nasion point B planes, **4. SN-GoMe:** Angle between the mandibular and sella nasion planes, **5. N-S-Ar:** Angle between the anterior cranial base plane and the Articulare point, **6. HRP-MxP:** The angle between the horizontal reference plane and the maxillary plane, **7. HRP-MnP:** Angle between the horizontal reference plane and the mandibular plane, **8. Gonial Angle:** The angle between the mandibular plane and the tangent drawn to the posterior edge of the ramus, **9. Facial Axis Angle (FAA):** Angle between Nasion-Basion plane and Pt-Gn plane, **10. SN-Pog:** Angle between the anterior cranial base plane and the Pogonion

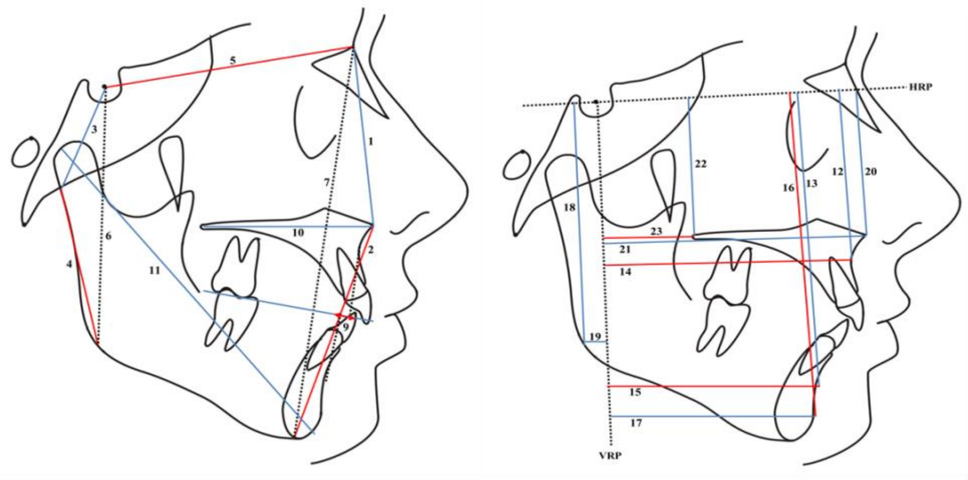

Figure 4: Linear skeletal measurements used in the study

1. N-ANS: Upper anterior facial height**, 2. ANS-Me:** Lower anterior facial height, **3. S-Ar:** Upper posterior facial height, **4. Ar-Go:** Lower posterior facial height, **5. S-N:** Distance between Sella and Nasion points, 6. S-Go: Total posterior facial height, **7. N-Me:** Total anterior facial height, **8. Jarabak:** The ratio of posterior facial height (S-Go) to anterior facial height (N-Me), **9. Wits value:** The distance between the vertical projections of points A and B on the occlusal plane, **10. ANS-PNS:** Distance between Anterior Nasal Spine and Posterior Nasal Spine, **11. Co-Gn:** Distance between Condillion and Gnathion points, 12. **HRP-A:** Perpendicular distance between point A and the horizontal reference plane, **13. HRP-B:** Perpendicular distance between point B and the horizontal reference plane, **14. VRP-A:** Perpendicular distance between point A and vertical reference plane, **15. VRP-B:** Perpendicular distance between point B and vertical reference plane, **16. Pog-HRP:** Distance between point Pogonion and horizontal reference plane, **17. Pog-VRP:** Distance between point Pogonion and vertical reference plane, **18. Go-HRP:** Distance between Gonion point and horizontal reference plane, **19. Go-VRP:** Distance between Gonion point and vertical reference plane, **20. ANS-HRP:** Distance of the ANS point to the horizontal reference plane, **21. ANS-VRP:** Distance of the ANS point to the vertical reference plane, **22. PNS-HRP:** Distance of the PNS point to the horizontal reference plane, **23. PNS-VRP:** Distance of the PNS point to the vertical reference plane

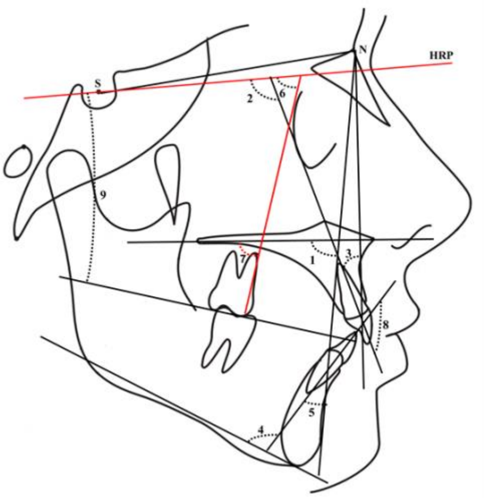

Figure 5: Angular dental measurements used in the study

1. U1-MxP: Angle between the long axis of the upper central incisor and the maxillary plane, **2. U1-HRP:** Angle between the long axis of the upper central incisor and HRP, **3. U1-NA:** Angle between the plane passing through the apex and incisal of the upper central incisor and the NA plane, **4. L1-MnP:** Angle between the long axis of the lower central incisor and the mandibular plane, **5. L1-NB:** Angle between the plane passing through the apex and incisal of the lower central incisor and the NB plane, **6. U6-HRP:** Angle between the long axis of the upper first molar and the horizontal reference plane, **7. U6-MxP:** Angle between the long axis of the upper first molar and the maxillary plane, **8. U1-L1 (Interincisal angle):** Angle between the long axes of the upper and lower incisors, **9. OP-HRP:** Angle between the occlusal plane and the horizontal reference plane

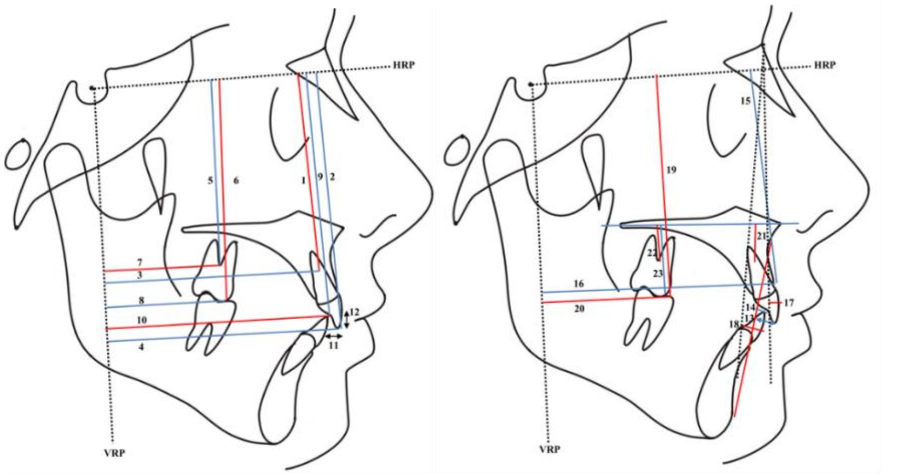

Figure 6: Linear Dental Measurements Used in the Study

1. U1-HRP (cr): Vertical distance between the centre of resistance (cr) of the upper incisor and the HRP, **2. U1-HRP (tip):** Vertical distance of the incisal edge of the upper central incisor to the HRP, **3. U1-VRP (cr):** Vertical distance between the centre of resistance (cr) of the upper incisor and the VRP, **4. U1-VRP (tip):** Vertical distance of the incisal edge of the upper central incisor to the VRP, **5. U6-HRP (cr):** Vertical distance between the center of resistance of the upper first molar and the HRP, **6. U6-HRP (tip):** Vertical distance between the mesiobuccal tubercle of the upper first molar tooth and the HRP, **7. U6-VRP (cr):** Vertical distance of the center of resistance of the upper first molar tooth to the VRP, **8. U6-VRP (tip):** Vertical distance between the mesiobuccal tubercle of the upper first molar tooth and the VRP, **9. L1-HRP:** Vertical distance of the incisal edge of the lower central incisor to the HRP, **10. L1-VRP:** Vertical distance of the incisal edge of the lower central incisor to the VRP, **11. Overjet (OJ):** Horizontal distance between the tips of the upper and lower central incisors, **12. Overbite (OB):** Vertical distance between the tips of the upper and lower central incisors, **13. U1- APog:** Vertical distance between the tip of the upper central incisor and the APog plane, **14. L1-APog:** Vertical distance between the tip of the lower central incisor and the APog plane, **15. Pr-HRP:** Vertical distance between Prosthion point and HRP, **16. Pr-VRP:** Vertical distance between Prosthion point and VRP, **17. U1-NA (mm):** Vertical distance between incisal edge of the upper central incisor and nasion point A plane, **18. L1-NB (mm):** Vertical distance between incisal edge of the lower central incisor and nasion point B plane, **19. L6 m.k.-HRP:** Vertical distance between the mesiobuccal tubercle of the lower first molar tooth and the horizontal reference plane, **20. L6 m.k.-VRP:** Vertical distance between the mesiobuccal tubercle of the lower first molar tooth and the vertical reference plane, **21. U1-MxP (cr):** Vertical distance between the centre of resistance (cr) of the upper incisor and the maxillary plane, **22. U6-MxP (cr):** Vertical distance between the centre of resistance (cr) of the upper first molar and the maxillary plane, **23. U6-MxP (tip):** Vertical distance between the mesiobuccal tubercle of the upper first molar and the maxillary plane

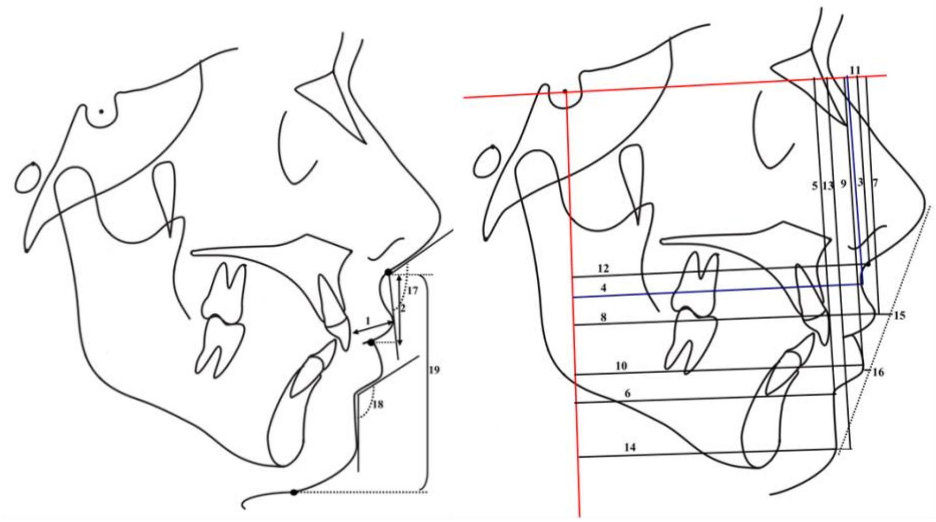

Figure 7. Soft tissue measurements used in the study

1. Upper lip thickness (ULT): Distance between the anterior point of the upper lip and the labial surface of the upper central tooth, **2. Upper lip length (ULL):** The distance between the subnazale point and the lowest point of the upper lip, **3. A'- HRP:** Vertical distance between the soft tissue point A and the horizontal reference plane, **4. A'- VRP:** Vertical distance between the soft tissue point A and the vertical reference plane, **5. B'-HRP:** Vertical distance between the soft tissue point B and the horizontal reference plane, **6. B'-VRP:** Vertical distance between the soft tissue point B and the vertical reference plane, **7. Ls-HRP:** Vertical distance between the upper lip and the horizontal reference plane, **8. Ls-VRP:** Vertical distance between the upper lip and the vertical reference plane, **9. Li-HRP:** Vertical distance between the lower lip and the horizontal reference plane, **10. Li-VRP:** Vertical distance between the lower lip and the vertical reference plane, **11. Sn-HRP:** Vertical distance between the subnazale point and the horizontal reference plane, **12. Sn-VRP:** Vertical distance between the subnazale point and the vertical reference plane, **13. Pog'-HRP:** Vertical distance between the soft tissue pogonion point and the horizontal reference plane, **14. Pog'-VRP:** Vertical distance between the soft tissue pogonion point and the vertical reference plane, **15. E-ULA:** Distance of the anterior point of the upper lip to the E plane, **16. E-LLA:** Distance of the anterior point of the lower lip to the E plane, **17. Nasolabial angle:** Angle between the lower edge of the nose and the line joining the intersection point of the upper lip with the lip tip, **18. Labiomental angle:** Angle between the tangent passing through the lower lip and the tangent passing through the soft tissue pogonion point, **19. Sn-Me':** Vertical distance between planes parallel to the horizontal reference plane drawn from the subnasale and soft tissue mentone points

Skeletal Measurements

Statistically significant differences were found in the comparisons of the ANB angles ($p < 0.01$) and HRP-MnP ($p < 0.01$) measurements in the CIA group. The ANB values decreased statistically, and the HRP-MnP values increased. The linear measurements such as Wits ($p < 0.01$), HRP-A ($p < 0.05$), HRP-B ($p < 0.05$), and Pog-HRP ($p < 0.05$) indicated statistically significant increases. No statistically significant change was detected in the other skeletal measurements at T1 and T2 in the CIA group (Table 3).

The within-group comparison indicated statistically significantly lower ANB angles ($p < 0.01$). It also indicated that there was no statistically significant change in the other skeletal measurements in the Miniscrew group (Table 4).

A between-group comparison indicated a statistically significant difference in the SNA ($p < 0.05$) in the skeletal measurements at T2 (Table 5).

Dental Measurements

In the CIA group, the following angles were found to be statistically increased: U1-MxP ($p < 0.001$), U1-HRP ($p < 0.001$), U1-NA ($p < 0.001$), L1-NB ($p < 0.05$), and L1-MnP ($p < 0.05$). The interincisal angle ($p < 0.001$) decreased significantly. The measurements indicated significant decreases in the U1-HRP (cr) ($p < 0.001$), U1-HRP (tip) ($p < 0.05$), U1-VRP (cr) ($p < 0.001$), overbite ($p < 0.001$), Pr-HRP ($p < 0.001$), and U1-MxP (cr) ($p < 0.01$). The linear measurements indicated statistically significant increases in the U1-VRP (tip) ($p < 0.01$), U6-HRP (cr) ($p < 0.001$), U6-HRP (tip) ($p < 0.001$), U1-APog ($p < 0.01$), overjet ($p < 0.01$)), U1-NA ($p < 0.05$), L1-NB ($p < 0.001$), L6 mk-HRP ($p < 0.001$), and U6-MxP (cr) ($p < 0.001$) (Table 6).

In the Miniscrew group, there were indicated significant increases in the following dental angular measurements: U1-MxP ($p < 0.001$), U1-HRP ($p < 0.001$), U1-NA ($p < 0.001$), L1-NB ($p < 0.05$), L1-MnP ($p < 0.05$), U6-HRP ($p < 0.001$), and U6-MxP ($p < 0.001$). However, there was a significant decrease in U1ˆ L1 (interincisal angle) ($p < 0.001$). The within-group comparisons indicated significant decreases in the following linear measurements in the Miniscrew group: U1-HRP (cr) ($p < 0.001$), U1-HRP (tip) ($p < 0.001$), Pr-HRP ($p < 0.001$), overbite ($p < 0.001$), and U1-MxP (cr) ($p < 0.001$). There were significant increases in the following values: U1-VRP (tip) ($p < 0.001$), U6-VRP (tip) ($p < 0.05$), L1-VRP ($p < 0.001$), U1-APog ($p < 0.001$), overjet ($p < 0.001$), Pr - VRP ($p < 0.05$), U1-NA ($p < 0.001$), L1-NB ($p < 0.001$), and L6 mk-VRP ($p < 0.05$). The other dental measurements in the Miniscrew group at T1 and T2 indicated that there was no statistically significant change (Table 7).

The between-group dental measurements indicated significant differences in the overjet ($p < 0.05$), overbite ($p < 0.05$), and U1-NA ($p < 0.001$) values (Table 8).

Soft Tissue Measurements

In the CIA group, the soft tissue measurements indicated significant decreases in the following values: upper lip length ($p < 0.05$), upper lip thickness ($p < 0.05$), and Pog′-VRP ($p < 0.05$). There were significant increases in the following: B′-HRP ($p < 0.05$), Ls-VRP ($p < 0.001$), Li-VRP ($p < 0.01$), Li-HRP ($p < 0.05$), Sn-HRP ($p < 0.05$), Pog′-HRP ($p < 0.05$), Ls-HRP ($p < 0.01$), and Sn-Me′ ($p < 0.01$). However, there were significant decreases in the E-ULA ($p < 0.05$) and E-LLA ($p < 0.05$) values. The within-group comparisons of the T1 and T2 values for the CIA group indicated that there was no statistically significant change in the other soft tissue measurements (Table 9).

In the Miniscrew group, the soft tissue measurements indicated a significant reduction in the following values: upper lip thickness ($p < 0.05$), nasolabial angle ($p < 0.001$), labiomental angle ($p < 0.05$). A significant increase was found in A′-VRP ($p < 0.05$), and B′-VRP ($p < 0.05$), Ls-VRP ($p < 0.001$), and Li-VRP ($p < 0.01$) values. There was a significant decrease in the E-LLA ($p < 0.001$) and E-ULA ($p < 0.01$). In the Miniscrew group, the within-group comparisons indicated that there was no statistically significant change in the other soft tissues (Table 10).

The T2 between-group comparisons indicated that there was a significant difference in the nasolabial angle ($p < 0.01$). The between-group comparisons at T1 and T2 also showed that there was no significant difference in the soft tissue measurements (Table 11).

Tablo 3. Descriptive statistics of skeletal measurements of the CIA group and comparison within group

		Parameter	n	T1				T2				p
				Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	
SKELETAL MEASUREMENTS	ANGULAR MEASUREMENTS	SNA	20	76.10	88.50	81.28	3.44	74.80	88.80	80.90	3.61	0.211 ns
		SNB	20	71.00	81.20	75.73	2.78	69.70	80.80	75.93	3.09	0.444 ns
		ANB	20	-2.40	11.00	5.57	2.92	-3.20	10.20	4.96	2.82	0.001 **
		SN-GoMe	20	22.00	47.00	32.55	4.92	24.00	50.00	32.85	5.43	0.343 ns
		NSAr	20	114.00	133.00	123.65	5,65	117.00	131.00	122.60	5.15	0.092 ns
		HRP-MxP	20	1.00	10.00	3.37	2.53	0.50	8.00	3.12	2.20	0.412 ns
		HRP-MnP	20	14.00	39.00	25.77	5.32	17.00	41.00	27.22	4.99	0.003 **
		Gonial angle	20	110.20	130.00	120.52	5.40	110.50	127.00	119.82	5.57	0.230 ns
		Facial axis angle	20	76.00	94.00	86.64	4.51	74.00	95.00	86.74	4.95	0.678 ns
		SN-Pog	20	72.00	81.00	77.00	2.75	71.10	81.00	77.05	2.97	0.846 ns
	LINEAR MEASUREMENTS	N-ANS	20	45.50	55.00	50.80	2.71	41.90	57.80	49.91	4.14	0.222 ns
		ANS-Me	20	51.80	79.00	61.98	6.56	48.30	72.50	60.95	6.60	0.457 ns
		S-Ar	20	30.00	43.00	35.40	3.92	30.00	41.00	34.25	2.95	0.130 ns
		Ar-Go	20	35.50	54.20	44.92	5.18	35.70	56.30	44.15	5.28	0.335 ns
		S-N	20	60.00	76.00	66.90	5.12	59.00	76.00	66.00	4.96	0.194 ns
		S-Go	20	66.00	92.00	77.05	8.26	66.00	91.00	74.85	7.16	0.066 ns
		N-Me	20	79.00	136.00	111.95	11.96	72.00	131.00	109.05	11.91	0.070 ns
		Jarabak	20	58.00	113.00	70.00	10.85	56.00	101.00	69.35	8.51	0.324 ns
		Wits	20	-3.00	10.00	1.80	3.42	-2.00	14.00	2.75	3.83	0.007 **
		HRP-A	20	47.00	65.00	54.95	4.07	48.00	64.50	55.92	4.36	0.027 *
		HRP-B	20	85.00	110.00	95.27	6.79	87.00	112.50	96.35	6.99	0.036 *
		VRP-A	20	66.50	88.00	75.50	5.66	67.00	88.00	75.52	5.18	0.940 ns
		VRP-B	20	54.00	76.50	64.95	6.63	56.00	76.00	65.12	6.05	0.698 ns
		ANS-PNS	20	42.90	59.00	48.88	3.34	42.60	60.10	49.06	3.46	0.572 ns
		Co-Gn	20	95.00	129.00	105.00	7.50	96.00	116.00	103.65	5.41	0.288 ns
		Pog-HRP	20	101.00	135.00	111.80	8.57	100.00	134.00	113.67	9.13	0.010 *
		Pog-VRP	20	50.00	83.00	66.47	8.21	53.00	80.00	66.27	7.13	0.767 ns
		Go-HRP	20	79.00	100.50	86.17	6.70	78.00	116.00	87.75	9.11	0.076 ns
		Go-VRP	20	1.00	21.00	10.75	4.66	1.00	19.00	11.02	4.75	0.680 ns
		ANS-HRP	20	41.00	66.00	49.60	5.08	42.50	65.00	50.25	4.97	0.166 ns
		PNS-HRP	20	45.00	60.00	49.72	4.06	44.00	60.00	49.62	4.62	0.737 ns
		ANS-VRP	20	69.00	93.00	79.40	5.62	69.00	92.00	79.12	5.28	0.502 ns
		PNS-VRP	20	15.00	30.00	23.85	3.64	16.00	30.00	23.67	3.51	0.742 ns

Table 4. Descriptive statistics of skeletal measurements of the Miniscrew group and comparison within group

		Parameter	n	T1				T2				*p*
				Min.	*Max.*	*Mean*	*S.D.*	*Min.*	*Max.*	*Mean*	*S.D.*	
	ANGULAR MEASUREMENTS	**SNA**	20	70.60	84.40	78.41	3.83	70.10	83.20	78.06	3.75	0.195 ns
		SNB	20	67.80	80.50	73.94	3.32	68.80	79.20	74.12	2.91	0.441 ns
		ANB	20	0.20	7.60	4.46	1.86	-0.50	6.70	3.93	1.82	0.007 **
		SN-GoMe	20	28.00	50.00	34.25	6.82	25.00	49.00	33.95	6.43	0.356 ns
		NSAr	20	115.00	134.00	125.55	5.89	114.00	133.00	125.50	6.12	0.936 ns
		HRP-MXP	20	0.00	5.00	2.77	1.35	0.00	7.00	2.75	1.65	0.920 ns
		HRP-MNP	20	12.00	43.00	27.55	7.84	11.00	42.00	27.30	8.00	0.344 ns
		Gonial angle	20	110.30	135.20	120.83	6.46	107.60	136.10	120.38	7.25	0.409
		Facial axis angle	20	74.00	92.00	85.88	4.67	74.30	91.00	85.96	4.31	0.810 ns
		SN-POG	20	68.00	83.20	75.86	4.20	70.00	83.00	76.21	3.65	0.144 ns
		N-ANS	20	46.40	56.40	50.90	2.82	46.40	56.40	50.72	2.82	0.249 ns
		ANS-Me	20	53.20	72.20	60.29	4.86	54.60	78.10	60.70	5.31	0.531 ns
		S-Ar	20	29.00	41.00	34.65	3.39	28.00	41.00	34.50	3.18	0.728 ns
		Ar-Go	20	36.00	53.60	43.88	5.48	35.50	53.20	44.59	5.35	0.161 ns
		S-N	20	61.00	73.00	66.35	3.88	60.00	80.00	67.35	5.52	0.142 ns
s		**S-Go**	20	66.00	87.00	75.90	6.96	63.00	90.00	76.45	6.73	0.425 ns
		N-Me	20	101.00	134.00	115.20	7.92	103.00	135.00	115.25	7.46	0.956 ns
		Jarabak	20	56.00	72.00	66.55	4.74	57.00	74.00	66.75	4.32	0.507 ns
		Wits	20	-2.00	7.00	2.15	2.30	-4.00	7.00	2.80	2.66	0.067 ns
	LINEAR MEASUREMENTS	**HRP-A**	20	51.00	61.00	56.05	2.72	53.00	60.00	56.35	2.40	0.289 ns
		HRP-B	20	89.00	107.50	96.60	6.07	89.00	111.00	96.42	6.62	0.779 n.s
		VRP-A	20	62.00	85.00	73.72	7.22	65.00	86.00	73.82	6.84	0.882 ns
		VRP-B	20	49.00	80.00	62.57	9.23	50.00	80.00	63.62	8.62	0.073 n.s
		ANS-PNS	20	45.00	53.90	48.12	2.86	42.40	54.60	48.28	3.73	0.691 ns
		Co-Gn	20	98.00	128.00	107.10	7.77	94.00	129.00	107.35	8.67	0.755 ns
		Pog-HRP	20	102.00	125.00	113.70	6.13	105.00	126.00	113.50	5.76	0.623 ns
		Pog-VRP	20	44.00	89.00	65.67	11.47	46.00	88.50	66.50	10.79	0.167 ns
		Go-HRP	20	76.00	99.00	86.55	7.73	73.00	98.00	87.12	7.81	0.209 ns
		Go-VRP	20	2.50	19.00	12.37	5.36	0.00	19.00	11.77	5.53	0.156 ns
		ANS-HRP	20	46.00	57.00	51.12	2.53	45.00	57.00	51.07	2.69	0.823 ns
		PNS-HRP	20	44.00	56.50	50.10	3.58	46.00	55.00	50.20	3.22	0.727 ns
		ANS-VRP	20	68.00	89.00	76.92	6.66	67.00	90.00	77.55	6.78	0.117 ns
		PNS-VRP	20	15.00	31.00	22.25	4.71	17.00	32.00	22.72	4.59	0.127 ns

Table 5. Comparison of the skelatal measurements between CIA and Miniscrew groups

		Parameter	n	T1 CIA and Miniscrew Mean	T1 CIA and Miniscrew S.D	T1 p	T2 CIA and Miniscrew Mean	T2 CIA and Miniscrew S.D	T2 p
SKELETAL MEASUREMENTS	ANGULAR MEASUREMENTS	SNA	20	-2.86	1.15	0.018 *	-2.83	1.16	0.020 *
		SNB	20	-1.78	0.97	0.074 ns	-1.81	0.95	0.065 ns
		ANB	20	-1.11	0.77	0.161 ns	-1.03	075	0.179 ns
		SN-GoMe	20	1.70	1.88	0.372 ns	1.10	1.88	0.563 ns
		NSAr	20	1.90	1.82	0.305 ns	2.90	1.79	0.114 ns
		HRP-MXP	20	-0.60	0.64	0.356 ns	-0.37	0.61	0.547 ns
		HRP-MNP	20	1.77	2.12	0.408 ns	0.07	2.10	0.972 ns
		Gonial angle	20	0.30	1.88	0.872 ns	0.56	2.04	0.786 ns
		Facial axis angle	20	-0.75	1.45	0.606 ns	-0.78	1.46	0. 598 ns
		SN-POG	20	-1.14	1.12	0.315 ns	-0.84	1.05	0.430 ns
	LINEAR MEASUREMENTS	N-ANS	20	0.09	0.87	0.914 ns	0.80	1.12	0.478 ns
		ANS-Me	20	-1.69	1.82	0.359 ns	-0.25	1.89	0.894 ns
		S-Ar	20	-0.75	1.16	0.522 ns	0.25	0.97	0.798 ns
		Ar-Go	20	-1.04	1.68	0.541 ns	0.44	1.68	0.793 ns
		S-N	20	-0.55	1.43	0.704 ns	1.35	1.66	0.421 ns
		S-Go	20	-1.15	2.41	0.637 ns	1.60	2.19	0.471 ns
		N-Me	20	3.25	3.20	0.318 ns	6.20	3.14	0.056 ns
		Jarabak	20	-3.45	2.64	0.201 ns	-2.60	2.13	0.231 ns
		Wits	20	0.35	0.92	0.707 ns	0.50	1.04	0.962 ns
		HRP-A	20	1.10	1.09	0.322 ns	0.42	1.11	0. 705 ns
		HRP-B	20	1.32	2.03	0.519 ns	0.07	2.15	0.972 ns
		VRP-A	20	-1.77	2.05	0.393 ns	-1.70	1.92	0.382 ns
		VRP-B	20	-2.37	2.54	0.356 ns	-1.50	2.35	0.528 ns
		ANS-PNS	20	-0.75	0.98	0.448 ns	-0.78	1.13	0. 498 ns
		Co-Gn	20	2.10	2.41	0.390 ns	3.70	2.28	0.114 ns
		Pog-HRP	20	1.90	2.35	0.425 ns	-0.17	2.41	0.943 ns
		Pog-VRP	20	-0.80	3.15	0.801 ns	0.22	2.89	0.938 ns
		Go-HRP	20	0.37	2.28	0.871 ns	-0.62	2.68	0.817 ns
		Go-VRP	20	1.62	1.58	0.313 ns	0.75	1.63	0.648 ns
		ANS-HRP	20	1.52	1.27	0.238 ns	0.82	1.26	0.518 ns
		PNS-HRP	20	0.37	1.21	0.759 ns	0.57	1.26	0.651 ns
		ANS-VRP	20	-2.47	1.95	0. 212 ns	-1.57	1.92	0.418 ns
		PNS-VRP	20	-1.60	1.33	0.237 ns	-0.95	1.29	0.467 ns

Table 6. Descriptive statistics of dental measurements of the CIA group and comparison within group

		Parameter	n	T1				T2				*p*
				Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	
DENTAL MEASUREMENTS	ANGULAR MEASUREMENTS	U1-MxP	20	80.60	103.70	92.81	7.38	97.40	115.50	106.12	5.24	0.000 ***
		U1-HRP	20	75.00	107.00	92.00	8.40	84.00	111.00	103.45	6.86	0.000 ***
		U1-NA	20	-9.80	20.30	4.61	8.70	6.60	29.80	17.74	6.46	0.000 ***
		L1-NB	20	2.50	34.10	20.95	7.68	8.20	38.40	24.71	6.68	0.009**
		L1-MnP	20	78.30	108.50	93.09	7.87	85.70	108.20	96.98	5.37	0.016 *
		U6-HRP	20	69.00	90.00	78.32	5.63	66.00	84.00	76.82	6.02	0.098 ns
		U6-MxP	20	69.00	89.00	78.57	5.69	67.50	87.00	77.15	5.77	0.135 ns
		U1^L1	20	129.50	170.30	149.03	11.77	117.70	145.20	132.42	7.31	0.000 ***
		OP-HRP	20	4.00	22.50	12.17	4.86	6.00	23.00	11.92	4.69	0.732 ns
	LINEAR MEASUREMENTS	U1-HRP (Cr)	20	56.00	84.00	63.72	6.76	53.00	82.00	61.82	6.80	0.000 ***
		U1-HRP (tip)	20	74.50	99.00	82.52	5.44	73.00	97.00	81.35	5.51	0.011 *
		U1-VRP (Cr)	20	63.00	87.00	73.82	6.36	63.00	82.00	71.05	4.89	0.000 ***
		U1-VRP (tip)	20	63.00	90.00	74.77	6.76	69.00	89.00	77.05	5.23	0.001 **
		U6-HRP (Cr)	20	54.00	72.00	61.72	5.71	55.00	75.00	63.45	5.94	0.000 ***
		U6-HRP (tip)	20	66.00	85.00	74.95	6.29	68.00	88.00	76.75	6.53	0.000 ***
		U6-VRP (Cr)	20	36.50	56.00	45.55	5.74	36.50	55.00	46.17	5.35	0.095 ns
		U6-VRP (tip)	20	34.00	55.00	44.85	5.73	34.00	54.00	45.17	5.50	0.437 ns
		L1-HRP	20	67.00	89.00	76.57	5.83	67.00	90.50	77.75	5.85	0.065 ns
		L1-VRP	20	61.00	80.00	72.17	6.52	63.00	81.00	73.07	5.30	0.059 ns
		U1-APog	20	0.00	10.00	3.10	2.66	2.00	9.00	4.97	1.80	0.001 **
		L1-APog	20	0.00	6.00	2.40	1.63	0.00	5.00	1.52	1.36	0.064 ns
		Overjet	20	2.10	6.10	3.91	1.18	2.00	7.90	5.41	1.34	0.000 ***
		Overbite	20	3.80	8.80	5.58	1.51	0.60	5.70	3.03	1.54	0.000 ***
		Pr-HRP	20	59.00	81.00	68.27	5.19	57.50	79.00	66.95	5.58	0.000 ***
		Pr-VRP	20	68.00	97.00	77.37	6.77	68.00	89.00	77.22	5.52	0.826 ns
		U1-NA	20	-2.00	6.00	2.45	2.30	1.00	7.00	3.35	1.46	0.022 *
		L1-NB	20	-1.00	8.00	3.55	1.82	1.00	8.00	4.90	1.80	0.000 ***
		L6m.k.-HRP	20	68.00	87.00	74.52	5.98	70.00	89.00	76.90	6.33	0.000 ***
		L6m.k.-VRP	20	28.00	52.00	42.35	6.13	30.00	51.00	42.85	5.78	0.390 ns
		U1-MxP (Cr)	20	9.00	21.00	14.30	2.89	8.00	19.00	12.65	3.01	0.001 **
		U6-MxP (Cr)	20	8.50	19.00	12.47	3.13	8.50	20.00	14.07	2.89	0.000 ***
		U6-MxP (tip)	20	19.00	27.60	22.38	2.87	18.00	28.00	22.40	2.62	0.952 ns

Table 7. Descriptive statistics of dental measurements of Miniscrew group and comparison within group

		Parameter	n	T1				T2				p
				Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	
DENTAL MEASUREMENTS	ANGULAR MEASUREMENTS	U1-MxP	20	80.40	106.90	94.50	6.81	101.70	125.40	111.66	5.63	0.000 ***
		U1-HRP	20	75.00	104.00	93.67	6.50	99.50	121.00	108.78	5.16	0.000 ***
		U1-NA	20	-8.00	19.00	7.14	7.64	11.00	41.80	24.23	6.43	0.000 ***
		L1-NB	20	11.70	30.50	19.61	5.27	11.90	35.00	22.57	5.41	0.015*
		L1-MnP	20	84.10	101.60	91.47	5.64	85.70	111.70	93.67	6.17	0.024 *
		U6-HRP	20	73.00	88.50	79.70	4.64	72.00	89.00	81.69	4.82	0.000 ***
		U6-MxP	20	72.50	94.00	80.62	4.89	73.00	95.00	82.70	5.10	0.000 ***
		U1^L1	20	127.40	161.80	148.18	8.82	113.30	148.30	128.64	8.44	0.000 ***
		OP-HRP	20	5.00	22.00	13.47	5.13	3.00	21.00	12.65	4.93	0.095 ns
	LINEAR MEASUREMENTS	U1-HRP (Cr)	20	58.00	71.00	65.02	3.81	52.00	68.50	61.32	4.50	0.000 ***
		U1-HRP (tip)	20	76.00	92.00	85.57	4.87	72.00	91.50	82.07	5.18	0.000 ***
		U1-VRP (Cr)	20	58.00	83.00	70.20	7.58	60.00	85.00	70.12	7.20	0.875 ns
		U1-VRP (tip)	20	62.00	86.00	71.47	7.31	68.00	90.00	77.37	7.29	0.000 ***
		U6-HRP (Cr)	20	57.00	70.00	63.45	4.24	56.00	70.00	63.25	4.22	0.391 ns
		U6-HRP (tip)	20	68.00	84.00	75.77	4.46	69.00	84.00	75.92	4.40	0.419 ns
		U6-VRP (Cr)	20	33.00	54.00	42.45	6.28	35.00	53.00	43.10	5.54	0.073 ns
		U6-VRP (tip)	20	33.00	53.00	42.07	5.98	36.00	53.50	43.32	6.09	0.022 *
		L1-HRP	20	68.00	85.00	77.37	4.94	68.50	88.00	77.50	5.32	0.635 ns
		L1-VRP	20	60.00	84.00	69.15	7.44	63.50	84.00	71.35	7.18	0.000 ***
		U1-APog	20	-2.00	9.00	2.65	2.89	2.50	13.00	6.45	2.73	0.000 ***
		L1-APog	20	-5.00	6.00	2.62	2.42	0.00	7.00	2.45	1.88	0.773 ns
		Overjet	20	2.00	5.40	3.87	0.98	2.00	9.20	6.43	1.67	0.000 ***
		Overbite	20	3.80	8.10	5.59	1.17	-0.80	4.90	1.92	1.36	0.000 ***
		Pr-HRP	20	63.50	77.00	69.52	3.95	58.00	74.00	65.62	4.29	0.000 ***
		Pr-VRP	20	62.00	87.00	74.92	7.22	65.00	89.00	76.07	6.86	0.019 *
		U1-NA	20	0.00	7.00	3.25	1.94	3.00	9.00	5.45	1.63	0.000 ***
		L1-NB	20	1.00	8.00	3.45	1.79	3.00	8.00	4.45	1.82	0.000 ***
		L6m.k.-HRP	20	67.00	83.00	76.62	4.12	69.00	83.50	77.05	3.74	0.157 ns
		L6m.k.-VRP	20	29.00	63.00	42.57	8.69	32.00	65.00	43.92	7.93	0.026 *
		U1-MxP (Cr)	20	7.00	21.00	14.40	3.18	3.00	19.00	10.82	3.55	0.000 ***
		U6-MxP (Cr)	20	8.00	19.00	14.20	2.80	8.00	19.00	14.30	2.86	0.585 ns
		U6-MxP (tip)	20	18.00	28.00	22.94	2.61	18.00	28.00	23.00	2.97	0.885 ns

Table 8. Comparison of the dental measurements between CIA and Miniscrew groups

		Parameter	n	T1 CIA and Miniscrew Mean	T1 CIA and Miniscrew S.D	T1 p	T2 CIA and Miniscrew Mean	T2 CIA and Miniscrew S.D	T2 p
DENTAL MEASUREMENTS	ANGULAR MEASUREMENTS	U1-MxP	20	1.68	2.24	0.458 ns	5.53	1.72	0.003 **
		U1-HRP	20	1.67	2.37	0.485 ns	5.33	1.92	0.008 **
		U1-NA	20	2.52	2.59	0.336 ns	6.49	2.04	0.003 **
		L1-NB	20	-1.34	2.08	0.523 ns	-2.14	1.92	0.273 ns
		L1-MnP	20	-1.61	2.16	0.461 ns	-3.31	1.83	0.079 ns
		U6-HRP	20	1.37	1.63	0.405 ns	4.87	1.72	0.008 **
		U6-MxP	20	2.05	1.67	0.230 ns	5.55	1.72	0.003 **
		U1^L1	20	-0.85	3.29	0.798 ns	-3.87	2.49	0.138 ns
		OP-HRP	20	1.30	1.58	0.416 ns	-0.72	1.52	0.637 ns
	LINEAR MEASUREMENTS	U1-HRP (Cr)	20	1.30	1.73	0.459 ns	-0.50	1.82	0.786 ns
		U1-HRP (tip)	20	3.05	1.63	0.070 ns	0.72	1.69	0.671 ns
		U1-VRP (Cr)	20	-3.62	2.21	0.110 ns	-0.92	1.94	0.638 ns
		U1-VRP (tip)	20	-3.30	2.22	0.147 ns	0.32	2.00	0.872 ns
		U6-HRP (Cr)	20	1.72	1.59	0.285 ns	-0.20	1.63	0.903 ns
		U6-HRP (tip)	20	0.82	1.72	0.635 ns	-0.82	1.76	0.642 ns
		U6-VRP (Cr)	20	-3.10	1.90	0.112 ns	-3.07	1.72	0.082 ns
		U6-VRP (tip)	20	-2.77	1.85	0.143 ns	-1.85	1.83	0.320 ns
		L1-HRP	20	0.80	1.71	0.643 ns	-0.25	1.76	0.888 ns
		L1-VRP	20	-3.02	2.21	0.180 ns	-1.72	1.99	0.393 ns
		U1-APog	20	-0.45	0.88	0.612 ns	1.47	0.73	0.051 ns
		L1-APog	20	0.22	0.65	0.733 ns	0.92	0.51	0.083 ns
		Overjet	20	-0.04	0.34	0.908 ns	1.02	0.48	0.040 *
		Overbite	20	0.01	0.42	0.972 ns	-1.11	0.46	0.021 *
		Pr-HRP	20	1.25	1.46	0.397 ns	1.32	1.57	0.406 ns
		Pr-VRP	20	-2.45	2.21	0.276 ns	-1.15	1.97	0.563 ns
		U1-NA	20	0.80	0.67	0.243 ns	2.10	0.49	0.000 ***
		L1-NB	20	-0.10	0.57	0.862 ns	-0.45	0.57	0.437 ns
		L6m.k.-HRP	20	2.10	1.62	0.204 ns	0.15	1.64	0.928 ns
		L6m.k.-VRP	20	0.22	2.37	0.925 ns	1.07	2.19	0.627 ns
		U1-MxP (Cr)	20	0.10	0.96	0.918 ns	-1.82	1.04	0.088 ns
		U6-MxP (Cr)	20	1.72	0.94	0.074 ns	0.22	0.91	0.806 ns
		U6-MxP (tip)	20	0.56	0.86	0.523 ns	0.60	0.88	0.499 ns

Table 9. Descriptive statistics of soft tissue measurements of the CIA group and comparison within group

	Parameter	*n*	*T1*				*T2*				*p*
			Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	
SOFT TISSUE MEASUREMENTS	Upper lip thickness	20	8.50	19.90	12.62	3.08	8.00	16.00	11.70	2.71	0.013 *
	Upper lip length	20	19.30	32.90	25.70	3.71	20.00	30.90	24.22	2.95	0.028 *
	A'-HRP	20	55.00	75.00	63.20	4.94	56.00	75.00	64.40	5.40	0.078 ns
	A'-VRP	20	78.00	107.00	90.62	7.80	77.50	105.00	91.02	7.51	0.283 ns
	B'-HRP	20	85.00	114.00	97.07	7.87	85.00	116.00	98.60	8.43	0.013 *
	B'-VRP	20	65.00	92.00	78.75	7.64	60.00	94.00	77.55	8.11	0.144 ns
	Ls-HRP	20	63.50	88.00	73.57	6.13	64.00	88.50	75.42	6.48	0.001 **
	Ls-VRP	20	81.00	107.50	94.35	7.90	81.00	106.50	96.05	7.32	0.000 ***
	Li-HRP	20	76.00	105.00	87.90	6.59	77.50	106.00	89.67	7.87	0.036 *
	Li-VRP	20	77.00	101.00	89.40	7.66	78.00	99.00	90.45	7.01	0.009 **
	Sn-HRP	20	48.00	65.00	56.97	4.36	49.00	64.00	57.92	3.91	0.024 *
	Sn-VRP	20	80.50	108.00	94.60	7.26	75.00	107.00	94.12	8.24	0.508 ns
	Pog'-HRP	20	95.00	126.00	111.47	8.42	102.00	127.00	113.02	7.63	0.041 *
	Pog'-VRP	20	64.00	98.50	80.25	9.35	61.00	96.50	78.57	8.85	0.049 *
	E-ULA	20	-10.00	3.00	-3.50	3.54	-9.00	4.00	-2.65	3.67	0.011 *
	E-LLA	20	-7.00	4.00	-1.80	3.44	-6.00	5.00	-0.90	3.14	0.012 *
	Nazolabial angle	20	89.90	133.00	110.83	10.89	89.00	127.00	111.41	9.77	0.691 ns
	Labiomental angle	20	75.00	135.00	111.20	16.62	78.00	151.00	116.15	20.19	0.106 ns
	Sn-Me'	20	61.50	90.00	71.97	7.09	62.00	89.00	73.10	6.74	0.002 **

Table 10. Descriptive statistics of soft tissue measurements of the Miniscrew group and comparison within group

	Parameter	n	T1				T2				p
			Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	
SOFT TISSUE MEASUREMENTS	Upper lip thickness	20	8.50	16.10	12.69	1.93	9.10	14.70	11.84	1.78	0.050 *
	Upper lip length	20	14.20	33.00	25.63	4.48	19.30	34.60	25.27	3.80	0.629 ns
	A'-HRP	20	55.00	69.00	63.40	4.23	54.00	69.00	63.75	4.37	0.320 ns
	A'-VRP	20	79.00	101.00	89.10	6.94	79.00	103.00	90.27	6.77	0.020 *
	B'-HRP	20	88.00	109.00	97.62	6.04	87.00	113.00	96.17	6.57	0.077 ns
	B'-VRP	20	60.00	93.00	76.87	8.36	68.50	92.00	78.30	7.04	0.023 *
	Ls-HRP	20	65.00	83.00	73.70	4.92	64.00	80.00	73.77	4.91	0.828 ns
	Ls-VRP	20	80.00	103.00	91.55	7.67	83.00	106.00	94.23	7.31	0.000 ***
	Li-HRP	20	79.00	98.00	88.07	5.60	78.00	97.00	87.82	5.68	0.558 ns
	Li-VRP	20	73.00	99.00	86.67	8.10	79.00	98.50	88.72	6.44	0.003 **
	Sn-HRP	20	48.00	63.00	57.47	4.13	49.00	62.00	57.50	3.72	0.925 ns
	Sn-VRP	20	80.00	102.00	91.87	6.68	80.00	106.00	92.57	6.98	0.202 ns
	Pog'-HRP	20	99.00	177.00	115.45	15.89	101.50	126.00	112.75	7.04	0.396 ns
	Pog'-VRP	20	58.00	89.00	77.25	9.53	67.00	91.00	78.05	8.70	0.118 ns
	E-ULA	20	-10.00	0.00	-4.50	2.37	-5.00	0.00	-2.95	1.84	0.004 **
	E-LLA	20	-7.00	3.00	-3.20	2.60	-6.00	3.00	-1.75	2.38	0.000 ***
	Nazolabial angle	20	89.80	128.00	109.49	10.80	81.00	124.00	100.95	13.13	0.000 ***
	Labiomental angle	20	77.00	135.00	115.00	15.12	80.00	145.00	109.19	18.26	0.018 *
	Sn-Me'	20	64.00	80.00	72.50	4.35	64.00	82.00	73.02	4.76	0.112 ns

Table 11. Comparison of the soft tissue measurements between CIA and Miniscrew groups

	Parameter	n	T1			T2		
			CIA and Miniscrew		*p*	*CIA and Miniscrew*		*p*
			Mean	*S.D*		*Mean*	*S.D*	
SOFT TISSUE MEASUREMENTS	Upper lip thickness	20	0.06	0.81	0.937 ns	0.14	0.72	0.843 ns
	Upper lip length	20	-0.07	1.30	0.957 ns	1.05	1.07	0.336 ns
	A'-HRP	20	0.20	1.45	0.891 ns	-0.65	1.55	0.678 ns
	A'-VRP	20	-1.52	2.33	0.518 ns	-0.75	2.26	0.742 ns
	B'-HRP	20	0.55	2.21	0.806 ns	-2.42	2.39	0.317 ns
	B'-VRP	20	-1.87	2.53	0.464 ns	0.75	2.40	0.757 ns
	Ls-HRP	20	0.12	1.75	0.944 ns	-1.65	1.82	0.370 ns
	Ls-VRP	20	-2.80	2.46	0.263 ns	-1.81	2.31	0.438 ns
	Li-HRP	20	0.17	1.93	0.928 ns	-1.85	2.17	0.400 ns
	Li-VRP	20	-2.72	2.49	0.282 ns	-1.72	2.12	0.423 ns
	Sn-HRP	20	0.50	1.34	0.712 ns	-0.42	1.20	0.727 ns
	Sn-VRP	20	-2.72	2.20	0.225 ns	-1.55	2.41	0.525 ns
	Pog'-HRP	20	3.97	4.02	0.329 ns	-0.27	2.32	0.906 ns
	Pog'-VRP	20	-0.80	3.15	0.801 ns	0.22	2.89	0.938 ns
	E-ULA	20	-1.00	0.95	0.301 ns	-0.30	0.91	0.746 ns
	E-LLA	20	-1.40	0.96	0.155 ns	-0.85	0.88	0.341 ns
	Nazolabial angle	20	-1.34	3.43	0.698 ns	-10.45	3.66	0.007 **
	Labiomental angle	20	3.80	5.02	0.454 ns	-6.96	6.08	0.260 ns
	Sn-Me'	20	0.52	1.86	0.779 ns	-0.07	1.84	0.968 ns

Discussion

Deep bites are a common orthodontic anomaly that may be of dental or skeletal origin. A dental deep bite is typically the result of supraocclusion of the upper incisors in Cl-II division 2 anomalies (22). However, it is also seen in Cl-I and III anomalies (23). Dermaut and Vanden Bulcke (22) reported that deep bites resulted from excessive eruption of the upper incisors. Lewis (24) associated deep bites with excessive eruption of the upper and lower incisors. Schudy (25) indicated that the vertical development of the upper and lower molars may be a factor in deep bites.

There are three basic approaches to deep bite correction: posterior teeth extrusion, incisor intrusion, and a combination of these two methods. Attaining pure intrusion in incisors is difficult; however, miniscrews are often used to achieve true intrusion. Studies (26,27) have discussed the mechanics that provide pure intrusion. However, true intrusion in incisors can be achieved only by using implants or bone screws (28). Experimental and clinical studies have found that miniscrews provide effective and stable anchorage for orthodontic treatment (13-18,20).

Burstone (29) suggested that the vertical dimension should not be increased in most class II cases. The increase in the vertical facial dimensions has negative effects on the class II relationship. It results in a long face, with adverse effects on the aesthetics. Especially in individuals with long faces and severe skeletal class II relationships, Burstone also found that molar extrusion causes downward and backward rotation of the mandible. Therefore, he suggested that deep bites be corrected by incisor intrusion. Fayeda et al. (30) examined buccolingual bone thickness in cone beam computed tomography performed on 100 patients aged 13-18 and 19-27 years. They found that the most suitable anterior regions for miniscrew insertion were between the central and lateral incisors in the maxilla and between the canine and lateral incisors in the mandible.

In the present study, the decrease in the ANB angle ($p < 0.01$) was statistically significant in both the CIA and Miniscrew groups. In a similar study, the ANB angle decreased after incisor intrusion (31). As a result of the protrusion that occurs during incisor intrusion, the root tip moves backward, and the incisal edge moves forward. As the root tip moves backward, the vestibule bone follows the tooth root. Thus, point A moves backward as a result of remodeling after intrusion, and the SNA angle decreases (32-34). In the present study, the SNA angle decreased in both groups; however, the decrease was not statistically significant.

In the present study, there was a significant increase in the HRP-MnP angle in the CIA group as a result of molar extrusion. The significant increase in the HRP-B and Pog-HRP measurements also supports molar extrusion and posterior rotation of the mandible in the CIA group. In related studies (12,31), the mandible was rotated posteriorly because of molar extrusion in the CIA group. In the Miniscrew group, there was no extrusion, as no application was made to the molar teeth. A meta-analysis by Sosly et al. found that miniscrews were more effective for correcting deep bites and providing true intrusion. In addition, there was no occurrence of molar extrusion (20,35). Al-Nimri et al. (33) investigated the relationship between the protrusion of the upper incisors and the position of the A point in Cl-II division 2 patients. They stated that point A moved downward and backward as a result of the protrusion of the incisors. In the present study, point A moved downward in both groups.

Using the utility and CIA arches to apply incisor intrusion, Amasyalı et al. (12) found a statistically significant increase in the ANS-Me, N-Me, and S-Go height. Otto et al. (36), Schudy (25), and Dake and Sinclair (37) also found an increase in front face height; however, Çakırer (38) found no increase in face height. In the present study, there was no statistically significant difference in the ANS-Me, N-Me, and S-Go measurements in either group. In the present study, a statistically significant difference in the lower anterior and posterior face height was not observed in the CIA group because the transpalatal arch was used to increase molar anchorage. The results in the Miniscrew group were similar to those of studies in which incisor intrusion was performed with bone anchoring (34,39).

In both groups, there was a significant difference in the reduction in the distance of the resistance center (U1-HRP [cr]) of the upper incisor to the horizontal reference plane. The U1-HRP (cr) decreased by 1.90 mm in the CIA group and an average of 3.70 mm in the Miniscrew group. These results, which were consistent with those of previous studies (12,34,38,40), were an indication of successful intrusion. However, in the present study, the resistance center of the upper incisor in the miniscrew group moved more. This indicates that more intrusion was achieved with miniscrew anchorage.

Bekler (39) performed upper incisor intrusion by placing miniscrews between the lateral and canine teeth in the upper jaw and applying 100 g of intrusion force. She reported the occurrence of protrusion and intrusion in the upper incisors. Amasyalı et al. (12) reported protrusion with intrusion in the upper incisors despite making the archwire cinch back in the posterior region in both groups in their study to correct deep bites with CIA and utility arches. In a comparison of the Ricketts and Burstone techniques for maxillary incisor intrusion, Çakırer (38) found a greater degree of labial tipping in the incisors in the Ricketts group. Parker et

of the mandible as a result of posterior extrusion. Similar to the present study, Amasyalı et al. reported upper molar extrusion and mandibular posterior rotation (12). The direct application of intrusive force with miniscrews provides an effective alternative to intrusion arches (34).

al. (41) reported a decrease in deep bites and the existence of protrusion in the incisors of individuals with deep bites treated with different mechanics. Similarly, McDowell and Baker (42) reported a high correlation between incisor protrusion and deep bite reduction.

In the present study, overjet significantly increased in both groups because of upper incisor protrusion and incisor inclination. Similar studies (31,37,38,43,44) on deep bite correction have reported a decrease in overbite and an increase in overjet. Jain et al. reported a decrease in overbite as a result of using the J-hook headgear, utility arch, and miniscrew techniques to perform maxillary incision intrusion (20). In the present study, there was a statistically significant decrease in the amount of overbite in both groups. The decrease was 2.55 mm in the CIA group and 3.67 mm in the Miniscrew group.

One of the treatment goals of deep bite treatment is to correct the interincisal angle. The reduction of this angle is necessary for treatment stability (24). Arvystas (45) suggested that the interincisal angle should be reduced for overbite correction and long-term stability. In the present study, the interincisal angle decreased by 16.61° in the CIA group and by 19.54° in the Miniscrew group.

In both groups, there was a significant decrease in upper lip thickness. Hor (31) reported a similar decrease. It was explained by the upward and backward movement of the area supporting the lip during the intrusion and protrusion of the upper incisors. In the present study, upper lip length decreased in both groups; however, this change was statistically significant in the CIA group. This decrease might be the result of intrusion-induced changes in the tooth and bone tissue, as well as the soft tissue. These findings are consistent with those of related studies (12,39).

The vertical distance from the upper and lower lip to the E plane (E-ULA and E-LLA) was significantly reduced in both groups. This shows that upper and lower incisor protrusion was followed by upper and lower lip protrusion (12,31). A statistically significant increase was detected in the Ls-VRP and Li-VRP measurements in the CIA and Miniscrew groups. This indicates that the greater increase in lip support resulted from the protrusion accompanying the incisor intrusion in both groups. Hor (31) reported upper and lower lip protrusion in the utility arch group; the study found upper lip retraction and lower lip protrusion in the CIA group.

Posterior extrusion, a side effect of intrusion arches, was observed in the CIA group in the present study. The decrease in the Pog′-VRP distance revealed downward and backward rotation

Conclusions

First, the CIA and miniscrew methods facilitated successful upper incisor intrusion and deep bite correction. In the treatment of deep bites with intrusion arches, anchorage-enhancing mechanics might be beneficial for preventing posterior extrusion.

Second, the miniscrew method is more clinically effective in deep bite treatment because it provides incisor intrusion without extrusion in the posterior region. In addition, it does not require patient compliance. Therefore, miniscrews are an ideal option as skeletal anchors in high-angle deep bite cases with an excessive incisor appearance.

Third, intrusion using CIA and miniscrews might lead to soft tissue changes because of incisor proclination. Both methods contribute positively to smiles and facial aesthetics in individuals with retrusive profiles.

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