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Intrusive Effects of the Connecticut Intrusion Arch and the Utility Intrusion Arch

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Abstract: The purpose of this study was to examine and compare the effects of two different arches, the Connecticut Intrusion Arch (CIA) and the Utility Intrusion Arch (UIA). A total of 20 patients (15 girls and 5 boys) having Class I or Class II malocclusions with deep bite were divided into two groups. Lateral cephalograms were obtained before treatment and after intrusion of upper incisors. Statistical evaluation of lateral cephalograms revealed that upper incisors were intruded and protruded, upper first molars were extruded, and lower incisors were protruded in both groups. Due to the extrusion of the molars, anterior and posterior facial heights increased. It was determined that both of the mechanics were effective on intrusion of anterior teeth.

Key Words: Intrusion arches; Connecticut intrusion arch; Utility intrusion arch; Incisor intrusion

Introduction

Deep overbite is a common orthodontic anomaly. Although the correction of deep overbite is routinely achieved by orthodontic treatment, the need for careful diagnosis and a logically sequenced plan of treatment is critical for optimal results. There are various classifications for deep overbite. According to the associated etiological factors, deep bite can be divided into two groups, developmental and acquired deep overbite (1-5).

Deep overbite can be corrected in several ways. Treatment approaches include transition from a horizontal to a vertical growth pattern by forcing the mandible into a clockwise rotation, labial tipping of anterior teeth, extrusion of posterior teeth, intrusion of anterior teeth and surgical approaches (6-9). The decision must be based on the patient's age, etiology of the anomaly, skeletal and dental morphology, surrounding muscular and periodontal tissues, existence of the deep bite in the rest position, length of lips, occlusal plane, ideal incisor position and the lower facial height (9-17). Extrusion of posterior teeth may be an acceptable treatment alternative in growing patients with short lower facial height and concave profile, since it will force the mandible into posterior rotation. In individuals presenting a gummy smile, intrusion of these teeth should be preferred (18,19).

Several mechanics have been described for the correction of deep overbite. Tip-back bends and base arches are some of the mechanics that have been suggested for the extrusion of posterior teeth (20-24). In order to intrude the incisors, J-Hook headgears, functional appliances, anterior bite-planes, segmented arch technique, Begg mechanics, Edgewise mechanics, three piece base-arch, Utility intrusion arch (UIA), and Connecticut intrusion arch (CIA) can be used (6,23,25-35).

Although it is a complete arch extending across both buccal segments, the utility arch engages only the first molars and the four incisors. It was originally developed to provide a method of leveling the curve of Spee in the mandible, but it has been adapted to perform many more functions than just lower incisor intrusion.

With an 0.018" appliance, the recommended wire for the mandibular arch is 0.016"x0.016" or 0.016"x0.022" Blue Elgiloy (not heat-treated). For most maxillary arches, 0.016"x0.022" Blue Elgiloy is recommended. With an 0.022" appliance, 0.019"x0.019" Blue Elgiloy can be used in either arch. Engaging the utility arch will produce approximately 25g of force on each of the lower incisors, a force level considered ideal for lower incisor intrusion.

The CIA is fabricated from a nickel titanium alloy to provide the advantages of shape memory, springback, and light, continuous force distribution. It incorporates the characteristics of the utility arch as well as those of the conventional intrusion arch. The CIA is preformed with the appropriate bends necessary for easy insertion and use.

Two wire sizes are available: 0.016"x0.022" and 0.017"x0.025". The maxillary and mandibular versions have different anterior dimensions (for example 34mm and 28mm, respectively). Although in most cases the wire is not directly ligated into the bracket slots, the anterior wire dimension is adequate to allow for it. The bypass, located distal to the lateral incisors, is to accommodate for extraction, nonextraction, and mixed dentition cases. The CIA's basic mechanism for force delivery is a V-bend calibrated to deliver approximately 40-60g of force.

The purpose of this study was to examine and compare the dental and skeletal changes obtained by CIA and the UIA. Both arches have similar biomechanical principles. CIA is a last generation prefabricated appliance with shape memory. It is developed from high elastic memory nitinol and applies light and continuous force. In this study, we intended to determine whether CIA has any advantage over conventional Blue Elgiloy UIA.

Materials and Methods

This prospective study includes 20 patients (15 girls and 5 boys). Group 1 (CIA) comprised 10 children (7 girls and 3 boys) with a mean age of 15.3 ± 0.3 years and Group 2 (UIA) 10 children (8 girls and 2 boys) with a mean age of 14.5 ± 0.1 years.

Individuals with normal or vertical growth pattern and deep overbite (4 mm or more) were selected. The criteria for the teeth to be intruded were as follows: Completion of apexification, no apical root resorption prior to orthodontic treatment and no trauma history in the anamnesis.

Fixed preangulated and pretorqued edgewise appliances and 0.016" nitinol arch wire were used to align the teeth. Following the leveling phase, CIA or UIA was attached for the treatment of deep bite. CIA was used in conjunction with the leveling arch. In our study 0.016x0.022" was preferred and lengths of the segments were determined according to requirements of each case. It was tied on the brackets and chinched back at the distal of the molar tubes. UIA with tip back bends at the molar sites was manipulated from 0.016x0.022" Blue Elgiloy wire by same investigator (MA) and directly ligated into the anterior bracket slots and it was also chinched back. Since the CIA delivers 40 to 60g of force, the same amount of force was chosen in the UIA group for standardization.

The patients were seen for 4 weeks intervals. Treatment period with intrusion mechanics was 6 months. Adequate intrusion was obtained in all patients at the end of 6 months. Since we aimed to determine the pure intrusion effects of the appliances, additional mechanics were not applied in order to correct the sagittal relationship of the jaws during the intrusion phase.

Records were taken before the application of the mechanics and after 6 months. Lateral cephalograms were obtained with the Frankfort horizontal plane parallel to the floor and periapical radiographs were taken with paralleling technique to obtain standard radiographs. The same investigator (MA) traced the radiographs and other researchers verified the anatomic outlines and landmarks. The suspicious structures and landmarks were retraced according to the mutual satisfaction of the investigators. If there were two images, a single average tracing was made between the bilateral structures. Landmarks and parameters used in the study are shown in Figures 1-3. Please note that U1-NV is exaggerated in Figure 2 to prevent superimposition of the lines. The investigator (MA) measured the parameters twice at different times to eliminate the measurement errors.

Statistical Method

Statistical analyses were performed using the SPSS (SPSS Inc, Chicago, Ill. USA) statistical programme and the results were shown as mean ± standard deviation.

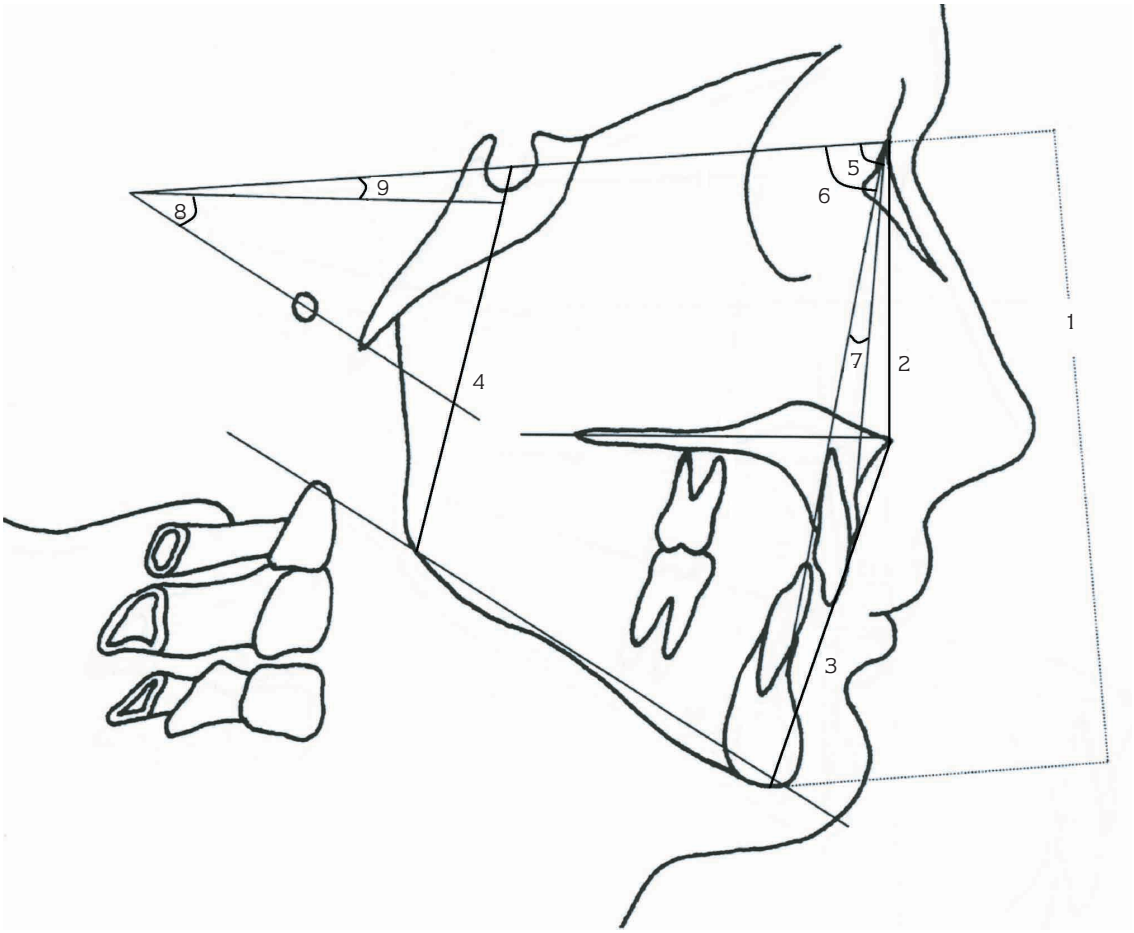

Figure 1. Skeletal parameters.
1) N-Me: anterior face height; 2) N-ANS: upper anterior face height; 3) ANS-Me: lower anterior face height; 4) S-Go: posterior face height; 5) SNA; 6) SNB; 7) ANB; 8) SN/GoGn; 9) SN /PP.

After the parametric assumptions were tested to determine if the variables were suitable for parametric tests, the differences between T1 and T2 measurements were evaluated with the paired-t test. The differences between the two groups were evaluated using student-t test. P values less than or equal to 0.05 were evaluated as statistically significant.

Results

The T1 (before intrusion) to T2 (after intrusion) changes are demonstrated in Tables 1 and 2 for both groups. Total anterior face height, lower anterior face height and posterior face height increased in both of the groups (N-Me, ANS-Me and S-Go increased) (Table 2). The maxillary incisors were intruded, protruded and tipped labially with both arch wires (U1-PP decreased and 1/NA, U1-NV increased) (Table 2). The mandibular incisors were also protruded and tipped labially in all patients (1/NB and 1/MP increased and L1-NV decreased) (Table 2). Interincisal angle and overbite decreased due to the alterations of the incisors in both groups (Table 2). Upper molars extruded with both arch wires (U6-PP increased) (Table 2). Molar extrusion forced the mandible into posterior rotation and Sn/GoGn increased in both of the groups (Table 2). Due to the dental alterations the occlusal plane revealed anterior rotation in both groups (SN/Occ decreased) (Table 2). The upper lip protruded in both of the groups (Nasolab and Sn-St decreased) (Table 2).

In the comparison group differences, statistically significant alterations were not observed in any of the parameters (Table 3).

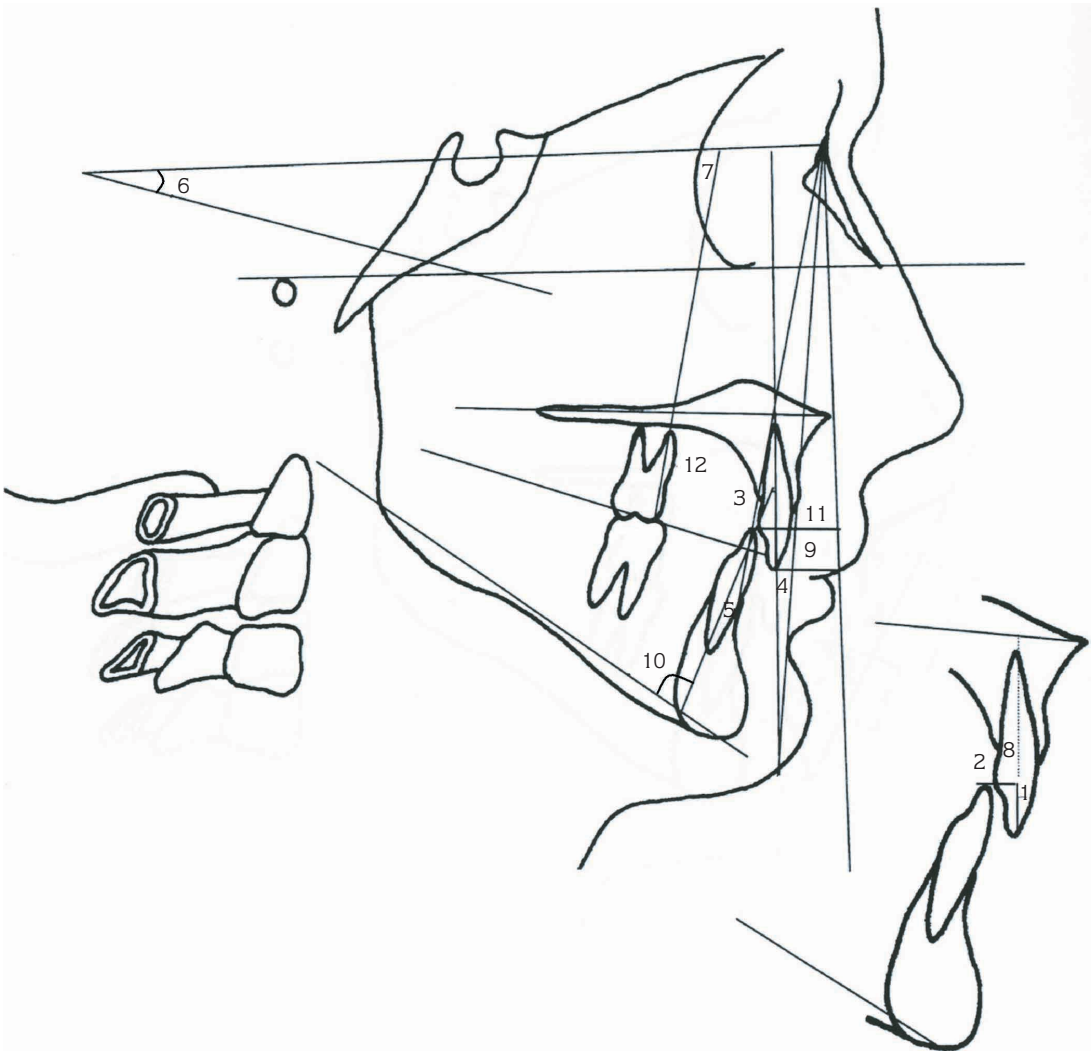

Figure 2. Skeletal and dentoalveolar parameters.
1) Overbite; 2) Overjet; 3) Interincisal (Iinc.); 4) 1/NA; 5) L1/NB; 6) SN/Occ; 7) U6/SN: the angle between axial inclination of upper first molar and SN; 8) U1-PP: the perpendicular distance between incisal edge of upper incisor and PP; 9) U1-NV: the perpendicular distance between incisal edge of upper incisor and NV; 10) L1/MP; 11) L1-NV; 12) U6-PP (Please note that U1-NV is exaggerated to prevent superimposition of the lines).

Discussion

Intrusion of the anterior teeth is one of the treatment modalities available for the correction of deep overbite and various intrusion mechanics have been introduced (23,24,26-35). Ricketts et al (23) suggested intrusion of incisors with utility arches. Nanda et al (35) demonstrated that the CIA could intrude the anterior teeth.

A literature review indicated different opinions regarding the amount of force for intrusion of incisors and usually light, continuous forces were stated to be more suitable (5,23,36). While CIA is fabricated from nickel titanium alloy, UIA was bent from Blue Elgiloy wire. The use of different wire materials should probably affect the amount of intrusion and the treatment time. To eliminate the differences originating from the materials the same force value was selected.

In our study, the anterior facial height and the lower facial height increased in both groups. Our findings are in accordance with Schudy (1), Otto et al (3), Dake and Sinclair (6), and Demirhanoglu (37). Contrary to our findings, Weiland et al (38) and Cakırer (39) found no significant alterations. In our opinion, the cause of the increase in the facial heights was the slight extrusion of

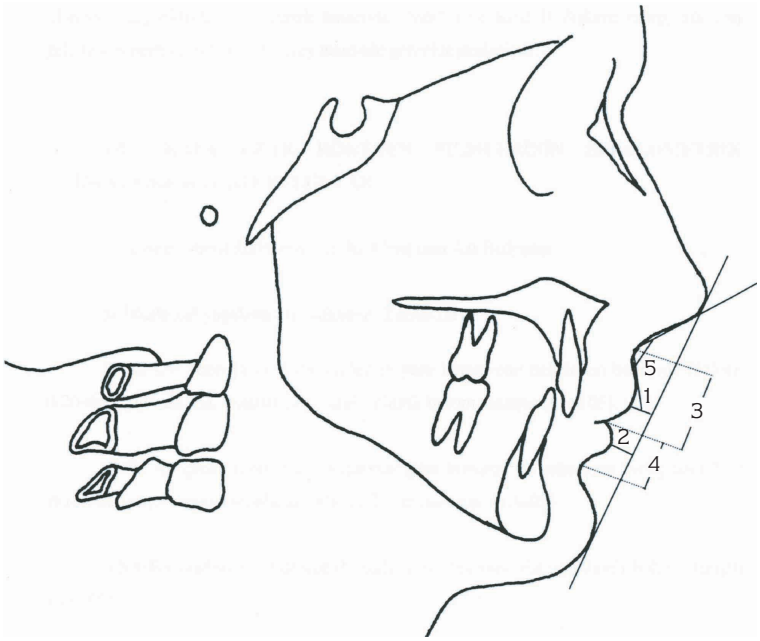

Figure 3. Soft tissue parameters
1)Ls-E; 2)Li-E; 3)Sn-St; 4)St-Sm; 5)Nslb: Nasolabial angle.

the molars. A significant alteration was also found in the posterior facial height. This finding was similar to the results of Demirhanoglu (37). McDowell and Baker (40), reported significantly greater increase in lower facial height and posterior facial height in the growers than in the nongrowers. Some of the previous studies have conflicting results with our findings and it was possibly due to the older age of the patients (38,39). Additionally, in these studies anchorage mechanics were used to prevent extrusion of the molars and to control the vertical facial heights.

In this study, the rotational force vector of the intrusion arches extruded the upper molars in both of the groups and this extrusion increased the posterior facial height. Our results are consistent with the observation of Barton (29), Demirhanoglu (37), Parker et al (19), Dake and Sinclair (6), and opposed to Weiland et al (38) and Cakırer (39) who used additional anchorage mechanics to prevent molar extrusion. Molar extrusion observed in CIA group was more, but it was not statistically significant in the comparison group differences. However, in this group mandible was forced to a slight posterior rotation. On the other hand, in the UIA group the increases in anterior and posterior facial heights compensated each other so the inclination of the mandible did not change.

Upper incisors were not only intruded but they were protruded and labially tipped also. These findings are in accordance with many authors (19,39-42). Although the intrusive mechanics were chinced back, they applied an intrusive force with a counterclockwise moment, which tended to flare the incisors. UIA was inserted into the brackets of the four incisors and CIA was tied on the brackets of the central incisors. The intrusive force was anterior to the center of resistance of the incisors so flaring was observed in both groups.

Overbite decreased significantly in both groups and the decrease was more than the amount of intrusion of the anterior teeth so we can conclude that not only the intrusion of the anterior teeth but also labial their inclination and extrusion of molars were effective in the treatment of deep bite. The occlusal plane angle decreased in both of the groups. This was a spontaneous result of the vertical changes of the molars and incisors.

In our study, protrusion and labial tipping of lower incisors was observed following the intrusion of upper incisors, and the interincisal angle decreased due to the changes in the axial inclination of upper and lower incisors. Schudy (1) stated that the interincisal angle is an important cause of overbite. When a deep overbite develops, accompanied by a wide interincisal angle, it

Table 1. Descriptive statistics of cephalometric measurements at T1 and T2 for UIA and CIA.

		UIA		CIA	
		X	SD	X	SD
SNA	T1	79.70	1.57	79.10	1.66
	T2	79.50	1.58	78.90	1.66
SNB	T1	76.90	1.85	76.40	1.96
	T2	76.80	2.20	76.90	2.18
ANB	T1	2.50	0.71	2.80	1.40
	T2	2.10	0.99	2.20	1.69
SN/PP	T1	9.80	2.35	10.60	1.84
	T2	9.50	2.32	10.30	2.71
SN/Occ	T1	16.80	2.90	17.70	2.26
	T2	15.10	2.64	15.30	2.54
N-Me	T1	114.10	3.67	114.60	2.80
	T2	116.20	4.26	118.30	2.67
N-ANS	T1	51.30	1.49	52.50	2.01
	T2	51.40	1.65	53.15	1.38
ANS-Me	T1	61.80	3.52	62.10	2.33
	T2	63.50	4.38	65.05	2.54
S-Go	T1	72.60	2.37	74.60	4.99
	T2	74.60	3.24	76.80	4.52
Interinc.	T1	148.40	13.55	142.50	7.69
	T2	137.50	16.69	132.60	9.12
1/NA	T1	15.90	4.43	16.00	4.29
	T2	23.40	3.72	22.80	5.45
1/NB	T1	19.40	5.25	18.10	5.40
	T2	22.20	4.71	22.20	4.94
O.bite	T1	6.60	0.52	7.35	0.88
	T2	3.40	0.52	3.55	0.60
O.jet	T1	3.70	1.16	4.10	1.20
	T2	4.00	0.82	4.10	0.88
SN/GoGn	T1	31.00	4.27	31.70	3.98
	T2	32.80	4.29	34.20	3.33
U6-SN	T1	73.80	3.12	75.70	2.95
	T2	75.20	3.65	77.00	1.94
U1-PP	T1	27.00	1.63	28.80	1.87
	T2	24.60	1.71	25.70	2.06
L1-NV	T1	6.80	2.30	6.00	2.59
	T2	4.80	1.69	4.30	2.16
U1-NV	T1	2.20	2.30	4.20	1.48
	T2	4.80	2.35	6.00	1.63
L1/MP	T1	89.90	4.09	91.00	4.99
	T2	94.70	3.06	94.70	4.40
U6-PP	T1	22.40	3.13	23.00	2.62
	T2	24.30	2.67	24.80	1.75
Ls-EL	T1	3.30	2.00	2.90	2.13
	T2	2.50	1.72	2.60	1.65
Li-EL	T1	3.00	1.89	2.30	2.11
	T2	3.50	1.72	2.70	1.42
Nasolab.	T1	78.70	6.73	74.60	14.49
	T2	76.60	5.46	71.50	11.19
Sn-St	T1	17.30	3.43	16.60	2.99
	T2	16.20	3.29	15.30	2.67
St-Sm	T1	14.20	2.04	14.90	2.73
	T2	14.80	2.39	15.90	2.23

tends to force the crowns of the mandibular incisors lingually and the apices of the maxillary incisors labially. This, in turn, increases the interincisal angle, which causes more overbite; thus a symbiotic relationship develops between the size of the interincisal angle and the depth of the overbite. Engel et al (9), who determined a direct relationship between interincisal angle and deep-bite relapse, suggested an interincisal angle between 125° and 135° at the end of treatment for stability. In CIA group, interincisal angle was sustained in this range and in UIA group it was near to upper limit (137,5°).

Upper lip positioned anteriorly in both of the groups due to the protrusion and labial tipping of the upper incisors. Arvystas (43,44) stated that the position of the upper lip did not change, whereas the lower lip positioned anteriorly. This conflicting result depends on the effects of the additional mechanics used to correct class II malocclusion in the report of Arvystas (43,44).

Conclusion

The CIA and UIA are both effective in the intrusion of incisors and can be used successfully in the treatment of deep overbite.

Extrusion of molars increased the anterior and the posterior facial heights so additional anchorage mechanics should be used in order to minimize this effect in dolichofacial patients.

The skeletal, dental and soft tissue effects of the appliances are almost the same. Being the last generation of intrusion appliances, CIA is made of super elastic Nitinol and provides an alternative for the treatment of deep overbite. It does not have any different effect than the UIA, but being a prefabricated appliance, it reduces chair time which is an advantage for both the patient and the clinician.

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Table 2. Comparison of the in-group differences for cephalometric measurements at T2.

	UIA					CIA				
	X	SD	t	p	Significance	X	SD	t	p	Significance
SNA	0.20	0.63	1.000	0.343	NS	0.20	0.42	1.500	0.168	NS
SNB	0.10	2.51	0.126	0.903	NS	-0.50	1.27	-1.246	0.244	NS
ANB	0.40	0.84	1.500	0.168	NS	0.60	1.07	1.765	0.111	NS
SN/PP	0.30	0.67	1.406	0.193	NS	0.30	1.42	0.669	0.520	NS
SN/Occ	1.70	1.06	5.075	0.001	***	2.40	2.91	2.605	0.029	*
N-Me	-2.10	2.02	-3.280	0.010	**	-3.70	1.34	-8.748	0.001	***
N-ANS	-0.10	0.32	-1.000	0.343	NS	-0.65	1.06	-1.948	0.083	NS
ANS-Me	-1.70	2.06	-2.613	0.028	*	-2.95	1.64	-5.686	0.001	***
S-Go	-2.00	1.70	-3.721	0.005	**	-2.20	1.32	-5.284	0.001	***
Interinc.	10.90	5.49	6.283	0.001	***	9.90	3.87	8.086	0.001	***
1/NA	-7.50	2.32	-10.217	0.001	***	-6.80	3.16	-6.815	0.001	***
1/NB	-2.80	1.99	-4.452	0.002	**	-4.10	1.45	-8.947	0.001	***
O.bite	3.20	0.42	24.000	0.001	***	3.80	0.63	19.000	0.001	***
O.jet	-0.30	1.25	-0.758	0.468	NS	0.00	0.67	0.000	1.000	NS
SN/GoGn	-2.50	2.51	-3.155	0.012	*	-1.80	2.49	-2.290	0.048	*
U6-SN	-1.40	3.34	-1.326	0.218	NS	-1.30	2.50	-1.647	0.134	NS
U1-PP	2.40	0.52	14.697	0.001	***	3.10	0.32	31.000	0.000	***
L1-NV	2.00	1.25	5.071	0.001	***	2.10	2.08	3.194	0.011	*
U1-NV	-2.60	1.07	-7.649	0.001	***	-1.80	1.23	-4.630	0.001	***
L1/MP	-4.80	1.87	-8.101	0.001	***	-3.70	1.89	-6.195	0.001	***
U6-PP	-1.90	1.60	-3.767	0.004	**	-1.80	1.48	-3.857	0.004	**
Ls-EL	0.80	2.15	1.177	0.269	NS	0.30	1.42	0.669	0.520	NS
Li-EL	-0.50	2.92	-0.542	0.601	NS	-0.40	1.26	-1.000	0.343	NS
Nasolab.	2.10	2.92	2.272	0.049	*	3.10	4.04	2.426	0.038	*
Sn-St	1.10	0.88	3.973	0.003	**	1.30	1.16	3.545	0.006	**
St-Sm	-0.60	1.78	-1.068	0.313	NS	-1.00	1.89	-1.677	0.128	NS

* P < .05, ** P < .01, *** P < .001, NS: Not Significant.

Table 3. Comparison of the between group differences for cephalometric measurements at T2.

	Mean Diff.	SE Diff.	t	p	Significance
SNA	0.00	0.24	0.000	1.000	NS
SNB	0.60	0.89	0.674	0.512	NS
ANB	-0.20	0.43	-0.463	0.649	NS
SN/PP	0.00	0.50	0.000	1.000	NS
SN/Occ	-0.20	1.16	-0.172	0.865	NS
N-Me	1.60	0.77	2.085	0.054	NS
N-ANS	0.55	0.35	1.579	0.144	NS
ANS-Me	1.25	0.83	1.502	0.151	NS
S-Go	0.20	0.68	0.294	0.772	NS
Interinc.	1.00	2.12	0.471	0.644	NS
1/NA	-0.70	1.24	-0.565	0.580	NS
1/NB	1.30	0.78	1.671	0.114	NS
O.bite	0.15	0.25	0.600	0.556	NS
O.jet	-0.30	0.45	-0.669	0.515	NS
SN/GoGn	-1.40	1.72	-0.816	0.426	NS
U6-SN	-0.10	1.32	-0.076	0.940	NS
U1-PP	1.80	1.31	1.378	0.190	NS
L1-NV	-0.50	0.87	-0.576	0.572	NS
U1-NV	-0.80	0.52	-1.549	0.139	NS
L1/MP	-1.10	0.84	-1.308	0.207	NS
U6-PP	-0.10	0.69	-0.146	0.886	NS
Ls-EL	0.50	0.81	0.614	0.548	NS
Li-EL	-0.10	1.00	-0.100	0.922	NS
Nasolab.	-4.10	5.05	-0.812	0.432	NS
Sn-St	1.20	0.87	1.381	0.194	NS
St-Sm	0.40	0.82	0.488	0.631	NS

* P < .05, ** P < .01, NS: Not Significant.

References

1. Schudy FF. The control of vertical overbite in clinical orthodontics. Angle Orthod. 38:19-39, 1968.
2. Hotz R. Orthodontics in daily practice. Bern: Hans Huber; 1974.
3. Otto RL, Anholm JM, Engel GA. A comparative analysis of intrusion of incisor teeth achieved in adults and children according to facial type. Am J Orthod Dentofacial Orthop. 77:437-446, 1980.
4. Graber TM, Rakosi T, Petrovic AG. Dentofacial orthopedics with functional appliances. St Louis: CV Mosby; 1997.
5. Proffit WR, Fields HW, Ackermann JI, Thomas PM, Tulloch JFC. Contemprorary Orthodontics. St. Louis: CV Mosby; 1979.
6. Dake ML, Sinclair PM. A comparison of the Ricketts and Tweed-type arch levelling techniques. Am J Orthod Dentofacial Orthop. 95:72-78, 1989.
7. Poulton DR. Correction of extreme deep overbite with orthodontics and orthognathic surgery. Am J Orthod Dentofacial Orthop. 96:275-280, 1989.
8. Bell WH, Jacobs JD, Legan H. Treatment of class II deep bite by orthodontic and surgical means. Am J Orthod Dentofacial Orthop. 85:1-20, 1984.
9. Engel G, Cornforth G, Damerell JM, Gordon J, Levy P, McAlpine J, Otto R, Walters R, Chaconas S. Treatment of deep-bite cases. Am J Orthod Dentofacial Orthop. 77:1-13, 1980.

10. Nanda R. Correction of deep overbite in adults. Dent Clin North Am. 41:67-87, 1997.

11. Eberhart BB, Kuftinec MM, Baker IM. The relationship between bite depth and incisor angular change. Angle Orthod. 60:55-58, 1990.

12. Levin RI. Deep bite treatment in relation to mandibular growth rotation. Eur J Orthod. 13:86-94, 1991.

13. Nanda R. The differential diagnosis and treatment of excessive overbite. Dent Clin North Am. 25:69-84, 1981.

14. Lindauer SJ. Orthodontic treatment planning. In: Nanda R, ed. Biomechanics in clinical orthodontics. Philadelphia: WB Saunders; 1997, pp: 23-49.

15. Janzen EK. Balanced smile- a most important treatment objective. Am J Orthod Dentofacial Orthop. 72:359-372, 1977.

16. Burstone CJ. Lip posture and its significance in treatment planning. Am J Orthod Dentofacial Orthop. 53:262-284, 1967.

17. Gianelly AA, Petras JC, Boffa J. Condylar position and Class II deep-bite, no-overjet malocclusions. Am J Orthod Dentofacial Orthop. 96:428-432, 1989.

18. Melsen B, Bosch C. Different approaches to anchorage: a survey and an evaluation. Angle Orthod. 67:23-30, 1997.

19. Parker CD, Nanda RS, Currier GF. Skeletal and dental changes associated with the treatment of deep bite malocclusion. Am J Orthod Dentofacial Orthop. 107:382-393, 1995.

20. Begg PR, Kesling PC. Begg orthodontic theory and technique. Philadelphia: WB Saunders; 1977.

21. Begg PR, Kesling PC. The differential force method of orthodontic treatment. Am J Orthod. 71:1-39, 1977.

22. Ricketts RM. Bioprogressive therapy as an answer to orthodontic needs: Part II. Am J Orthod Dentofacial Orthop. 70:359-397, 1976.

23. Ricketts RM, Bench RW, Gugino CF et al. Bioprogressive Therapy. Book 1. Denver, Colo: Rocky Mountain Orthodontics; 1978.

24. Hellsing E, Eliassons S. Effect of fixed anterior bite plane therapy- a radiographic study. Am J Orthod Dentofacial Orthop. 110:61-68, 1996.

25. Braun S, Marcotte MR. Rationale of the segmented approach to orthodontic treatment. Am J Orthod Dentofacial Orthop. 108:1-8, 1995.

26. Burstone CJ. Mechanics of the segmental arch technique. Angle Orthod. 36:99-120, 1966.

27. Burstone CJ. Deep overbite correction by intrusion. Am J Orthod Dentofacial Orthop. 72:1-22, 1977.

28. Shroff B, Yoon WM, Lindauer SJ, Burstone CJ. Simultaneous intrusion and retraction using a three-piece base arch. Angle Orthod. 67:455-461, 1997.

29. Barton KA. Overbite changes in the Begg and edgewise techniques. Am J Orthod Dentofacial Orthop. 62:48-55, 1972.

30. Goerick B, Diedrich P, Wehrbein H. Intrusion of the anterior teeth with the segmented arch technique of Burstone- a clinical study. Fortschr. Kieferorthop. 53:16-25, 1992.

31. Gordon JB. Treatment of deep-bite cases. Am J Orthod Dentofacial Orthop. 77:1-13, 1980.

32. Greig DG. Bioprogressive therapy.overbite reduction with the lower utility arch. Br J Orthod. 10:214-216, 1983.

33. Hamdan AM, Rock WP. The effect of archwire forces on incisor intrusion. Br J Orthod. 22:155-160, 1995.

34. Xu TM, Lin JX, Kui H, Huang JF. Bite-opening mechanics as applied in the Begg Technique. Br J Orthod. 21:189-195, 1994.

35. Nanda R, Marzban R, Kuhlberg A. The Connecticut Intrusion. J Clin Orthod. 32:708-715, 1998.

36. Steigman S, Michaeli Y. Experimental intrusion of rat incisors with continuous loads of varying magnitude. Am J Orthod Dentofacial Orthop. 80:429-436, 1981.

37. Demirhanoglu M. Evaluation of the effects and stability of bite opening mechanics in deep-bite cases treated with edgewise mechanics [PhD thesis]. Ankara: University of Hacettepe; 1990.

38. Weiland FJ, Bantleon HP, Droschl H. Evaluation of continuous arch and segmented arch leveling techniques in adult patients – A clinical study. Am J Orthod Dentofacial Orthop. 110:647-652, 1996.

39. Cakırer B. Comparison of segmented arch technique and Bioprogressive Therapy in the treatment of deep bite [PhD thesis]. Ankara: University of Hacettepe; 1997.

40. McDowell EH, Baker IM. The skeletodental adaptations in deep bite correction. Am J Orthod Dentofacial Orthop. 100:370-375, 1991.

41. DeVincenzo JP, Winn MW. Maxillary incisor intrusion and facial growth. Angle Orthod. 57:279-289, 1987.

42. Cleall JF, BeGole EA. Diagnosis and treatment of Class II division 2 malocclusion. Angle Orthod. 52:38-60, 1982.

43. Arvystas MG. Nonextraction treatment of severe Class II division 2 malocclusions. Part 1. Am J Orthod Dentofacial Orthop. 97:510-521, 1990.

44. Arvystas MG. Nonextraction treatment of severe Class II division 2 malocclusions. Part 2. Am J Orthod Dentofacial Orthop. 99:74-84, 1991.