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Original Article

Rate of intrusion of maxillary incisors in Class II Div 1 malocclusion using skeletal anchorage device and Connecticut intrusion arch

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ABSTRACT

Background: Nonsurgical correction of deep bite involves either extrusion of posterior teeth, intrusion of incisors, or combination of both. The introduction of skeletal anchorage device with microimplant provides near absolute anchorage without producing any untoward effects on anchor unit. Connecticut Intrusion Arch (CIA) provided an efficient system of intruding anterior segment without producing much adverse affects on anchor teeth.

Methods: The study comprised of 30 patients of Class II Div 1 malocclusion with overbite of >6 mm and required therapeutic extractions of all first premolars, randomly distributed into two groups. Group 1 was treated using orthodontic microimplants, while Group 2 treated with CIA. Lateral cephalograms were taken pre-intrusion (T1) and post-intrusion at the end of six months (T2).

Results: The rate of intrusion was 0.51 and 0.34 mm/month for Group 1 and Group 2 respectively. The average amount of change in centroid point to PP distance and U1-SN angle was significantly higher in Group 1 compared to Group 2 ($P < 0.001$). The average amount of change in U6 to PP distance did not differ significantly between two study groups ($P > 0.05$).

Conclusion: The amount of intrusion is significantly higher in SAD group. Although vertical molar positional change was higher in CIA group than the SAD group, it was not changed significantly in both treatment modalities. SAD group overall had better results and was easier in handling during intrusion.

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Introduction

Class II malocclusions accounted for 15% in United States population as per National Health and Nutritional Estimates Survey III (NHANES III)[1,2] and 23% in Indian population, especially in armed forces population.[3] One of the prominent features of the class II malocclusion is increased overbite. Correction of increased overbite is one of the important objectives to be achieved in this type of malocclusion. 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.[4,5] Nonsurgical correction of deep bite involves either extrusion of posterior teeth, intrusion of incisors, or combination of both.[6–9] This involves the basic principle of tipback bends at the molars to provide an intrusive force at the incisors. Definitive planning in anchorage preservation in leveling phase of fixed orthodontic cases is required to prevent undesirable side effects in the rest of the dental arches.[10,11]

Conventional methods of intrusion include utility arches, three piece intrusion arches, and reverse curve of spee archwires. But all these auxiliaries/archwires produce unwanted effects in the anchor segment affecting the overall treatment results. The introduction of skeletal anchorage device or temporary anchorage device with mini/microimplant has revolutionized the treatment options available for clinicians. It has enhanced the envelope of discrepancy and treatment options, thus increasing the scope of orthodontic treatment and achieving more reliable and stable results.[12] Connecticut Intrusion Arch developed by Nanda provided an efficient system of intruding anterior segment without producing much adverse affects on anchor teeth.[13]

This prospective experimental pilot study was an effort to find out the rate of intrusion between skeletal anchorage device and Connecticut intrusion arches which are commonly used in clinical practice. The study quantified the rate of intrusion between two methods and its efficiency in treatment of Class II Div 1 malocclusion.

To determine the rate of intrusion attained with Skeletal Anchorage Device and Connecticut Intrusion Arch.

- To compare the rate of intrusion of maxillary incisor segment in Class II Div 1 malocclusion using Skeletal Anchorage Device and Connecticut Intrusion arch.

Fig. 1 – Microimplants and CIA used in sample groups.

- To compare the positional changes in first maxillary molars in two methods of intrusion.
- To compare the overall efficiency and handling of two methods of intrusion.

Material and methods

The present study involved the selection of Class II Div 1 malocclusion cases from orthodontic OPD at a tertiary care dental center. The study was carried out after a formal approval from the ethical committee of the institution. All patients and/or their parents were informed about the purpose of this study and a written consent was obtained.

The inclusion criteria included:

(i) Age group of 15–20 yrs.
(ii) Angle's Class II Div 1 malocclusion.
(iii) Overbite of >6 mm.
(iv) No previous orthodontic or interceptive intervention carried out.

The exclusion criteria were

(i) Any craniofacial disorders including cleft lip and palate.
(i) Local/systemic problems or trauma which affects the growth and development of facial structures or body.
(i) Medically compromised cases.

The study comprised of 30 patients of Class II Div 1 malocclusion with overbite of >6 mm and required therapeutic extractions of all first premolars. The patients were randomly distributed by lottery method among two groups of 15 patients each. The deep bite in Group 1 was treated using Skeletal Anchorage Devices (SAD) with orthodontic microimplants, while in Group 2, deep bite was treated with Connecticut intrusion arches (CIA).

The pre-treatment orthodontic records for all patients were collected which included study models, lateral cephalogram, and orthopantomogram. All patients were treated using 0.018 in. Roth Preadjusted Edgewise Appliance. Patients were recalled in four weeks interval for reviews. After initial alignment phase, individual canine retraction was carried out using NiTi closed coil spring in sliding mechanics on 0.016 in. × 0.022 in. stainless steel archwire. After completion of canine retraction, anterior segment consists of maxillary incisors and posterior segment consisting of maxillary first molar, second premolar, and retracted canine was consolidated with 0.010 in. stainless steel ligature on a 0.017 in. × 0.025 in. stainless steel archwires separately.

Group 1

In Group 1 cases, for treatment of deep bite correction, self-drilling microimplants (*AbsoAnchor*®, *Dentos*, *Daegu*, *Korea*)[14,15] of diameter 1.3 mm and length 7 mm Circle Head pattern, tapered type (CH 1312–07) (Fig. 1) were placed between maxillary lateral incisors and central incisors bilaterally. Mini starter surgical kit was used for the sterilization and insertion of microimplants as per manufacturer's directions.[16,17] A surgical guide was made with 0.016 in. × 0.022 in. stainless steel archwire to mark the exact position of placement of the implant clinically and on a radiograph. Selection of site for microimplant was done so that it should not interfere with intrusion process. Radiovisiographs were taken post-insertion of microimplants to reconfirm the position and proximity to roots of incisors. In the anterior segment wire, two vertical loops were placed for the placement of elastic chain to microimplants for intrusion, to allow force to be applied at desired point. Microimplants were loaded after a healing period of two weeks.[18] 60 g of force was used for the intrusion of four upper anterior teeth. Dontrix gauge was used for calibration of force and placement of elastic chain. Two horizontal loops were placed in the distal end of anterior segment wire for placement of elastics to prevented flaring of incisors during intrusion, which could adversely affect the study.

Group 2

In Group 2 cases, deep bite correction was achieved using Connecticut intrusion arches (Ortho Organizer Inc., USA) of dimension 0.016 in. × 0.022 in. NiTi archwire[12] (Fig. 1). Transpalatal arch was used for anchorage control. The CIA was passed through the auxiliary tube of the maxillary triple tube in posterior segment and was ligated in anterior segment gingivally with the help of 0.010 in. stainless steel ligature wire. Dontrix gauge was used to measure 60 g of intrusive force for intrusion of maxillary anterior segment.

Digital lateral cephalograms were taken using Planmeca, Proline XC Cephalostat (Planmeca OY, 60880 Helsinki, Finland). Pre-intrusion lateral cephalograms were taken before initiating intrusive mechanics (T1). Patients were reviewed in the interval of four weeks. Post-intrusion lateral cephalogram was taken at the end of six months (T2). Pre- and post-intrusion cephalograms were analyzed using Nemo-Ceph Dental Studio NX 2006, Version 6.0 (Nemotec®, Madrid, Spain) for the assessment of upper incisor and maxillary molar positions. Post-treatment lateral cephalograms were taken at the end of orthodontic treatment. On completion of fixed orthodontic treatment, the pre-treatment and post-treatment lateral cephalograms were compared for overall skeletal and dental changes. Principal investigator traced all the pre- and post-cephalograms. Out of 15 cases in each group, 05 cases were selected randomly and retraced by same operator after a gap of one week to check the intra-operator variability.

The landmarks and planes were used to calculate the intrusion achieved and the angular changes for maxillary incisors and maxillary first molars are depicted in Fig. 2.

Two linear measurements and one angular measurement was recorded

(i) Vertical position of the maxillary incisors: Perpendicular distance from incisor centroid point to the palatal plane in mm.
(ii) Vertical position of the maxillary first molar: Perpendicular distance from the mesiobuccal cusp tip of the molar (U6) to the palatal plane in mm.

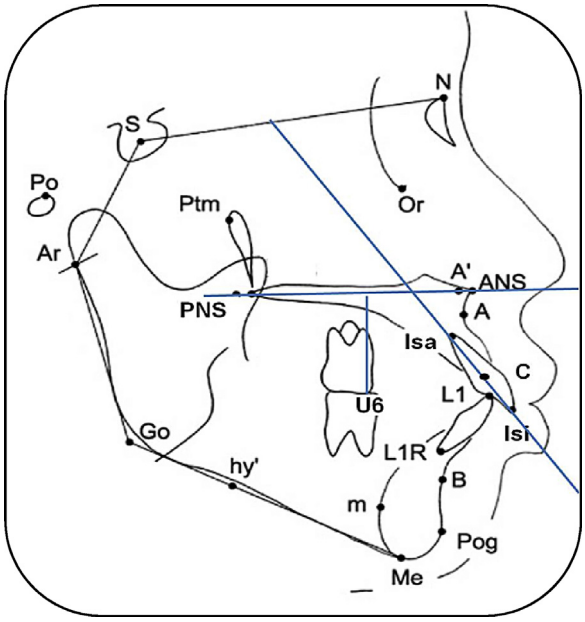

Fig. 2 – Landmarks used for lateral cephalogram analysis.

(iii) Change in the inclination of the maxillary incisors: Angle between the long axis of the maxillary incisor and the Sella Nasion (SN) plane in degrees.

Rate of intrusion of incisors was calculated by dividing the mean amount of intrusion in mm with mean treatment time, i.e. six months. Measurements are recorded and tabulated in Table 1. Algorithms of methodology are depicted in Fig. 3. Comparison of changes between T1 and T2 in both groups is shown in Figs. 4 and 5, respectively.

Results

The statistical analysis was performed using Statistical Package for Social Sciences (SPSS, Ver 11.5; Chicago, USA) for Microsoft Windows. Inter-group statistical comparisons of the study parameters were performed by using independent sample 't' test and intra-group comparisons were performed by using paired 't' test, after confirming the underlying normality assumptions. On comparing the average age of the cases, it did not differ significantly between two study groups ($P > 0.05$). The analysis based on Kappa statistics revealed that there was a statistically significant agreement between first and second evaluation of pre- and post-cephalogram.

Assessment of rate of maxillary incisor intrusion

The mean amount of intrusion of incisor was calculated comparing pre- and post-intrusion from perpendicular distance between centroid point to PP in mm over a period of six months.

For Group 1, the mean pre-intrusion distance was 17.37 mm and post-intrusion distance measured was 14.27 mm. The overall mean amount of intrusion was 3.10 mm. The rate of intrusion for Group 1 was calculated by dividing overall intrusion by six, i.e. 3.10/6 = 0.51 mm/month. For Group 2, the mean pre-intrusion distance was 16.37 mm and post-intrusion distance measured was 14.30 mm. The overall amount of intrusion was 2.07 mm. The rate of intrusion for Group 2 was 0.34 mm/month.

The mean intrusion that occurred in Group 1 was 3.10 mm (SD ± 0.67) and 2.07 mm (SD ± 0.53) in Group 2 (Table 2). On intra-group comparison, the average post-intrusion centroid point to PP distance is significantly lesser compared to the average pre-intrusion centroid point to PP distance in Group 1 ($P < 0.001$). The average post-intrusion centroid point to PP distance is significantly lesser compared to the average pre-intrusion centroid point to PP distance in Group 2 ($P < 0.001$). On inter-group comparison, the average pre-intrusion centroid point to PP distance is significantly higher in Group 1 compared to Group 2 ($P < 0.05$). The average post-intrusion centroid point to PP distance did not differ significantly between two study groups ($P > 0.05$). The average amount of change in centroid point to PP distance is significantly higher in Group 1 compared to Group 2 ($P < 0.001$).

Assessment of maxillary first molar position

In Group 1, mean pre-intrusion distance between U6 and PP was 20.10 ± 1.1 mm and post-intrusion distance was 21.1 ± 1.2 mm. In Group 2, mean pre-intrusion distance between U6 and PP was 19.1 ± 1.10 mm and post-intrusion distance was 20.3 ± 1.10 mm. The mean difference in maxillary first molar position was 0.97 mm (SD ± 0.40) in relation to PP in Group 1. In Group 2, the mean difference was 1.20 mm (SD ± 0.32) (Table 3). On intra-group comparison, the average position of maxillary first molar post-intrusion was significantly higher compared to Group 1 ($P < 0.001$). The average post-intrusion U6 to PP distance is significantly higher compared to the average pre-intrusion U6 to PP distance in Group 2 ($P < 0.001$). On inter-group comparison, the average change in maxillary first molar position pre-intrusion was significantly higher in Group 1 compared to Group 2 ($P < 0.05$). The average post-intrusion U6 to PP distance did not differ significantly between two study groups ($P > 0.05$). The average amount of change in U6 to PP distance did not differ significantly between two study groups ($P > 0.05$).

Assessment of maxillary incisor inclination

In Group 1, pre-intrusion U1 to SN plane angular measurement was 105.9 ± 6.3 degrees and post-intrusion angular measurement was 105.7 ± 5.7 degrees. In Group 2, pre-intrusion U1 to SN plane angular measurement was 104.7 ± 5.4 degrees and post-intrusion angular measurement was 108.5 ± 4.5 degrees. The mean change in the incisor inclination was 0.93 degree (SD ± 1.27) in Group 1 in relation to SN plane. In Group 2, the difference was -3.73 degrees (SD ± 1.28) (Table 4). On intra-group comparison, the average post-intrusion U1-SN angle is significantly lesser compared to the average pre-intrusion U1-SN angle in Group 1 ($P < 0.05$). The average post-intrusion U1-SN angle is significantly lesser compared to the average pre-intrusion U1-SN angle in Group 2 ($P < 0.001$). On inter-group

Table 1 – Pre- and post-measurements for assessment of incisor and molar position.

S. No.	Centroid point to PP distance (mm)						U1-SN angular measurements (degree)						U6-PP distance (mm)					
	Pre-intrusion		Post-intrusion		Amount of intrusion		Pre-intrusion		Post-intrusion		Change in incisor inclination		Pre-intrusion		Post-intrusion		Amount of molar extrusion	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
1	16	14	13.5	12.5	2.5	1.5	120	110	118	111	−2	1	21	20	22	21.5	1	1.5
2	15.5	15.5	13.5	13.5	2	2	110	98	109	102	−1	4	20	19.5	21.5	20.5	1.5	1
3	17	16	14	13.5	3	2.5	101	108	102	113	+1	5	19	21	20	22.5	1	1.5
4	19.5	15	16	13	3.5	2	98	111	99	114	+1	3	19.5	18.5	20	19.5	0.5	1
5	17.5	17	15	14.5	2.5	2.5	104	104	103	108	−1	4	20.5	17	21.5	18.5	1	1.5
6	16	16.5	12.5	15	3.5	1.5	112	106	110	109	−2	3	20	19	20.5	20	0.5	1
7	20	15.5	16.5	13.5	3.5	2	99	99	98	104	−1	5	18.5	19.5	19.5	20	1	0.5
8	18	17	14	14.5	4	2.5	101	115	99	117	−2	2	21	18	22.5	19.5	1.5	1.5
9	18.5	17.5	16	15.5	2.5	2	103	101	101	106	−2	5	21.5	17.5	23	18.5	1.5	1
10	17.5	18	15	15	2.5	3	105	102	106	106	−1	4	20.5	19	21	20.5	0.5	1.5
11	17	15.5	14	14	3	1.5	108	112	107	114	−1	2	20	20.5	21	21.5	1	1
12	16	15	13.5	13.5	2.5	1.5	115	102	113	106	−2	4	18	20	18.5	21.5	0.5	1.5
13	18.5	18	14.5	15	4	3	99	100	100	105	−1	5	19.5	19.5	21	21	1.5	1.5
14	16.5	18.5	13	16.5	3.5	2	106	98	104	103	−2	5	22	18.5	22.5	19.5	0.5	1
15	17	16.5	13	15	4	1.5	108	105	106	109	−2	4	20.5	19	21.5	20	1	1
Mean	17.37	16.37	14.27	14.3	3.10	2.07	106	105	105	109	−1	4	20.10	19.10	21.07	20.30	0.97	1.20
Min	15.5	14	12.5	12.5	2	2	98	98	98	102	0	2	18	17	18.5	18.5	0.5	0.5
Max	20	18.5	16.5	16.5	3.5	3	120	115	118	117	−2	5	22	21	22.5	22.5	1.5	1.5

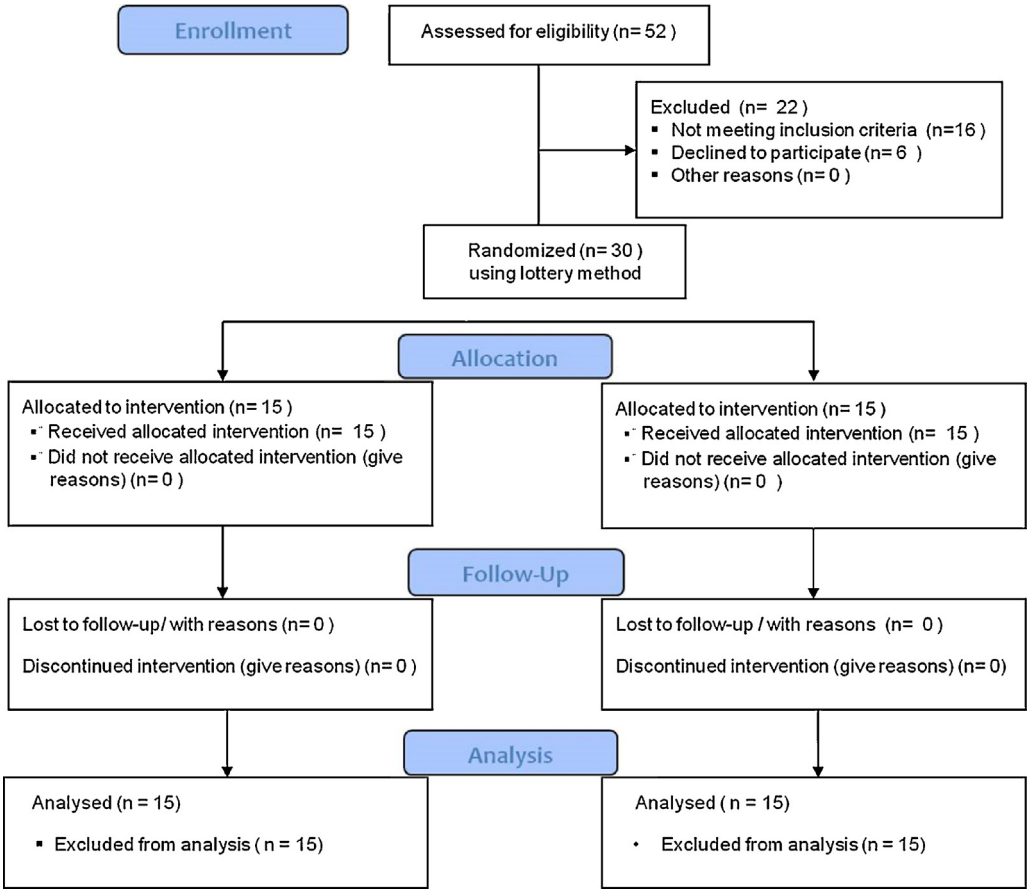

Fig. 3 – Flow diagram of methodology.

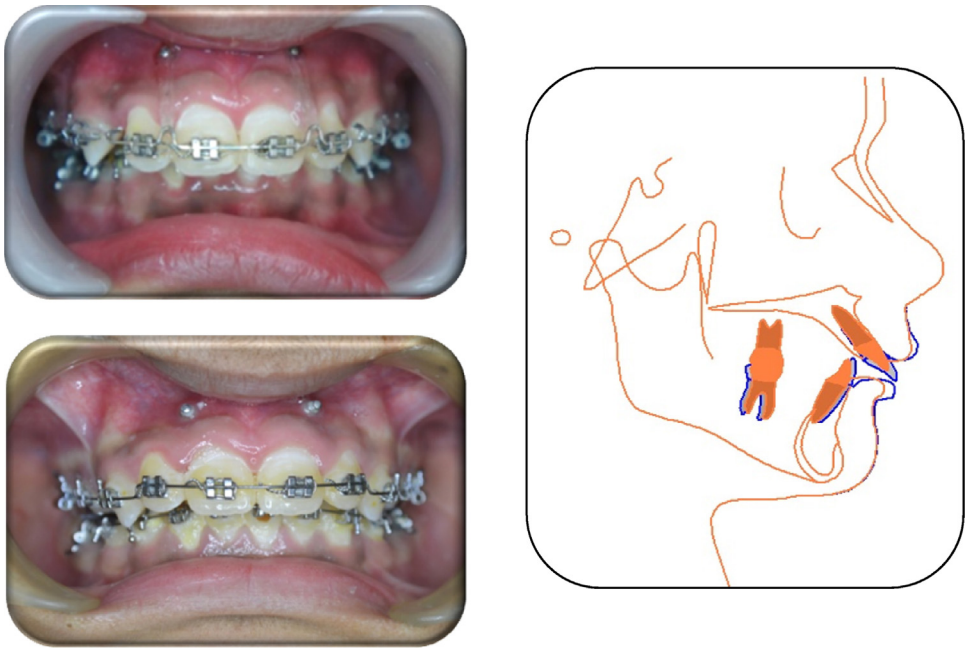

Fig. 4 – Group 1 – Comparison of T1 and T2.

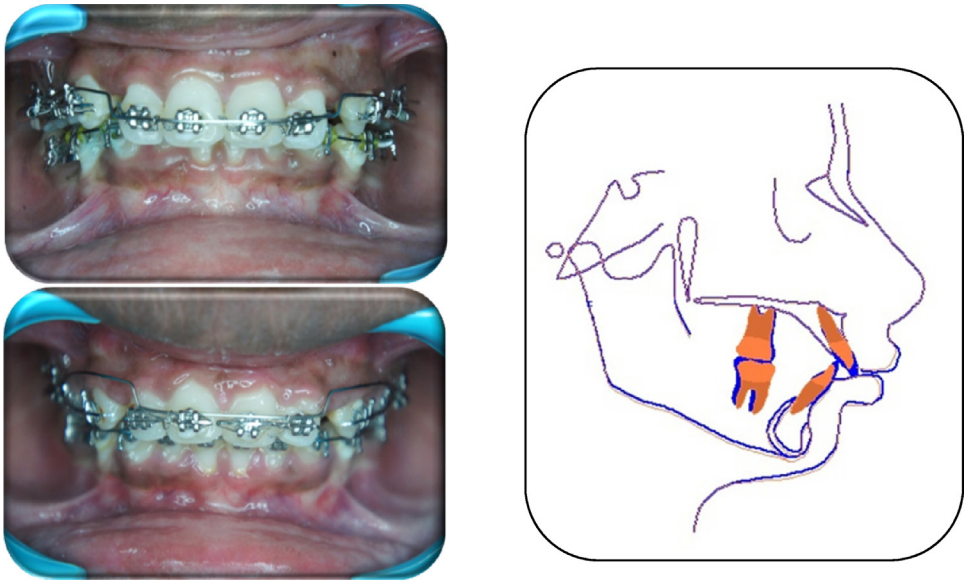

Fig. 5 – Group 2 – Comparison of T1 and T2.

comparison, the average pre-intrusion U1-SN angle did not differ significantly between two study groups ($P > 0.05$). The average post-intrusion U1-SN angle did not differ significantly between two study groups ($P > 0.05$). The average amount of change in U1-SN angle is significantly higher in Group 2 compared to group 1 ($P < 0.001$).

Discussion

Correction of deep bite often requires intrusion of anterior teeth. Intrusion requires careful control of force application both in magnitude and direction. Light forces are preferable as the concentration of forces is in a small area around apex of the incisors. Any inadvertent force application will cause root resorption. Intrusion also causes changes in the pulpal tissue such as vascularization of the odontoblast and pulpal edema.[19] For this reason, use of light force is advocated for intrusion of teeth which should be directed in long axis of the tooth. A light force of 15 to 20 gm per tooth is recommended for intrusion.[7,20] Thus, total of 60 g is adequate for intrusion of four maxillary incisor teeth. Use of heavier force will not fasten the intrusion rate, instead it will cause resorption of apical portion of teeth and in prolonged cases it leads to pulpal death.[14] For true

Table 2 – Inter- and intra-group distribution of intrusion at centroid point to PP for incisor position.

CP to PP distance (mm)	Group 1 ($n = 15$) Mean ± SD	Group 2 ($n = 15$) Mean ± SD	Inter-group comparison (P-value for unpaired 't' test)
Pre-intrusion	17.4 ± 1.3	16.4 ± 1.3	0.047 (S)
Post-intrusion	14.3 ± 1.2	14.3 ± 1.1	0.937 (NS)
Amount of change (Pre–Post)	3.10 ± 0.67	2.07 ± 0.53	0.001 (S)
Intra-group comparison (P-value for paired 't' test) Pre v/s Post	0.001 (S)	0.001 (S)	

P-value < 0.05 is considered to be statistically significant. S: Significant, NS: Non-Significant.

Table 3 – Inter- and intra-group distribution of intrusion at U6 to PP distance.

U6 to PP distance (mm)	Group 1 ($n = 15$) Mean ± SD	Group 2 ($n = 15$) Mean ± SD	Inter-group comparison (P-value for unpaired 't' test)
Pre-intrusion	20.1 ± 1.1	19.1 ± 1.1	0.018 (S)
Post-intrusion	21.1 ± 1.2	20.3 ± 1.1	0.087 (NS)
Amount of change (Pre–Post)	0.97 ± 0.40	1.20 ± 0.32	0.087 (NS)
Intra-group comparison (P-value for paired 't' test) Pre v/s Post	0.001 (S)	0.001 (S)	

P-value < 0.05 is considered to be statistically significant. S: Significant, NS: Non-Significant.

Table 4 – Inter- and intra-group distribution of U1-SN angular measurement.

U1-SN angle (degrees)	Group 1 (n = 15) Mean ± SD	Group 2 (n = 15) Mean ± SD	Inter-group comparison (P-value for unpaired 't' test)
Pre-intrusion	105.9 ± 6.3	104.7 ± 5.4	0.582 (NS)
Post-intrusion	105.0 ± 5.7	108.5 ± 4.5	0.075 (NS)
Amount of change	0.93 ± 1.27	−3.73 ± 1.28	0.001 (S)
Intra-group comparison (P-value for paired 't' test) Pre v/s Post	0.014 (S)	0.001 (S)	

P-value < 0.05 is considered to be statistically significant. S: Significant, NS: Non-Significant.

intrusion to happen in anterior segment, forces should be directed through center of resistance of the tooth.[21]

Various modalities of intrusion mechanics are used for correction of deep bite. Propagators of different prescriptions of Preadjusted Edgewise Appliances used various auxiliaries integrated to their appliance system to achieve maximum intrusion of incisor segment.[22–24] But all these auxiliaries produce unwanted effects in the anchor segment affecting the overall treatment results. Introduction of SAD provided an option to move tooth/teeth without producing any reciprocal movement in anchorage unit. Incisor intrusion treatment with microimplants only affects the maxillary incisor area and position of molars is maintained during intrusion phase. In cases of CIA, molar extrusion is a reciprocal movement that occurs in the posterior anchor segment. The altered occlusion and muscles of mastication might move the extruded posterior teeth back to their original positions causing relapse, until soft tissues and hard tissue equilibrium are obtained.

The microimplants are available in diameters of 1.2–2.7 mm. In the present study, we used microimplants of 1.3 mm diameter and 7 mm length. This was chosen considering the available inter-radicular space between central and lateral incisors and the stability requirement for intrusion of maxillary incisors segment. CIA is fabricated from nickel titanium alloy providing shape memory, spring-back, and light continuous force. Its basic mechanism for force delivery is a V bend calibrated to deliver approximately 40–60 g of force.

Distance from incisal edge to palatal plane in case of proclination and retraction of incisors during treatment procedures can bring about varied values. Thus, incisal edge cannot be taken as a reliable reference point in case of true intrusion due to positional changes of incisor edge. The incisor centroid, defined as a point on the longitudinal axis of the tooth that is independent of any change in inclination, was taken as reference point. In the present study, the midpoint between the incisal edge and apex of the maxillary incisor was taken as centroid point.[25,26]

In SAD group, overbite reduction was obtained by both maxillary incisors intrusion and retraction. The overall maxillary intrusion was 3.10 ± 0.67 mm and reduction of 0.93 ± 1.27 degree in upper incisor to SN plane angle. In CIA group, overbite reduction was achieved by the combined effect of maxillary incisor intrusion, incisor protrusion, and molar extrusion. In this group, the maxillary intrusion was 2.07 ± 0.53 mm, increase of 3.73 ± 1.28 degree in upper incisor to SN plane angle and molar extrusion of 1.20 ± 0.32 mm. The findings of this study were in agreement with the study by Senisik and Tukkahraman, except proclination of maxillary incisor in the implant group.[27] The present study was in comparison with the study by Polat-Ozsoy et al. in which the mean intrusion of incisor segment was 2.97 ± 0.4 mm in implant group and 1.81 ± 0.5 mm in utility arch group in relation to palatal plane.[28] The mean intrusion achieved by Nayak USK et al. was 3.29 mm with mini implants and 1.29 mm with utility arches in a period of six months.[29] The present study showed similar results in implant group. In CIA group, mean intrusion was comparatively more than utility arch group.

Rate of intrusion shows the efficiency of the treatment modality with side effects like loss of anchorage, external apical root resorption, and proclination. The rate of intrusion achieved in the present study for incisors was 0.51 mm/month which is comparable to the study by Virang B in which the mean amount of intrusion was 2.58 mm in a period of six months and rate of intrusion was 0.43 mm/month.[30] But in that study, sample group had the anterior segment that consisted of incisors and canines.

Conclusions

Following conclusions were drawn from the present study

- The amount of intrusion attained with Skeletal Anchorage Device (SAD) group was 3.10 ± 0.67 mm and 2.07 ± 0.53 mm in Connecticut Intrusion arch (CIA) group. The amount of intrusion is significantly higher in SAD group.
- Rate of intrusion in the SAD group was 0.51 mm/month and 0.34 mm/month in CIA group.
- Although vertical molar positional change was higher in CIA group than the SAD group, the vertical position of molars was not changed significantly in both treatment modalities.
- SAD group showed maximum intrusion with minimal side effects compared to CIA group.
- Self-drilling microimplants 1.3 mm in diameter and 7 mm in length provided excellent anchorage for maxillary incisors intrusion.

Conflicts of interest

The authors have none to declare.

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