ORIGINAL RESEARCH

Maxillary Incisor Intrusion Using Two Conventional Intrusion Arches and Mini Implants: A Prospective Study

Prateek Shakti[1], Suja Ani G[2], Elbe Peter[3], Khushtar Haider[4], Jitendra Kumar[5]

Abstract

Aim and objective: This study aimed to compare cephalometrically the rate of maxillary incisor intrusion using mini implants, Connecticut intrusion arches, and segmental intrusion arches.

Materials and methods: Thirty-two adult patients with deep bite were divided into three groups: 10 patients in mini implant and Connecticut intrusion arch group each and 12 patients in segmental intrusion arch group. Bilateral mini implants were used for intrusion in Group 1. Connecticut intrusion arch and Burstone's three-piece intrusion arch were used for intrusion in Group 2 and Group 3, respectively. Intrusion was carried out in all the patients for 4 months. Lateral cephalograms were taken just after alignment and leveling (T1) and after 4 months of intrusion (T2).

Results: The mean amount of intrusion observed was 1.7 mm (0.425 mm/month) in mini implant group, 1.4 mm (0.35 mm/month) in Connecticut intrusion arch group, and 1.66 mm (0.415 mm/month) in segmental intrusion arch group. No statistically significant difference was found in the extent of incisor intrusion in the three groups ($p < 0.05$).

Conclusion: The study failed to reject the null hypothesis, and there was no statistically significant difference in the amount and rate of incisor intrusion achieved among the three groups ($p > 0.05$).

Clinical Significance: Significant amount of incisor intrusion was carried out by all the three methods. There was no statistically significant difference in the amount and rate of incisor intrusion achieved by the three methods. Clinically, mini implants can be considered superior to the conventional techniques as it provides absolute anchorage which eliminates unwanted effects of incisor intrusion.

Keywords: Connecticut intrusion arch, Deep bite, Intrusion, Mini implants, Segmental intrusion arch.

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Introduction

Esthetics and attractiveness of smile is one of the major demands in contemporary orthodontic treatment. The ideal position of the maxillary incisors on its apical base in all three planes of space plays an important role in its stability.

The dentoalveolar extrusion of maxillary incisors from its normal position is commonly seen in various types of malocclusions, more specifically in Angle Class I malocclusion and Angle Class II malocclusion cases resulting in deep bite, increased incisor exposure at rest, and gingival exposure at smile. According to Bishara,[1] the distribution of positive overbite of about 3 mm among Americans between 8 years and 50 years was 9%. Severe overbite of about 6 mm was seen in 8%. The edge centroid relationship of lower incisor edge to upper incisor centroid plays an important role in maintaining the normal position of incisors in vertical plane of space.[2]

Although treatment of choice depends on multiple factors, such as smile line, incisor display, and vertical dimension, correction of deep overbite with incisor intrusion has its own role during orthodontic treatment. Depending on the diagnosis and treatment objectives, a deep overbite can be corrected by intruding the incisors, extruding the buccal segments, or combining these treatments. Maxillary incisor intrusion should be the preferred treatment in nongrowing patients with anterior deep bites caused by over eruption of the maxillary incisors.

The advantages of segmental approach in orthodontic treatment included predictability of movements, use of wires of variable stiffness in the same arch, use of prefabricated calibrated springs—allowing the choice of posterior extrusion, or anterior intrusion, or a combination to correct deep bite—use of predetermined anchorage units, reduction in number of wires being changed, and elimination of functional forces.[3]

Extrusion of incisors which results in pseudo deep bite can be corrected by various appliances like Utility arch, Mulligan arch, Connecticut arch, three-piece intrusion arch, and the latest being implants. Carano et al.[4] suggested several advantages of mini screws

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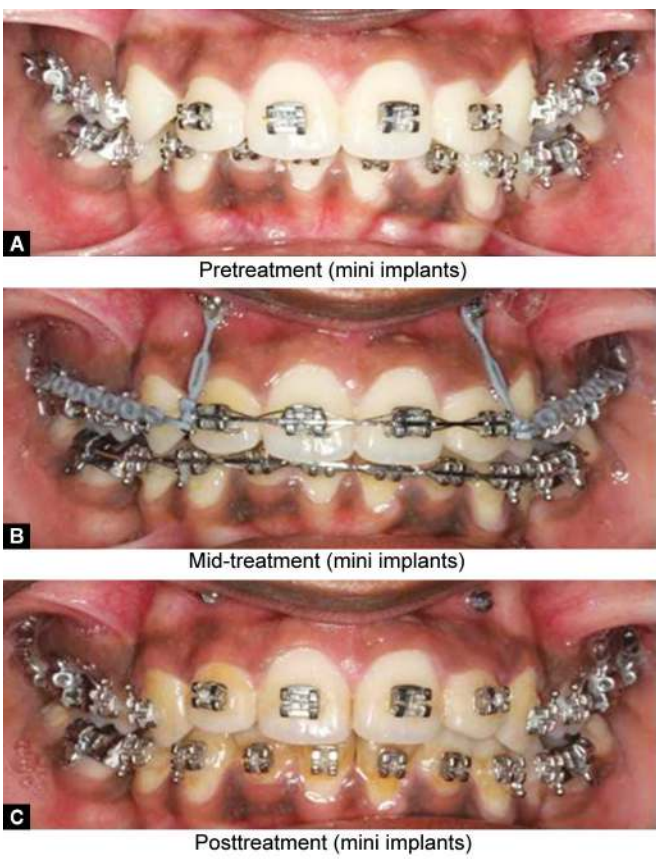
which included optimal use of traction forces applicable at any stage of development, even in the interceptive therapy, a shorter treatment time, with no need for preparation of dental anchorage and it is not dependent on patient cooperation. They also mentioned the disadvantages which included damage to anatomical structures and loss of screw during loading/placement, break of screw during insertion or removal, and/or inflammation that can occur around the implant. The principal advantage of Connecticut intrusion arch is that it is made up of nickel titanium alloy. This material is considered as the material of choice because of its properties of delivering light continuous force over large activations, low-load deflection rates, and high memory. It remains active at a constant force level over a long period of implant. The long intervals between appointments and virtually eliminating the necessity for adjustments.[5]

All the three methods used in this study work on segmental arch mechanics which uses statistically determinate technique and molar extrusion can be avoided. This study aims to compare cephalometrically the amount and rate of maxillary incisor intrusion using mini implants and conventional intrusion methods including Connecticut intrusion arches and segmental intrusion arches. Therefore, the null hypothesis was that there is no difference in the rate of intrusion of maxillary incisors using three different methods.

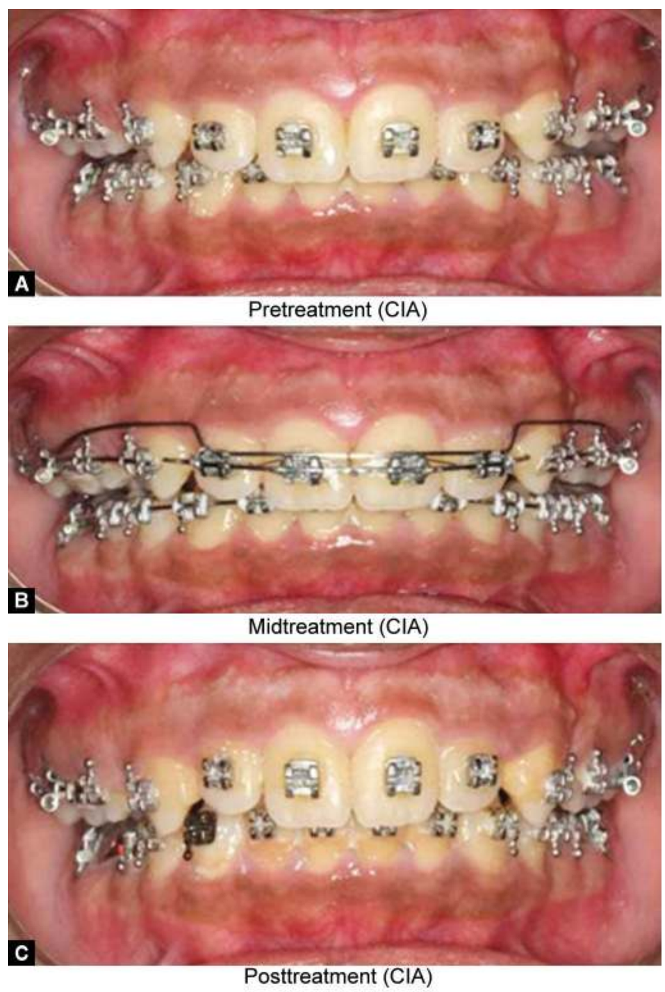
Materials and Methods

The Ethics Committee approval (IEC/M/05/2014/DCK) was obtained prior to the conduct of the study. The study sample included 32 participants (6 males and 26 females), aged 16–25 years, and undergoing fixed appliance treatment with 0.022 Roth appliances. The criteria for the selection of the treatment group were (1) cases that require maxillary incisor intrusion for deep bite correction, (2) patients with deep overbite of 4 mm or more and increased incisor/gingival display, and (3) patients willing to participate in the study. The exclusion criteria were(1) patients with active periodontal disease, (2) severe craniofacial disorders, cleft lip and palate, or extensive prosthetic appliances, and (3) medically compromised cases.

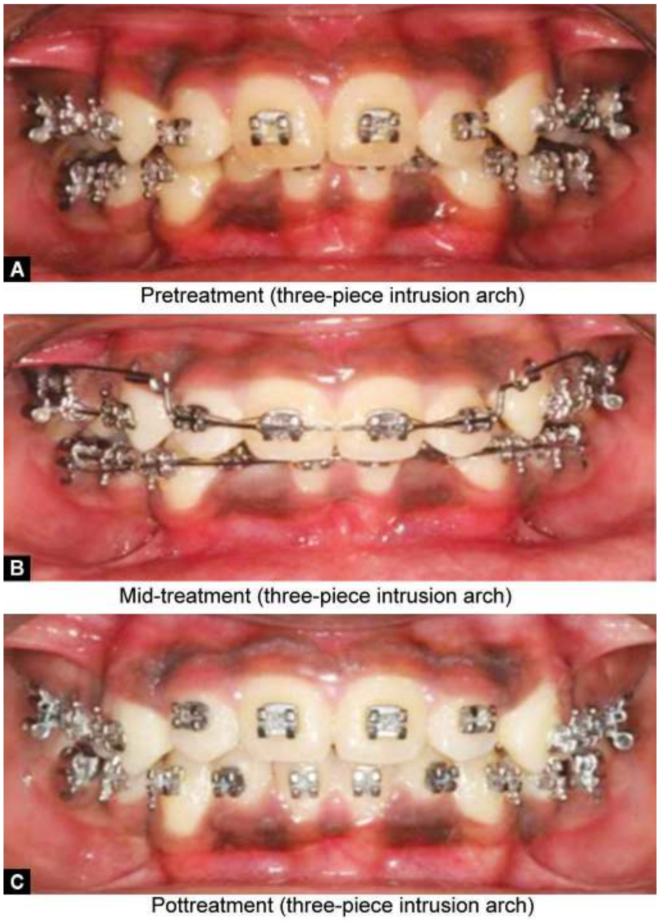
Informed consent was obtained prior to the initiation of treatment, and enrolled participants were divided into three groups sequentially based on the order of selection. Randomization was not performed while allocating the participants in study groups. Study participants in Group 1 were treated with mini implants ($1.3 \times 8\ mm^2$) (Dentos India Pvt. Ltd.), positioned between maxillary lateral incisor and canines on both sides in the interradicular bone (Fig. 1). Participants in Group 2 were treated with Connecticut intrusion arches (Ortho Organizers) (Fig. 2), and participants in Group 3 were treated using Burstone's three-piece intrusion arches (Fig. 3). After initial alignment and leveling of the incisors, bilateral individual canine retraction was performed to create space for incisor intrusion. Following individual canine retraction, mini implants were placed in participants in Group 1 and Connecticut arches and three-piece intrusion arches were placed in participants



Figs 1A to C: (A) Pre-; (B) Mid-; and (C) Posttreatment in Group 1 (mini implants)



Figs 2A to C: (A) Pre-; (B) Mid-; and (C) Posttreatment in Group 2 (Connecticut intrusion arch)



Figs 3A to C: (A) Pre-; (B) Mid-; and (C) Posttreatment in Group 3 (three-piece intrusion arch)

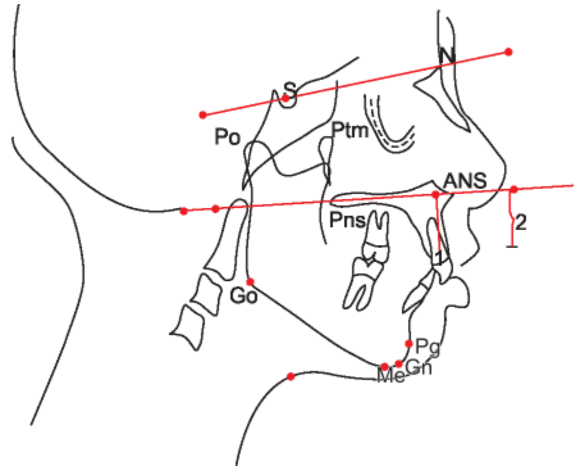


Fig. 4: Cephalometric landmarks and parameter in the present study. (1): Center of maxillary incisor = total length of the tooth/2 and (2): vertical position of the maxillary incisor

in Group 2 and Group 3, respectively. Goshgarian arch was used in all the patients for vertical stability of molars. A force of 100 g was (calibrated by dontrix gauge) applied at the incisor region in each patient for intrusion. A passive elastomeric chain was attached from maxillary first molar to incisor region to prevent any labial flaring during intrusion.

Standardized lateral cephalograms were taken before the placement of mini implants, Connecticut intrusion arches, and three-piece intrusion arches, i.e., at the end of leveling (T1). Vertical position of maxillary incisors at the end of leveling was recorded. After the placement of mini implants and intrusion arches in respective groups, activation was done periodically every 4 weeks to maintain the force level of 100 g in all the patients. Standardized lateral cephalograms were taken at the end of intrusion (T2), i.e., after 4 months. Change in vertical position of maxillary incisors after upper incisor intrusion was measured. Cephalograms were traced. One linear measurement was selected for cephalometric analysis. Five cephalograms were retraced after 2 weeks, and an intraclass correlation of 0.9 with excellent agreement was observed. Cephalometric variables studied are depicted in Figure 4.

Vertical Position of Maxillary Incisors

Perpendicular distance from the midpoint between the incisal edge and the apex of the tooth along the long axis of the central incisor to the palatal plane was measured.

Rate of intrusion of incisors was calculated by dividing the mean amount of intrusion in millimeter with mean treatment time, i.e., 4 months. Comparison of changes between T1 and T2 in all the three groups is shown in Table 2 and Figure 5.

The data was entered on a Microsoft excel spread sheet, and statistical analysis was done using SPSS version 20.0. Paired *t*-test was done to compare the values within each of the three groups, and ANOVA test was done to compare the values among the three groups. Unpaired *t*-test was done to compare the amount of incisor intrusion with respect to gender and age. Kappa analysis was done to record interobserver and intraobserver correlations.

Result

The mean amount of intrusion of incisor was calculated comparing pre- and post-intrusion values in millimeter over a period of 4 months. The amount of maxillary incisor intrusion was found to be 1.7 ± 0.44 mm in Group 1, 1.4 ± 0.41 mm in Group 2, and 1.66 ± 1.03 mm in Group 3 (Table 1 and Fig. 6).

The rate of intrusion was calculated by dividing mean intrusion achieved by four. The rate of incisor intrusion achieved per month was found to be 0.425 mm in Group 1, 0.35 mm in Group 2, and 0.415 mm in Group 3. No significant difference was observed in the rate of incisor intrusion among the three groups as $p = 0.773$ (Table 1).

Significant difference was observed between T1 and T2 in all the three different methods; highest being in Group 1, followed by Group 3 and Group 2. The mean values of T1 and T2 in Group 1 were 16.9 ± 3.02 and 15.2 ± 2.97 mm, respectively. The mean values of T1 and T2 in Group 2 were 15.3 ± 1.52 and 13.9 ± 1.81 mm, respectively. The mean values of T1 and T2 in Group 3 were 14.9 ± 2.03 and 13.2 ± 2.38 mm, respectively (Table 2 and Fig. 5).

No significant difference was observed in incisor intrusion gender wise in all the three groups (Table 3). No significant difference was observed in incisor intrusion age wise in both groups (Table 4).

Intraclass correlation of 0.929 showed excellent agreement with $p \leq 0.005$. Interclass correlation of 0.997 showed excellent correlation with significant agreement (Tables 5 and 6).

Table 1: Comparison of incisor intrusion among the three groups

Treatment stage	*Groups*	*N*	*Mean*	*Std. deviation*	*Statistics/mean squares*	*Df2 (Welch)/F (ANOVA)*	*p value*
T1	Group 1	10	16.9	3.02903	5.826	1.135	0.351
	Group 2	10	15.3	1.5248			
	Group 3	12	14.9167	2.03511			
	Total	32	15.6563	2.2856			
T2	Group 1	10	15.2	2.97069	5.281	0.893	0.433
	Group 2	10	13.9	1.81659			
	Group 3	12	13.25	2.38223			
	Total	32	14.0625	2.41437			
Difference	Group 1	10	1.7	0.44721	0.138	0.263	0.773
	Group 2	10	1.4	0.41833			
	Group 3	12	1.6667	1.0328			
	Total	32	1.5938	0.68845			

Table 2: Comparison of T1 and T2 within the three groups

					Paired differences			
Group	*Treatment stage*	*Mean*	*N*	*Std. deviation*	*Mean difference*	*Std. deviation*	*T*	*p value*
Group 1	T1	16.9	10	3.02903	1.7	0.44721	8.5	0.001
	T2	15.2	10	2.97069				
Group 2	T1	15.3	10	1.5248	1.4	0.41833	7.483	0.002
	T2	13.9	10	1.81659				
Group 3	T1	14.9167	12	2.03511	1.66667	1.0328	3.953	0.011
	T2	13.25	12	2.38223				

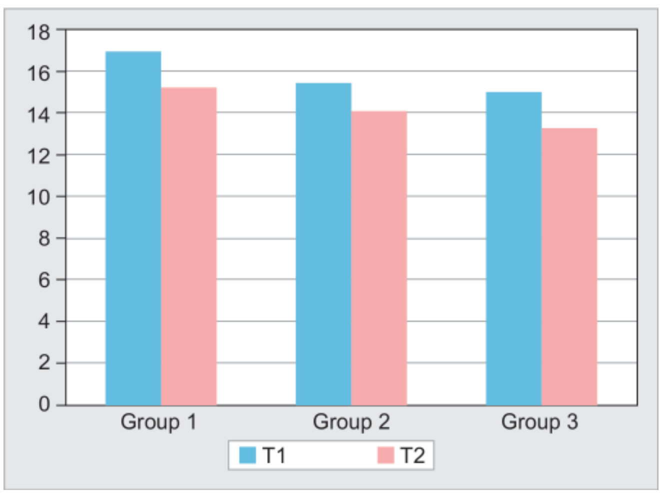


Fig. 5: Comparison of T1 and T2 in all the three groups

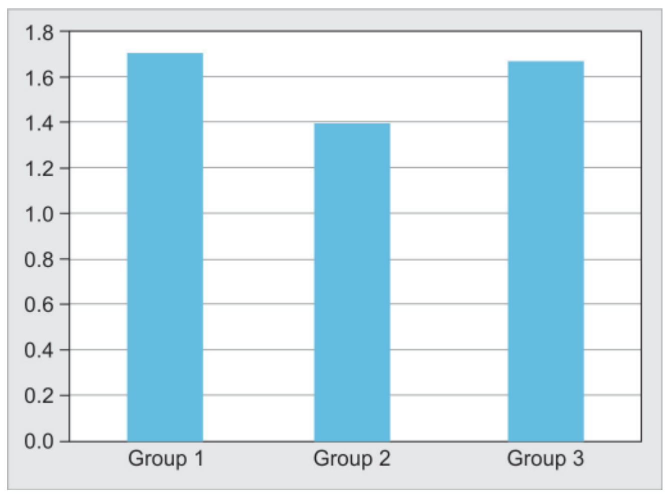


Fig. 6: Amount of intrusion in all the three groups

Discussion

The purpose of the study was to evaluate the amount and rate of incisor intrusion using mini implants and two conventional intrusion arches including Connecticut intrusion arch and segmental intrusion arch. Patients were divided into three groups, and incisor intrusion was carried out for 4 months in Group 1 with mini implants, in Group 2 with Connecticut intrusion arches, and in Group 3 with three-piece intrusion arches. At the end of 4 months, rate of intrusion was measured in all the three groups. The results obtained in the present study are discussed below.

In the present study, perpendicular distance from the palatal plane to the midpoint on the long axis of the central incisor was measured in contrast to other methods like Otto et al.[2] (root apices), Ohnishi et al.,[6] Deguchi et al.[7]and Jain et al.[8] (incisor tip to palatal plane distance), Ozsoy et al.,[9,10] and Senisik et al.[11] (center of resistance). Very light forces of 15–20 g/tooth have been recommended for intrusion by Burstone.[12] In the present study, force of 25 g/tooth was used.

In the present study, the rate of intrusion was found to be 0.425 mm/month in the mini implant group. Ma et al.[13] had

Table 3: Gender wise comparison of incisor intrusion in all three groups

Group	*Treatment stage*	*Sex*	*N*	*Mean*	*Std. deviation*	*T*	*Df*	*p value*
Group 1	T1	Male	2	21	-	2.005	3	0.139
		Female	8	15.875	2.28674			
	T2	Male	2	19	-	1.772	3	0.175
		Female	8	14.25	2.39792			
	Difference	Male	2	2	-	0.701	3	0.534
		Female	8	1.625	0.47871			
Group 2	T1	Male	2	17	-	1.38	3	0.261
		Female	8	14.875	1.37689			
	T2	Male	2	15.5	-	0.98	3	0.399
		Female	8	13.5	1.82574			
	Difference	Male	2	1.5	-	0.234	3	0.83
		Female	8	1.375	0.47871			
Group 3	T1	Male	2	17	-	1.159	4	0.311
		Female	10	14.5	1.9685			
	T2	Male	2	15	-	0.771	4	0.483
		Female	10	12.9	2.48495			
	Difference	Male	2	2	-	0.32	4	0.765
		Female	10	1.6	1.14018			

Table 4: Comparison of incisor intrusion in two age-groups (Age Group 1—up to 17 years and Age Group 2—18 years and above)

Treatment stage	*Age groups*	*N*	*Mean*	*Std. deviation*	*t value*	*p value*
T1	Age Group 1	16	14.8125	2.23507	0.419	0.528
	Age Group 2	16	16.5000	2.13809		
T2	Age Group 1	16	13.1875	2.53458	1.854	0.195
	Age Group 2	16	14.9375	2.07773		
T1–T2	Age Group 1	16	1.6250	0.91613	2.163	0.163
	Age Group 2	16	1.5625	0.41726		

Table 5: Intraobservercorrelation

Intraclass correlation coefficient		
		Ftest with true value 0
Group	*Intraclass correlation*	*Sig*
Single measures	0.929	0.004

Table 6: Interobservercorrelation

Reliability statistics		
Cronbach's alpha	*Cronbach's alpha based on standardized items*	*Number of items*
0.997	1.000	5

concluded that less treatment time was needed with mini implants. Ohnishi et al.[6] had observed an incisor intrusion of 3.5 mm over a period of 15 months by using mini implants. Ozsoy et al.[10] had reported a mean upper incisor intrusion of 1.92 mm in 4.6 months. Ozsoy et al.[9] had reported 0.44 mm/month intrusion with mini implants in 6 months. Mittal et al.[14] had observed incisor intrusion of 2.8 mm over a period of 3.3 months. Krishnanayak et al.[15] reported an incisor intrusion of 3.29 mm for mini implant group over a period of 6 months. In the present study, the incisor intrusion achieved was 1.7 mm over a period of 4 months with mini implants. Deguchi et al.[7] compared mini implants with J-hook headgear and found that maximum 5 mm and average 1.1 mm incisor intrusion was obtained in J-hook headgear group, whereas maximum 5 mm and average 3.6 mm intrusion was obtained in the implant group. Ozsoy et al.[9] compared intrusion by mini implants and utility arches in 6.61 ± 2.95 and 6.61 ± 2.46 months, respectively. In their study, the mean amount of true intrusion (at center of resistance) was 1.75 mm for mini implants group. This was close to the values obtained by Hans et al.[16] using tendem mechanics and headgear and Weiland et al.[17] using Burstone's intrusion base arch. Jain et al.[8] found a mean intrusion of 2.1 mm in mini implant group, 0.7 mm in J-hook headgear group, and 1.4 mm in utility arch group with 0.75 mm of molar extrusion as side effect. Senisik et al.[11] compared mini implants and Connecticut intrusion arches for incisor intrusion and reported 2.47 mm intrusion by mini implants and 2.20 mm intrusion by Connecticut intrusion arches over a period of 7 months.

Intrusive effects of Connecticut intrusion arch and utility intrusion arch were compared by Amasyali et al.,[18] and they found that incisor intrusion of 3.10 mm in Connecticut intrusion arch group and 2.40 mm in utility arch group. In the present study, incisor intrusion by Connecticut intrusion arch was found to be 1.4 mm (Table 1 and Fig. 6). The findings of Amasyali et al.[18] were in accordance with the study reports of Schudy,[19] Otto et al.,[2] and Dake and Sinclair.[20] Verma et al.[21] evaluated intrusion and root resorption using Connecticut and Burstone's intrusion arches over a period of 16 weeks. Average amount of intrusion measured at the center of resistance was 0.9 mm with mean rate of intrusion of 0.20 mm/month for Burstone's intrusion arch. For Connecticut intrusion arch, it was found to be 3.5 mm with 0.81 mm/month mean rate of intrusion. Statistically significant difference was seen in both groups for intrusion. In the present study, the rate of incisor intrusion was evaluated to be 0.35 mm/month.

Biomechanical considerations of deep bite treated with Connecticut intrusion arch which included basic principles of intrusion listed by Burstone were reported by Sana et al.[22] Janakiraman et al.[23] quantified the effects of tip-back mechanics on maxillary incisors and first molars. The incisal edge was seen to be intruded vertically by 0.97 ± 1 mm at T2 (after tip-back moments) but at T3 (after molar uprighting), the incisal edge was found to be extruded by 0.56 ± 0.85 mm. After T2, the maxillary incisor apex was intruded by 0.46 ± 0.76 mm, and 0.31 ± 0.89 mm of the intrusion was seen to be lost at T3. No unwarranted incisor flaring was observed in their study. In the present study, only intrusion was aimed for, and no proclination was to occur during these 4 months of treatment time. The value of 1.4 mm for intrusion observed in the present study was less than the value observed by Amasyali et al.[18] (3.1 mm) and Verma et al.[21] (3.5 mm). Janakiraman et al.[23] observed intrusion of 0.97 ± 1 mm, which was less than the value obtained in the present study. The mean rate of intrusion reported by Verma et al.[21] by using Connecticut intrusion arch was 0.81 mm/month and by Amasyali et al.[18] was 0.51 mm/month, which is more than the value obtained in the present study (0.35 mm/month).

In the present study, all the principles of incisor intrusion were considered. Lu et al.[24] found that under appropriate intrusive forces, the three-piece segment arch was found to be useful in intrusion of incisors and also to control the extrusion of posterior teeth, especially in cases with high-mandibular plane angle, gummy smile, and adult patients. Weiland et al.[17] compared and found an overbite reduction of 3.17 mm by continuous arch wire technique and 3.56 mm by segmental intrusion arch. Mid point between the incisal edge and the apex of the incisors was used for the analysis of the vertical position of the incisors, rather than the incisal edge. In the present study also, incisor intrusion was measured at midpoint between the incisal edge and the apex of the upper incisor. Incisor intrusion of 3 mm by Burstone's three-piece intrusion arch along with rapid maxillary expansion was achieved by Pearson and Pearson.[25] Prabhakar et al.[26] performed corticotomy-assisted orthodontic intrusion and retraction using the three-piece intrusion arch and achieved intrusion of 3 mm. Arun Raj et al.[27] compared mini implants and Burstone's intrusion arch for incisor intrusion. They found an intrusion of 4.3 mm in both groups.

The rate of incisor intrusion using segmental intrusion arch in this study was found to be 0.415 mm/month. The mean value of intrusion was found to be 1.66 mm. This value is less than the values reported by Weiland et al.,[17] Pearson and Pearson,[25] Prabhakar et al.,[26] and ArunRaj et al.[27]

The mean age of the sample was found to be 18.6 years. Age wise comparison of incisor intrusion was done by dividing the study sample into two groups (Age Group 1 = up to 17 yearsand Age Group 2 = 18 years and above). No significant difference was observed in incisor intrusion age wise in both groups (Table 4). This finding is in agreement with Otto et al.,[2] who suggested that there is no correlation between the amount of incisor intrusion and age of the patient.

Min-Ho[28] and Uzuka et al.[29] reported incisor intrusion of 1.8 and 5.1 mm, respectively, while using mini implants to treat deepbite. Peddu et al.[30] had observed overbite correction of 3.5 mm using mini implants over a period of 3.5 months. In the present study, the achieved incisor intrusion was 1.7 mm using mini implants over a period of 4 months. Gupta et al.[31] had achieved incisor intrusion of 2.46 ± 1.21 mm (0.53 mm/month) using mini implants and 1.75 ± 0.72 mm (0.30 mm/month) using Connecticut intrusion arches. Similarly, Kumar et al.[32] observed incisor intrusion of 0.51 mm/month using mini implants and 0.34 mm/month using Connecticut intrusion arches. In the present study, mean amount of intrusion found was 1.7 mm (0.425 mm/month) in mini implant group, 1.4 mm (0.35 mm/month) in Connecticut intrusion arch group, and 1.66 mm (0.415 mm/month) in segmental intrusion arch group.

Conclusion

The study failed to reject the null hypothesis as mentioned in Abstract. Following conclusions were drawn.

The mean value of incisor intrusion obtained in Group 1 (mini implants) was 1.7 mm. The rate of incisor intrusion in Group 1 was found to be 0.425 mm/month. The mean value of incisor intrusion obtained in Group 2 (Connecticut intrusion arch) was 1.4 mm. The rate of incisor intrusion in Group 2 was found to be 0.35 mm/month. The mean value of incisor intrusion obtained in Group 3 (three-piece intrusion arch) was 1.66 mm. The rate of incisor intrusion in Group 3 was found to be 0.415 mm/month.

Significant amount of incisor intrusion was achieved in all the three methods used. No statistically significant difference was found in the amount of incisor intrusion achieved among the three groups. No statistically significant difference was found in the rate of incisor intrusion achieved among the three groups, i.e., mini implants, Connecticut intrusion arch, and segmental intrusion arch ($p > 0.05$).

The amount of incisor intrusion could not be correlated with gender and age.

Limitations of the Study

The present study lacks gender matching. Another limitation of the present study is that the incisor intrusion–associated changes in molar and incisor angulationsare not assessed.

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