



**To Compare The Skeletal and Dental Effects of Different Intrusion Arches and Mini-Implants in Deep Bite Patients**

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**Abstract**

**Introduction:** Deep bite is characterized by increased overbite in which the vertical dimension between the incisal margins of the upper and lower teeth are excessive. Depending on the diagnosis and treatment objectives, it can be corrected orthodontically by intruding the incisors, extruding the buccal segment or combination of both.

**Aims and Objectives:** To evaluate and compare the skeletal and dental effects of utility intrusion arch, Connecticut intrusion arch and mini-implants in deep bite patients for incisor intrusion.

**Materials and Methods:** The subjects (n=30) were divided into three groups depending upon the type of intrusion mechanics used in the methodology. In group I intrusion was done by using utility intrusion arch, in group II intrusion was done by using Connecticut intrusion arch and in group III intrusion was done by using mini-implant mechanics. Lateral cephalogram were taken before the start of treatment (T1) and at the end of

the intrusion process(T2) in all the three groups. The data obtained was statistically analysed by using SPSS software.

**Results:** Significant changes from T1 to T2 among the three groups were seen in U1-PP and CR-PP. Reduction in UI- PP and CR-PP were significantly high (p<.001) in the mini- implant group compared to the utility and Connecticut intrusion arch group. **Conclusion:** The mini-implant group showed maximum intrusion and minimal protrusion of maxillary incisors as compared to utility arch and Connecticut intrusion arch.

**Keywords:** Utility arch, Connecticut arch, Mini-implant.

**Introduction**

The vertical malocclusion overlies a multitude of hidden skeletal or dental discrepancies. Deep bite is a state of increased vertical overbite in which the dimension between the incisal margins of the upper and lower teeth are excessive. Several factors like shortened anterior lower face height, flat mandibular plane angle, more acute gonial angle, parallel upper and lower occlusal

planes and deep curve of spee in the mandibular arch that contribute to the development of deepening of the bite<sup>1</sup>.

Depending on the diagnosis and treatment objectives, deep-bite can be corrected orthodontically by intruding the incisors, extruding the buccal segment, or combining these treatments<sup>2</sup>. The choice of treatment is partly based on the etiology of the deep bite, the expected size of the growth, the vertical dimension, the relationship of the teeth to the adjacent soft tissue structures and the desired position of the occlusal plane. In patients with vertical growth tendencies, opening the bite by extruding the posterior occlusion would not be recommended. True incisor intrusion is the choice for these patients<sup>3</sup>. Orthodontic intrusion is a common treatment for orthodontic aesthetic and functional problems, including gummy smile and deep bite.

Conventional methods for incisor intrusion usually involve 2x4 appliances like Rickett's utility arch, Connecticut intrusion arch, Burstone's intrusion arch, Kalra simultaneous intrusion and retraction arch. Intrusion arches are frequently used to treat deep-overbites<sup>4</sup>.

Utility arch is one of the most versatile auxiliary arch wires that can be used in either mixed or permanent dentition. It is a continuous wire that extends across both buccal segments, but engages only the 1<sup>st</sup> permanent molars and four incisors<sup>5</sup>.

Connecticut intrusion arch is used for intrusion of incisors. The Connecticut arch is fabricated from a nickel titanium alloy to provide the advantages of shape memory, spring back and light continuous force distribution. The Connecticut intrusion arch is significantly different in its force delivery because it is not engaged in the incisor bracket<sup>5</sup>.

Intrusion arches are frequently used to treat deep-overbites. However, undesirable side effects such as

extrusion of posterior teeth or flaring of anterior teeth limit treatment efficiency are thus a disadvantages of intrusion arches. Anchorage control, especially in the vertical dimension, is most important if an effective bite opening is to be created by genuine intrusion of anterior teeth<sup>1</sup>.

The main goal of the treatment is to achieve the desired intrusion with minimal side effects. Although an extraoral anchorage complements tooth fixation, it requires excellent patient cooperation. Nowadays, skeletal anchorage systems tooth-borne anchorage systems such as miniplates, palatal plates, and mini-implants have revolutionized in providing a much more stable anchorage<sup>6</sup>. So, orthodontic mini-implants have been added to the treatment options due to their ability to perform better than the conventional methods for incisors intrusion.

Though there are various studies that have been done to compare the intrusive effects using different intrusion arches but there is limited literature in which the comparison of different intrusion arches like utility arch, Connecticut arch and mini-implants in deep bite patients has been done. Thus, the objectives of this study were to evaluate and compare the skeletal and dental effects of utility intrusion arch, Connecticut intrusion arch and mini-implants in deep-bite patients.

### **Materials and Methods**

The study sample consisted of 30 patients selected from patients reporting to the department for fixed orthodontic treatment. The ethical approval for the study was taken from the institutional research ethical committee under reference no. HDC/ethical/ortho/2020/15. Informed consent was taken from the patient, parent or guardian. Prior to the study, all patients were provided written informed consent.

The inclusion criteria for the study were (a) Patient history to be taken without any systemic disease, (b) having deep bite of at least 4mm, (c) Excessive gingival display on smiling, age group between 15-30 years and (d) normal vertical dimensions represented by a GoGn-SN ( $32^{\circ} \pm 2^{\circ}$ ).

Exclusion criteria for the study were (a) Patient with trauma or craniofacial anomalies, (b) Periodontal disease, (c) Congenitally missing or impacted teeth in the anterior segment, (d) Extremely flared incisor, & (e) Cleft lip and cleft palate patient.

### Methodology

The patients were divided into three groups (n=30) depending on the types of intrusion mechanics used in the study in GROUP I: Intrusion was done using utility arch (n=10), in GROUP II: Intrusion was done using Connecticut intrusion arch(n=10) and in GROUP III: Intrusion was done using mini-implants (n=10).

Bonding was done for each patient using (MBT 0.022 x 0.028 inch). Initial levelling and alignment were done in all the groups.

In group I intrusion was done using utility arch made from 0.016x 0.022inch blue elgiloy wire. The arch wire was tied in the maxillary incisor brackets and then goes through the maxillary molars via the auxiliary tube as shown in figure 1. The canine and premolars was stabilized by 0.019 x 0.025inch stainless steel wire placed in the main arch wire slot. It can be activated by placing an occlusally directed gable bend in the vestibular segment.



Figure 1:

In group II intrusion was done using prefabricated 0.016 x 0.022inch Connecticut intrusion arch. Both posterior and anterior segments was stabilised by 0.019x 0.025inch stainless steel wire. The intrusion arch wire was tied over the anterior stabilized segment and goes through the maxillary first molar via auxiliary tube as shown in figure 2.



Figure 2:

In group III intrusion was done by using self-drilling mini-implant of 1.5 mm diameter and 6mm length which was inserted between the maxillary lateral incisors and canine at the muco-gingival junction on both sides of maxillary arch. J hooks were soldered distal to the lateral incisor on 0.019"x 0.025" stainless steel archwire on both sides and an elastomeric chain was tied between the J hook and to the head of the mini-implant as shown in figure 3.



Figure 3:

Lateral cephalograms were taken of all the patients, both before the start of treatment (T1) and at the end of the intrusion process(T2) in all the three groups spanning on a period of 4 months. Various linear and angular measurements were used in the study as shown in Table 1& figure 4 & 5.

Table 1: Skeletal, Dental and Soft Tissue Measurements Used in the Study

Skeletal Measurements		
1.	SNA (°)	Angle formed between sella- nasion plane and the line joining nasion to point A.
2.	SNB (°)	Angle formed between sella- nasion plane and the line joining nasion to point B.
3.	ANB (°)	Angle formed between the line joining nasion to point A and the line joining nasion to point B.
4.	GoGn-SN (°)	Angle formed between the line joining gonion to gnathion and the sella-nasion plane.
5.	GoGn-PP/SN-PP(°)	Ratio between angle formed between the line joining gonion gnathion to palatal plane upon Angle formed between sella-nasion plane to palatal plane.
Dental Linear Measurements		
1.	U1-PTV(mm)	Linear distance from the labial surface of upper incisor to pterygoid vertical plane.
2.	U6-PTV(mm)	Linear distance from the mid-point of the crown of upper molar to pterygoid vertical plane.
3.	U1- PP(mm)	Linear distance from the incisal edge of upper incisor to palatal plane.
4.	U1-VR(mm)	Linear distance from the labial surface of upper incisor to the point of intersection of anterior wall of sella-turica anterior clinoid process.
5.	U6-VR(mm)	Linear distance from the mid-point of the crown of upper molar to the point of intersection of anterior wall of sella turica anterior clinoid process.
6.	CR-PP(mm)	Linear distance from the center of resistance of maxillary central incisor to palatal plane.
7.	OVERJET	Linear distance between upper and lower incisors with reference to the upper occlusal plane.
8.	OVERBITE	Vertical overlap of the upper and lower incisors.
Dental Angular Measurements		
1.	U6-SN(°)	Angle formed between the mid-point of the crown of upper molar to sella-nasion plane.
2.	U1- PP(°)	Angle formed between the long axis of upper incisor to palatal plane.
3.	IMPA(°)	Angle formed between the long axis of lower incisors to mandibular plane.
4.	U1-L1(°)	Angle formed between the long axis of upper incisor to the long axis of lower incisor.
Soft Tissue Measurements		
1.	Ls-E line(mm)	Linear distance from the labrale superius to Esthetic line.
2.	Li- E(mm)	Linear distance from labrale inferius to Esthetic line.

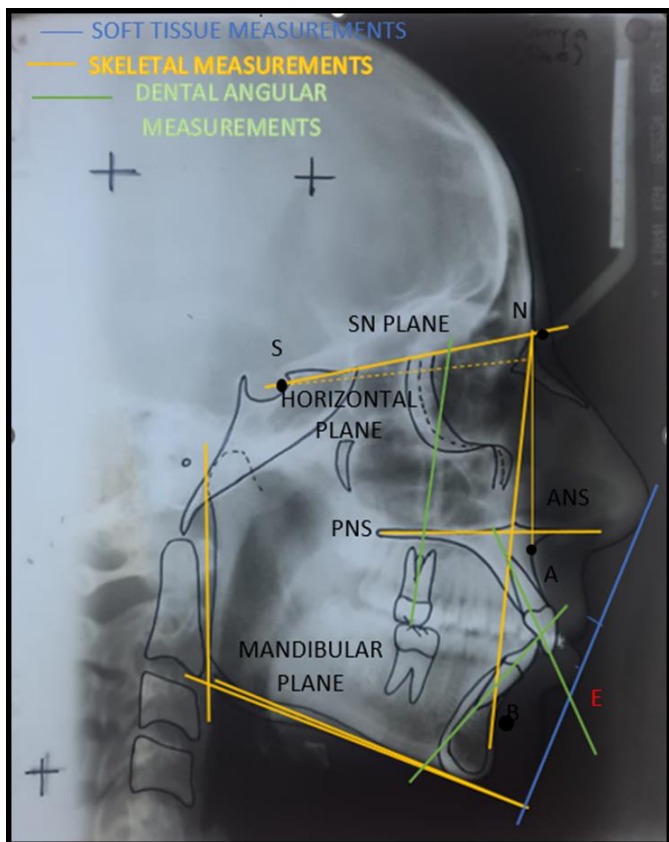


Figure 4:

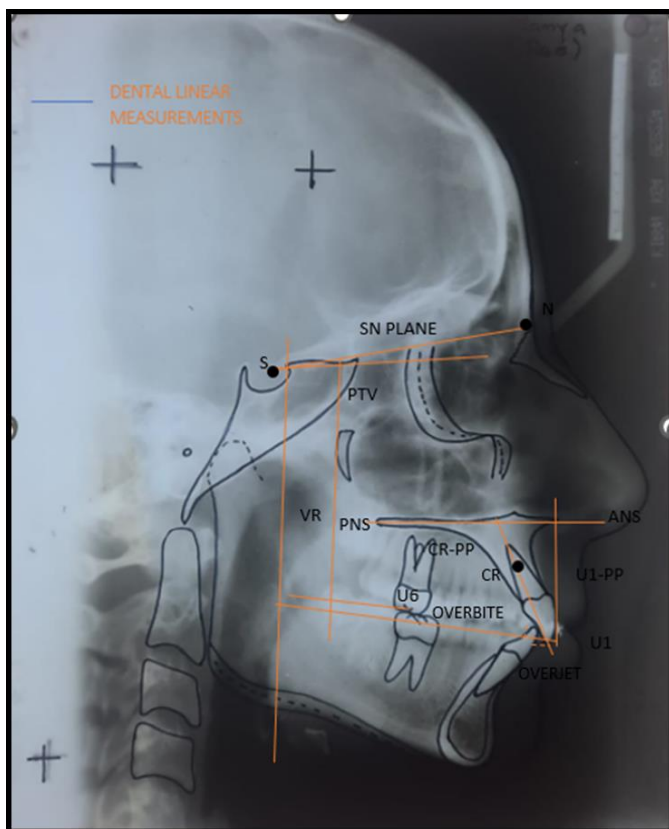


Figure 5:

### Method Error

All measurements on the lateral cephalogram were done twice by the same examiner to minimize the error of measurements. Assessment of the intra-examiner reliability analysis was performed using Spearman rho correlation. The intra-examiner reliability was found to be Spearman = 0.85 which showed perfect agreement.

### Statistical Analysis

The measurements were obtained and statistically analyzed using SPSS (Statistical package for social sciences) software version 21. The descriptive statistics were calculated as mean and standard deviations. The comparison of skeletal and dental effects in all the three groups were done by using ANOVA statistically test. The level of statistical significance used in this study was set at  $p < 0.05$ .

### Results

The mini-implant showed significant changes in the dental parameters with maximum amount of intrusion and minimal amount of protrusion as compared to utility and Connecticut intrusion arch mechanics.

The utility arch group showed statistically significantly higher mean an increase in U1-PTV ( $p=0.003$ ) and U1-L1 ( $p=0.05$ ) than mini-implant group as shown in Table 2. In Connecticut arch group, less proclination of incisors as compared to utility arch group as shown in Table 3. The intrusion arches group showed statistically significantly higher mean an increase in overjet than mini-implant group.

Mini-implant group showed a statistically significantly higher decrease in CR-PP mm than the intrusion arches group ( $p=0.004$ ) as shown in table 4. The intrusion arches and mini-implants were statistically different in the extent of incisor proclination, as an intrusion arch groups tended to procline upper incisors more than mini-implant group.

There was no statistically significant difference between mean changes of other skeletal, dental and soft tissue measurements in the three groups as shown in table 5.

**Discussion**

Deep bite is characterized by increased overbite in which the vertical dimension between the incisal margins of the upper and lower teeth are excessive. Maxillary incisor display and amount of gingival exposure on smiling plays a key role in determining treatment plan in deep bite patients. This could be corrected orthodontically by intruding the incisors, extruding the buccal segment, or combining these treatments. The treatment objective is to achieve desired intrusion with minimal side effects. The aim and objective of the study was done to evaluate and compare the skeletal and dental effects of utility intrusion arch, Connecticut intrusion arch and mini-implants in deep bite patients.

The results of the present study showed the mean values of SNA in Group I pre-treatment (78.34±3.89) and post-treatment (78.12±3.45), in Group II pre-treatment (77.49±3.89) and post-treatment (77.21±3.17) and in

Group III pre-treatment (80.19±5.16) and post-treatment (80.12±5.08). On comparing the pre-treatment and post treatment mean values of SNA in Group I, Group II and Group III, the decrease in SNA was found to be statistically insignificant(p>0.05) as shown in Table 2, 3 & 4. This decrease in SNA angle in Group I and Group II may be because of intrusive force acting away from the center of resistance of maxillary incisors which resulted in more tipping rather than bodily movement of incisors. Whereas in Group III the decrease in SNA was comparatively less as compared to Group I and Group II because intrusive forces are applied through the center of resistance of four maxillary incisors. When the intergroup comparison was done between different groups, it was found to be statistically insignificant (p>0.05) as shown in Table 5. These results were in accordance with the study conducted by Weiland FJ et al (1996)<sup>7</sup>.

Table 2: Comparison of Pre-Treatment and Post-Treatment Mean Values of the Parameters in Group I (Utility Intrusion Arch)

Parameters	Pretreatment	Post treatment	Test of Significance
	MEAN±SD	MEAN±SD	p value
Skeletal			
SNA (°)	78.34±3.89	78.12±3.45	0.232
SNB (°)	74.89±2.78	74.55±2.19	0.543
ANB (°)	4.98±1.89	4.23±1.56	0.002*
GoGn-SN(°)	20.04±2.34	20.87±2.78	0.672
GoGn-PP/SN-PP(°)	2.65±0.12	2.34±0.05	0.371
Dental Linear			
U1-PTV (mm)	52.65±3.78	53.12±3.98	0.003*
U6-PTV(mm)	23.78±2.17	23.34±2.02	0.671
U1-PP (mm)	30.62±1.89	29.07±1.37	0.003*

U1-VR(mm)	68.83±3.25	70.23±3.89	0.002*
U6-VR (mm)	31.56±2.18	29.78±2.05	0.001**
CR-PP (mm)	12.34±1.89	11.90±1.16	0.007*
OVERJET	6.12±1.67	6.89±1.89	0.05*
OVERBITE	7.12±1.56	6.88±1.38	0.023*
Dental Angular			
U6-SN (°)	69.56±3.56	67.12±2.78	0.004*
U1- PP (°)	100.09±5.89	102.34±6.23	0.001**
IMPA (°)	92.17±3.67	92.78±3.28	0.678
U1-L1(°)	105.78±5.34	102.42±5.19	0.05*
SOFT TISSUE			
LS – E LINE(mm)	2.98±0.16	2.34±0.08	0.876
LI-E LINE(mm)	2.25±0.34	2.67±0.78	0.231

p<0.05 \* statistically significant; p<0.001\*\* statistically highly significant; p<0.0001\*\*\* statistically very highly significant

Table 3: Comparison of Pre-Treatment and Post- Treatment Mean Values of the Parameters in Group Ii (Connecticut Intrusion Arch)

Parameters	Pretreatment	Post treatment	Test of Significance
	MEAN±SD	MEAN±SD	p value
Skeletal			
SNA (°)	77.49±3.89	77.21±3.17	0.324
SNB (°)	74.65±3.15	74.32±3.09	0.456
ANB (°)	5.12±1.78	5.09±1.08	0.002*
GoGn-SN(°)	20.56±2.56	20.98±2.89	0.563
GoGn-PP/SN-PP(°)	2.98±0.19	2.67±0.13	0.429
Dental Linear			
U1-PTV (mm)	53.98±3.78	54.65±3.45	0.002*
U6-PTV(mm)	24.35±2.90	24.02±2.02	0.291
U1-PP (mm)	30.10±2.90	29.60±2.78	0.005*
U1-VR(mm)	68.45±3.29	69.54±3.45	0.003*
U6-VR (mm)	31.45±2.18	30.67±2.07	0.034*
CR-PP (mm)	12.12±2.90	11.89±2.45	0.006*
OVERJET	6.03±1.89	6.98±2.56	0.04*
OVERBITE	6.88±2.45	6.34±2.12	0.003*

Dental Angular			
U6-SN (°)	68.67±3.45	67.56±3.25	0.025*
U1- PP (°)	99.89±5.89	100.86±6.05	0.003*
IMPA (°)	92.10±6.56	92.89±6.98	0.167
U1-L1(°)	104.67±7.28	102.11±7.10	0.05*
Soft Tissue			
Ls – E LINE(mm)	3.12±0.12	2.67±0.08	0.543
Li-E LINE(mm)	2.12±0.07	2.56±0.34	0.245

p<0.05 \* statistically significant; p<0.001\*\* statistically highly significant; p<0.0001\*\*\* statistically very highly significant.

Table 4: Comparison of Pre-Treatment And Post-Treatment Mean Values of The Parameters In Group Iii (Mini -Implants)

Parameters	Pre treatment	Post treatment	Test of Significance
	MEAN±SD	MEAN±SD	p value
Skeletal			
SNA (°)	80.19±5.16	80.12±5.08	0.651
SNB (°)	75.86±4.78	75.76±4.64	0.433
ANB (°)	5.78±0.10	5.76±0.10	0.452
GoGn-SN(°)	22.67±2.67	22.23±2.29	0.351
GoGn-PP/SN-PP(°)	2.54±0.36	2.12±0.12	0.392
Dental Linear			
U1-PTV (mm)	55.45±4.90	55.46±4.96	0.052
U6-PTV(mm)	25.34±3.23	25.04±3.55	0.251
U1-PP (mm)	32.15±1.67	30.68±1.34	0.003*
U1-VR(mm)	69.65±3.67	70.08±3.89	0.452
U6-VR (mm)	30.12±2.96	29.89±2.78	0.254
CR-PP (mm)	12.67±1.90	10.24±1.03	0.004*
OVERJET	5.63±1.67	5.64±1.56	0.453
OVERBITE	5.76±1.89	4.45±1.17	0.003*
Dental Angular			
U6-SN (°)	70.12±3.87	69.98±2.90	0.087
U1- PP (°)	100.12±5.67	100.23±5.89	0.567
IMPA (°)	94.55±4.89	94.67±4.98	0.567
U1-L1(°)	108.45±6.67	108.34±5.67	0.003*

Soft Tissue

Li – E LINE(mm)	4.12±1.78	3.89±1.60	0.654
Li-E LINE(mm)	3.34±0.45	2.67±0.23	0.786

p<0.05 \* statistically significant; p<0.001\*\* statistically highly significant; p<0.0001\*\*\* statistically very highly significant.

Further, the dental effects produced by the different treatment mechanics showed the mean values of U1-PTV in Group I pre-treatment (52.65±3.78) and post-treatment (53.12±3.98), in Group II pre-treatment (53.98±3.78) and post-treatment (54.65±3.45) and in Group III pre-treatment (55.45±4.90 and post-treatment (55.46±4.96). On comparing the pre-treatment and post treatment mean values of U1-PTV in Group I and Group II, the increase in U1-PTV was found to be statistically significant(p<0.05) as shown in Table 2&3 and whereas increase in U1-PTV in Group III was found to be statistically insignificant(p>0.05) as shown in Table 2, 3&4. This increase in U1-PTV in Group I and Group II was due to protrusion of maxillary incisors which leads to increase in arch length. Whereas in Group III the increase in U1-PTV was less as compared to other groups because there was less proclination of the maxillary incisors in the mini-implant group. When the intergroup comparison of mean difference of U1-PTV in Group I, Group II and Group III was done, it was found to be statistically significant(p<0.05) as shown in Table 5. The results of our study were in accordance with the study conducted by Peddu R et al (2018)<sup>6</sup>.

The result of the present study showed the mean value of U1-VR in Group I pre-treatment (68.83±3.25) and post-treatment (70.23±3.89), in Group II pre-treatment (68.45±3.29) and post-treatment (69.54±3.45), and in Group III pre-treatment (69.65±3.67) and post-treatment (70.08±3.89). On comparing the pre-treatment and post-treatment mean values of U1-VR in Group I and Group II, increase in U1-VR was found to be statistically

significant(p<0.05) as shown in Table 2&3 whereas increase in U1-VR in Group III was found to be statistically insignificant(p>0.05) as shown in Table 4. In Group I and Group II arch length increases due to maxillary incisors protrusion. In the intrusive mechanics, the wire was cinched back to prevent the flaring of incisors but they also applied an intrusive force with a counter-clockwise moment, which also leads to incisor flaring. Whereas in Group III the increase in U1-VR was comparatively less as in Group I and Group II because the intrusive force passes through the center of resistance of four maxillary incisors. When the intergroup comparison of mean difference of U1-VR in Group I, Group II and Group III was done, it was found to be statistically significant(p<0.05) as shown in Table 5. The results of our study were in accordance with the study conducted by Parker CD et al (1995)<sup>8</sup>.

The result of the present study showed the mean value of U6-VR in Group I pre-treatment (31.56±2.18) and post-treatment (29.78±2.05), in Group II pre-treatment (31.45±2.18) and post-treatment (30.67±2.07) and in Group III pre-treatment (30.12±2.96) and post-treatment (29.89±2.78). On comparing the pre-treatment and post treatment mean values of U6-VR in Group I and Group II, the decrease in U6-VR was found to be statistically significant (p<0.05) as shown in Table 2&3, whereas decrease in U6-VR in Group III was found to be statistically insignificant(p>0.05) as shown in Table 4. This decrease in U6-VR in Group I and Group II was due to the distal tipping of molar. Whereas in Group III the decrease in U6-VR was comparatively less as in Group I

and Group II because reinforcement of posterior teeth by using rigid stainless-steel arches was recommended to minimize the movement of the posterior anchorage unit. The moments that would normally be produced with conventional intrusion arches did not occur since the segmented arch used did not extend to the posterior teeth.

When the intergroup comparison of mean difference of U6-VR in Group I, Group II and Group III was done, it was found to be statistically significant( $p < 0.05$ ) as shown in Table 5. The results of our study were in accordance with the study conducted by Polat O et al (2009)<sup>9</sup>.

Table 5: Comparison of Mean Difference of Skeletal and Dental Effects Among Three Groups

Parameters	Mean Difference			p value
	G1	G2	G3	
Skeletal				
SNA (°)	-0.22	-0.28	-0.07	0.532
SNB(°)	-0.34	-0.33	-0.10	0.431
ANB (°)	-0.75	-0.03	-0.02	0.056
GoGn-SN (°)	-0.83	-0.42	-0.44	0.328
GoGn-PP/SN- PP(°)	-0.31	-0.31	-0.24	0.343
Dental Linear				
U1-PTV (mm)	-0.47	-0.67	-0.01	0.003*
U6-PTV(mm)	-0.44	-0.33	-0.30	0.483
U1-PP (mm)	-1.55	-0.5	-1.47	0.042*
U1-VR(mm)	1.4	1.09	0.43	0.002*
U6-VR (mm)	-1.78	-0.78	-0.23	0.001**
CR-PP (mm)	-0.44	-0.23	-2.43	0.023*
OVERJET	0.77	0.95	0.01	0.056
OVERBITE	-0.24	-0.54	-1.31	0.003*
Dental Angular				
U6-SN(°)	-2.44	-1.11	-0.14	0.001*
U1-PP (°)	2.25	0.97	0.11	0.042*
IMPA (°)	0.61	0.79	0.12	0.328
U1-L1 (°)	-3.36	-2.56	-0.11	0.002*
Soft Tissue				
Ls – E LINE (mm)	-0.64	-0.45	-0.23	0.691
Li- E line (mm)	0.42	0.44	-0.67	0.481

$p < 0.05$  \* statistically significant;  $p < 0.001$ \*\* statistically highly significant;  $p < 0.0001$ \*\*\* statistically very highly significant.

The result of the present study showed that the mean value of U1-PP in Group I pre-treatment ( $30.62 \pm 1.89$ ) and post-treatment ( $29.07 \pm 1.37$ ), in Group II pre-treatment ( $30.10 \pm 2.90$ ) and post-treatment ( $29.60 \pm 2.78$ ) and in Group III pre-treatment ( $32.15 \pm 1.67$ ) and post-treatment ( $30.68 \pm 1.34$ ). On comparing the pre-treatment and post treatment mean values of U1-PP in Group I, Group II and Group III, the decrease in U1-PP was found to be statistically significant ( $p < 0.05$ ) as shown in Table 2,3 &4. This decrease in U1-PP in Group I and Group II was due to intrusive force which passes away from the center of resistance of maxillary incisors. In Group III, the decrease in U1-PP was comparatively more as in Group I and Group II because intrusive force that is applied passes through the center of resistance of maxillary incisors by mini-implant mechanics. When the intergroup comparison of mean difference in Group I, Group II and Group III was done, it was found to be statistically significant ( $p < 0.05$ ) as shown in Table 5. These results were in accordance with the study conducted by De Vincenzo JP et al (1987)<sup>10</sup>.

Further, the results of the present study showed the mean value of CR-PP in Group I pre-treatment ( $12.34 \pm 1.89$ ) and post-treatment ( $11.90 \pm 1.16$ ), in Group II pre-treatment ( $12.12 \pm 2.90$ ) and post-treatment ( $11.89 \pm 2.45$ ) and in Group III pre-treatment ( $12.67 \pm 1.90$ ) and post-treatment ( $10.24 \pm 1.03$ ). On comparing the pre-treatment and post-treatment mean values of CR-PP in Group I, Group II and Group III decrease in CR-PP was found to be statistically significant ( $p < 0.05$ ) as shown in Table 2,3& 4. This decrease in CR-PP in Group I and Group II may be because of intrusive force acting away from the center of resistance of four maxillary incisors. The center of resistance of an upper incisor was located at one-third of the distance of the root length which was the reference point of choice in the present study due to the fact that it

is easily identified and its reproducibility is high. Whereas in Group III, the decrease in CR-PP was comparatively more as in Group I and Group II because the force that is applied during intrusion passes through the center of resistance of four maxillary incisors by mini-implants. When the intergroup comparison of mean difference of CR-PP in Group I, Group II and Group III was done, it was found to be statistically significant ( $p < 0.05$ ) as shown in Table 5. The results of our study were in accordance with the study conducted by Deguchi T et al (2008)<sup>11</sup>.

The results of the present study showed the mean value of overbite in Group I pre-treatment ( $7.12 \pm 1.56$ ) and post-treatment ( $6.88 \pm 1.38$ ), in Group II pre-treatment ( $6.88 \pm 2.45$ ) and post-treatment ( $6.34 \pm 2.12$ ) and in Group III pre-treatment ( $5.76 \pm 1.89$ ) and post-treatment ( $4.45 \pm 1.17$ ). On comparing the pre-treatment and post-treatment mean values of overbite in Group I, Group II and Group II, this decrease in overbite was found to be statistically significant ( $p < 0.05$ ) as shown in Table 2, 3&4. The decrease in overbite in Group I and Group II was due to less intrusion of incisors as force applied away from the center of resistance of four maxillary incisors. Whereas in Group III, the intrusive force passes through the center of resistance of four incisors by mini-implants. When the intergroup comparison of mean difference of overbite in Group I, Group II and Group III was done, it was found to be statistically significant ( $p < 0.05$ ) as shown in Table 5. The results of our study were in accordance with the study done by Van Steenbergen et al (2005)<sup>12</sup>.

The result of the present study showed the mean value of U6-PTV in Group I pre-treatment ( $23.78 \pm 2.17$ ) and post-treatment ( $23.34 \pm 2.02$ ), in Group II pre-treatment ( $24.35 \pm 2.90$ ), post-treatment ( $24.02 \pm 2.02$ ) and in Group III pre-treatment ( $25.34 \pm 3.23$ ) and post-treatment

(25.04±3.55). On comparing the pre-treatment and post treatment mean values of U6-PTV in Group I, Group II and Group III, the decrease in U6-PTV was found to be statistically insignificant ( $p>0.05$ ) as shown in Table 2&3. This decrease in U6-PTV in Group I was due to a tip back bend given in the utility arch which leads to distal tipping of molars whereas the decrease in U6-PTV in Group II was due to a v bend in the Connecticut intrusion arch which leads to distal tipping of molars. In Group III the decrease in U6-PTV was comparatively less as in Group I and Group II because incisor intrusion with mini-implant only affects the incisal area as there was sectioning of wire distal to lateral incisors. When the intergroup comparison of mean difference of U6-PTV in Group I, Group II and Group III was done it was found to be statistically insignificant ( $p>0.05$ ) as shown in Table 5. The results of our study were in accordance with the study done by Phor D et al (2018)<sup>13</sup>.

The results of the present study showed the mean value of U6-SN in Group I pre-treatment (69.56±3.56) and post-treatment (67.12±2.78), in Group II pre-treatment (68.67±3.45) and post-treatment (67.56±3.25) and in Group III pre-treatment (70.12±3.87) and post-treatment (69.98±2.90). On comparing the pre-treatment and post-treatment mean values of U6-SN in Group I and Group II, the decrease in U6-SN was found to be statistically significant ( $p<0.05$ ) as shown in Table 2, 3&4, whereas decrease in U6-SN in Group III was found to be statistically insignificant ( $p>0.05$ ) as shown in Table 4. This decrease in U6-SN in Group I and Group II was due to the distal tipping of first molar whereas in case of Group III, decrease in U6-SN was comparatively less as in Group I and Group II because intrusion mechanics were confined to incisors only and no attachment was done on molars. When the intergroup comparison of mean difference of U6-SN in Group I, Group II and

Group III was done, it was found to be statistically highly significant ( $p<0.001$ ) as shown in Table 5. These results were in accordance with the study conducted by Kinjel J et al (2002)<sup>14</sup>.

Further, the results of the present study showed the mean value of U1-L1 in Group I pre-treatment (105.78±5.34) and post-treatment (102.42±5.19), in Group II pre-treatment (104.67±7.28) and post-treatment (102.11±7.10) and in Group III pre-treatment (108.45±6.67) and post-treatment (108.34±5.67). On comparing the pre-treatment and post treatment mean values of U1-L1 in Group I, Group II and Group III, the decrease in U1-L1 line was found to be statistically significant ( $p<0.05$ ) as shown in Table 2, 3&4. This decrease in U1-L1 line angle in Group I and Group II was due to change in the axial inclination of upper and lower incisors as a results of various force vector produced by utility intrusion arch and Connecticut intrusion arch. Whereas in Group III, decrease in U1-L1 line was comparatively less as in Group I and Group II because there is minimal protrusion of maxillary incisors by mini-implant. When the intergroup comparison of mean difference of U1-L1 line in Group I, Group II and Group III was done, it was found to be statistically significant ( $p<0.05$ ) as shown in Table 5. These results were in accordance with the study conducted by Amaysali M et al (2005)<sup>15</sup>.

We found that intrusion of incisors by using utility intrusion arch and Connecticut intrusion arch showed more proclination of incisors. However, introduction of minis-screws has simplified most orthodontic mechanics and reduced treatment time by minimization of unwanted side effects as a result of proclination of the incisors and anchorage loss. The side effects are minimal and patient acceptance as positive. The intrusion of maxillary incisors by using mini-screws was beneficial in

minimizing incisor protrusion and provided true intrusion in deep bite patients. Therefore, we concluded that the mini-implant showed significant changes in the dental parameters with maximum amount of intrusion and minimal amount of protrusion as compared to utility and Connecticut intrusion arch mechanics.

### **Conclusion**

The conclusion drawn from the study were as follows

1. The utility intrusion arch, Connecticut intrusion arch and mini-implants showed significant dental and skeletal effects which leads to intrusion of incisors in deep bite patients.
2. The mini-implant group showed maximum intrusion and minimal protrusion of maxillary incisors as compared to utility arch and Connecticut intrusion arch whereas distal tipping of upper first molar was found to be more in utility and Connecticut intrusion arch as compared to mini-implant group.

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