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Original Article

Dentistry Section

Clinical Evaluation of Efficacy of CIA and CNA Intrusion Arches

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ABSTRACT

Background and Objectives: Excessive overbite is one of the most common problems that confront the orthodontist. Deep bite can be due to infraocclusion of posterior teeth, supraocclusion of anterior teeth or a combination of the two. Correction of same can be carried out by extrusion of molars, intrusion of incisors or by a combination of both respectively. Various intrusion arches are recommended for correcting deep bite by true intrusion of anterior teeth, Utility arches, Segmental arch, Connecticut Intrusion Arch (CIA) and Connecticut New Arch (CNA). The purpose of this study was to evaluate clinical efficacy of CIA and CNA intrusion arches.

Materials and Methods: Tracings recorded from pre and post-treatment lateral cephalograms of 25 patients treated by CIA (Group I) and another 25 patients treated by CNA (Group II) intrusion arches in deep bite cases after four months of treatment were analysed and findings were recorded.

Statistical Analysis: Paired t-test was used to compare pre and post-treatment changes within Groups I and II and unpaired t-test was used to compare treatment changes between Group I and Group II. A P-value of < 0.05 was set for statistical significance.

Results: Findings of this study demonstrate that an average of 1mm of intrusion takes place with CIA intrusion arch and 1.3mm with CNA intrusion arch in a period of 4 months. Both intrusion arches do not affect the position of molar in vertical or anteroposterior plane.

Interpretation & Conclusion: Both CIA and CNA intrusion arches are effective in bringing about intrusion of lower incisors.

Keywords: Deep bite, Deep bite correction, Malocclusions

INTRODUCTION

Malocclusions have been a problem for most individuals since antiquity and attempts to correct this disorder dates back a long time. In Orthodontics malocclusion is analysed in three planes; transverse, sagittal and vertical. Malocclusion in vertical plane manifests as deep bite [1].

Deep bite can occur due to infraocclusion of posterior teeth, supraocclusion of maxillary and mandibular anteriors, supraocclusion of mandibular incisors only or a combination of anterior supraocclusion and posterior infraocclusion [2-9].

Deep bite can be corrected by allowing supraeruption of posteriors and associated clockwise rotation of mandible leading to increased lower facial height. This is relative intrusion or pseudo intrusion [10]. Deep bite can also be corrected by intrusion of upper and/or lower anteriors. This is absolute intrusion [11]. Increasing labial inclination of incisors and molar extrusion are also means of correcting deep bite [12,13].

Intrusion of incisors is indicated in deep bite patients with large vertical dimension and deep curve of Spee. Intrusion refers to the apical movement of the geometric centre of the root (centroid) with respect to occlusal plane or plane based on long axis of teeth [14]. For true-intrusion to take place the force should pass through the center of resistance of that tooth or group of teeth. In Pre-adjusted Edgewise mechanics bite opening is achieved with utility arches [11], intrusion arches [14] mini implants, magnets, reverse curve of spee [15], bite plates, step bends in arch wire and extraoral traction. Conventional intrusion arches were made of Stainless Steel or Blue Elgiloy alloy. Nowadays intrusion arches made of newer materials like Nickel Titanium or Beta Titanium is used. The aim of this study was to clinically evaluate the efficacy of CIA and CNA intrusion arch and recommend the better intrusion arch.

MATERIALS AND METHODS

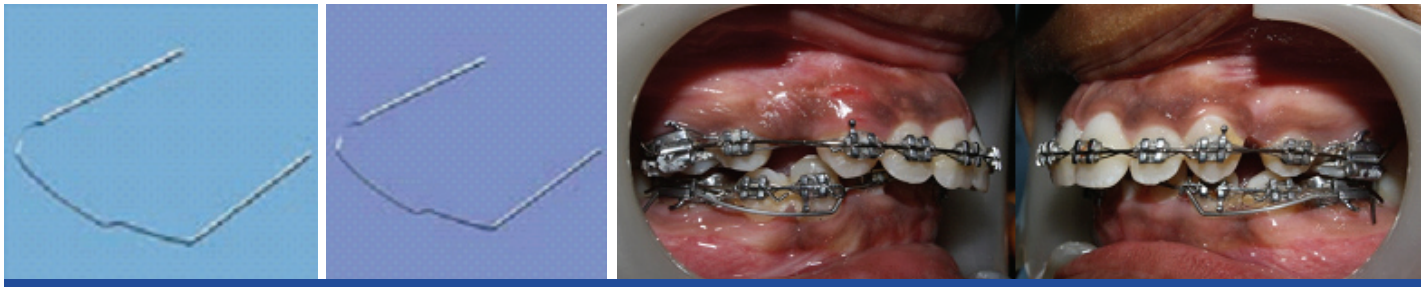
This invivo study was conducted in the Department of Orthodontics, GITAM Dental College, Hospital and Research Centre, Visakhapatnam, India. This study was carried out in a time span of 2 years, during which intrusion arches were placed on lower anteriors for a period of 4 months following alignment.

Inclusion criteria involved non-growing patients as growth changes make it difficult to assess the amount of intrusion [16] and extrusion of molars for deep bite correction in such patients will lead to relapse, both males and females are included in the study sample, all patients had permanent dentition with average to vertical growth pattern and curve of spee of 4mm, anterior deep bite with normal upper incisor exposure, normal upper lip length and fully erupted molars. All subjects were treated with premolar extraction and Pre-adjusted Edgewise mechanotherapy (MBT System). Deep bite was corrected by intrusion of mandibular incisors.

Exclusion criterion considered while sample selection was, recession and bone loss of mandibular anteriors, apical root resorption of mandibular incisors as seen in intraoral periapical radiographs, horizontal growth pattern, partial eruption of molars, curve of spee less than 4mm and anterior deep bite with maxillary incisor visibility of more than 2mm.

Sample consisted of 50 patients (28 male and 22 females) divided into two groups of 25 each. Age group of sample ranged from 16 to 25 years (average age of 18.5 years). Written consent was obtained from each patient before starting the treatment. Ethical committee clearance was also obtained prior to commencing the study.

In Group I mandibular incisor intrusion was achieved by CIA [Table/Fig-1] and Group II was treated by CNA intrusion arch [Table/Fig-2]. Pre intrusion standardized lateral cephalograms were taken after alignment was complete and just before starting intrusion mechanics. Standardized cephalograms were obtained by orienting patient's



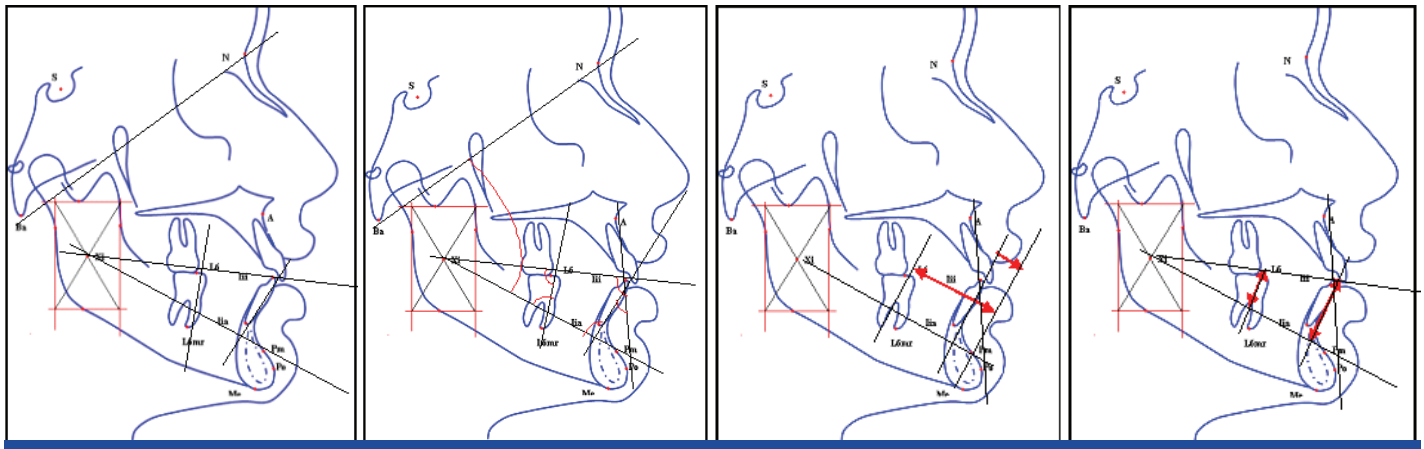
[Table/Fig-1]: CIA intrusion arch **[Table/Fig-2]:** CNA intrusion arch. **[Table/Fig-3]:** Posteriors consolidated and intrusion arch placed

[Table/Fig-4]: Anteriors consolidated and intrusion arch

head in the cephalostat with Frankfort Horizontal plane parallel to the horizon, while maintaining the midsagittal plane perpendicular to it. The ear rods were inserted in the external acoustic canal, preventing rotation of head. Segmental mechanics was used. Intrusion mechanics involved consolidating the lower arch into anterior and posterior segment. Anterior segment consisted of four incisors and posterior segment consisted of canine, premolar and molar [Table/Fig-3]. 0.017"x0.025" CIA and 0.017'x0.025" CNA intrusion arches (manufactured by Ortho Organizers) were ligated to 0.019"x0.025"SS segmental base arch wire in between the incisor brackets [Table/Fig-4]. Double tubes were used on mandibular molars. Post intrusion standardized lateral cephalograms were taken after four months of intrusion mechanics. Pre and post intrusion cephalographs were traced and superimposed.

The measurements were carried out on lateral cephalograph tracings [Table/Fig-5]. The measurements are divided into angular [Table/Fig-6], horizontal [Table/Fig-7] and vertical [Table/Fig-8]. Angular measurements were used to determine the change in inclination of the lower incisor and lower first permanent molar under the effect of intrusion arch. For this long axis of lower incisor and a line crossing the mesial cusp tip of lower molar to mesial root tip were measured in relation to corpus axis (Xi, which is located at geographic centre of ramus to PM), occlusal plane (Xi to lower incisal edge) and mandibular plane [17]. Horizontal measurement determines the amount of mesial movement of molars and lingual movement of incisors under the effect of intrusion arch. A line perpendicular to corpus axis at PM (Protuberance Menti or suprapogonion is the point where the curvature of anterior border of symphysis changes from concave to convex) is taken as reference [17]. Vertical measurement determines the amount of tooth movement in vertical plane. Distance from incisal edge of lower incisor to corpus axis and mandibular plane was used to check the amount of lower incisor intrusion. Distance from lower molar mesial cusp tip to corpus axis and mandibular plane was used to check the amount of lower molar extrusion.

To eliminate the error of reproducibility and measurement, the lateral cephalographs were traced and measurements were obtained by a single operator, twice, at different times. To eliminate any bias same cephalographs were traced and measured by a different operator too. The mean of values were considered for the study.



[Table/Fig-5]: PARAMETERS. 1) Ba-N: Line from Basion to Nasion. 2) Corpus Axis (CA): Line extending from Xi point to Protuberance Menti. 3) Occlusal Plane: Line from Xi point to DP point (point on APog line following the divine proportion of 1:1.618). 4) Iia–Iii: Line passing through long axis of lower incisor. 5) L6–L6mr: Line passing through mesiobuccal cusp tip to mesial root tip of lower first molar.

[Table/Fig-6]: ANGULAR MEASUREMENTS.
LI–CA: It is the angle formed by joining a line from Iii to Iia and corpus axis (CA). It evaluates the inclination of lower incisor in relation to corpus axis.
LI–APog: It is the angle formed by joining a line from Iii to Iia and point A to Pogonion. It defines the protrusion of mandibular anteriors.
LI–OP: It is the angle formed by joining a line from Iii to Iia and occlusal plane. It indicates the treatment induced change in inclination of mandibular incisor.
LM–CA: It is the angle formed by joining a line from L6 to L6mr and corpus axis (CA). It evaluates the angulation of lower molar in relation to corpus axis.
LM–OP: It is the angle formed by joining L6 to L6mr and occlusal plane. It indicates the treatment induced mesial or distal tipping of molar.
Ba-N–CA: It is the angle formed between two stable reference planes (Basion-Nasion and Corpus Axis). It was selected as an indicator of possible treatment-induced mandibular rotation.

[Table/Fig-7]: HORIZONTAL MEASUREMENT.
LI–Pm: It is the horizontal distance from the incisal edge of the lower central incisor to the Pm point measured parallel to the corpus axis.
LM–Pm: It is the horizontal distance from the mesiobuccal cusp tip of the lower molar to the Pm point measured parallel to the corpus axis.
LI–APog: It is the horizontal distance from the incisal edge of the lower central incisor to the APog line.

[Table/Fig-8]: VERTICAL MEASUREMENTS.
LI–CA: It is the vertical distance between the incisal edge of the lower central incisor and the corpus axis measured perpendicular to the corpus axis.
LI–OP: It is the vertical distance between incisal edge of lower central incisor and occlusal plane measured perpendicular to
LM–CA: It is the vertical distance between the mesiobuccal cusp tip of the lower molar and the corpus axis measured perpendicular to the corpus axis.
LM–OP: It is the vertical distance between the mesiobuccal cusp tip of the lower molar and the occlusal plane measured perpendicular to the corpus axis.

STATISTICAL ANALYSES

Mean and standard deviation of pre-intrusion and post-intrusion values were calculated for both the groups from the primary data. The following statistical procedures were undertaken to compare the data obtained.

Paired t-test was used to compare between pre and post intrusion changes within Group I and Group II. Unpaired t-test was used to compare treatment changes between Group I and Group 2. A p-value of < 0.05 was set for statistical significance.

RESULTS

A sample of 50 patients was selected on the basis of inclusion criteria and divided into two groups. Group I comprised of 25 subjects in whom overbite correction was achieved with CIA intrusion arch and Group II had 25 patients where CNA intrusion arch was used.

[Table/Fig-9] shows pre and post intrusion angular measurements in Group I and II. There is a significant decrease in proclination of lower incisors in relation to corpus axis, A-Pog line and occlusal plane but no significant movement of lower first molar is seen in relation to corpus axis, occlusal plane.

[Table/Fig-10] shows pre and post intrusion horizontal measurements of Group I and II. There is a significant backward movement of lower incisor in relation to Protuberance menti and A-Pog line whereas there is no significant movement of lower molar in relation to Protuberance menti.

[Table/Fig-11] shows pre and post intrusion vertical measurements of group I and II. There is a significant intrusion of lower incisor in relation to corpus axis and occlusal plane whereas there is no significant movement of lower first molar in relation to corpus axis and occlusal plane.

Para-meters (Degrees)	Treatment	Group I	Group II	t-value	p-value
		Mean±Std. Dev.	Mean±Std. Dev.		
LI – CA	Pre-intrusion	91.8000±3.3928	89.9000±3.9847	1.1481	0.2660
	Post-intrusion	91.2000±3.4254	89.1000±4.3063	1.2069	0.2431
	Difference	0.6000±0.6992	0.8000±0.7888	-0.6000	0.5560
LI-APO	Pre-intrusion	24.4000±2.3190	19.2000±3.4577	3.9497	0.0009
	Post-intrusion	23.7000±2.4518	18.4000±3.8355	3.6818	0.0017
	Difference	0.7000±0.6749	0.8000±0.7888	-0.3046	0.7642
LI-OP	Pre-intrusion	25.6000±3.1693	25.2000±4.2635	0.2381	0.8145
	Post-intrusion	25.0000±3.2318	24.4000±4.7656	0.3295	0.7456
	Difference	0.6000±0.6992	0.8000±0.7888	-0.6000	0.5560
LI – MP	Pre-intrusion	95.8000±4.1580	93.9000±4.3576	0.9975	0.3317
	Post-intrusion	95.2000±4.0222	93.1000±4.7011	1.0734	0.2973
	Difference	0.6000±0.6992	0.8000±0.7888	-0.6000	0.5560
LM – CA	Pre-intrusion	73.2000±3.9944	75.4000±2.7162	-1.4402	0.1670
	Post-intrusion	73.0000±3.8586	75.1000±2.6013	-1.4270	0.1707
	Difference	0.2000±0.4216	0.3000±0.4830	-0.4932	0.6278
LM – OP	Pre-intrusion	7.3000±4.7854	8.4000±3.8715	-0.5651	0.5790
	Post-intrusion	7.1000±4.8865	8.1000±3.8137	-0.5102	0.6161
	Difference	0.2000±0.4216	0.3000±0.4216	-0.5303	0.6024
LM-MP	Pre-intrusion	80.3000±4.4734	79.3000±5.1218	0.4650	0.6475
	Post-intrusion	80.0000±4.5461	79.1000±5.0870	0.4172	0.6815
	Difference	0.3000±0.6749	0.2000±0.4216	0.3974	0.6958
SN-MP	Pre-intrusion	30.9000±4.9542	31.1000±5.3009	-0.0872	0.9315
	Post-intrusion	30.9000±4.8637	31.0000±5.0111	-0.0453	0.9644
	Difference	0.0000±0.4714	0.1000±0.3162	-0.5571	0.5843
NBA-CA	Pre-intrusion	42.5500±10.2210	54.7000±5.0783	-3.3665	0.0034
	Post-intrusion	42.5000±10.1680	54.6000±4.8351	-3.3985	0.0032
	Difference	0.0500±0.1581	0.1000±0.3162	-0.4472	0.6601

[Table/Fig-9]: Comparison of pre and post intrusion angular measurements in Group I and Group II by unpaired t-test

Para-meters (Degrees)	Treatment	Group I	Group II	t-value	p-value
		Mean±Std. Dev.	Mean±Std. Dev.		
LI - PM	Pre-intrusion	7.0500±1.6741	7.6000±1.7764	-0.7125	0.4853
	Post-intrusion	7.3500±1.7646	8.0000±1.8559	-0.8026	0.4327
	Difference	-0.3000±0.3496	-0.4000±0.3944	0.6000	0.5560
LM - PM	Pre-intrusion	25.2500±3.2851	29.8000±1.6193	-3.9286	0.0010*
	Post-intrusion	25.2500±3.2851	29.9000±1.7920	-3.9296	0.0010*
	Difference	0.0000±0.0000	-0.1000±0.3162	1.0000	0.3306
LI - APO	Pre-intrusion	3.2000±1.8135	2.5500±1.8020	0.8040	0.4319
	Post-intrusion	2.9000±1.8529	2.1500±1.8567	0.9042	0.3778
	Difference	0.3000±0.3496	0.4000±0.3944	-0.6000	0.5560

[Table/Fig-10]: Comparison of pre and post intrusion horizontal measurements in Group I and group II by unpaired t-test

Para-meters (milli-meter)	Treatment	Group I	Group II	t-value	p-value
		Mean±Std. Dev.	Mean±Std. Dev.		
LI - CA	Pre-intrusion	29.800±05.0122	29.4000±3.2472	0.2118	0.8346
	Post-intrusion	28.7500±5.0014	28.1000±3.1340	0.3483	0.7317
	Difference	1.0500±0.2838	1.3000±0.5375	-1.3007	0.2098
LI - OP	Pre-intrusion	2.3500±1.3344	0.9000±1.3904	2.3793	0.0286
	Post-intrusion	1.3500±1.2921	-0.4000±1.3703	2.9383	0.0088
	Difference	1.0000±0.2357	1.3000±0.5375	-1.6164	0.1234
LI - MP	Pre-intrusion	45.9500±6.1121	45.3500±2.3811	0.2893	0.7757
	Post-intrusion	44.9500±6.2203	44.0500±2.4546	0.4256	0.6754
	Difference	1.0000±0.2357	1.3000±0.5375	-1.6164	0.1234
LM - CA	Pre-intrusion	18.7500±4.0087	16.0500±1.6907	1.9625	0.0653
	Post-intrusion	18.7000±4.0565	15.9500±1.5890	1.9961	0.0613
	Difference	0.0500±0.1581	0.1000±0.3162	-0.4472	0.6601
LM - OP	Pre-intrusion	-0.7000±1.7670	-1.4000±1.9972	0.8301	0.4174
	Post-intrusion	-0.7000±1.7670	-1.2500±1.9755	0.6562	0.5200
	Difference	0.0000±0.0000	-0.1500±0.3375	1.4056	0.1769
LM - MP	Pre-intrusion	38.2000±5.5737	34.6500±1.5995	1.9360	0.0687
	Post-intrusion	38.1000±5.6657	34.5000±1.8257	1.9125	0.0719
	Difference	0.1000±0.3162	0.1500±0.3375	-0.3419	0.7364

[Table/Fig-11]: Comparison of pre and post intrusion vertical measurements in Group I and Group II by unpaired t-test

Comparison between Group I and Group II shows that there is no significant difference in angular, horizontal and vertical measurements obtained.

DISCUSSION

Numerous methods have been described for incisor intrusion by various authors. Begg used Australian Stainless Steel wire with anchor bends [18], Ricketts used intrusion utility arch [11] and Burstone used 0.017"x0.025" TMA helical springs [14]. In 1998, Nanda introduced the CIA intrusion arch which was developed on the principles of Burstone intrusion arch. Past literature shows several studies comparing CIA with utility intrusion arch, Burstone utility arch and miniscrews. But in this study, for the first time two intrusion arches i.e. CIA and CNA are compared which have same design but differ in composition.

Both CIA and CNA intrusion arch are available in two wire sizes: 0.016"x0.022" and 0.017"x0.025". The maxillary and mandibular intrusion arches have anterior dimensions of 34mm and 28m respectively. The posterior dimensions of these preformed arches are available in two different sizes for extraction (15mm) and non-extraction (22mm) cases [19].

Amasyali compared Utility intrusion arch (UIA) and Connecticut intrusion arch (CIA) and found that there was no difference in dental and soft tissue effects of both arches but CIA being prefabricated reduces the chair side time which is an advantage for both patient and clinician [20]. Meha Verma compared CIA and Burstone Intrusion arch and found greater intrusion of maxillary incisors in CIA group than Burstone group after therapy of 16 weeks [21].

A wide range of materials have been used to bring about intrusion and these materials have different physical properties which has a critical effect on intrusion mechanics. Ricketts used Blue Elgiloy which had same stiffness as Stainless Steel but was more formable [22]. Then Burstone used Beta Titanium or TMA wires for making intrusion spring with the advantage of excellent amalgamation of high springback, low stiffness and high formability [23]. Connecticut Intrusion Arch (CIA) developed at the University of Connecticut [19] displays low force magnitude and force constancy from the memory and springback characteristics of the material. Since Nickel-Titanium has low formability under regular clinical circumstances due to its material properties, these arches are preformed. CNA is composed of Beta III Titanium. It has the advantage of lower Elastic Modulus compared to Stainless Steel while retaining formability, which is not possible with Nickel -Titanium wires [24]. Juvaddi compared CNA and TMA wires and suggested that CNA has more Titanium but less Molybdenum, Zirconium and Tin. Zirconium in CNA and TMA contributes to increased strength and hardness and prevents formation of embrittling omega phase during processing at elevated temperature. Low zirconium content in CNA contributes to its decreased stiffness. CNA is considered to be superior to TMA as it has greater fracture resistance due to increased ultimate tensile strength. So CNA is the better of the two wires in terms of deflection, stiffness and flexibility [25].

CIA intrusion arch produces light continuous force which is in accordance to Bench, Burstone, Begg and Nanda [11,14,18,19,26,27]. CIA intrusion arch exerts a force of 35–45 gms bringing about 1mm of intrusion in 6 weeks and CNA exerts greater intrusive force of 50–60 grams which can be used in adults [28]. Nanda recommends an optimal force of 10 gm for each mandibular incisor with a total of 40 gm for four incisors [29].

True intrusion takes place when line of force passes through the Center of resistance of the unit [30-32]. In this study the intrusion arch is tied to the base arch between central and lateral incisors and between two central incisors. The anterior and posterior units are consolidated separately. Anterior unit comprises of four lower incisors and posterior unit comprises of first molar, second premolar and canine. According to Dermaut, when intrusive forces are applied between lateral incisors and canines, the force passes through the Center of resistance of anterior unit thereby bringing about true intrusion of lower incisors [30].

Patients with average to vertical growth pattern were chosen for this study as recommended by McDowell [17]. In patients with vertical growth, extrusion of posterior teeth is avoided as it could cause increase in the lower anterior face height and further worsening the profile. Although horizontal growing patients have a wider symphysis and intrusion of incisors is easier, but extrusion of posterior teeth is preferred for leveling curve of Spee. According to Otto, in these patients extrusion of posterior teeth rotates the mandible downward and backward thereby improving the profile [11,32].

All patients in this study had deep bite and Curve of Spee of 4mm or more and space is required for leveling the curve of Spee by incisor intrusion as suggested by Baldridge [33]. In non-extraction cases as leveling occurs mainly by proclination of lower incisors due to lack of space, premolar extraction cases were chosen in this study to bring about true intrusion of mandibular incisors.

Changes in angular measurements indicate that there is a significant decrease in lower incisor inclination in both the groups unlike Ricketts utility arch in which flaring is seen. This finding is supported by Nanda [19]. The reason for decrease in inclination of lower incisors with intrusion is due to point of force application. Instead of engaging into the anterior bracket slot, intrusion arch is tied below the main archwire between central incisors and at lateral incisor. This creates a point contact which is necessary for pure intrusion.

Angular measurement of lower first molars did not show any change in both the groups. This indicates that there is no distal tipping of lower molars as seen in techniques described by Begg [18] and Ricketts [11]. This is because the posterior unit is composed of first molar, premolar and canine, thus making it a rigid unit which can better resist the tip back moment produced by the intrusion arch.

Linear horizontal measurements indicate significant backward movement of lower incisal edge in relation to Protuberance Menti and A-Pog plane in both Group I and Group II. This finding is also supported by Nanda [17]. The intrusion arch is pulled and cinched tightly which may account for this effect.

Linear vertical measurements show a significant amount of intrusion in Group I and Group II with mean intrusion of 1.05 mm in Group I and 1.3 mm in Group II in relation to corpus axis. So comparison of two groups indicates that there is slightly greater amount of true intrusion with CNA intrusion arch. The intrusive capacity of CIA intrusion arch is supported by Amasyali [20] and Meha Verma [21]. Little literature is available on intrusion of mandibular incisors using intrusion arch. Studies using intrusion arch are mainly done on maxillary arch. The amount of intrusion obtained in maxillary arch cannot be comparable to that of mandibular arch since the force as well as the bone architecture varies. Based on meta-analysis carried out by Ng J segmented arch in non-growing patients can produce 1.5 mm of incisor intrusion in maxillary arch and 1.9 mm in mandibular arch [34]. Studies by Nanda show 1mm of intrusion in 6 weeks of time but in our study approximately 1mm of intrusion is obtained in a period of 18 weeks. This may be because incisal edge was taken as the reference point and decrease in inclination of incisors raised the incisal edge, thereby decreasing the amount of measured intrusion.

LIMITATIONS

This study include a small sample size, tracing and measuring errors on lateral cephalogram, reference of incisal edge of the lower incisor which may be inaccurate.

CONCLUSION

Within the limitations of the present in vivo study it can be concluded that both Connecticut Intrusion Arch (CIA) and Connecticut New Arch (CNA) are efficient in bringing about intrusion of lower incisors, CNA (1.3mm) is relatively more efficient than CIA (1.05mm). They can be used successfully for the treatment of deepbite. There was significant amount of retraction with both CIA and CNA intrusion arches. There was no extrusion of molars so it can be used in average to vertical growth pattern.

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