Correction of deep overbite with Mini-implants using a 2 x 4 appliance design in adult patients: A prospective clinical study

Dr. Rekha Mittal, Dr Anand K Patil(Professor), Dr Sanjay v Ganeshkar(Professor and HOD)

Objective: This prospective clinical study was undertaken to quantify the amount of the true incisor intrusion achieved during orthodontic treatment using mini-implants (TADs) to correct the dental deep overbite in adult patients, as well as to assess the overall treatment time period in achieving a true incisor intrusion.

Material and Methods: The treated group consisted of fifteen subjects with a dental deep bite of at least 4mm (mean overbite, 4.44mm and mean age 21 years). After initial alignment of anterior teeth, a mini-implant was placed below the anterior nasal spine and was used to intrude the maxillary incisors on a segmented archwire connecting the four incisors and molars together.Lateral cephalograms and study models were taken before and immediately after the bite opening to assess the amount of true intrusion achieved. The mean change in the cephalometric parameters and study model changes was subjected to paired 't'–test using composite analysis (including centroid analysis) to determine whether the change achieved was significant.

Results: A significant amount of intrusion resulting in overbite reduction was achieved following the usage of a mini-implant with a mean value of 2.8 mm, when measured from centroid point(I_1) in relation to palatal plane ($p < .001$). Molars were not extruded following the intrusion of anterior teeth. No increase in lower facial height was observed (+0.3mm, NS).

Conclusions: The results of the study revealed that mini-implants (TAD's) serve as an efficient source of anchorage for achieving true incisor intrusion of anterior teeth in deep overbite correction. It does not have any deleterious side effects on the posterior segment, especially in patients with unfavorable growth patterns and non-growing patients.

INTRODUCTION

Deep overbite is one of the most common components of a malocclusion as well as a major challenge even for a competent orthodontist. It can be corrected with various treatment modalities like extrusion of posterior teeth, intrusion of anterior teeth or a combination of both, depending upon the nature of the existing discrepancy[1]. It has been documented that the correction of a deep overbite by extrusion of posterior teeth is difficult to accomplish as it is opposed by strong muscles of mastication. In addition, it is less stable in non-growing individuals as the extruded posterior teeth would impinge on the freeway space, leaving the prognosis for the leveling technique in doubt[2,3].

In certain types of malocclusions, like in Class II, Div. 2 malocclusions, where the incisors are over-erupted, true incisor intrusion of anterior teeth is absolutely indicated to correct the existing deep overbite[4]. A similar example is of spaced and elongated incisors, frequently seen following the loss of periodontal attachment; especially in adult patients wherein true incisor intrusion becomes the treatment of choice[5]. Moreover, in cases with missing molars requiring deep overbite correction, true incisor intrusion is again indicated[6].

For many years, the true intrusion of teeth was considered difficult and was associated with numerous side-effects from the periodontium and cementum (like root resorption). However, in recent years successful true intrusion has been clinically documented and is now considered a safe procedure, provided that the magnitude and direction of forces are carefully monitored[7]. Mini-implants (TAD’s), which have been recently introduced into the field of orthodontics, have revolutionized the orthodontic armamentarium and gained enormous popularity in the clinical management of various orthodontic tooth movements by making anchorage absolutely stable. Since 1983, case reports have been documented regarding the usage of mini-implants (TAD’s) placed below the anterior nasal spine to achieve deep overbite correction. Creekmore T D and Eklund[8] published a case report using a vitallium implant for anchorage while intruding the upper anterior teeth. The vitallium screw was inserted just below the anterior nasal spine and after a healing period of 10 days, an elastic thread was tied from the head of the screw to the archwire. Within one year, 6 mm intrusion was demonstrated along with 25° lingual torque. However, the study concluded that it is premature for the procedure to be used clinically and needs further validation. Ohnishi et al[9] described the correction of significant deep bites using mini-implants (TAD’s) as anchorage for the intrusion of the upper anterior segment. Mini-implants were placed in between the roots of maxillary central incisors, three millimeters above the root apex, using local anesthesia. A light force application of 20 grams for intrusion was undertaken. The overbite was reduced from +7.2 mm to +1.7 mm by upper incisor intrusion. Kim et al[10] presented a case report wherein they corrected a Class II, Div. 2 deep bite malocclusions by using a mini-implant (TAD) placed below the anterior nasal spine. 4mm of incisor intrusion was achieved in 6 months.

Since there are very few case reports documenting and evaluating the efficacy of mini-implants (TAD’s) as a source of anchorage for intrusion of anterior teeth in deep bite cases; we undertook this study to fill this void.

Therefore, the present study was planned to achieve the following aims and objectives:

- To evaluate the efficiency of mini-implants (TAD’s) as a rigid source of anchorage for the intrusion of maxillary incisors in deep overbite correction.
- To assess the overall time period for the correction of the same.
- To derive clinical implications.

MATERIAL AND METHODS

The present study was prospective in nature. It involved a sample size of 10 patients, undergoing treatment in the Department of Orthodontics and Dentofacial Orthopedics, S.D.M. College of Dental Sciences and Hospital, Dharwad, Karnataka.

The study-design was reviewed and approved by the institutional ethical and review committee. Inclusion criteria for selection of samples included in this study consisted of ten patients with age in the range of

18-24 years, with a mean age of 21 years and overbite in the range of 4.2 - 5.2 mm, with a mean overbite of 4.44mm. Though no discrimination was done on the basis of gender, the sample consisted of all female patients with dental deep bites of 4mm (mean, 4.2mm) and increased incisor exposure (at rest) of more than 4mm below the upper lip requiring incisor intrusion. The teeth requiring intrusion had adequate alveolar bone support and healthy periodontium with no underlying systemic disease. Incisors included for intrusion were upright or minimally proclined with incisor inclination ranging from 102^{o}-115^{o} in relation to Sella Nasion plane. The mini-implant (Absoanchor), with length of 6mm and 1.4 mm head diameter, was fixed in the interdental region between the two central incisors below the anterior nasal spine. The insertion site chosen was measured from a guide bar on the IOPA radiographs. All implants were placed by a single clinician. The implants were positioned at the maximum thickness of the interdental bone. The archwires used during the intrusion of maxillary incisor after the initial alignment phase were 0.018 inch stainless steel archwire with utility design engaging four incisors and two molar, bypassing the canine and premolar in a pre-adjusted edgewise appliance (.O22" MBT) (Fig 1a, 1b).

Figure 1 a Pre intrusion intraoral photograph

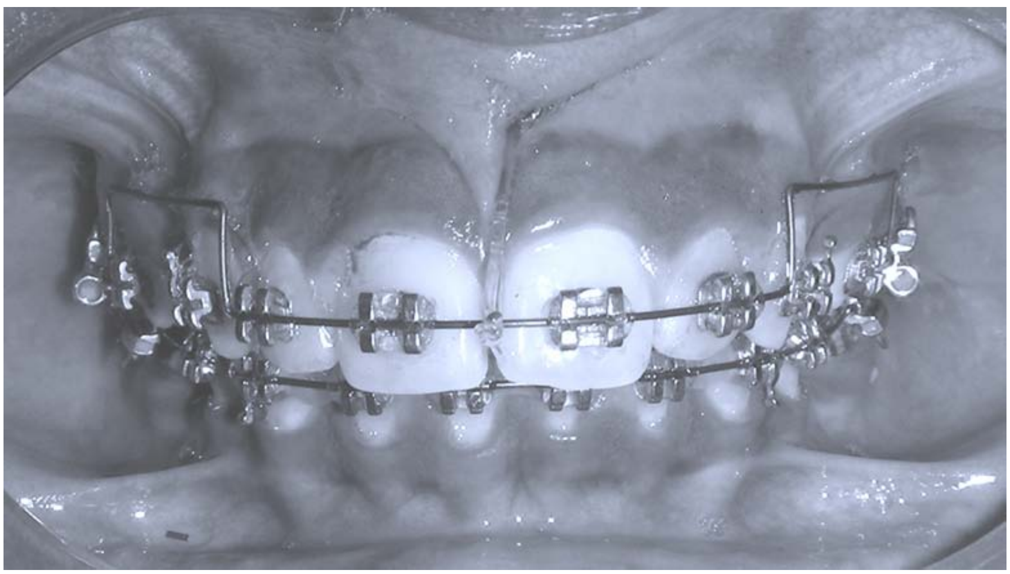
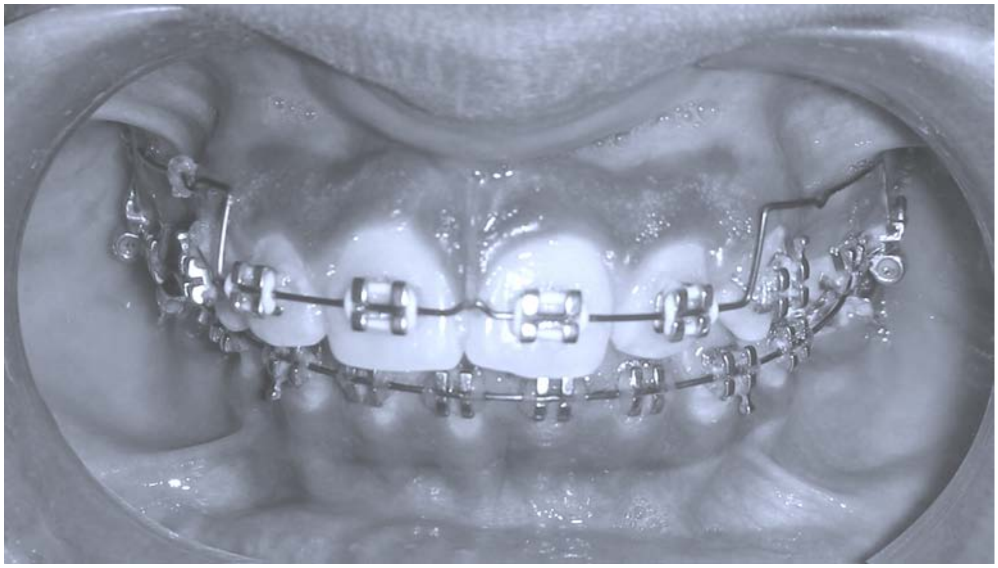


Figure 1 b Post intrusion intraoral photograph



The TAD was loaded immediately with no waiting period, followed by loading of orthodontic forces by means of elastic zing string. A force of 60 grams was applied by stretching the zing string. Patients were recalled at four week intervals until a desired intrusion was achieved. The zing string was changed to deliver the required force.

Lateral cephalograms were taken and study models were prepared before the intrusion of anterior teeth was started (time period T1) and after intrusion was achieved (time period T2).

Tracings were made and 21 dental variables (TABLE 1a, 1b, 1c, 1d and Figs. 2 and 3) were measured on the individual cephalograms at T1 and T2.All registrations (tracing and measurements) were done twice by the same observer for final evaluation, and the mean value of the double registrations was used. No correction for magnification was taken into consideration. Since the incisal edge, when used for evaluating the amount of intrusion, would falsify the result, measurements were taken from a point centroid "I" which lies at the midpoint between the incisal edge of the incisor and the root apex. Both maxillary and mandibular incisors, including the posterior teeth, were evaluated for any orthodontic tooth movement which might have lead to bite opening and would falsify the result of true incisor intrusion.Model analysis included overbite measurement, which was calculated using digital calipers to measure the amount of intrusion achieved.

Table 1a

A. True intrusion of maxillary incisor intrusion

Point I_1- PP	Perpendicular distance between centroid of maxillary central incisor and the palatal plane.
Point I_1- SN	Perpendicular distance between centroid of maxillary central incisor and the Sella Nasion plane.
Io_1- PP	Perpendicular distance between incisal edge of maxillary central incisor and the palatal plane.
Io_1-SN plane	Perpendicular distance between incisal edge of maxillary central incisor and SN plane.
Overbite:	Vertical overlap of the upper and lower central incisors perpendicular to the occlusal plane.
Stms-U1	Distance between stomium superioris and the incisal edge of maxillary incisor projected on vertical reference plane.

UL1 – SN	Posterior inferior angle between FH and long axis of the maxillary central incisor .
UL1-FH	Posterior inferior angle between SN and long axis of the maxillary central incisor.

Table 1b

Table 1c

A. Extrusion of posterior teeth

SN-GoGn	Relates the lower border of the mandible to the anterior cranial base.
Y axis on FH plane	The angle between S-Gn and frankfurt horizontal plane.
Y axis on SN plane	The angle formed by S-Gn and Sella –Nasion plane.
Gonial angle	Ar –Go-Me angle is an expression for the form of the mandible ; a large angle indicaes tendency to a posterior rotation of the mandible.
UM6-PP	The perpendicular distance between the mesiobuccal cusp tip of the maxillary first molar and the palatal plane.
LM6-MP	The perpendicular distance between the mesiobuccal cusp tip of the mandibular first molar and the mandibular plane.
Basal plane angle	Is the angle between palatal and mandibular planes and relates the lower border of the mandible to the maxillary plane.
PP-Occlusal plane	Is the angle between palatal plane and the occlusal plane.
Lower Facial height	It is measured from anterior nasal spine to menton.

Table 1d

D) Vertical and angular movements of lower incisors	
Io_2-MP (mm)	The perpendicular distance between incisal edge of mandibular incisor and mandipular plane.
Point I_2 - MP (mm)	The perpendicular distance between point Im and mandibular plane.
LI –MP (degrees)	The angle formed between long axis of mandibular central incisor and mandibular plane.

Fig 2. Pre-treatment tracing

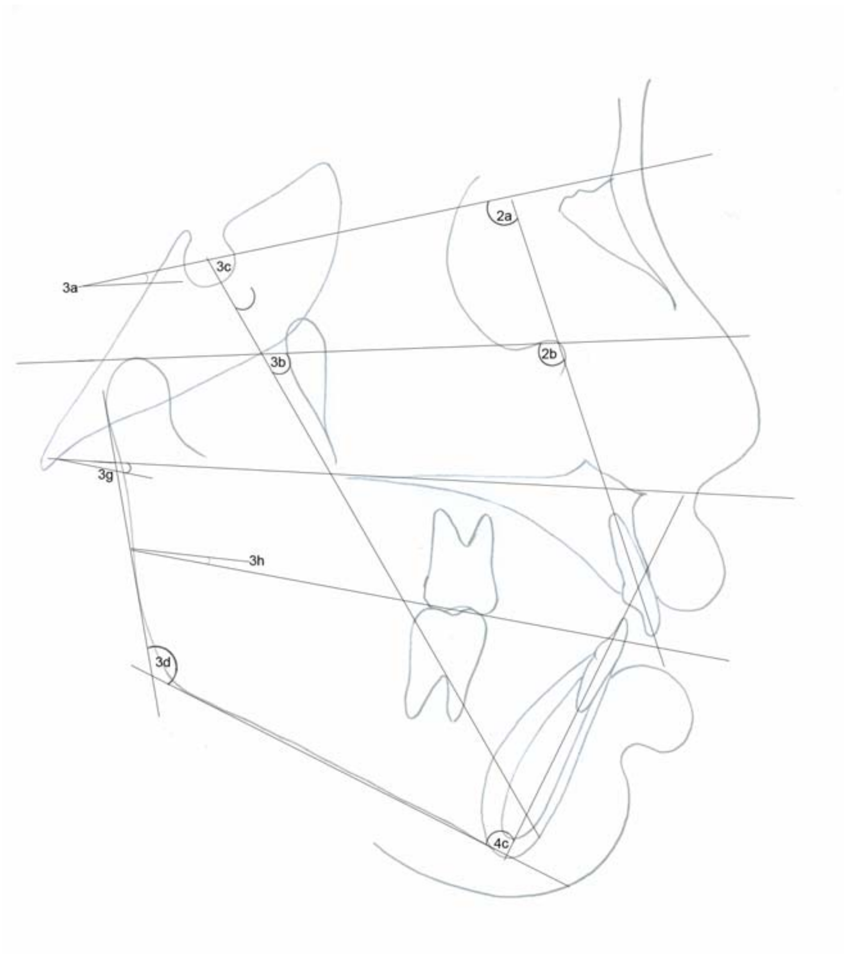
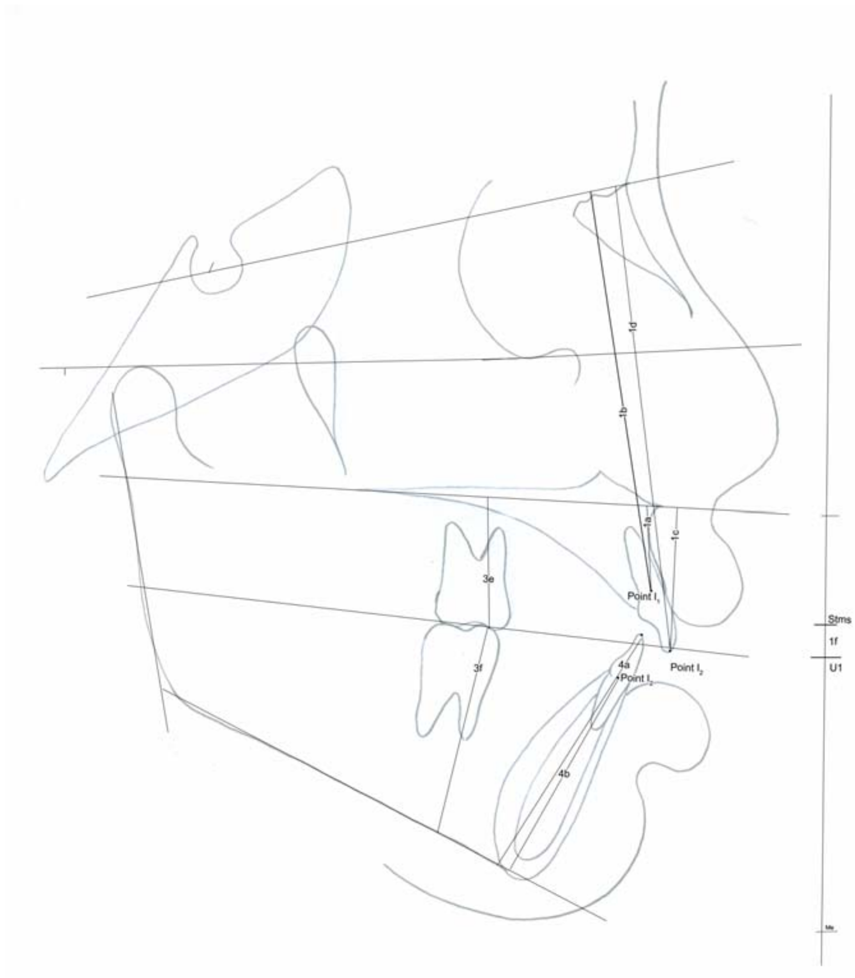


Fig. 3 Post-treatment tracing



Statistical methods:

The mean and the standard deviation were calculated for all cephalometric and model measurements at T1 and T2 stages. The mean change in cephalometric parameters was subjected to paired t-tests to determine whether the change was significant. The correlation coefficient r (Pearson) was used to describe the relationship between the overbite and the cephalometric and study model parameters. $p < .05$ confidence level was considered significant.

Results:

The changes induced by the usage of mini-implant for anterior deep bite correction are

demonstrated in Table 2 and 3 .

Table 2

Measurement	Treatment	Mean	Std.Dv.	P value
Point I_1-PP (mm)	Pre intrusion	21.3	2.2136	
	Post intrusion	18.5	2.2730	0.0000
Point I_1-SN(mm)	Pre intrusion	74.1	4.1753	
	Post intrusion	71.7	4.0565	0.0001
I_0 -PP(mm)	Pre intrusion	30.8	2.2998	
	Post intrusion	28.0	2.4037	0.0000
I_0-SN(mm)	Pre intrusion	84.7	5.0343	
	Post intrusion	82.4	4.5265	0.0006
Overbite (mm)	Pre intrusion	4.2	0.7027	
	Post intrusion	1.8	0.6413	0.000
Stms-U1(mm)	Pre intrusion	6.8	2.8597	
	Post intrusion	4.1	2.0790	0.0000

Table 3

SN-GoGn(degrees)	Pre intrusion	33.0	4.9216	
	Post intrusion	32.2	3.9101	0.4830
I_{02} -MP(mm)	Pre intrusion	45.4	2.7568	
	Post intrusion	45.3	2.7101	0.6783
Point I_2 - MP	Pre intrusion	35.6	2.5033	
	Post intrusion	35.4	2.2998	0.6783

LM6-MP(mm)	Pre intrusion	32.4	3.5340	
	Post intrusion	32.7	3.5292	0.2789
L1-MP(degree)	Pre intrusion	96.0	5.0772	
	Post intrusion	95.3	5.1435	1.000
UM6-PP (mm)	Pre intrusion	24.0	1.6330	
	Post intrusion	23.9	1.6193	0.5911
SN-GoGn(degrees)	Pre intrusion	33.0	4.9216	
	Post intrusion	32.2	3.9101	0.4830
Y axis on FH(degrees)	Pre intrusion	62.1	4.7481	
	Post intrusion	62.2	4.9621	0.8321
Y axis on SN(degrees)	Pre intrusion	68.0	3.6515	
	Post intrusion	68.1	3.6347	0.7804
Lower facial height	Pre intrusion	68.0	3.8873	
	Post intrusion	68.3	4.0565	0.1934
PP-Occlusal plane	Pre intrusion	11.9	2.6854	
	Post intrusion	11.0	2.8674	0.1467
Basal-plane angle	Pre intrusion	28.7	3.4657	
	Post intrusion	28.1	3.2128	0.1405

Dental parameters:

The cephalometric and cast analysis showed that a significant amount of intrusion was achieved following the use of mini-implants (TAD's), with a mean value of 2.8 mm when measured from point I_1 (centroid) in relation to the palatal plane. This value was statistically and clinically significant (p<.001).

The mean pre-treatment value of the posterior inferior angle formed by the long axis of incisor to Frankfurt plane was 112.7 ± 3.62^{0} while the mean post-treatment value for the same variable was 113.1± 3.81^{0}.The mean value of the difference of the pre and post-intrusion value of the variable was 0.4 ± 2.11^{0}. The probability value (0.6290) and test value (0.5450) for this variable showed that the change in the value was not statistically significant (p>.001). Maxillary and mandibular molars were not significantly extruded.

Skeletal parameters:

After the correction of the deep overbite, lower facial height was not significantly increased. The Basal plane angle was also not increased (p>.001) and the vertical dimension of the face was maintained.

Average duration of intrusion achieved was 3.32 ± 0.7 months.

The rate of intrusion of incisors per month as calculated by the given formula:

Rate of intrusion of incisors = Mean amount of intrusion / Mean treatment time recorded per month = 2.8/3 = 0.8 mm /month.

DISCUSSION

Certain clinical conditions often demand selective intrusion of anterior teeth like Class II, Div.2 cases where only the incisors are extruded. Similarly, Class II, Div.1 patients often require the intrusion of only two or four incisors up to the level of the canines[11]. Hence, the present study evaluated only the amount of true incisor intrusion achieved and not the en masse intrusion of all anterior teeth, including canines for deep overbite correction. The results revealed that a significant amount of incisor intrusion was achieved following the use of mini-implants (TAD's), with a mean intrusion value of 2.8 mm (p<.001) from point I_1 (centroid) in relation to palatal plane, in a mean time period of 3.3 ± 0.7 months. This was both clinically and statistically significant.

Since the incisal edge and the root apex are not good reference points being dependent on tooth inclination changes, incisor centroid was chosen as a choice of reference plane to evaluate the amount of intrusion[12]. Measurements were taken from midpoint 'I', located between the incisal edge and the root apex of the upper incisor. This was done on the pre-treatment radiographs and the same point was relocated on the post-intrusion radiograph by means of a template[13]. Julia et al[12] had conducted a meta-analysis to quantify the amount of true incisor intrusion attained during orthodontic treatment using electronic databases- PubMed, Medline, Medline In-Process & Other Non-Indexed Citations and EBM reviews. They concluded that in non-growing patients, the segmented arch technique can produce 1.5 mm of incisor intrusion in the maxillary arch and 1.9 mm of intrusion in the mandibular arch. The present study revealed a significant amount of intrusion which was achieved following the use of mini-implants (TADs) without any root resorption of incisors as evaluated by IOPA's. This can be attributed to the use of very light intrusive forces (60gms) which were applied for a brief period of time (mean time period of 3.3± 0.7 months).When compared to the conventional continuous arch wire technique as documented by Berstein et al[14], which accomplishes most of the leveling by extrusion of the premolars, and segmented arch technique[15,16] which achieves incisor intrusion at the expense of extrusion of molars, correction of deep bite using mini-implants (TADs) provides absolute anchorage without any undesirable side effects on the molars. Mandibular and maxillary plane angle was maintained and no increase in lower facial height was observed. In patients with unfavorable growth patterns where muscles are weak, extrusion of molars can occur more readily resulting in worsening of the facial profile due to the downward rotation of the mandible. In such cases, extra-oral anchorage reinforcement, like high pull headgear, would be required to control the potential side effects. However, it results in the added requirement of patient cooperation. With mini-implants (TADs) patient cooperation is not required as its placement procedure is atraumatic and painless. In addition, mini-implants (TADs) once placed below the anterior nasal spine, are highly stable[17].

Since intrusive forces are applied via mini implants (TADs), molars are not strained like conventional or segmental arch mechanics in which a tip back bend is given; therefore, there is no effect on posterior segments of the dentition. Intrusive forces when applied labial to the center of resistance, results in flaring of the anterior segment due to biological constraints[18] and hence wire was cinched back in the present study. The change in incisor inclination was observed during the application of intrusive forces and was not statistically significant (0.4^{o}, NS). Alqabandi et al[19] have compared the effects of rectangular and continuous arch wires with a mild reverse curve of Spee on the axial inclination of lower incisors during the initial stage of treatment. They reported that the change in lower incisor inclination was the same in both groups and lower incisor proclination will occur in both groups unless they are cinched back. The cinch back produced in rectangular wire will inculcate torque into the wire which may affect the amount of net intrusion achieved . For instance, the incorporation of the labial root torque into the wire by the cinch back will result in increased intrusive forces on the anterior teeth[20].

Hence, in the present study, a round wire was preferred over a rectangular wire to evaluate the amount of the true intrusion achieved. Torque, though produced in the round wire as well, will be minimal.

Conclusion:

We can conclude that:

Single mini implant (TAD) placed below the anterior nasal spine is an effective and biologically sound method to achieve true incisor intrusion. This intrusion is absolutely indicated in some cases for deep overbite correction like in patients with an unfavorable growth pattern, Class II, Div. 2 cases, periodontally compromised cases and patients with missing molars.

The upper incisors were intruded to a mean value of 2.8 mm in a relatively short period of time (mean time period of 3.3 months) provided light and continuous forces are maintained throughout the intrusion period. Molars were not extruded following the intrusion of anterior teeth. No increase in mandibular and maxillary plane angle was observed.

It is a convenient and highly efficient method for deep overbite correction with decreased chairside time and without any requirement of patient compliance.

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