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Mini-Screw for Deep Bite Correction: A Prospective Clinical Trial

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Abstract: *Correction of deep bite problem through intrusion of maxillary incisors is done by several accepted treatment modalities. The objective of this prospective study was to evaluate the skeletal, dental and soft tissue effect of the maxillary incisors intrusion using miniscrews.*

Methods: *The sample comprised of 15 post pubertal patients (6 females and 9 males) with mean age 19.5 ± 2.5. They underwent maxillary incisors intrusion using miniscrews. Pre and post treatment lateral cephalometric x-rays and study models were made to evaluate the dento-skeletal effects. During the study period no other intervention was attempted. Paired t-test was used to study the changes after treatment.*

Results: *The mean amount of overbite correction was 2.6 ± 0.8 (0.49mm per month) and the mean amount of incisors retraction was 1.5± 0.9. Although there was statistically significant decrease in the mean overbite, no significant changes were found in skeletal, soft tissue and intermolar width measurements.*

Conclusion:*Intrusion of maxillary incisors was effective in treatment of deep bite and gummy smile caused by over eruption of upper incisors. Molar anchorage was conserved despite constriction of inter canine area.*

Keywords: *miniscrew, deep overbite, incisors intrusion*

I. Introduction

Deep overbite has been considered as one of the most common malocclusion problems that is difficult to be treated and retained. Correction of deep bite is often a main objective during orthodontic treatment because of its potentially detrimental effects on periodontal health, tempromandibular joint function, as well as esthetics. Prevalence of deep overbite was found to range from 21% to 26% in normal population compared to 75% in orthodontic patients [1],[2]

Extrusion of posterior teeth is one of the most common methods to correct deep bite in growing patients[3]. Intrusion of upper and/or lower incisors is a desirable method to correct deep bite in many adolescents and adult patients. This can be done by either continuous arch wire that bypass the premolars and canines (bypass arches) or with segmental arch mechanics [4]. Flaring of incisors may be effective for correction of mild to moderate deep bite. This option may be best indicated in patient with lingually tipped incisors, that can withstand proclination of upper and lower incisors, such as Class II div 2 patients[5], [6]. Relative intrusion (combining intrusion of upper and lower incisor with extrusion of posterior teeth) is the treatment of choice for adolescents. Bite plates and reverse curved arches are recommended in such cases [7].

Maxillary incisor intrusion is the treatment of choice in non-growing patients (mainly) to correct deep bite and gummy smile caused by super-eruption of maxillary incisors [8], [9]. Three treatment modalities were proved to effectively decrease deep overbite by intruding upper incisors: J-hooks headgear, intrusive arches and mini-screw supported intrusion system. The intrusion effect of j-hooks headgear may vary since it depends upon patient cooperation[10]. Although, intrusive arches (utility and Connecticut) are an alternative in wide spread use; undesirable side effects such as extrusion of posterior teeth and flaring of anterior teeth may compromise their efficiency [11], [12].

Recently, mini-screws were used to provide anchorage for intruding maxillary incisors by application of force close to the center of resistance with no counteractive movement in molars. However, extra cost, patient tolerance and looseness of the screw during treatment may compromise their use[13], [14], [15].

Since deep overbite correction is accompanied by unwanted side effects. The present study aimed to evaluate the efficiency of using mini-screws in maxillary incisors intrusion

II. Materials And Methods

The sample was selected from Egyptian population who sought orthodontic treatment at the out patient clinic, Department of Orthodontics and dentofacial orthopedics, Faculty of Oral and Dental Medicine, Cairo University. Fifteen post pubertal patients (6 females and 9 males) with deep bite and with mean age 19.5 ± 2.5 participated in this study. The inclusion criteria for selection of both treatment groups were the following: post-pubertal patients dental Class I or Class II malocclusion, excessive gingival display on smiling, 4mm overbite or greater and super eruption of maxillary incisors. While the exclusion criteria were: having missing teeth on maxillary anterior area, any history of trauma or root canal treatment, previous orthodontic treatment and having any hormonal disorder or syndromes. Detailed case history was taken for each patient. Clinical examination and an individualized diagnostic chart were made. Data from history, clinical examination and analysis of diagnostic records were assessed to fulfill the inclusion criteria. The study was approved and supported by the medical scientific ethics committee of Cairo University. A consent form was obtained from all the patients and/or parents after explanation of the purpose of the study.

A pre-adjusted edgewise appliance was used (0.022" x 0.028") Roth prescription (series 2000; Ormco, Glendora, Calif). Alignment was carried out in the upper arch using 0.016" and then (0.016" x 0.022") nickel-titanium wires. Followed by (0.016" x 0.022") St.St. stabilizing arch wire (Ormco). After alignment, the brackets of the 4 maxillary incisors were laced by ligature wire and the stainless steel wire was cut into two buccul segments and a maxillary anterior segment.

Intrusion of maxillary incisors was done using two mini-screws (Jeil medical Co., Seoul, Korea), 1.4mm in diameter and 6mm in length. The mini-screws were placed at the mucogingival junction distal to the maxillary lateral incisors. The mini-screws were loaded 2 weeks later with medium super-elastic nickel-titanium closed-coil springs (3M Unitek™ TAD constant force coil spring 3mm medium force). A force of 100 g. was measured using a calibrated Dontrix gauge (Correx; Ortho Care, Saltaire, United Kingdom). (Fig. 1)

Control appointments were scheduled every 4 weeks, and the force level were checked at every appointment and adjusted whenever needed. No other treatment was performed until suitable overbite was achieved. Termination of intervention was done after 6 months of treatment or if one of the following was observed 1) Reaching adequate overbite 2) Sever inflammation or mini-screws failure.

The outcome measures that were evaluated were; rate of incisor intrusion, skeletal, dental and soft tissue effects. Also, patient tolerance and pain experience was evaluated using a questionnaire with pain assessed as mild, moderate or severe. Evaluation of the skeleto-dental changes was carried out using measurements in the lateral cephalometric radiograph and study models. Lateral cephalometric images were taken for each patient before appliance insertion (T0) and at the end of the study period (T1). The same investigator traced all images over a negatoscope in a dark room using 0.3 mm pencil. Dental and soft tissue measurements are presented in Fig 2. Cervical vertebrae maturation was assessed using lateral cephalometric radiograph (CVS5, CVS6) phase [16] to assure that all selected patients for the present study were post pubertal.

Upper and lower alginate impressions were taken before and after intrusion and were poured into dental stone to obtain upper and lower models. Measurements before start of intrusion (T0) and after 6month of treatment or achieving normal overbite were done (T1). With the models in centric occlusion, the amount of greatest vertical overlap (overbite) of maxillary central incisors was marked on the corresponding mandibular central incisors with a pencil (0.3mm) parallel to the occlusal plane then the casts were disengaged. The distance between the mark and the incisal edge was measured using a digital Boley gauge (USA). With the models in centric occlusion, the amount of greater horizontal overlap (Over jet) was measured using a digital Boley gauge. Inter-canine width: (distance between canines cusp tips), Inter-molar width: (distance between upper first maxillary molar centric fossa) were also measured.

III. Statistical Analysis

The predicted minimum sample size (n) was 11 cases. Over-sampling was done to compensate for dropouts or any failures. After a 2-week interval, 5 study models and 5 cephalograms were randomly selected and re-measured by the same investigator for reproducibility of the measurements. Measurement error was assessed using Dahlberg's formula: Measurement error = $\sqrt{\frac{d^2}{2n}}$; Where (d) is the difference between the measurements and (n) is the number of duplicates. The errors were 0.28 mm for linear measurements and 0.5°for angular measurements in the lateral cephalometric radiographs. Also, it was 0.12 mm for the cast measurements. Numerical data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests. Numerical data were presented as mean and standard deviation (SD) values. Paired t-test was used to study the changes after treatment. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

® IBM Corporation, NY, USA.

® SPSS, Inc., an IBM Company.

IV. Results

The total rate of intrusion was 2.6 ±0.8 and the monthly rate of intrusion was 0.40 mm/month. Table 1 and 3 show that there was no statistically significant change in mean skeletal and soft tissue measurements after treatment. Regarding dental measurements there was a statistically significant decrease in mean U1-VCP (mm), CR-VCP (mm), UI-PP (mm), CR-PP (mm), U1-HCP (mm) and CR-HCP (mm) measurements after treatment as shown in table 2 and Fig. 3.

There was a statistically significant decrease in mean over bite 2.6 ± 0.8 mm and inter-canine width 0.6 ±0.5 measurements after treatmentwhile no statistically significant changes in mean inter-molar width and other dental measurements after treatment. (Table 4)

V. Discussion

Deep bite is a complex orthodontic problem that needs to be corrected. Maxillary incisor intrusion is recommended in non-growing patients with deep overbites, especially in those with gummy smile [17]. The position of maxillary incisors, especially in relation to the upper lip is a key factor in determining the type of treatment, since overbite correction with maxillary incisor intrusion in patients with insufficient incisor display leads to flattening of the smile arc and reduces smile attractiveness [18], [19].

The only applied force was the maxillary incisors intrusion force to evaluate the genuine treatment efficiency of the mini-screw-supported intrusion system. It is suggested that an intrusive force should be constant, and low load-deflection mechanisms should be used during incisor intrusion [8].

Different force ranges from 40 to 100 g have been used in recent literature. Steenbergen compared the effect of 40 g and 80 g[20]. Polat used 80 g [14], and Senisik used a range from 90 to 100 g[12], While Deguchi et al used 80-120 g [10].

Conventional intrusion-arch mechanics frequently cause labial tipping of the incisors, which does not always give favorable treatment outcomes [11], [21] .To minimize this effect the forces were applied through the center of resistance (CR) to intrude the teeth without producing any labial or lingual rotation. The center of resistance can be estimated to be located near the geometric center of their root. In-vitro studies with different methods such as the laser reflection technique, holographic interferometry [22].photo-elastic stress analysis the finite element method [23] and in-vivo studies [24] were performed to determine the CR of the incisors. All showed that the CRs of the 4 incisors lie 8 to 10 mm apically and 5 to 7 mm distally to the lateral incisors. By placing the screws laterally to the maxillary lateral incisors, the intrusive force could be applied close to the CR of the 4 incisors [25].

Most of previous studies used either the incisor crown tip or the apex for the evaluation of the amount of intrusion. If attainment of true intrusion is the purpose of treatment, its evaluation should be made using the center of resistance of the incisor. Only few studies have incorporated the CR for the measurement of the amount of intrusion [14], [26]. Therefor the CR of the maxillary central incisor was determined for each patient rather than for the anterior segment because of its ease of location and high reproducibility [27], [28]. It was taken as the point located at one-third of the distance of the root length apical to the alveolar crest [29].

Two reference planes were constructed for measurement confirmation of dental movements. The first reference plane was the constructed horizontal plane (drawn $7^{o}$to the SN plane) and the second was constructed vertical at the Sella point. As the palatal plane could not be reliable due to its position near to the area of intrusion. Polat-ozsoy found that the palatal plane moved after intrusion[27].

After intrusion there was a statistically significant decrease in mean U1-VCP mm, CR-VCP mm, U1-PP mm, CR-PP mm, U1-HCP mm, and CR-HCP mm showing that the maxillary incisors moved upward and backward. The possible reason for the maxillary incisor retraction could be the direction of the intrusion force, which may be applied distal to the CR of the four incisors, these results agree with those of recent studies [10], [26].Further, comparison of this study with previous reports of incisor intrusion with mini-screws cannot be made because of the differences in the direction of force application and measurements. In this study mini-screws placed between laterals and canines resulting in over bite correction by 2.6 ±0.8 mm while using a mini-implant placed between the maxillary central incisors by Ohnishi et al in obtained 3.5 mm of incisor intrusion relative to the maxillary incisor tip[13]. Kim et al applied a segmental intrusion force between the maxillary central incisors [15].The amount of true maxillary intrusion was not given in these studies.

Inter molar width was preserved in the present study however the inter canine width significantly decreased and that was one of the side effects of intrusion mechanics as mentioned by Burstone.

The side effects in this study were minimal, and patient tolerance was positive. Two mini-screws were loosened in the first month of orthodontic force loading. These were replaced immediately. Soft tissue changes were minimal. Although the distance between labralis superior and the E-plane decreased but it was not statistically significant.

According to the result of this study, maxillary incisor intrusion with mini-screws was effective in reducing the amount of protrusion. Hence it may be advocated in patients with deep bite and proclined incisors.

VI. Conclusions

Intrusion of maxillary incisors by mini-screw-aided segmented mechanics could be efficiently achieved with a rate of 0.49 mm per month. The intrusion mechanics using mini-screws tends to retract maxillary incisors. Anchorage was conserved despite constriction of inter canine area.

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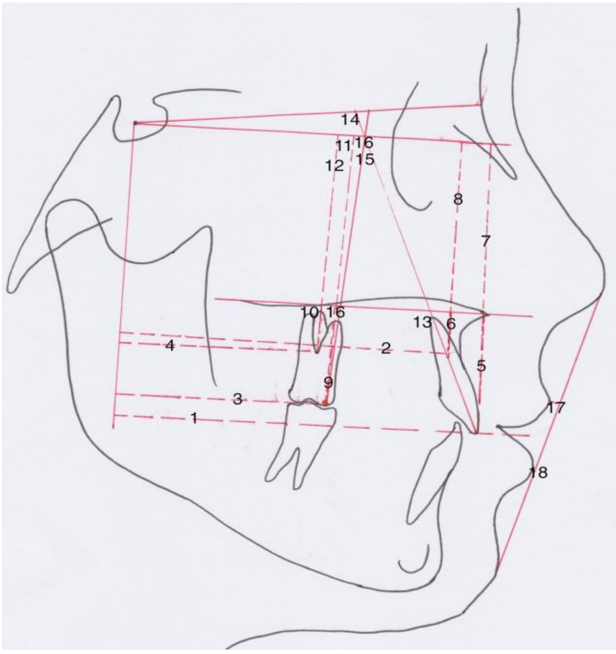
Figures:

(Fig. 1) Mini screws-supported upper incisor intrusion. (Start of treatment T0)



(Fig. 2) Dental and soft tissue measurements.

1. U1-VCP, 2. CR-VCP , 3. U6-VCP , 4.CR-VCP , 5. U1PP, 6. CR-PP , 7. U1-HCP, 8. CR-HCP , 9. U6-PP, 10. CR-PP , 11. U6-HCP , 12. CR-HCP , 13. U1-PP^0, 14. U1-SN^0, 15. U1-HCP^0, 16. U6-PP^0, 17. LS-Eplane , 18. LI-Eplane

(Fig. 3) Maxillary incisors intrusion using miniscrews (end of treatment)

Tables:

Table 1: Skeletal cephalometric measurements before and after treatment

Skeletal measurements	T0	T1	Change	P-value
Anteroposterior SNA (°)	81.2 ± 4.1	82.2 ± 5.6	1 ± 4.7	0.426
SNB (°)	75.2 ± 3	75.2 ± 3	0 ± 0	1.000
ANB (°)	6 ± 3.1	5.8 ± 3	-0.2 ± 0.4	0.083
A-VCP (mm)	69.4 ± 4.8	69.1 ± 4.8	-0.3 ± 0.4	0.051
B-VCP (mm)	58.9 ± 6.6	58.9 ± 6.6	0 ± 0	1.000
AB perpendicular to HCP Vertical	8.8 ± 2.6	8.5 ± 2.7	-0.3 ± 0.6	0.120
GoMe.SN (°)	37.9 ± 7.3	37.9 ± 7.3	0 ± 0	1.000
N-ANS (mm)	53.9 ± 3.5	53.7 ± 3.5	-0.2 ± 0.5	0.189
ANS-Me (mm)	72.6 ± 5.5	72.7 ± 5.6	0.1 ± 0.3	0.164
ANS-HCP (mm)	44.8 ± 3.9	44.7 ± 3.9	0.1 ± 0.3	0.164
PNS-HCP (mm) Rotation	42.2 ± 2.7	42.1 ± 2.8	0.1 ± 0.5	0.334
SN.PP (°)	9.1 ± 3.7	9 ± 3.8	0.1 ± 0.3	0.157
GoMe.PP (°)	27.7 ± 7	27.6 ± 7.1	0.1 ± 0.4	0.334

*: Significant at P ≤ 0.05

Table 2: Dental cephalometric measurements before and after treatment

Dental measurements	T0	T1	Change	P-value
Anteroposterior U1-VCP (mm)	73 ± 5.6	72 ± 5.2	-1 ± 1.7	0.038*
CR-VCP (mm)	68.8 ± 4.9	67.3 ± 4.4	-1.5 ± 0.9	<0.001*
U6-VCP (mm)	44.1 ± 4.9	44.1 ± 4.9	0 ± 0	1.000
Molar CR-VCP (mm)	42.3 ± 4.5	42.3 ± 4.5	0 ± 0	1.000
Vertical UI-PP (mm)	32.9 ± 2.7	30 ± 2.7	-2.9 ± 1.1	<0.001*
CR-PP (mm)	17 ± 2.8	14.7 ± 2.9	-2.3 ± 0.8	<0.001*
U1-HCP (mm)	77.7 ± 4.9	74.9 ± 4	-2.9 ± 2	<0.001*
CR-HCP (mm)	61.3 ± 4.4	58.7 ± 3.2	-2.6 ± 1.9	<0.001*
U6-PP (mm)	24.9 ± 2.3	24.9 ± 2.3	0 ± 0	1.000
Molar CR-PP (mm)	13.9 ± 2.2	13.9 ± 2.2	0 ± 0	1.000
U6-HCP (mm)	67.1 ± 5.4	67.1 ± 5.4	0 ± 0	1.000
Molar CR-HCP (mm)	56.5 ± 3.8	56.5 ± 3.8	0 ± 0	1.000
Rotation U1-PP (°)	109.7 ± 7.3	112 ± 10	2.3 ± 5.7	0.146
U1-SN (°)	100.2 ± 6.8	102.2 ± 9.2	2 ± 5.5	0.172
U1-HCP (°)	105.9 ± 9.9	108.1 ± 11.3	2.2 ± 5.9	0.170
U6-PP (°)	84.3 ± 6.5	84.3 ± 6.5	0.03 ± 0.1	0.334
U6-SN (°)	74.3 ± 4.6	74.2 ± 4.6	-0.1 ± 0.3	0.334
U6-HCP (°)	85.3 ± 9.8	85.2 ± 9.6	-0.1 ± 0.3	0.334

*: Significant at P ≤ 0.05

Table 3: Soft tissue cephalometric measurements before and after treatment

Soft tissue measurements	T0	T1	Change	P-value
LS-E plane (mm)	-0.8 ± 2.4	-1.1 ± 2.1	-0.3 ± 0.6	0.102
LI-E plane (mm)	1.1 ± 2.2	1 ± 2.2	-0.1 ± 0.3	0.317

*: Significant at P ≤ 0.05

Table 4: Dental cast measurements before and after treatment

Dental measurements	T0	T1	Change	P-value
Over bite (mm)	5.2 ± 0.7	2.6 ± 0.8	-2.6 ± 0.8	<0.001*
Over jet (mm)	4.1 ± 1.3	3.7 ± 1.1	-0.4 ± 1.2	0.137
Inter-canine width (mm)	37.6 ± 4.2	37 ± 4	-0.6 ± 0.5	0.001*
Inter-molar width (mm)	49.7 ± 3.2	49.7 ± 3.2	0 ± 0	1.000

*: Significant at P ≤ 0.05