Deepbite correction with incisor intrusion in adults: A long-term cephalometric study

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Introduction: The purpose of this study was to investigate the long-term stability of deep overbite correction with mandibular incisor intrusion with utility arches in adult patients. Methods: Pretreatment, posttreatment, and 5-years postretention lateral cephalograms of 31 patients (mean age, 26.8 years; range, 24.1-30.9 years) with Class II Division 1 malocclusion and deepbite, treated by maxillary first premolar extraction and mandibular incisor intrusion, were traced and measured. Results: Significant decreases in overjet and overbite (6.4 ± 1.2 and 3.9 ± 0.7 mm, respectively), significant retroclination (17° ± 1.9°) and retraction (3.8 ± 1.1 mm) of the maxillary incisors, and significant increases in protrusion (0.8 ± 1.5 mm), proclination (0.6° ± 0.9°), and intrusion (2.6 ± 1.4 mm) of the mandibular incisors were observed at posttreatment. At postretention, there were statistically significant but clinically unimportant increases in overjet and overbite (0.4 ± 0.2 and 0.8 ± 0.4 mm, respectively) and extrusion of the mandibular incisors (0.8 ± 1.1 mm). Conclusions: Correction of deepbite in nongrowing patients by mandibular incisor intrusion with a utility arch can be considered effective and stable.

Correction of deepbite is often a challenging step in orthodontic treatment. Untreated deepbite can cause increased anterior crowding, maxillary dental flaring, periodontal problems, and temporomandibular joint problems and can interfere with lateral and anterior mandibular movements.1-3

Deepbite can be treated orthodontically by intrusion or flaring of the incisors, extrusion or passive eruption of the buccal segments, or a combination of these.4-6 The choice of treatment depends on several factors. Extrusion of the posterior dentition, although an effective method of bite opening in growing patients,7,8 is not indicated in patients with normal incisor display or normal or low lower facial height; its stability is questionable in nongrowing patients with average to low mandibular plane angles.6,9-14 Intrusion of the maxillary incisors is indicated in patients with excessive incisor and gingival display and a large interlabial gap.13-15 Considering these facts, mandibular incisor intrusion is the most suitable deepbite treatment for adults with normal incisor and gingival display and a normal or high mandibular plane angle.

Although many studies have examined the stability of deepbite treatment, most included growing subjects. In some studies, different malocclusions or different treatment methods were assessed together, and in others the follow-up durations were short.16-19 Two studies of nongrowing subjects did not include information about long-term follow-up results and treatment stability.20,21 The purpose of this study was to investigate the long-term stability of deepbite correction with mandibular incisor intrusion with utility arches in adult patients. The null hypothesis was that dental deepbite correction with mandibular incisor intrusion in adults is stable.

MATERIAL AND METHODS

In this retrospective longitudinal study, pretreatment (T1), posttreatment (T2), and postretention (T3) lateral cephalograms of 31 patients (24 women, 7 men) with Class II Division 1 malocclusion treated with a 1-phase maxillary first premolar extraction protocol by either of the first 2 authors were used. Their mean age at the beginning of treatment was 26.8 years (range, 24.1-30.9 years). The inclusion criteria were (1) standardized lateral cephalograms available at 3 time periods, T1, T2, and T3; (2) deepbite of at least 4.5 mm; (3) normal vertical dimension represented by...
lower face height of 47° ± 3°; (4) 3 to 4 mm or less of maxillary incisor display at rest; (5) overjet of at least 6 mm; and (6) 4 mm or less crowding in the maxillary and mandibular arches.

Because of the retrospective nature of the study and because no additional x-rays were taken, ethical approval was not needed; informed consent had been obtained at T1 from all patients as the routine protocol.

The treatment protocol included intrusion of the mandibular incisors to correct the deepbite and extraction of the maxillary first premolars to correct the overjet. All patients had transpalatal arches on the maxillary first molars before the extractions. All patients had 0.018-in slot preadjusted metal brackets with the Roth prescription. In the maxillary arch, after alignment, the canines were retracted with nickel-titanium coil springs (Sentalloy; GAC International, Central Islip, NY) exerting 150 g of force on 0.016 × 0.022-in stainless steel archwires (Accuform; GAC International). The incisors were retracted by 0.017 × 0.025-in beta-titanium alloy archwires (Resolve; GAC International) with mushroom loops.

The mandibular incisors and premolars were leveled by 0.016-in nickel-titanium segments if necessary. After leveling, custom-made mandibular utility arches (0.016 × 0.022-in Blue Elfloy wires; Ormco, Glendora, Calif), activated to exert 40 g of force, were used for incisor intrusion. During this period, 0.016 × 0.022-in stainless steel stabilizing sections extending from the first molars to the first premolars were placed. The intrusive force of 40 g was checked before tying the archwire, and the force levels were checked every 4 weeks. Intrusion was considered complete when a 2-mm overbite was achieved, and a 0.016 × 0.022-in Blue Elfloy stabilization utility arch was placed. At this point, the mandibular canines were tied to the stabilizing utility arch with elastic thread if their intrusion was necessary; 0.017 × 0.025-in stainless steel wires were used for finishing in both arches. The mean active treatment time was 2.7 years (range, 2.4-3 years). Immediately after debonding, maxillary and mandibular wraparound retainers were delivered. The patients were instructed to wear the retainers 24 hours a day for the first year and only at night after that. The retention period lasted 1.5 years.

The same author (S.K.V.) hand-traced the lateral cephalograms and identified all landmarks. All hand-tracings were scanned with a scanner at 200 dpi, and Dolphin software (version 10; Dolphin Imaging & Management Solutions, Chatsworth, Calif) was used to obtain the cephalometric measurements. The measurements are shown in the Figure and Table I. The center of resistance (a point located at one-third of the distance of the root length apical to the alveolar crest) was used to evaluate the vertical positions of both the mandibular and maxillary central incisors.22

Sixty randomly chosen lateral cephalograms were re-traced and redigitized, and method error was calculated with Dahlberg’s formula.23

**Statistical analysis**

Statistical analysis was completed using the Statistical Package for Social Sciences (version 13; SPSS, Chicago, Ill).

Because the Shapiro-Wilks test showed that all data were normally distributed, treatment (T2-T1), postretention (T3-T2), and overall changes (T3-T1) were compared by repeated measurements analysis of variance (ANOVA), followed by multiple comparisons with the Bonferroni adjustment. The significance level was set at P <0.05.

**RESULTS**

The method error ranged from 0.15 mm (U1CR to PP) to 0.55 mm (L6 to MP) for the linear measurements, and from 0.25° (L1 to MP) to 0.45° (U1 to L1) for the angular measurements.

Because the sample size was 31 subjects and the 0.8-mm change in overbite in postretention period was statistically significant, the power of the study at a significance level of 0.05 was 0.86.
mandibular arch, significant intrusion of the incisors (−2.6 ± 1.4 mm) and extrusion of the molars (0.8 ± 0.6 mm) were observed. The SN to MP and ANS to Xi/Xi-PM angles did not change significantly.

Among the postretention (T3–T2) changes, there were significant increases in overjet and overbite (0.4 ± 0.9 and 0.8 ± 0.4 mm, respectively). In the mandibular arch, significant extrusion of incisors (0.8 ± 1.1 mm) was observed. Other variables did not show any changes.

During the overall period (T3–T1), the maxillary incisors were retroclined (16.9° ± 0.4°) and retracted (−3.7 ± 1 mm), and the mandibular incisors were protruded (0.7 ± 1.1 mm) significantly; these changes contributed to a significant decrease in overjet (−6.3 ± 1.2 mm) and an increase in the interincisal angle (21.4° ± 5.2°). The mandibular molars were extruded, and the mandibular incisors were intruded significantly; these changes resulted in a significant reduction in overbite. The vertical positions of the maxillary incisors and molars and the proclamation of the mandibular incisors had no significant changes from T1 to T3.

**DISCUSSION**

The aim of this study was to evaluate the long-term stability of deepbite correction in adults with mandibular incisor intrusion using the bioprogressive sectional arch technique. The null hypothesis was that dental deepbite correction with mandibular incisor intrusion in adults is stable; based on our results, the null hypothesis was not rejected.

The mean overbite correction at T2 was 3.9 mm, which corresponded to 66.1% of the pretreatment overbite. This ratio is higher than the ratio reported in the study of Weiland et al20 using adult patients. In that...
study, 2 different mechanics were used, and the correction values were 3.17 and 3.56 mm, corresponding to 58.8% and 58.1%, respectively. The difference could be because in our study, the posttreatment overbite value was slightly lower than that reported by Weiland et al. In our study, a statistically significant but clinically insignificant relapse of 0.8 mm was observed at T3, and the mean overbite (2.8 mm) at T3 was acceptable. In previous studies, either similar or higher relapse values ranging from 0.1 to 2.1 mm were reported. However, when our results were compared with those of previous studies, there are differences in terms of factors that were previously reported to have affected overbite stability, such as the subjects’ growth potential, growth pattern, muscle strength, adaptation capacity, follow-up and retention durations, initial overbite value, and retainer type. 

We used incisor centroid as a reference point and evaluated true intrusion, as was proposed by Ng et al. At the end of the treatment, 2.6 mm of mandibular incisor intrusion was achieved. Similar mean intrusion values between 1.1 and 3 mm were reported in previous studies where deepbite correction was accomplished by only mandibular incisor intrusion with segmental or sectional arches. An important consideration with regard to centroid while evaluating the mean incisor intrusion value is that although it was claimed to be independent of any change in the axial inclination, the possibility that centroid can slightly move apically because of proclamation of the incisors, resulting in somewhat higher than actual intrusion values, cannot be ruled out. In this study, an 0.8-mm relapse was observed at T3. Although this relapse was statistically significant, it was not clinically important because the overbite value at T3 was well within the normal range, and the overall intrusion value of 2.1 mm was quite remarkable.

The interincisal angle is believed to play a critical role in the stability of deepbite correction. Berg suggested that the interincisal angle should be less than 140° at the end of treatment for stability of deepbite treatment. According to Houston, an approximate interincisal angle of 135° inhibits incisor overeruption and thus has an impact on the stability of deepbite treatment. In this study, the mean interincisal angle, which was below the normal range at T1, increased significantly after treatment mainly because of retraction of the maxillary incisors; it approached the norm values proposed by several authors and did not change at T3. The substantial stability of overbite correction in this study seems to support the validity of the interincisal angle values suggested for stability by Berg and Houston.

An intrusive force that is labial to the center of resistance of the incisors would intrude them but also tip them labially. Labial tipping tends to decrease overbite because it influences the vertical incisal edge position, and depending on the original inclination of the incisors, it can be advantageous in deepbite correction. However, flaring has been associated with an increased incidence of relapse. In this study, statistically significant increases in both proclination and protrusion of the mandibular incisors were observed after treatment. The mean increases in L1 to Apg and L1 to MP were 0.8 mm and 0.6°, respectively. Although statistically significant, these values were much lower than the values reported in other studies in which intrusion utility arches were used.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Treatment changes (T2-T1)</th>
<th>Postretention changes (T3-T2)</th>
<th>Overall changes (T3-T1)</th>
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<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Sig</td>
<td>Mean ± SD</td>
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<tr>
<td>SN to MP (°)</td>
<td>0.5 ± 1.6</td>
<td>NS</td>
<td>-0.2 ± 1.3</td>
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<tr>
<td>ANS to Xi/Xi-PM (°)</td>
<td>0.2 ± 3.7</td>
<td>NS</td>
<td>-0.1 ± 3.7</td>
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<td>Overbite (mm)</td>
<td>-3.9 ± 0.7</td>
<td>*</td>
<td>0.8 ± 0.4</td>
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<tr>
<td>Overjet (mm)</td>
<td>-6.4 ± 1.2</td>
<td>*</td>
<td>0.4 ± 0.9</td>
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<tr>
<td>U1CR to PP (mm)</td>
<td>-0.3 ± 0.9</td>
<td>NS</td>
<td>0.1 ± 0.6</td>
</tr>
<tr>
<td>U1 to PP (°)</td>
<td>-17.0 ± 1.9</td>
<td>*</td>
<td>-0.2 ± 0.8</td>
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<tr>
<td>U1 to Apg (mm)</td>
<td>-3.8 ± 1.1</td>
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<td>0.1 ± 1.3</td>
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<tr>
<td>U6 to PP (mm)</td>
<td>-0.1 ± 0.8</td>
<td>NS</td>
<td>0.2 ± 0.6</td>
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<tr>
<td>L1CR to MP (mm)</td>
<td>-2.6 ± 1.4</td>
<td>*</td>
<td>0.8 ± 1.1</td>
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<tr>
<td>L1 to MP (°)</td>
<td>0.6 ± 0.9</td>
<td>*</td>
<td>-0.2 ± 0.9</td>
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<td>L1 to Apg (mm)</td>
<td>0.8 ± 1.5</td>
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<td>L6 to MP (mm)</td>
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<tr>
<td>U1 to L1 (°)</td>
<td>21.5 ± 5.1</td>
<td>*</td>
<td>-0.1 ± 1.7</td>
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</tbody>
</table>

Sig. Significance; NS, not significant.
*P <0.001.
incisor flaring could be due to the use of $0.016 \times 0.022$-
in utility arches in this study, thus providing better torque control.

Relapse of proclined incisors is thought to be related to distortion of the perioral neuromuscular balance\textsuperscript{13} or the tendency of incisors that were upright at the beginning of treatment to return to their original positions.\textsuperscript{8} The changes in the sagittal position of the mandibular incisors in our study were stable in the postretention period. The reason for no relapse might be that the L1 to APtg and L1 to MP measurements were within normal ranges at T1; despite some flaring, they remained within the normal ranges at T2 and therefore caused no neuromuscular imbalance.

This study involved nongrowing patients with normal vertical dimensions; therefore, prevention of posterior extrusion that could result in relapse and opening rotation of mandible was intended. To this end, sectional arches were used for intrusion, and stabilization sections were used to enhance the vertical anchorage of the mandibular molars and premolars.\textsuperscript{41-42} Still, despite these measures, extrusion of 0.8 mm occurred in the mandibular molars. This value was lower than reported in other studies in which mandibular incisor intrusion was performed with segmental or sectional arches. In the study of Dake and Sinclair,\textsuperscript{10} when the mandibular incisors were intruded with utility arches, they reported 2.6 mm of mandibular molar extrusion. Al Buraiki et al\textsuperscript{16} used lever arches and reported 1.6 mm of mandibular molar extrusion. One explanation for the lower value in our study could be that these 2 studies were conducted with growing subjects who had a likelihood of continuing molar eruption.\textsuperscript{31} Moreover, the intrusion force used in this study was lower than that used by Dake and Sinclair; an intrusion force of 40 g might not have affected the posterior vertical anchorage. According to Nanda and Kuhlberg,\textsuperscript{13} 1 mm of maxillary or mandibular molar extrusion effectively reduces incisor overlap by 1.5 to 2.5 mm. In our study, the mean overbite reduction was $3.9 \pm 0.7$ mm, and the mean mandibular incisor intrusion was $2.6 \pm 1.4$ mm. That is, together with the modest increases in the proclination and protrusion of the mandibular incisors, molar extrusion might have contributed to overbite correction.

Seemingly, 0.8 mm of mandibular molar extrusion did not result in mandibular posterior rotation because the mandibular plane and lower facial height angles did not change at either T2 or T3. The molars retained their new vertical positions in the postretention period; thus, the 0.8-mm relapse in overbite cannot be attributed to a posttreatment change in molar position. Similarly, Burzin and Nanda\textsuperscript{14} also found no relationship between molar extrusion and overbite relapse.

This study had some limitations because of its retrospective design without randomization. Although consecutively treated subjects were included without regard to treatment and postretention outcomes and 2 orthodontists with similar experience provided the orthodontic treatment, adhering strictly to treatment and retention protocols, the potential for selection bias still exists. Therefore, these findings must be regarded with some caution.

**CONCLUSIONS**

1. With mandibular intrusion utility arches, 2.6 mm of true incisor intrusion was obtained. Only 0.8 mm of molar extrusion was observed.
2. Five years after the end of the retention period, a statistically significant but clinically unimportant relapse of 0.8 mm (which corresponded to approximately 30% of the total intrusion amount) was observed in mandibular incisor intrusion and overbite.
3. Deepbite treatment with mandibular incisor intrusion with utility arches was effective and appeared to be stable in nongrowing patients.

**REFERENCES**


