Anterior dental crossbite: relationship between incisor crown length and incisor irregularity before and after orthodontic treatment

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Abstract

The purpose of this study involving a sample of children with single central incisor crossbite was to determine the relationship between clinical crown lengths of the crossbite and noncrossbite mandibular incisors, incisor irregularity, and orthodontic correction of the crossbite. In addition, for comparison, the normal maturational change in position of the labial gingival margin of mandibular incisors not undergoing orthodontic correction was examined. Twenty-one children treated for single central incisor crossbite were matched individually by gender and age to a comparison group. Pre- and post-treatment mandibular central incisor crown lengths and incisor irregularity were measured. In 10 of the 21 anterior crossbite cases, the crown length of the crossbite incisor was more than 1.5 mm greater than that of the noncrossbite incisor. This difference improved with orthodontic treatment by a combination of apical movement of the gingival margin of the noncrossbite incisor (0.9 ± 0.8 mm) and coronal movement (0.2 ± 0.6 mm) of the gingival margin of the crossbite incisor. In contrast, for the remaining 11 anterior crossbites without such a crown length difference, and for the comparison cases, the gingival margins of both mandibular central incisors moved equally from pre- to post-treatment by 0.5 ± 0.5 mm in an apical direction. Pretreatment crown length difference between crossbite and noncrossbite incisor was associated strongly to incisor irregularity ($P \leq 0.005$, $r = 0.65$). Orthodontic correction of the crossbite produced an improvement in irregularity index (IR) that was greatest in those anterior crossbite cases with a pretreatment crown length difference. Improved mandibular incisor alignment occurred secondary to orthodontic movement of the maxillary incisor as the crossbite was corrected. (Pediatr Dent 15:394–97:1993)

Introduction

It has been demonstrated previously that in about half of the cases of anterior dental crossbite the gingival margin of the mandibular central crossbite incisor is positioned more than 1 mm apical to the gingival margin of the adjacent, noncrossbite incisor.[1] This difference in position of the gingival margin rapidly improves with orthodontic correction of the crossbite and continues to improve in the years following treatment, primarily as a result of apical movement of the gingival margin on the noncrossbite incisor and, to a much lesser extent, by coronal movement of the gingival margin on the incisor previously in crossbite. The mechanisms that encourage such rapid, apical movement of the gingival margin of the incisor not in crossbite are not yet known.

Mandibular incisor crowding has been shown to contribute to differences in the position of the gingival margin;[2] therefore, there may be a relationship between clinical crown length and the degree of incisor irregularity. A better understanding of the normal maturational changes in position of the labial gingival margin of mandibular central incisors in children without anterior crossbite may help to explain the pattern of gingival migration observed in children with incisor crossbite.

The purpose of this study was to determine the relationship between permanent mandibular incisor clinical crown length, incisor irregularity, and orthodontic correction of the crossbite. In addition, the normal change in position over time of the labial gingival margin of mandibular incisors not undergoing orthodontic correction was examined for comparison.

Methods and materials

Sample

A group of 21 children (11 males, 10 females) from one orthodontic practice (DBK), who had been treated for a single central incisor crossbite, comprised the experimental group in the study. These children were culled from all anterior crossbite cases treated in this practice over a 9-year period. The 21 cases were chosen because only one central incisor was in crossbite; therefore, the crown length of the crossbite incisor could be compared with that of its noncrossbite antimere. All of the subjects were treated with a removable appliance; 19 with an appliance to procline the maxillary incisor, two with an appliance to retract the mandibular incisor.

The comparison group of 21 children from the same practice had been treated for a unilaterally presenting posterior crossbite resulting from bilateral maxillary constriction with a functional shift of the mandible to the side of the crossbite. A cemented maxillary expansion appliance was used to treat 18 of the posterior crossbites and a removable appliance was used for the

remaining three cases. Pretreatment records for both groups of patients were taken just prior to beginning orthodontic treatment, and post-treatment records were taken at completion of active treatment. The mean time interval between pre- and post-treatment records was 9.2 months for the anterior crossbite cases, and 9.8 months for the comparison group.

Children in the anterior crossbite group were matched individually for age and gender to children in the comparison group. The mean age of the children in both groups was 8 years 3 months, pretreatment, and 9 years 0 months at conclusion of treatment. The age range of the children in the anterior crossbite group was 5 years 11 months to 10 years 11 months, and for the comparison group was 5 years 10 months to 11 years 8 months.

Clinical crown length

All measurements were made by one examiner (RLH). Criteria for inclusion in the study sample were intact study models with both mandibular central incisors erupted equally and sufficiently for measurement. Thus, measurement of clinical crown length reflected the relative positions of the gingival margins. In the anterior crossbite cases, the crossbite incisor was compared with the adjacent, noncrossbite incisor. For the posterior crossbite comparison cases, the mandibular central incisor with the greatest clinical crown length pretreatment arbitrarily was chosen as the test incisor for comparison to the adjacent incisor. The crown lengths of the incisors were measured with a Boley gauge to the nearest 0.1 mm from the incisal edge to the most apical point on the gingival margin of the midfacial aspect of each mandibular incisor. The position of the gingiva pre- and post-treatment then could be compared.

Method error was determined by repeating 40 of the measurements and was tested according to the formula:[3]

$$si = \sqrt{\frac{d}{2(n-1)}}$$

The error was established as 0.13 mm.

For the anterior crossbite cases, the difference in clinical crown length between crossbite and noncrossbite incisor was determined. Similar calculations were made for the comparison posterior crossbite cases between the test and the adjacent mandibular incisor.

Incisor irregularity

A modified Little Irregularity Index was used to measure incisor crowding.[4] Because of the age range of the sample, some of the children had partially erupted lateral incisors, mobile or extracted mandibular primary canines, and—in some cases—the canines had been disked proximally to relieve anterior crowding. Only those subjects (N = 17) with lateral incisors sufficiently erupted to be in contact with the central incisors were included, and only the three contact points between the four permanent mandibular incisors were used to calculate the Irregularity Index (IR). Measurements were obtained directly from the mandibular study model with a Boley gauge, and method error—determined in a similar manner to that for clinical crown length—was calculated to be 0.24 mm, which compared favorably to the maximum error of 0.41 mm in the original report by Little.[4]

Statistical analysis

The anterior crossbite cases separated almost evenly into two groups: those cases where the clinical crown length of the crossbite incisor was greater than its antimere by at least 1.5 mm, and another group where the crossbite and noncrossbite incisor had identical crown lengths, or were different by an amount less than 0.5 mm. Because no difference was found between the clinical crown lengths of the test and control incisors in the posterior crossbite comparison cases, the measurements of all the mandibular central incisor lengths in this group were averaged together. Differences in crown length and incisor irregularity were assessed by paired *t*-tests. The relationship between incisor irregularity and clinical crown length difference was explored by regression analysis.

Results

Of the 21 anterior crossbite cases, 10 had a crown length difference of at least 1.5 mm between the clinical crown length of the crossbite incisor and of the noncrossbite incisor prior to appliance therapy. The difference, mean $\pm$ SD, was 2.4 $\pm$ 0.6 mm. When the appliance was discontinued the difference had significantly decreased to 1.3 $\pm$ 0.8 mm. ($P < 0.01$). The difference resolved by a combination of apical movement of the gingival margin of the control, noncrossbite incisor (0.9 $\pm$ 0.8 mm) and coronal movement of the gingival margin of the crossbite incisor (0.2 $\pm$ 0.6 mm). In contrast, for the 11 cases of anterior crossbite with no such crown length difference, the gingival margins of both crossbite and control incisors moved apically by 0.5 $\pm$ 0.5 mm from pre- to post-treatment. A similar apical change in position also was observed in the posterior crossbite comparison cases.

The relationship between a modified IR and difference in crown length between the crossbite and noncrossbite incisor was examined for the 17 anterior crossbite cases with sufficiently erupted mandibular central and lateral incisors. Pretreatment crown length difference was associated strongly with IR, ($P \leq 0.005$, $r = 0.65$). Those crossbites with a crown length difference had a significantly greater IR pre- and post-treatment than the other crossbite cases without a crown length difference (Table). The decrease in IR with orth-

Table. Irregularity index of crossbite mandibular incisors pre- and post-treatment

	Crown Length Difference (N = 10)	*No Crown Length Difference (N = 11)*
Pretreatment	5.2 (3.0) •	2.0 (1.6)
Post-treatment	3.4 (1.3) •	1.4 (1.0)
Difference	-1.8 (3.0)	-0.7 (1.2)

• Irregularity index significantly different, $P < 0.05$.

odontic treatment was greatest in anterior crossbites where a pretreatment crown length difference was observed.

Discussion

Children treated for posterior crossbite were a suitable group in which to examine the normal change in position over time of the labial gingival margin of mandibular incisors not undergoing orthodontic correction because none of these children had a mandibular incisor in crossbite and appliance therapy did not involve the incisors. Therefore, any observed change in incisor crown length over time in this comparison group was due to maturation. The subjects were matched individually to the anterior crossbite group in age, gender, time interval between pretreatment and post-treatment records, and use of a single appliance. Unlike the anterior crossbite group, the comparison group demonstrated minimal mandibular incisor irregularity, 1.7 ± 1.4 mm, that remained constant before and after treatment.

The children in this study demonstrate diversity in maturational changes of the labial gingival margin. Apical migration occurred at a mean rate of 0.5 mm over 9 months of treatment time in the comparison posterior crossbite group. Identical migration occurred in incisor crossbites cases when no pretreatment clinical crown length difference was present. By contrast, the treatment response of the mandibular incisors with a pretreatment clinical crown length difference did not follow this pattern. In these subjects, there was 0.9-mm apical migration on the noncrossbite incisor, and 0.2-mm coronal movement on the crossbite incisor. While apical migration of the gingival margin is a normal age change in children as indicated by gradually increasing clinical crown length,[5] in this study the gingiva on the noncrossbite incisor in subjects with a clinical crown length difference moved apically almost double the normal distance in a relatively brief period of time of 9 months. Both the rate and amount of movement increased.

The finding that improvement of the crown length difference occurred with correction of the crossbite, and without gingival surgery is in agreement with that of other investigators who also observed that the improvement of the gingival contour was primarily a result of apical migration of the gingival margin of the noncrossbite tooth.[3,6]

The supporting tissues of the teeth in a growing child undergo a continuous process of remodeling and adjustment to changes in tooth position within the jaws whether the alterations in tooth position occur as a function of normal growth or as a result of orthodontic correction. In the anterior crossbite cases in this study, the substantial decrease in the IR that occurred following crossbite correction indicated that mandibular incisor alignment improved secondary to maxillary incisor movement, and, in a few cases, in response to additional interventions such as disking or extracting primary cuspids. The labiolingual position of the noncrossbite mandibular incisors also may have been affected. This change in position may have precipitated some rapid remodeling of the overlying gingival tissues and may explain the rapid apical migration of the labial gingiva on the noncrossbite incisor.

Results of this study indicate that a difference in clinical crown length between the crossbite and noncrossbite incisor is associated with incisor irregularity. This association is similar to the observations of previous investigators.[2,7] The fact that incisors with a pretreatment clinical crown length difference of at least 1.5 mm also had the greatest amount of incisor irregularity suggests the crossbite mandibular incisors in these cases were possibly tipped or displaced more labially than in the other cases. Previous investigators have reported an association between the thickness of the alveolar process and the amount of gingival recession that occurs during orthodontic treatment.[7] Therefore, our subjects with increased anterior crowding and a clinical crown length difference may have had a thin alveolar housing secondary to labial positioning that predisposed them to gingival margin irregularities.[8] Correction of the crossbite not only may have moved the affected mandibular incisor lingually and the adjacent control incisor labially, thus decreasing the crowding, but also may have stimulated deposition of labial alveolar bone.[9] However, the thickness of the alveolar bone was not measured in this study, either pre- or post-treatment.

In addition, because this study was retrospective and utilized study models only, it was not possible to measure the probing attachment levels or gingival inflammation to determine the relationship between gingival health and apical position of the gingival margin. Elimination of the traumatic CR/CO shift in the anterior crossbites following orthodontic correction also may have contributed to a reduction in tissue inflammation, an improved attachment level, and an altered position of the gingival margin.

Caution is warranted in making clinical recommendations based on this study considering the size of the

sample, lack of probing, and the documented limitations of a retrospective study. However, because our results demonstrate improvement in mandibular incisor alignment and crown length, reassessment of tissue contour following crossbite correction rather than pretreatment surgical intervention is recommended. Future studies are planned to investigate the relationship between mandibular crowding, clinical crown length, and cephalometric position of the incisors in children with anterior crossbite.

Conclusions

1. The normal apical migration of the gingival margin of a mandibular incisor is 0.5 mm over a 9-month period in a child in the early mixed dentition.
2. The greater the mandibular crowding in cases of mandibular incisor crossbite, the greater the likelihood of a crown length difference.
3. Following orthodontic correction in cases of anterior crossbite with no crown length difference, the tissue responds with normal apical migration. In cases with a difference, the crossbite incisor does not show this apical migration, while the noncrossbite incisor shows almost double the expected amount of apical migration.
4. A substantial improvement in mandibular incisor alignment occurs secondary to labial movement of the maxillary incisor for crossbite correction.

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