MAXIMIZING TISSUE RESPONSE IN SELECTED SUBJECTS WITH ANTERIOR OPEN BITES

Aim: Open bites are challenging malocclusions with a multifactorial etiology, varying clinical severity, and questionable stability. The aim of this article is to describe a method for maximizing tissue response in the treatment of selected subjects with anterior open bites.

Method: Twelve subjects with an anterior open bite and insufficient incisor display underwent a limited corticotomy to augment alveolar bone response by creating an anteroposterior intra-arch anchorage differential. Cephalometric radiographs were taken before treatment (T1) and 1 month after open bite closure (T2). The change in perceived smile esthetics was assessed by a visual analog scale.

Results: All open bites were closed after a mean of 6 weeks. Radiographic evaluation showed significant maxillary incisor extrusion and retrusion. There was a notable improvement in smile esthetics after treatment.

Conclusion: It is possible to close anterior open bites rapidly with significant improvement in smile esthetics in a selected group of anterior open-bite subjects. World J Orthod 2009;10:187–195.

Key words: accelerated tooth movement, corticotomy, open bite, smile esthetics, tissue response

Anterior open bites are one of the most difficult malocclusions to treat because they are usually a result of an interaction of multiple etiologic factors.1,2 Anterior open bites can be skeletal or dentoalveolar or have a functional or a habit-related cause.3 Many therapeutic approaches and appliances have been used for anterior open bite treatment, including habit-therapy,4,5 vertical chin cups,6 vertical holding appliances,7 high-pull headgears,8,9 posterior bite blocks,10 spring-loaded bite blocks,11 active vertical correctors,12 and Fränkel IV appliances.13 Other treatment modalities include orthodontic camouflage using fixed appliances with extractions,14 elastics,15 extrusion arches,16 multiloop edgewise archwires,17 and reverse/accentuated curve of Spee Ni-Ti archwires.18 Plates19 and microimplants20 have also been used for the treatment of anterior open bites. Subjects with severe open bites require a combined surgical-orthodontic approach.21 Orthodontists are also faced with the challenge of retaining successfully treated open bites. In a review article on anterior open bite stability, Huang concluded that the level of evidence provided by current literature is not conclusive.22

For decades, tooth movement has largely been attributed to a resorption-apposition process occurring within the periodontal ligament. Attempts to accelerate tooth movement include physical agents,23–26 local and systemic drug administrations,27–32 and combining orthodontics with alveolar surgery.33–35 Alveolar corticotomies accelerate tooth movements, resulting in a shorter orthodontic treatment.36–38 This acceleration is believed to be due to bony block movement.39 However, it should be considered a combination of conventional tooth movement and bony block movement.
Wilcko et al.\textsuperscript{37} attributed the increased tooth movement rate to the initiation of a so-called regional acceleratory phenomenon in the alveolar bone.\textsuperscript{40} The understanding of the histologic basis of rapid tooth movement with corticotomy is not yet clear. Experimental studies on this subject have shown an increase in the number of osteoclasts ahead of the moving tooth\textsuperscript{41} and an increased alveolar bone reaction in the marrow cavities with less hyalinization,\textsuperscript{42} in addition to more extensive and active bone remodeling.\textsuperscript{43}

A pleasing smile is an important component of facial attractiveness. Anterior open bites can have a detrimental effect on facial esthetics\textsuperscript{44} and thus on an individual’s social interactions.\textsuperscript{45,46} A flat or reverse smile arc is judged as unattractive by orthodontists and laypersons.\textsuperscript{47}

The aims of this study were to validate the application of a selective corticotomy and grafting in the treatment of selected anterior open bites, evaluate cephalometrically the tooth movements involved in the correction, and assess the improvement in smile esthetics after treatment.

### SUBJECTS AND METHODS

The sample comprised 12 subjects with a mean age of 17.5 years (range 15.5 to 23.0 years) (Table 1). Nine of these had a Class I, one had a Class II, and two had a Class III subdivision. Inclusion criteria were

1. anterior open bite with insufficient amount of maxillary incisor display at rest and/or smiling;
2. no signs of excessive vertical facial development;
3. exaggerated curve of Spee in the maxillary arch;
4. absence of systemic disorders with open bites (eg, Down syndrome–associated open bites);
5. absence of any systemic disease that may have an influence on tooth movement (eg, diabetes or rheumatic arthritis);
6. complete permanent dentition (excluding third molars); and
7. healthy periodontium.

The cutoff measurement for considering a face excessively vertically developed was set arbitrarily at a SN-MP value of 40 degrees (normal value for Egyptian adults = 32 degrees ± 5 degrees; unpublished data, Cairo University).

For all subjects, the following records were evaluated: dental casts, photographs, and panoramic and cephalometric radiographs before treatment (T1) and on average 1 month after open bite closure (T2). The cephalograms were traced and numerous variables measured (Figs 1a and 1b, Table 2). The overbite was measured as the distance between the incisal edges of maxillary and mandibular incisors perpendicular to the functional occlusal plane on the lateral cephalometric radiographs.

The research protocol was approved by the Research Ethics Committee of the Cairo University Faculty of Dentistry, Cairo, Egypt. The treatment plan, including the

<p>| Table 1  Sample distribution according to number, sex, age, and severity of anterior open bite |
|-----------------------------|-----------------------------|-----------------------------|</p>
<table>
<thead>
<tr>
<th>n</th>
<th>Mean age (y)</th>
<th>Mean open bite (mm)</th>
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<tbody>
<tr>
<td>Female 9</td>
<td>16.7</td>
<td>–5.7</td>
</tr>
<tr>
<td>Male 3</td>
<td>18.2</td>
<td>–4.9</td>
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<tr>
<td>Total 12</td>
<td>17.5</td>
<td>–5.3</td>
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Fig 1a Measured skeletal cephalometric variables (compare to Table 2). Fig 1b Measured dental cephalometric variables (compare to Table 2).
corticotomy, was explained to the subjects and/or subjects’ parents, and a signed informed consent obtained. The subjects were banded/bonded, and sequential leveling wires were placed. When the maxillary archwire was 0.016-inch Ni-Ti and the mandibular 0.016-inch /0.022-inch stainless steel, the subjects were instructed to use vertical intermaxillary elastics and scheduled for corticotomy. The corticotomy was performed under conscious sedation or bromazepam premedication (Calmepam, 3 mg, Glaxo-Wellcome) and local anesthesia. A mucoperiosteal flap was reflected extending one tooth distal to the open bite area bilaterally. Using a No. 2 round bur in a high speed handpiece under copious irrigation, vertical corticotomy cuts were made interradicularly, starting 2 mm to 3 mm apical to the alveolar crest and extending beyond the root apices. Horizontal cuts were made to connect the vertical ones. Whenever possible, the cortex over the prominences of the roots was perforated (Fig 2). The depth of the cuts was assessed by observation of bleeding from the cortical bone. After the corticotomy, the flap was carefully repositioned and closed with interrupted loop sutures. All subjects were seen subsequently every 2 weeks and instructed to resume wearing their elastics on the day following the surgery.

In three subjects, denuded roots were seen after flap surgery. These roots were covered with a mixture of equal parts demineralized freeze-dried bone and bovine bone soaked in sterile saline and clindamycin phosphate according to Wilcko et al.38

The smile attractiveness was assessed by a group of dental students on the pre- and posttreatment photographs that were cropped so only the lips and contiguous perioral area were visible (Fig 3). The photographs were projected onto a screen, and the raters received a sheet of paper with visual analog scales (VAS). The raters were instructed on how to use the VAS.

<table>
<thead>
<tr>
<th>Table 2 Skeletal and dentoalveolar cephalometric measurements (compare to Figs 1a and 1b)</th>
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<tr>
<td><strong>Skeletal measurements</strong></td>
</tr>
<tr>
<td>SN-MP (degrees)</td>
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<tr>
<td>SN-FH (degrees)</td>
</tr>
<tr>
<td>SN-PP (degrees)</td>
</tr>
<tr>
<td>SNA (degrees)</td>
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<tr>
<td>SNB (degrees)</td>
</tr>
<tr>
<td>ANB (degrees)</td>
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<tr>
<td>N-Me (mm)</td>
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<tr>
<td>ANS-Me (mm)</td>
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</table>

**Fig 2** Intraoral view after flap reflection. Notice the interradicular cortical cuts and perforations of the cortical bone over the root prominences.

**Fig 3** Cropped smile photograph used for assessment of smile esthetics.
Each VAS consisted of a 100-mm line anchored with Highly Unattractive on the left and Highly Attractive on the right. The raters were asked to put a well-defined mark along the VAS to best describe the attractiveness of each projected image. The raters were blinded as to whether the photograph was pre- or posttreatment and about the subject’s sex.

Statistical methods

The cephalometric measurement for 10 randomly selected pre- and posttreatment cephalograms were repeated. The Dahlberg formula was used to determine the method error. The method error was found to be 0.5 degrees for angular measurements and 0.5 mm for linear measurements.

Statistical analysis was performed with SPSS 14.0 (SPSS). The descriptive statistics for the cephalometric measurements included minimum, maximum, mean, standard deviation, and standard error. The paired t test was used to compare the T1 and the T2 means for all measurements except for ANB (the Wilcoxon signed-rank test was used because the data were not normally distributed). The significance level was set at $P \leq .05$.

### RESULTS

#### Clinical findings

The open bites were closed in a mean of 6 weeks with a range of 4 to 12 weeks. The subjects tolerated the surgical procedure well, and postoperative discomfort was minimal. Cooperation with elastic wear was found to be high.

#### Cephalometric findings

Table 3 shows the descriptive statistics and the results of the statistical tests for the cephalometric measurements at T1 and T2. There were significant changes in the cephalometric measurements SN-MP (degrees), SNB (degrees), N-ANS (mm), ANS-Me (mm), and U6-PP (degrees). The changes in U1-PP (degrees), U1-PP (mm), L1-MP (degrees), L1-MP (mm), U6-PP (mm), and L6-MP (mm) were highly significant.

The maxillary incisors showed a mean uprighting of $-4.4$ degrees ($P < .001$), while the mandibular incisors uprighted on an average of $-5.0$ degrees ($P < .002$). The mean 2.5 mm ($P < .001$) extrusion of maxillary incisors was 1.5 times greater than that of the mandibular ones (1.7 mm).
On the other hand, the mean 1.1 mm extrusion of mandibular molars was 1.5 times greater than that of the maxillary ones (0.7 mm).

Assessment of smile esthetics

Table 4 shows the descriptive statistics for the VAS scores at T1 and T2. There was a mean increase of 3.3 at T2.

DISCUSSION

It was hypothesized that a selective corticotomy would successfully reduce the treatment duration in selected subjects with anterior open bites. Indeed, anterior open bites could be closed with this procedure (and grafting) on average in 6 weeks. The underlying rapid tooth movement is in agreement with previous reports. The corticotomy was limited to the anterior area with the rationale to create an intra-arch anchorage gradient. The presented technique is similar to the closure of anterior open bites using multiloop edgewise archwires, maxillary accentuated/mandibular reversed curve of Spee Ni-Ti archwires, and extrusion arches, which are indicated for patients with an open bite and insufficient amount of incisor displays at smile. The technique used in the present study has several advantages over the aforementioned ones. It is time-consuming to bend and insert multiloop edgewise archwires, which can cause soft-tissue irritation. The open bite can worsen if cooperation with elastic wear is less than optimal. This also holds true for the accentuated/reverse curve of Spee Ni-Ti archwire technique even though it is more hygienic. The present technique is very failsafe as its anchorage management is superior, and it uses flat archwires.

Figures 4 through 7 show two representative subjects before and after treatment. Positive overlap was still seen 2 years posttreatment (Fig 8). The subjects are currently being followed to assess long-term stability.

Cephalometric findings

The cephalometric analysis showed that the open bite was closed due to an extrusion and uprighting of the maxillary and mandibular incisors, following the so-called drawbridge effect. Previous research has shown that tipping of the incisors contributes significantly to open-bite treatment. There was a slight increase in lower face height (ANS-Me) and a comparable increase in the inclination of the mandibular plane (SN-MP). This can be explained by the mean 0.7 mm and 1.1 mm extrusion of the maxillary and mandibular first molars, respectively. It should be taken into consideration, however, that these values may not represent the actual amount of extrusion that occurred because a mean uprighting of 1.1 degrees and 1.3 degrees was observed for the maxillary and mandibular molars, respectively. This uprighting may have increased the perpendicular distance from the cusp tips of the molars to their respective planes.

The cephalometric findings corroborated the intra-arch anchorage gradient hypothesis. There was more extrusion of the maxillary than the mandibular incisors (mean 2.5 mm and 1.7 mm, respectively). Also, there was more extrusion of the mandibular than the maxillary molars (1.1 mm and 0.7 mm, respectively). This is less than in the study of Küçükkeles et al in which the first maxillary molars showed a mean extrusion of 1.1 mm. In another study by Hans and Feng, the mandibular incisors extruded more (3.4 mm) than the maxillary ones (3.2 mm), which is again in contrast to the present study. Chang and Moon also reported

### Table 4
Descriptive statistics for the VAS scores at T1 and T2 (in cm)

<table>
<thead>
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<th></th>
<th>Mean</th>
<th>SD</th>
<th>Maximum</th>
<th>Minimum</th>
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<tbody>
<tr>
<td>T1</td>
<td>4.1</td>
<td>0.9</td>
<td>2.0</td>
<td>5.5</td>
</tr>
<tr>
<td>T2</td>
<td>7.4</td>
<td>0.9</td>
<td>6.0</td>
<td>9.0</td>
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</table>

SD = standard deviation.
more mandibular incisor (2.8 mm) than maxillary incisor (2.0 mm) extrusion. This supports the hypothesis that the noncorticotomized mandibular anterior segment in this study had more anchorage than the corticotomized maxillary anterior area.

Assessment of smile esthetics

Only 20% of a sample of high-angle subjects had an anterior open bite, while 80% had a normal or increased overbite due to dentoalveolar compensation.
The overbite was accomplished in this study mainly by extrusion of the maxillary anteriors correcting an insufficient incisor display, which gives the subjects an aged appearance and results in a flat or reversed unattractive smile arc. This explains the increase in smile esthetic scores after open-bite closure. Furthermore, the improvement in incisor inclination contributed to the overall esthetic improvement. Properly inclined and angulated maxillary incisors ensure the best esthetic result.
CONCLUSIONS

From this study, it can be concluded that:

• A restricted corticotomy of the maxillary anterior alveolar segment was successful in the treatment of selected subjects with anterior open bites.
• The treatment changes were mainly accomplished by extrusion and uprighting of the maxillary incisors.
• There was a significant improvement in the perceived smile esthetics after treatment.

ACKNOWLEDGMENT

The authors are grateful to Dr Rameya Y. Mostafa for her scrupulous revision.

REFERENCES


