The segmented arch approach: A method for orthodontic treatment of a severe Class III open-bite malocclusion

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An open bite is a common malocclusion, and it is generally associated with several linked etiologic factors. When establishing the treatment plan, it is essential to consider every aspect of the various etiologic causes and their evolution; this will help to correct it. This article reports the case of a girl aged 10.7 years with a skeletal Class III malocclusion and an open bite. The treatment mechanics were based on compensatory dental changes performed to close the bite and correct the skeletal Class III malocclusion. The patient had a deep maxillary deficiency, and the lower facial third was severely enlarged. In this article, we aimed to describe a simple mechanical approach that will close the bite through changes in the occlusal plane (segmentation of arches). It is an extremely simple method that is easily tolerated by the patient. It not only closes the bite effectively but also helps to correct the unilateral or bilateral lack of occlusal interdigitation between the dental arches. A Class III patient with an anterior open bite is shown in this article to illustrate the effectiveness of these treatment mechanics. (Am J Orthod Dentofacial Orthop 2013;143:254-65)

A
d open bite is a deviation in the vertical relationship of the maxillary and mandibular arches, characterized by lack of contact between opposite dental segments.1 It can be associated with any type of malocclusion in the sagittal plane (Class I, Class II, or Class III).

A dental open bite is characterized by a reduction in the vertical growth of the dentoalveolar process in the affected area, generally associated with an oral habit (prolonged pacifier use, finger sucking, or altered swallowing habits) and a normal or favorable growth pattern. It is usually accompanied by incisor proclination and a reduced interincisal angle, and it generally responds to myofunctional treatment and mechanotherapy.

On the other hand, a skeletal open bite is due to a hyperdivergent phenotype with a vertical growth pattern that affects both the maxillary and mandibular bony bases.2 Because of its skeletal component, the orthodontic correction of a skeletal open bite is much more difficult, and there is no clear limit between what can be achieved by orthodontic compensation and what inevitably requires orthognathic surgery. Early treatment of the vertical dysplasia (during the deciduous or mixed dentition) might reduce the treatment needed in the permanent dentition2,4 when surgery is a valid option.5

A logical question regarding this matter is where to place the limits of the dentoalveolar compensation. To answer this question, we report a patient with a Class III open-bite malocclusion and vertical skeletal dysplasia treated with camouflage orthodontic therapy.

DIAGNOSIS AND ETIOLOGY

The patient was a girl aged 10.7 years with no relevant medical history or bone or dental pathology in her family history. The extraoral examination showed a distinct increase of the lower facial third, with slight mandibular asymmetry and midface deficiency along with a Class III profile (Fig 1). The intraoral examination showed a Class III malocclusion with severe maxillary compression in all 3 planes that caused posterior and anterior crossbites (both with negative results). In the vertical plane, there were both anterior and lateral open bites. The mandibular dental cast (Fig 2) showed that the deciduous canines were missing, and the incisors were
Fig 1. Pretreatment photographs.

Fig 2. Pretreatment dental casts.
The mandibular arch-length discrepancy was 3.7 mm. In the maxillary arch (Fig 3), a transverse deficiency and an arch length deficiency of 3 mm were noted. Moreover, a molar Class III relationship coexisted with the anterior and posterior crossbites and the previously mentioned open bite. The panoramic radiograph showed the lack of space for the permanent canines, and the condyles appeared thin and elongated, as normally seen in patients with vertical growth patterns (Fig 4).

The cephalometric analysis was typical of a skeletal Class III pattern with a retruded maxilla and retroclined mandibular incisors (showing that the skeletal malocclusion was worse than it seemed because of the physiologic dentoalveolar compensation) in a hyperdivergent pattern with a significant vertical growth discrepancy.

**TREATMENT OBJECTIVES**

The proposed treatment consisted of 2 phases: (1) correction of the crossbite and protraction of the maxilla with a facemask; and (2) (during the permanent dentition) leveling, alignment, and coordination of the dental arches, with bite closure and finishing of the occlusion. This treatment plan reflects the importance of treating the transverse and sagittal problems during the early stages and subsequently correcting the open bite through changes in the occlusal plane in the permanent dentition with a segmented arch approach.

The treatment plan involved 2 phases that took into account the eruption times and growth of the patient: (1) crossbite correction (maxillary disjunction with rapid palatal expansion) and traction with a facemask for dentoalveolar mobilization (phase 1); (2) a waiting period until dental eruption has been completed preceded by dental alignment; and (3) control of the open bite and the possibility of its closure (phase 2).

Complete correction of this type of malocclusion by providing only orthodontic treatment mechanics is especially difficult because of the underlying skeletal malrelationship. Therefore, the patient would need to undergo surgery if the response to dental compensation were not good enough. For this reason, in similar cases, orthodontic treatment seeks to improve some dental esthetic aspects, whereas the sagittal and transverse skeletal corrections are achieved through orthognathic surgery.
Class III patients with severe vertical problems are rather controversial, since all correction approaches, both sagittal and transversal, can severely worsen the vertical relationship. On the other hand, all vertical responses lead to improvements of sagittal Class III expression. In other words, it is difficult to improve vertical Class III problems while closing the bite. This depends on the magnitude of both problems and the way the mechanics are managed.

A bite-closure technique with segmented arches was used in this patient; it allowed us to obtain dentoalveolar closure thanks to a counterclockwise rotation of the occlusal plane without anterior vertical elastics, which could have increase the potential for relapse.

**TREATMENT ALTERNATIVES**

Patients with severe skeletal dysplasia require multiple treatments to solve their various problems. The treatment of patients with a Class III malocclusion is likely to require orthognathic surgery in adulthood. In other words, this approach will correct not only the dental problems, but also the facial and skeletal discrepancies. Treatment is not complete until the patient’s facial growth has ceased.

On the other hand, a first phase of treatment with initial control of the transverse and sagittal dimensions is considerably effective and useful for these patients. It improves the patient’s dentofacial appearance, and the remaining improvements can be achieved in the post-growth stage through a surgical approach. Therefore, orthodontic treatment cannot be fully efficient but can sometimes help the patient, at least transversely, making the required surgical treatment less substantial.

A 2-phase treatment plan allows us to assess progress, and in patients whose response is positive, we can pursue a dentoalveolar correction. Orthodontic treatment will obviously not solve the skeletal problem, especially the vertical, since this can only be corrected by a surgical approach or by using temporary skeletal anchorage devices. They are a useful alternative when trying to reduce the anterior vertical dimension.

If there were a loss of the achieved objectives after growth and dental compensation are over, an orthognathic surgical treatment would be a valid option to resolve all problems and to obtain appropriate dentofacial harmony.

**TREATMENT PROGRESS**

Initially, a transpalatal arch was used during phase 1 to correct the mesial rotation and the torque of the molars. Placement of an expander was deferred because of the early stage of dental development.
Meanwhile, anterior traction was performed with a facemask for a year.

Second, and as part of phase 1, rapid palatal expansion was achieved with a cemented hyrax appliance while continuing with the facemask to prevent sagittal relapse. Once the rapid palatal expansion was finished, a transpalatal arch was placed for retention. Maxillary and mandibular brackets were bonded (Fig 5).

Closing the open bite with segmented arches involved a sequence that started with superelastic wires to align and level the dental arches. Once coordinated, the archwires were segmented in 3 sections: 2 sections including the molars and premolars, and a third section including all 6 anterior teeth. In the maxillary arch, a 0.021 × 0.028-in or a 0.019 × 0.025-in superelastic wire was used. Similarly, in the mandibular arch, a 0.020 × 0.020-in superelastic archwire was used. At this point, triangular elastics were used to achieve bite closure in the premolar area and to modify the canting of the occlusal plane. Once these changes were accomplished, a thermoelastic 0.014-in overlay (piggyback) was placed to obtain an acceptable overbite. After closing the bite, the treatment was finished with a regular wire sequence (Fig 5).

**TREATMENT RESULTS**

A Class III skeletal malocclusion with an open bite is not simple to treat. In many cases, orthognathic surgery is the only therapeutic option to correct all dental and facial aspects. In some patients, achieving dental compensation would solve some important problems associated with this kind of malocclusion (open bite, dental Class III, maxillary compression, and so on). Satisfactory results can be achieved if the orthodontic treatment mechanics and management are good and the patient cooperates effectively. However, the facial pattern will remain severely dysplastic. Occlusal stability of the generated dental compensation will only be achieved if the end of treatment coincides with the end of facial growth.

The final results were satisfactory for this patient (Figs 6-8 and Table). The use of a facemask, attached to the palatal expander, helped to reduce the dental discrepancy. Further treatment with segmented archwires and
multibracket therapy for bite closure also produced satisfactory results. The patient was considerably stable skeletally, probably because she had finished her growth.

The retention phase after treating the patient involved the following.

1. In the maxillary arch, a thermoplastic retainer provided stability during the daytime, especially regarding dental rotations. This splint is highly sensitive and provides maximum fixation if the patient cooperates. It was used during the day for 6 months after bracket removal. Also, in the maxillary arch, a circumferential Hawley retainer was used at night to provide the required lateral stability.

2. In the mandibular arch, a bonded lingual wire was placed and was to remain for at least 24 months. The patient’s collaboration with these retainers was essential to provide stability to the orthodontic treatment.

After questioning her family and studying the levels of growth hormone, which were deficient, we concluded that the patient had nearly completed her growth. The fact that she also had an early menarche caused us not to expect major changes.

The analysis of existing and new records and superimpositions 2 years after the end of the treatment showed a slight decrease of the overbite and a secondary labial interposition habit (Table). The patient is currently out of active retention and is wearing only the mandibular lingual wire, which will be removed after 36 months (Figs 9-11).

### DISCUSSION

Overall, the final results can be considered to be satisfactory, exceeding our expectations. This was due mainly to excellent patient compliance, which allowed the biomechanical approach to work satisfactorily. The treatment of a patient like this involves a continuous diagnostic process in which biomechanical decisions should be made appropriately. It would be difficult to treat such a severe sagittal and vertical discrepancy with dentoalveolar compensation.

The treatment of most of these patients, if undertaken at early stages, will allow partial improvement of the sagittal relationship but can sometimes worsen the vertical dimension. Attention should be paid to crossbite corrections throughout this stage, since skeletal modifications can occur. Early treatment usually simplifies any orthognathic surgical procedures that are required in adulthood.

During the first stage of treatment, the sagittal correction was quite efficient as well as the crossbite correction. Generally, both conditions do not improve the
Fig 8. Posttreatment lateral skull radiograph, cephalometric analysis, and superimpositions (pretreatment to posttreatment).

<table>
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<tr>
<th>Table. Cephalometric analysis</th>
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<th>Posttreatment</th>
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<td>Sagittal skeletal relationships</td>
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<td>Maxillary position S-N-A (°)</td>
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vertical problem but worsen it. Our aim is generally to treat these patients with vertical control, restraining and in some cases intruding the posterior segments by using an expander with complete occlusal coverage. However, the severity of this patient’s vertical problem was considered excessive for this approach.

According to Hwang et al, Class III occlusal planes have a flatter orientation, and the treatment goals for this type of malocclusion should involve achieving a steeper occlusal plane. The treatment of a Class III patient with an open bite will be successful by controlling the posterior occlusal plane and making it steeper. Treatment planning for both sagittal and vertical problems comes together with changes in the occlusal plane. These changes should be developed by clockwise modification of the maxilla and counterclockwise changes in the mandible, but with a vector of intrusion of the posterior segments.

The segmented arch approach provides rotation of the occlusal plane. The maxillary arch rotates independently on the lateral sectors, with subsequent leveling of the anterior segment, as shown in Figure 12.

As the superimpositions show, the closure was established by clockwise rotation of the maxilla and counterclockwise rotation of the mandible. The elastic vector affects this correction, and it must remain active in the second step of anterior leveling.

During phase 1, the occlusal plane decreased as a consequence of the anterior traction with the face-mask. The maxillary complex was moved forward and downward. Despite this, the overbite was still maintained in phase 2. This shift was clearly established by resolving both the sagittal and vertical malocclusions.

The orthodontic treatment was finished after the leveling was completed and the recovery of the mandibular arch segmentation achieved. The procedure must extend until growth has finished because, in an open bite, either growth or persistent habits can eliminate the corrections partially. When possible, it is important to correct the skeletal alteration after the end of the treatment.

This type of “heroic” treatment is perhaps unpredictable. Therefore, patient selection, patient compliance, and the predicted response to the mechanical treatment must be judged carefully.
The obtained corrections affect the dentoalveolar relationships, but the patient will continue to have dysplastic skeletal development, which can only be solved by orthognathic surgery.12 Most of this patient’s expectations were met, and surgery was avoided. Only the vertical dimension remained severely impaired and would need a surgical solution. Options should be discussed with the patient to determine the final treatment approach.

The improvements obtained for this patient were due to a change in the cant of the occlusal plane. The problem was clearly surgical; therefore, no matter how well the dentoalveolar situation was corrected, no skeletal changes were obtained, and the vertical facial pattern was maintained. Therefore, the lower facial height was not reduced, since the patient did not undergo surgery.

Subtelny and Sakuda1 stated that patients with a truly skeletal and severe open bite cannot be corrected by orthodontic treatment alone, and orthodontic correction alone should not be recommended in these surgical situations.

Since the introduction of temporary skeletal anchorage devices (miniplates and miniscrews), better skeletal outcomes have been demonstrated in the treatment of these types of malocclusions with dolicho facial patterns, by overcoming the classic limits of posterior segment intrusion. By intruding the posterior segments, the treatment is more effective, and the patient’s facial esthetics improve.13 Treating an open bite by pure intrusion would in theory be possible, but there is a lack of evidence. A literature review by Ng et al14 showed no evidence of real intrusion or, if there is any, it is very little. Baek et al15 evaluated long-term stability and found that most of the relapse occurs in the first year—hence the need to increase the retention period to prevent the relapse.

Occasionally, dental compensation treatments can relapse significantly over time. Huang16 suggested that 20% of the treated open-bite subjects will lose their overbite whether they received either treatment—orthognathic surgery or orthodontics. Stability is mainly determined by the presence or absence of growth, functional alterations (habits, tongue interposition), and the instability of the surgical fragments.17–19 Our patient had almost finished her growth by the end of treatment.

Determining the appropriate time to start orthodontic treatment combined with orthognathic surgery is one of the most controversial aspects regarding stability, since relapse can also occur after this type of treatment. Orthognathic surgical treatments have proven to be successful in a 15-year follow-up study of LeFort surgical treatment along with bilateral sagittal osteotomy.20 However, the success rate was low compared with the results produced by orthodontic treatment alone, and it
Fig 11. Retention lateral skull radiograph, cephalometry, and superimpositions (treatment to retention).

Fig 12. Scheme of the segmented arch mechanics: changes of dental inclinations and occlusal planes, maxillary and mandibular, to achieve bite closure.
had worse long-term stability.\textsuperscript{21} Other studies have shown similar results and a similar frequency of relapse, with clinical stability in only 66.7% of the patients studied.\textsuperscript{22} Bondemark et al\textsuperscript{23} analyzed morphologic stability and patient satisfaction. They found that most of the relapse occurs during the first 6 months after surgery, and there can be secondary dentoalveolar compensation.

In a recent meta-analysis, Greenlee et al\textsuperscript{24} analyzed the stability parameters of open bites of patients treated orthodontically or surgically. The average stability values were 75% in those treated with orthodontics and 82% for surgical treatment. In our patient, the overbite was reduced from $-2.7$ mm before treatment to $1.3$ mm after treatment. Two years after treatment, the overbite was $0.7$ mm. Our patient’s response was similar to the results of other nonsurgical treatments that varied from $-2.5$ mm before treatment to $1.3$ mm after treatment, with a relapse to an $0.8$-mm overbite after 3.2 years.

The patient had some vertical relapse, possibly caused by the tongue’s interposition at rest, which could result in proclined maxillary incisors. The resulting overbite loss is not dramatic considering the significant improvement in the anterior overbite. To prevent further relapse and maintain the current occlusion, a retainer was designed with a hole in the palate to promote a proprioceptive lingual habit.\textsuperscript{25} Cal-Neto et al\textsuperscript{26} recommended long-term retention of open-bite patients.

As shown in the superimpositions, we found intrusion of the mandibular incisors and proclination of the maxillary incisors. The molar inclination was corrected as well and, although minimal, caused some loss of anterior overbite.

**CONCLUSIONS**

Skeletal malocclusions follow a natural course until the end of growth. The beneficial or harmful consequences of dentoalveolar compensations must be foreseen and assessed. As the reader will understand, this type of treatment is contraindicated in patients with significant vertical excess of the lower third of the face, but it could nevertheless be a valid alternative for patients with minor problems, or when orthognathic surgery is rejected by the patient. The decisions made should not limit future options, especially in Class III malrelationships, when extractions before the patient stops growing could erase the dentoalveolar compensation and eliminate further options of correction, since the malocclusion has not completely developed. Vertical control in patients with increased lower facial height should be addressed by intruding the posterior segments or restricting their vertical growth.

An early intervention can change the progression of some patients. Class III corrections should be performed in the early mixed dentition, especially if there is a cross-bite. The prognosis of the sagittal result depends on future mandibular growth. Moreover, sagittal improvements could be more efficient in early stages rather than later, but, as previously stated, the remaining growth could ultimately transform the case into a surgical one. As in every treatment involving intermaxillary elastics, special care and control must be taken not to distract the condyle from the fossa.

The association between Class III and skeletal open bite exacerbates the problem. A dental compensation can significantly improve the malocclusion. In open bites, changes in the occlusal plane can help its correction. The segmented arch approach is an effective tool when used in the correction of open bites. The resulting compensation generally produces an efficient dentoalveolar improvement, at the expense of individualizing the anterior and posterior segments of the mandible by using the maxillary arch as a guide.

The tongue habit at rest generated an insignificant relapse in this patient. Her long-term prognosis is good thanks to the use of a more specific retainer, a longer retention period, and the completion of facial growth.

**REFERENCES**


