Abstract: This article reports the case of a patient with severe mandibular deficiency and crowding in the mandibular arch treated with atypical extractions of two premolars followed by mandibular advancement with the Herbst appliance. It became clear that this therapy corrected the malocclusion while improving facial.

Keywords: Class II; Herbst appliance; atypical extractions.

Introduction

The morphological characterization of Class II malocclusion varies widely, and can be caused by both dental and skeletal changes. This sagittal problem is reflected in the isolated presence of maxillary prognathism, mandibular retrognathia, maxillary dentoalveolar protrusion, mandibular dentoalveolar retrusion or a combination of these factors, whereas mandibular retrognathia is often the key factor behind this discrepancy.1,2,3,4,5

Many removable or fixed appliances have been designed in an attempt to find a solution for Class II malocclusion with mandibular retrognathia, producing postural changes in the mandible and moving it forward in order to stimulate its growth. According to each appliance inventor, their invention produces specific dental and skeletal changes and each is fabricated and employed in a wide range of methods. Determining the ideal mechanism depends on the professional’s knowledge or preference, depending on where the discrepancy is located as well as on patient compliance.

With a view to eliminating the compliance factor, HERBST devised an apparatus that effectively addresses mandibular protrusion without depending on patient cooperation while providing continuous forces for 24 hours. The main changes arising from the use of this appliance in treating patients with Class II, Division 1 occlusal relationship are reported in the orthodontic literature. According to these reports, the Herbst induces a restriction or redirection of the anterior displacement of the maxilla, an increase in anteroposterior mandibular growth rate, an increase in lower anterior facial height, marked mentolabial sulcus and virtually non-existent nasogenian sulcus. In evaluating the facial profile, one could observe increased facial convexity, adequate nasolabial angle, forced lip competence, marked mentolabial sulcus,

Diagnosis and Etiology

The 13-year-old patient (L.B.S.L.) sought the Specialization Program in Orthodontics at the University of the Sacred Heart (Universidade do Sagrado Coração, Bauru-SP/Brazil) with the chief complaint of protrusion in the maxillary teeth. In assessing the face frontally, there was symmetry, decreased lower anterior facial height, marked mentolabial sulcus and virtually non-existent nasogenian sulcus. In evaluating the facial profile, one could observe increased facial convexity, adequate nasolabial angle, forced lip competence, marked mentolabial sulcus,
relatively short chin-neck line in relation to facial depth, and open chin-neck angle (Figure 1), unmistakable signs of mandibular deficiency.

Occlusal assessment showed that the patient was at the end of the second transitional period of mixed dentition, with only teeth 53 and 83 not yet exfoliated. There was a Class II occlusal relationship (1/4) with pronounced overbite and overjet, dentoalveolar atresia with consequent moderate crowding in the upper arch, and severe crowding in the lower arch. Tooth 43 was found to be positioned intraosseously with not enough space for eruption, whereas some bulging in the palatal region of the tooth 83 could be seen. The lower dental midline coincided with the upper midline (Figure 1 and 2).

In evaluating the panoramic radiograph, one could observe the presence of three supernumerary teeth in the posterior region of the lower dental arch, two in the region of tooth 34 and one in the region of tooth 44 (Figure 3). Teeth 13 and 43 were still erupting but lacked space. The upper and lower third molars were still forming. The TMJ condition was normal.

Analysis of standardized lateral radiographs (Figure 3) confirmed the clinical findings after morphological evaluation of the face, which revealed mandibular retrusion (SNB=77th) with mild maxillary protrusion (SNA=84th), and predominance of vertical growth (SN.SGn=73º and SN.GoMe=37º). The maxillary incisors were slightly inclined lingually (1.NA=19º and 1-NA=3mm), and the lower incisors were proclined and protruded (1.NB=31º, IMPA=97º and 1-NB=7mm). Such incisor position is compensatory and adaptive in patients with mandibular deficiency.

Assessment of the clinical and radiographic examinations made it possible to diagnose the patient as presenting with a moderate mandibular deficiency and mild maxillary protrusion, with a Class II occlusal relationship (1/4), maxillary dentoalveolar atresia and severe mandibular crowding, with upper and lower compensated incisors.

**Treatment Objectives**

Treatment goals were to (1) solve the upper and lower crowding issue, (2) correct the dental Class II malocclusion, consequently correcting overjet and overbite, (3) achieve a Class I canine relationship, Class III molar relationship and (4) improve facial aesthetics, despite the limitations.

**Treatment Alternatives**

The therapeutic options available to this patient involved distinct approaches with substantially different therapeutic goals and treatment plans. All therapeutic hypotheses were extensively discussed with the patient’s legal guardians taking into account cost-effectiveness, age and growth management.

As a result of the upper crowding and especially the more severe lower crowding, one option would be to start treatment by extracting four premolars, followed by retraction of the upper incisors, which would involve some anchorage loss in the maxillary arch to correct the Class II occlusal relationship. Since there was no protrusion in the upper incisors, it seemed illogical...
Another possibility would be to extract only two maxillary premolars in order to correct the Class II and one lower incisor to address the crowding in the mandibular arch. This option would be unproductive since the Class II molar relationship (¼) would require a significant loss of anchorage to enable a full Class II relationship at the end of treatment, while providing little space to correct the overjet. Given these limitations, both hypotheses were ruled out as both posed potential risk to the patient’s profile and/or undermined overjet correction.

Another treatment option submitted to the legal guardians was surgical mandibular advancement, which would very likely yield gains in facial and occlusal relationships. Such treatment would be indicated after pubertal growth spurt. This option was rejected by the patient and his legal guardians owing to the costs and risks implied, the impossibility of immediate treatment and difficulties in decision-making given the patient’s age.

Although an admittedly limited alternative, a compensatory treatment with corrective intent was ultimately proposed and accepted. In these circumstances, treatment planning includes removal of the compensation in both dental arches, thereby exposing the skeletal discrepancy. The difference is that instead of using a mandibular advancement orthognathic surgery treatment, which might have a corrective bias, advancement is made with a fixed mandibular protractor (Herbst appliance), rendering the treatment compensatory in nature. In order for these proposed objectives to be achieved, extraction of two lower premolars (other than supernumerary) was planned as well as correction of the mandibular crowding, followed by rapid maxillary expansion and placement of the Herbst appliance, along with mandibular advancement to correct the sagittal occlusal relationship and ensure a more balanced face. The treatment plan also established that treatment with fixed orthodontic appliances would be completed with the goal of eliminating any unwanted outcomes from the orthopedic treatment, and that a Class I canine relationship and a Class I or III molar relationship would be attained.

Treatment Progress

The orthopedic/orthodontic treatment was initiated with the extraction of teeth 34 and 44, in addition to the supernumerary teeth in the lower arch. The main objective was to correct the lower anterior intra-arch model discrepancy and create enough overjet to allow continuous mandibular advancement with the Herbst appliance in a second phase (Figure 4). In other words, decompensation.

After the extractions, the initial retraction of canines was started with 0.016” steel wire combined with a moderate lip-bumper anchorage in the mandibular arch. During the partial retraction of the
canines, incisors were not included to avoid protrusion. After creating the necessary spaces for alignment, the incisors were included in the mechanics and were therefore bonded with Capelozza II Plus prescription brackets (+2° angulation, +8° torque). The mechanics continued until the extraction spaces were closed, with the canine relationship evolving into a full Class II (Figure 4).

Six months after beginning the mechanics in the lower arch, a Haas type appliance was placed in the upper arch to perform rapid maxillary expansion to correct the dentoalveolar atresia, and thus make room for the eruption of tooth 23 and in particular tooth 13 - while also serving as anchorage for the Herbst, thereby minimizing the effect of the telescoping mechanism on the maxilla. The amount of expansion is defined by the inter-arch transverse relation with predictive mandibular advancement. This advancement was simulated with the Herbst.

Also during the retention phase of the rapid maxillary expansion, direct bonding was performed on the incisors, canines and second premolars with Capelozza I prescription brackets, aiming at the full alignment and leveling of these teeth. The combination of protrusive mechanics in the upper arch and restrictive mechanics in the lower arch created suitable conditions (sufficient overjet or exposure of the sagittal malocclusion) for the orthopedic stage of the mandibular advancement process. As planned, a compensatory treatment with corrective intent was performed.

The Herbst appliance, inserted with the purpose of correcting the canine relationship - which created in one single advancement an edge-to-edge bite in the incisors - remained attached to the maxillary (Haas expander) and mandibular (modified lingual arch, with bands on teeth 33, 36, 43 and 46) anchorages, and was maintained for a period of eight months (Figure 5).

After removal of the Herbst appliance, the first upper and lower molars were banded, the upper and lower second premolars, and the lower canines were bonded. Leveling in both arches proceeded until the use of 0.019”x0.025” steel wire, with hooks in the upper arch mesially to the canines to allow the use of Class II vector elastics to stabilize the mandibular advancement and improve intercuspation.

The fixed orthodontic appliance was removed and the retainers (Hawley retainer and lower 3x3) were placed twenty-three months after the beginning of treatment (Figure 6).

**Treatment Results**

Final photographs and radiographs show that the orthopedic/orthodontic treatment produced typical characteristics of a normal occlusion, with a favorable aesthetic impact on the face, characterized by a reduction in facial convexity. The occlusal relationships were satisfactory with considerable compensation, especially in the lower arch, as well as increased buccal inclination of mandibular incisors and mesial movement of posterior teeth. This implied limitations that were predicted in the prognosis, and which define the treatment as compensatory. The final occlusal relationship was a Class III in first molars and Class
I in canines, with a significant overjet reduction and overbite correction (Figure 6).

The final panoramic radiograph showed adequate parallelism between the roots of the teeth. Bone loss was observed in the region of tooth 34, and resulted from extraction of the supernumerary teeth. This region is still undergoing repair and require radiographic follow-up. Likewise, the upper third molars should be monitored and extracted in due course, since these teeth have no antagonists in the lower arch.

The dental and skeletal changes that occurred during the orthodontic/orthopedic treatment - characterized by a sagittal compensation of the dental arches - could be confirmed by cephalometric analysis and comparison/superimposition of initial and final radiographs (Figure 7 and 8 – Table 1).

Intraoral and facial control photographs taken one year and four months after removal of the appliances show that the facial and occlusal relationships remained stable (Figure 9 and 10).

**Discussion**

Class II malocclusion can involve the basal bones in the sagittal, vertical and transverse direction. It is characterized by a maxillomandibular discrepancy and, in most cases, a convex facial profile. Assessment of Class II sagittal changes reveals that mandibular retrognathia is considered one of the main factors responsible for this malocclusion. Additionally, the upper arch often exhibits compensatory transverse atresia, requiring expansion prior to mandibular advancement. This diagnosis is essentially morphological. It is reached based on an isolated evaluation of the upper dental arch and the inter-arch relationship with the advanced mandible, predictively in relation to Class I.15, 16

Given the need for frequent maxillary transverse deccompensation, the Haas type expansion appliance appears as an optional anchorage method for continuous mandibular advancement with the Herbst appliance. The Haas appliance optimizes clinical treatment time since after the active expansion phase, during the retention period, the expander itself can be used as anchorage for mandibular advancement, as in this case. It is noteworthy that given a lack of space for maxillary canines, prior expansion worked even more effectively in providing a resource for creating space for alignment of the upper teeth.

Given that the Herbst is tooth supported, it induces major changes in the dentoalveolar component and a more stable and significant orthopedic effect in the maxilla than in the mandible. In the clinical case described in this study, restriction to maxillary growth along with stimulation of mandibular growth resulted in a significant improvement in facial profile and maxillomandibular relationship.7,8,10,18,19 The main changes in soft tissue profile resulting from treatment with the Herbst are: upper lip retrusion, lower lip retrusion or protrusion, decreased facial convexity and improved facial profile.3,11

Orthopedic effects are most evident when the Herbst is placed at growth spurt. When the Herbst is used after craniofacial growth spurt, dental changes are predominant at the expense of skeletal changes.12,20 Thus, the ideal time to introduce Herbst treatment is when permanent dentition is complete, or shortly after statural growth spurt. The treatment performed in permanent dentition allows proper occlusal engagement after therapy, which enhances long-term stability.21,22,23

The upper incisors exhibit no significant changes in their position.7,8,9 On the other hand, the lower incisors tend to procline.7,8,9,19,24 In this case, mandibular incisors showed lower dentoalveolar compensation due to the use of such a rigid system. The mandibular posterior teeth, especially molars, showed a strong tendency to move mesially, corroborating the literature.7,8,9,18,19,24

First premolar extraction was aimed at correcting the lower anterior intra-arch model discrepancy and creating enough overjet to allow ongoing mandibular advancement with the Herbst appliance. In other words, the goal was to align the lower anterior teeth, averting protrusion in the first phase, while allowing a certain amount of occlusal discrepancy consistent with the facial error. These are typical treatment procedures of a compensatory treatment performed prior to mandibular advancement surgery. This surgery was replaced - in a new proposal presented in this study, called compensatory treatment with corrective intent - by orthopedic advancement of the mandible, with the advantages and disadvantages inherent in this method. At this stage of canine retraction and mandibular arch leveling, the use of moderate anchorage was preferred over skeletal anchorage, whereas extractions were indicated to correct the model discrepancy in the lower arch, but not for lower incisor uprighting. Given the longer time required to close the spaces, treatment was begun in the lower arch.

It is of paramount importance that patient and legal guardian(s) understand the limitations of this treatment modality, namely compensatory treatment with corrective intent, to avoid false expectations. As described in the literature,25 management of mandibular growth may prove inadequate, regardless of age or the appliance used to promote growth. In the clinical case presented, the occlusal relationship was corrected and the facial convexity reduced, although both the correction and reduction were extremely limited compared to surgical advancement. This assertion is particularly important since some studies correlate - mandibular retrusion with respiratory problems, including OSAS.26 In adulthood, if the patient’s complaint is of an aesthetic or functional (breathing) character, a decompensatory orthodontic treatment in preparation for orthognathic surgery is bound to be limited in terms of lower arch decompensation, since the first premolars will have already been extracted to enable the correction of lower arch crowding and orthopedic advancement. As a rule, this should not be an unsolvable problem, considering that

**Table 1: Initial and final cephalometric values**

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<tr>
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<th>Initial values</th>
<th>Final values</th>
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<tr>
<td>SNA</td>
<td>84°</td>
<td>82°</td>
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<tr>
<td>SNB</td>
<td>77°</td>
<td>77°</td>
</tr>
<tr>
<td>ANB</td>
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the recommended surgery for patients with compensated mandibular deficiency as well as those presenting with OSAS, usually require maxillary and mandibular advancement.

Conclusions

The atypical treatment approach used in this case is defined as a compensatory treatment with corrective intent (CTCI). It combines the extraction of two lower premolars to eliminate mandibular crowding and thereby expose the sagittal skeletal discrepancy while allowing continuous mandibular advancement using Herbst’s rigid system. As a result, Angle Class II occlusal relationship was corrected and facial relationships improved.

References
