Using the Forsus Appliance to Correct Class II Mandibular Asymmetry in a Growing Patient: A Case Report

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USING THE FORSUUS APPLIANCE TO CORRECT CLASS II MANDIBULAR ASYMMETRY IN A GROWING PATIENT: A CASE REPORT

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The case report described the orthodontic treatment of a 13-year-old male patient diagnosed as Angle Class II Division 1 subdivision left malocclusion with deep bite and spacing. The chief complaint was protrusive upper front teeth prone to injury. Non-extraction treatment with Forsus appliance and Class II elastics was used to correct the Class II relationship on the left side, and to improve the deviated mandibular dental midline, protrusive front teeth and lips, and lip incompetence. Although there were residual mandibular dental deviation of 0.5 mm and lip incompetence, the patient and his parents were satisfied with the treatment results revealing improvement of facial appearance and achievement of Class I molar and canine relationship with solid interdigitation. (Taiwanese Journal of Orthodontics. 29(4): 244-255, 2017)

Keywords: Class II subdivision; mandible asymmetry; deep bite; Forsus appliance

INTRODUCTION

Class II subdivision malocclusion presents asymmetric occlusion with Class II molar relationship on one side and Class I on the other side. The cause of occlusal asymmetry is dentoalveolar asymmetry, functional asymmetry, skeletal asymmetry or a combination. The primary contributor is proposed to be the distal positioning of the mandibular first molar on the Class II side within a mandible that exhibited no other unusual asymmetry, and maxillary dentoalveolar asymmetry is the second contributor.1-3 When it comes to skeletal origin, mandibular asymmetry that is shorter and more posteriorly positioned on the Class II side is more common and significant than maxillary asymmetry.4,5

Asymmetric occlusion poses difficulties in orthodontic treatment, and improving the dental midline deviation has long been an important issue in this category.3,6,7 For Class II subdivision malocclusion, a large number of patients have mandibular asymmetry and the consequent mandibular dental midline deviation, and correcting the dental midline deviation will be remarkably challenging in that case.3,7 Asymmetric extraction usually is an easier way to correct the dental midline deviation,
while non-extraction orthodontics with elastics or Forsus Fatigue Resistance Devices (Forsus™; 3M Unitek, Monrovia, Calif) often finish in residual midline deviation.\textsuperscript{7,8} This case report presented the orthodontic treatment of Class II Division 1 subdivision malocclusion of skeletal origin in a growing patient, in which the extraction protocol was contraindicated mainly because of the large amount of interdental spaces in the maxillary arch.

CASE REPORT

A 13-year-old male patient was brought to our department by his mother with a complaint of protrusive upper front teeth prone to injury. His prior medical history revealed epilepsy, mild mental retardation, and growth retardation undergoing growth hormone therapy. He had quite severe thumb biting habit, and thick scars with fresh wound could be found on his thumbs. He received regular dental care in the department of pediatric dentistry at Chang Gung Memorial Hospital. The incisal edge of #21 got traumatic enamel fracture and subsequent management of edge rounding at about 6 to 7 years old of age. No significant symptoms of sound, pain, or limited movement of temporomandibular joints (TMJs) was shown.

CLINICAL AND RADIOGRAPHIC FINDINGS

Extra-orally, the patient showed a convex profile, acute nasolabial angle (Cm-Sn-Ls: 80.0°), protrusive lips, everted lower lip placing behind the maxillary incisors and exhibiting a deep mento-labial sulcus, and mentalis muscle strain from lip incompetence. The vertical ratio of middle face to lower face was 1.0 to 0.8. The upper lip length was short (Sn-Sto at rest: 15.0 mm, norm of children: 21.5 ± 2.2 mm).\textsuperscript{9} The maxillary incisal display was 7.0 mm at rest and 9.5 mm (full-crown height) on posed smile. The smile arc was non-consonant. The maxillary dental midline deviated to the right by 0.5 mm, the mandibular dental midline to the left by 3.0 mm, and the chin to the left by 5.0 mm relative to the facial midline. A centric relation-centric occlusion (CR-CO) discrepancy of 2.0 mm was present. Intra- orally in CR, the patient had Angle Class I molar relationship on the right side and Class II molar relationship on the left side, an overjet of 10.0 mm, and an overbite of 4.5 mm. #55 and #65 were retained. #35 was emerging. The amounts of spacing were 10.5 mm and 3.0 mm in the maxillary and mandibular arches, respectively. The anterior Bolton ratio was 77.1%, and the overall Bolton ratio was 89.0%. The curve of Spee was 0.5 mm on the right side and 1.5 mm on the left side (Figure 1).

The panoramic film showed the unemerged #15, 17, 25, 27, 37, 38, 47, 48 with grossly normal development and mild flattening of the left condyle. Lateral cephalometric analysis showed skeletal Class I in CO (SNA: 84.0°, SNB: 82.0°, ANB: 2.0°, Wits appraisal: -2.0 mm, Pg-Nv: -7.0 mm) and skeletal Class II tendency with mildly retrusive mandible in CR (SNA: 84.0°, SNB: 80.0°, ANB: 4.0°, Wits appraisal: +1.0 mm, Pg-Nv: -9.5 mm), average mandibular plane angle (SN-MP: 31.0° in CO, 32.0° in CR), and proclined and protrusive maxillary and mandibular incisors (U1-SN: 125.0°, U1-NA: +10.0 mm, L1-MP: 101.0°, L1-NB: +6.5 mm) (Figure 2 & 3, Table 1). The lower border of the second and third cervical vertebrae presented concavities, and the body of C3 was rectangular horizontal in shape, indicating that the patient was between cervical vertebral stage 3 and 4.\textsuperscript{10}

The postero-anterior cephalogram showed skeletal chin deviation to the left by 5.0 mm (Figure 2).

DIAGNOSIS

The patient was diagnosed as having skeletal Class II tendency with mild mandibular retrognathism, mesodivergent facial type, and facial asymmetry. The dental diagnosis was Angle Class II Division 1 subdivision left malocclusion with deep bite and spacing.
Figure 1. Pre-treatment extra-oral and intra-oral photographs, and study models, in centric relation.

Figure 2. Pre-treatment panoramic film and cephalograms in centric occlusion. The posteroanterior cephalogram showed the mandibular asymmetry (i.e., 5.0 mm of skeletal menton deviation to the left in relation to the facial midline) contributing to the subdivision malocclusion.
Table 1. The pre- and post-treatment cephalometric analyses.

<table>
<thead>
<tr>
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<th>Pre-Tx</th>
<th>Post-Tx</th>
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<td></td>
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<tr>
<td>SN-FH (°)</td>
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<td>3.0</td>
<td>5.7 ± 3.5</td>
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<td>SNA (°)</td>
<td>84.0</td>
<td>84.0</td>
<td>81.5 ± 3.5</td>
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<tr>
<td>SNB (°)</td>
<td>80.0</td>
<td>80.0</td>
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<tr>
<td>ANB (°)</td>
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<td>4.0</td>
<td>4.0 ± 1.8</td>
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<tr>
<td>Wits appraisal (mm)</td>
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<td>-2.0</td>
<td>-1.2 ± 1.9</td>
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<tr>
<td>A-Nv (mm)</td>
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<td>-1.5</td>
<td>0.0 ± 2.0</td>
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<tr>
<td>Pg-Nv (mm)</td>
<td>-9.5</td>
<td>-10.0</td>
<td>-5.0 ± 8.0</td>
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<tr>
<td>SN-MP (°)</td>
<td>32.0</td>
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<td>33.0 ± 1.8</td>
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<tr>
<td><strong>Dental</strong></td>
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<tr>
<td>U1-NA (mm)</td>
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<td>L1-NB (mm)</td>
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<td>L1-MP (°)</td>
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<td>93.7 ± 6.3</td>
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<td>UL-E-line (mm)</td>
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<td>+1.5</td>
<td>1.1 ± 2.2</td>
</tr>
<tr>
<td>LL-E-line (mm)</td>
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<td>+3.5</td>
<td>0.5 ± 2.5</td>
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</table>

Figure 3. Pre-treatment cephalometric tracing in CO (dashed line) and CR (solid line).
TREATMENT OBJECTIVES

The treatment objectives were to (1) retract the maxillary incisors and subsequently the lips by closing the spaces in the dental arch; (2) achieve bilateral Class I molar relationship by protracting the mandibular left teeth; (3) establish proper overbite by relatively or absolutely intruding the mandibular incisors; (4) establish proper overjet and interdigitation; and (5) monitor the growth and facial asymmetry.

TREATMENT PROGRESS

#55 and #65 were extracted. Pre-adjusted edgewise brackets (OPA-K® prescription) with 0.022-in slots were bonded. Leveling and alignment was performed with sequential wires from 0.014-in NiTi, 0.018-in SS, to 0.016 × 0.022-in NiTi wires for five months. In the third month, retraction and inclination improvement of the maxillary incisors were softly started by using light elastomeric chains with 0.018-in SS wire and 0.032-in TMA trans- palatal arch in the maxillary arch.

In the following 6 months, retraction of the maxillary anterior teeth was continued, and protraction of the mandibular left teeth was started using sliding mechanics with 0.016 × 0.022-in SS wires in both arches. During this period, Class II elastics extending from the maxillary canines to the mandibular first molars and bilateral intrusive lever arms of 0.017 × 0.025-in TMA in the maxillary arch were applied to reinforce anchorage and prevent extrusion of the maxillary anterior teeth while being retracted for one month. Later due to the poor compliance in wearing the elastics, and the requirement of anchorage reinforcement for anterior retraction of the maxillary anterior teeth and intrusion of the mandibular anterior teeth, Forsus appliance fitting onto the mandibular wire between the canine and first premolar brackets was placed on both sides for 3.5 months until the occlusion was overcorrected to mild Class III molar relationship (Figure 4 & 5). The symmetric setting of the orthodontic appliances on the asymmetric occlusion would theoretically exert asymmetric forces on bilateral sides and improve the asymmetric occlusion. #15 and #25 were also bonded with brackets and engaged during this period.

In the 12th month of treatment, Forsus appliance was removed and 0.018 × 0.025-in NiTi wires were placed for re-leveling and re-aligning both arches which had been mildly deformed by Forsus appliance; bilateral Class II elastics were prescribed to maintain the correction of molar relationship and improvement of dental midline

Figure 4. One month after the placement of Forsus.
Class II Mandibular asymmetry corrected by Forsus

deviation for one month (Figure 5). The subsequent panoramic film and lateral cephalogram showed good root parallelism and acceptable inclination of the maxillary incisors, but proclined mandibular incisors (Figure 6). The 0.016 x 0.022-in SS wires were then used to coordinate maxillary and mandibular arches. Third-order bending from #32 to #42 was made to improve the proclination of the mandibular incisors. Left side Class II elastics all day long without replacement were demanded to ensure the compliance and the continuous improvement of the mandibular dental midline deviation for 3 to 4 months. An intrusive arch tied to the maxillary archwire at two

Figure 5. In the 12th month of treatment, bilateral Forsus devices were removed, and 0.018 x 0.025-in NiTi wires were placed for re-leveling and re-alignment.

Figure 6. In the 13th month of treatment, panoramic and lateral cephalogram were taken.
points between the lateral incisors and canines along with second-order bends from #33 to #43 were applied to improve the deep bite (Figure 7). After 24 months of treatment, all the orthodontic appliances were removed. Lingual fixed retainers were bonded at teeth #14-24 and #34-44, and maxillary wraparound and mandibular Hawley retainers were delivered (Figure 8).

**TREATMENT RESULTS**

The lip protrusion was well improved, and the mentalis muscle strain was also greatly improved as the result of 6-mm lingual movement of the maxillary incisors, which subsequently improved the facial appearance (Figure 8 & 10). The residual lip incompetence

![Figure 7. In the 16th month of treatment, an intrusive arch was tied to the maxillary archwire, and unilateral Class II elastics were prescribed.](image1)

![Figure 8. Post-treatment extra-oral and intra-oral photographs.](image2)
might be attributed to the short upper lip (Sn-Sto at rest before and after treatment: 15.0 mm). The maxillary dental midline was coincided with the facial midline, and the mandibular dental midline deviation was improved from 3.0 mm to 0.5 mm to the left. The spaces in the maxillary and mandibular dental arches were all closed. The excessive overjet and overbite were both reduced to 2.5 mm. Bilateral Class I molar relationship with solid interdigitation was achieved. No CR-CO discrepancy was observed after treatment. The patient and his parents were satisfied with the treatment results.

The post-treatment panoramic film showed acceptable root parallelism without obvious external root resorption. The superimpositions of the pre- and post-treatment tracings indicated 0.5-mm forward and 1.0-mm downward growth of the maxilla, and 2-mm horizontal and 1-mm vertical growth of the mandible. The post-treatment cephalometric analysis presented clockwise rotation of the mandible and increased mandibular plane angle (SN-MP: 32.0° → 35.0°) and lower anterior facial height, which resulted from the mean 2-mm extrusion of the mandibular molars; this contributed to the correction of the deep bite instead of relative or absolute intrusion of the mandibular incisors as initially planned. The favorable growth in the horizontal direction of the mandible secured the antero-posterior position of the pogonion and the

Figure 9. Post-treatment panoramic film and cephalograms. The posteroanterior cephalogram showed no deterioration in the mandibular asymmetry after treatment (i.e., 5.0 mm of skeletal menton deviation to the left before and after treatment).
skeletal Class II tendency without further exacerbation. However, the increase of the lower anterior facial height might have adversely affected the elimination of the lip incompetence. The chin deviation of 5.0 mm was maintained. The proclination and protrusion of the maxillary incisors were corrected (U1-SN: 125.0° → 104.0°, U1-NA: +10.0 mm → +4.0 mm). The proclination of the mandibular incisors was improved (L1-MP: 101° → 99°) (Figure 9 & 10, Table 1).

**DISCUSSION**

The CR-CO discrepancy is easily found in Class II Division 1 malocclusion; the large overjet is one of the contributors to the centric slide from CR to CO. The correct CR is essential for coordination of the occluding tooth surfaces and the TMJs. The CR and CO cephalometric values demonstrated significant differences for the majority of the mandible-related measurements according to the study of Shildkraut et al. It is difficult to instruct this patient with mild mental retardation to bite in CR when cephalograms were taken, so adjustments of the mandibular position of the lateral cephalometric tracing toward distal direction grossly along the maxillary occlusal plane were made until the occlusion especially the overjet and the facial profile were similar with those observed clinically (Figure 3). The cephalometric measurements in CR showed an increase in the SNB, ANB, and SN-MP angles as well as the Pg-Nv distance compared with those in CO, which was in agreement of Shildkraut et al. reporting a more retrusive mandible and a more antero-superior position of condyle in CR than in CO. Therefore, the skeletal diagnosis of this patient shifted from Class I to Class II tendency (Table 1), as did the subsequent treatment planning.

The etiology of the excessive overjet of this patient was multifactorial including skeletal, soft tissue, dental, and habitual components. The underlying skeletal Class II tendency from the mildly retrusive mandible especially the left side was associated with the left side Class II molar relationship and the large overjet, although the impact from the skeletal part might not be prominent since the skeletal discrepancy was not severe (ANB: 4.0°). The patient’s habit of thumb biting and pushing toward the maxillary anterior teeth seemed to be the major contributor of the protrusive and severely proclined maxillary anterior teeth and the consequent large overjet.
The lower lip drawn up behind the maxillary anterior teeth due to the large overjet along with the lip incompetence leaded to exacerbation of the labioversion of the maxillary anterior teeth and the overjet. This patient gradually quit the habit of thumb biting and pushing, and kept lips closed most of the time, which helped the retraction of the maxillary incisors go well with an final achievement of 6.0 mm.

For this growing patient with a large overjet, skeletal Class II tendency and mandibular asymmetry, there were three treatment strategies including mandibular growth modification, orthodontic camouflage, or waiting for orthognathic surgery (OGS). Treatment considerations were primarily the extent of skeletal and dental discrepancy, the dentoalveolar contribution to the overjet, and facial esthetics as well as growth potential. After overall evaluation and discussion with the patient’s parents, orthodontic camouflage was chosen for the following considerations. In the skeletal aspect, the extent of the antero-posterior skeletal discrepancy and the mandibular retrusion were not severe (ANB: 4.0°, SNB: 80.0°, Pg-Nv: -9.5 mm); the transverse discrepancy was mostly confined to the anterior part of the mandible featured as chin deviation, and no obvious posterior dental crossbite or compensation was noticed. In the dental aspect, the antero-posterior molar discrepancy on the left side was only 3.0 mm (i.e., Class II end-on molar relationship); the increased overjet of 10.0 mm was largely attributable to the 10.5 mm spaces in the maxillary dental arch. The overall facial appearance was mainly disfigured by the protrusive lips and anterior teeth, which could be expected to be well improved based on the visualized treatment objective (VTO) analysis. Although the mandibular deviation was beyond normal range (Me deviation to the left by 5.0 mm, norm: 2.0~4.0 mm), there were no other prominent asymmetric features on the face, and therefore no strong impression of skewed face was perceived by the patient and his parents and friends. In addition, mandibular growth modification was not adopted because of the already proclined mandibular incisors and lip incompetence (that is, the removable functional appliance might increase the lower anterior facial height and exacerbate the lip incompetence), the patient’s questionable potential of growth and cooperation, and the complexity and unpredictability of asymmetric functional appliances. Also, surgical intervention was unfavored regarding the mental and physical status of this patient, but monitoring of the asymmetric growth during and after the orthodontic treatment was needed, and OGS was still an option for this patient after growth spurt.

Class II elastics, Forsus appliance, headgear, temporary anchorage devices (TADs) are widely used for the orthodontic treatment of Class II Division 1 malocclusion. It is a comparatively more invasive alternative to place TADs, and repeated operations might be needed if TADs were loosened, which often happens in young adolescents. Therefore, TADs were less preferable for this patient. Orthodontic headgear is dangerous for naughty kids like this patient, so this option was also discarded. Class II elastics and Forsus both are effective in treating Class II malocclusion, and their effects are primarily dentoalveolar; the effects in common are maxillary anchorage reinforcement, distal movement of maxillary teeth, and mesial movement of mandibular teeth with similar amounts of proclination of mandibular incisors. In the vertical aspect, Forsus appliance produces intrusion of mandibular incisors, while Class II elastics produce extrusion of mandibular molars; both produce palatal tipping and extrusion of maxillary incisors as well as clockwise rotation of the occlusal plane, which is greater for Class II elastics. Therefore, Forsus appliance shows an advantage, over the Class II elastics, of anchorage enforcement for intrusion of the mandibular anterior segment in correcting deep bites, which is important in treating Class II malocclusion. Aras and Pasaoglu also reported that Forsus had greater improvement of overjet and Class II molar relationship.
in a shorter treatment period with minimal patient compliance required than Class II elastics; both needed overcorrection, while Forsus group showed less relapse. In this case, Forsus application resulted in obvious changes in the mandibular dental midline deviation, overjet, overbite, and molar relationship with slight overcorrection in 3.5 months (L1 midline deviation: 3.0 mm → 1.0 mm, overjet: 5.0 mm → 1.0 mm, overbite: 4.0 mm → 1.0 mm, right side molar relationship: Class I → mild Class III, left side molar relationship: Class II → mild Class III) (Figure 5). However, after finishing the following orthodontics, there was no absolute intrusion of the mandibular incisors, neither was the relative intrusion in this growing patient. Relative intrusion of incisors needs a suitable amount of vertical growth of mandibular rami providing vertical space into which posterior teeth erupt. But, in this case, only 1-mm vertical growth of the mandibular rami was found and which was invalidated by the downward growth of the maxilla of the same amount. Burstone and Weiland et al. pointed out that dental intrusion with continuous archwire mechanics usually leads to dental extrusion. The failure of intrusion of the anterior segment with the usage of Forsus as anchorage reinforcement might be explained by the short span of Forsus usage (i.e., 3.5 months), and the weak masticatory performance and force of this patient in addition to the continuous archwire mechanics. Aras and Pasaoglu also reported the average intrusion amount of mandibular incisors was only 0.49 mm. In the end, the deep bite of this patient was reduced by clockwise rotation of the mandible as shown on the superimpositions of the pre- and post-treatment lateral cephalometric tracings.

Proclination of mandibular incisors is one of the side effects of Forsus appliance, which might impact esthetics and hinder correction of Class II molar relationship. In this case, several attempts were made to prevent the exacerbation of the slightly proclined mandibular incisors during treatment, and 2-degree of improvement was found at the end of the orthodontic treatment (L1-PM: 101° → 99°). First, the risk of flaring of mandibular incisors were decreased through the usage of rectangular SS archwires, cinching back distal to the first molars, and no over-activation of Forsus appliance. Second, 0.018 × 0.025-in NiTi archwires were placed after the removal of Forsus appliance to enhance the expression of bracket prescription. Third, third-order wire bending on the mandibular wire was performed.

Four months after removal of Forsus appliance, slight relapse occurred in the bilateral molar relationship but not in the improved midline deviation. In the following orthodontics, mild Class II molar relationship on the left side was corrected to Class I, and the mandibular dental midline deviation was further improved from 1.0 mm to 0.5 mm by unilateral Class II elastics. Unilateral Class II elastics rather than unilateral Forsus was used because of the relatively light force of the former with theoretically less side effects in the vertical aspect; that is, less chance for the occlusal plane cant to occur. Total correction of the mandibular dental midline deviation in cases with Class II subdivision problems is difficult and not always achieved especially in cases of skeletal origin. In the study of Aras and Pasaoglu, applying asymmetric settings of Forsus or intermaxillary elastics on bilateral sides, the mean values of residual mandibular dental midline deviation were 0.29 mm and 0.55 mm for the Forsus group of 14 patients and the intermaxillary elastics group of 14 patients, respectively. There were 55 subjects treated with a variety of strategies (extractions, headgear, elastics, fixed functional appliances, or surgery) in the Cassidy’s study, most of whom initially exhibiting some degree of mandibular skeletal asymmetry, showed residual mandibular dental asymmetry of 1.0 mm. On the other hand, according to the results of a systematic review about smile esthetics, a 2.0-mm dental discrepancy was identified as the acceptance threshold for lay people. Therefore, the 0.5 mm residual mandibular dental asymmetry in this patient would be well tolerated.
CONCLUSIONS

This growing patient of Class II Division 1 subdivision left malocclusion were treated with non-compliance Forsus appliance along with unilateral Class II elastics. The presence of the mandibular growth minimised the impact of the unwanted backward rotation of the mandible during the orthodontics. The patient and his parents were satisfied with the correction of the protrusive lips and maxillary anterior teeth, and well understood the residual lip incompetence and mandibular dental asymmetry in regard to the limitations of the soft and hard tissues.

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