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Two-phase Management in a Developing Class III Malocclusion with the Aid of Rapid Maxillary Expander and Facemask

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INTRODUCTION

Orthopedic treatment with a facemask and rapid maxillary expansion (RME) is a common technique for correction of Class III growing patients. Many studies have indicated that facemask treatment in prepubertal patients may have an orthopedic effect to advance the maxilla in conjunction with downward and backward rotation in the mandible. The dental effects in the anterior teeth are favorable, including proclination of the maxillary incisors and retroclination of the mandibular incisors.

RME was first reported by Edward H. Angell in 1860. In 1970, Haas presented a theory to correct patients with maxillary deficiency by opening the midpalatal suture. The circumaxillary sutures (frontomaxillary, nasomaxillary, zygomaticotemporal, zygomaticomaxillary, pterygopalatine, intermaxillary, ethmomaxillary, and lacrimomaxillary sutures) are disengaged by palatal expansion. According to the hypothesis of Hass, as the palate of maxilla are separated, these sutures begin to open. The force produces an effect similar to growth, so that the maxilla could be moved downward and forward.

CASE REPORT

Finding and Diagnosis

A 7-year 10-month-old boy sought treatment to correct his crooked front teeth. He had a mild concave
profile (Figure 1), and his body height was 128 cm. His dental development was in early mixed dentition. There were residual roots of teeth 51 and 64, as well as rotation of teeth 21 and 22. He had a 1 mm overbite and a 1 mm overjet with Class III malocclusion (Figure 2). The lateral cephalometric analysis revealed a skeletal Class III jaw relation (A point-nasion-B point [ANB] angle, −2.0°), and an orthodivergent facial pattern. Cervical vertebral maturation (CVM) stage was in CS1. He also had proclined upper incisors (Figure 3). The diagnosis was skeletal Class III jaw relationship, orthodivergent facial pattern, and dental Class III malocclusion in early mixed dentition.

Figure 1. Initial extraoral photographs.

Figure 2. Initial intraoral photographs.

Figure 3. Initial cephalometric and panoramic radiographs.
Treatment Objectives

Our initial treatment objectives were to correct the malalignment of the anterior teeth and regain space for tooth 24. His skeletal growth could be monitored after correction of dental alignment.

The second treatment objectives were to improve skeletal jaw relationship, facial profile, and correct his dental Class III malocclusion to achieve a positive overbite and overjet.

Treatment alternatives included no orthodontic treatment with continuing follow-up until growth ceased, or two-phase treatment to correct the anterior teeth alignment and Class III jaw relationship during mixed and permanent dentition.

Treatment Plan

After explanation of the possible treatment alternatives to the parents, two-phase orthodontic treatment was decided. The sequence of treatments included the followings: 1) Phase one: 2 × 4 fixed appliance for the anterior teeth alignment, a RME combined with a facemask for improvement of jaw relation; 2) Phase two: full mouth fixed edgewise orthodontic treatment for stable interdigititation.

Treatment Progress

In phase one treatment, we used a 2 × 4 fixed appliance to align his anterior teeth and regain space for tooth 24 (Figure 4, 5), and we followed him until he
Figure 6. The extraoral photographs, after initial alignment.

Figure 7. Reevaluation intraoral photographs.

Figure 8. Reevaluation lateral cephalometric and panoramic radiographs.
reached permanent dentition. He presented for phase two treatment when he was 10 years 3 months old (Figure 6, 7). His facial profile was concave with a retrusive upper lip. Body height was 159 cm. Intraoral photographs revealed a Class III molar relationship with 0 mm overbite and 0 mm overjet. He had permanent dentition at the timing, the tooth 21 still had mild rotation. The follow up cephalometric analysis (Figure 8) indicated a skeletal Class III jaw relationship (ANB, −4.0°), orthodivergent facial pattern, proclined upper incisors, and retroclined lower incisors. CVM stage was in CS2.

The RME was applied after the growth reevaluation. The RME was activated twice a day, 0.25 mm per turn; the facemask was worn for at least 14 hours per day to advance the maxillary growth (Figure 9, 10). After 4 weeks of activation, the RME was fixed with resin for another 3 months intraorally (Figure 11–13).

Figure 9. The facemask was applied.

Figure 10. The RME was activated.
Figure 11. The extraoral photographs at fixation of RME (after 4 weeks of RME treatment).

Figure 12. The intraoral photographs at fixation of RME (after 4 weeks of RME treatment).

Figure 13. The lateral cephalometric film at fixation of RME (after 4 weeks of RME treatment).
The ANB angle was improved from $-4.0^\circ$ to $-2.5^\circ$, the mandibular plane angle had increased, the anterior edge-to-edge bite was corrected, the overjet was increased, and the upper incisors were slightly labially inclined.

Later, the full mouth fixed edgewise orthodontic treatment was initiated. After 26 months of treatment, an acceptable occlusion, a better overbite and overjet were achieved (Figure 14–16). After treatment, CVM stage was in CS4. The patient’s skeletal growth change still need to be monitored.

**Treatment Result**

The maxillary anterior teeth were well aligned, the rotation of left central incisor was corrected, the harmonious smile was achieved (Figure 14, 15). The patient still requires long-term follow-up for his facial skeletal growth changes.
Figure 17. The cephalometric tracings. Black, reevaluation; red, after treatment.

Figure 18. Serial cephalometric superimposition. Black, reevaluation; blue, after RME and facemask treatment; red, after treatment.
Bilateral Class I molar relationships with acceptable overjet and overbite were achieved. The final radiographs indicated parallel roots, proper root alignment, and no obvious root resorption (Figure 16). The cephalometric analysis at the end of treatment demonstrated an improved skeletal relationship (Table 1). The upper incisors were more protruded. His soft tissue facial profile was also improved after treatment.

**DISCUSSION**

Studies related to skeletal changes after RME revealed that changes consist of a forward and downward movement of the maxilla in conjunction with a backward and downward rotation of the mandible; the related dental effects include extrusion of the upper molars and proclination of the upper alveolar process. This skeletal and dental changes would improve some part in patients with skeletal Class III malocclusions. However, the improvement is limited or not effective in cases with high mandibular plane angle or anterior open bite.

The treatment of RME is usually performed in two stages. Stage one is an active expansion of the maxilla by sutural expansion, and stage two is retention that allows for reorganization and calcification of the midpalatal suture. RME also applies force against 10 other extramaxillary osseous structures. It is possible that RME could produce skeletal effects in the maxilla. Isaacson RJ and Ingrain AH have demonstrated that an RME appliance applies up to 30 pounds of force against the maxilla. This force might be conducted to other facial osseous structures in which the circumaxillary sutural growth may be promoted.

### Table 1. Serial cephalometric analysis.

<table>
<thead>
<tr>
<th></th>
<th>Norms</th>
<th>Pre-Tx</th>
<th>Re-evaluate</th>
<th>FM+RPE</th>
<th>Post-Tx</th>
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<td><strong>Skeletal</strong></td>
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<tr>
<td>SNA</td>
<td>82.7±2.8</td>
<td>80.5</td>
<td>81.5</td>
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<td>84.0</td>
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<td>SNB</td>
<td>79.7±3.0</td>
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<td>85.5</td>
<td>86.0</td>
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<td>ANB</td>
<td>3.0±1.8</td>
<td>-2.0</td>
<td>-4.0</td>
<td>-2.5</td>
<td>-2.0</td>
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<tr>
<td>SN-MP</td>
<td>33.5±4.6</td>
<td>30.0</td>
<td>29.5</td>
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<td>30.0</td>
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<tr>
<td>PP-MP</td>
<td>18.0±4.4</td>
<td>22.0</td>
<td>22.0</td>
<td>24.0</td>
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<td>UFH/LFH</td>
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<td>47/63</td>
<td>50/66</td>
<td>51/68</td>
<td>54/73</td>
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<td>Mx Length</td>
<td>87.5±3.6</td>
<td>86.0</td>
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<td>Md Length</td>
<td>113.4±4.8</td>
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<td>123.5</td>
<td>124.5</td>
<td>137.5</td>
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<td><strong>Dental</strong></td>
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<td>U1-SN</td>
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<td>U1-PP</td>
<td>117.4±4.8</td>
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<td>131.5</td>
<td>133.3</td>
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<td>U1-NA(mm)</td>
<td>5.5±1.8</td>
<td>7.0</td>
<td>11.0</td>
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<tr>
<td>U1-APog(mm)</td>
<td>7.3±1.6</td>
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<td>L1-MP</td>
<td>98.0±5.4</td>
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<td>L1-APog(mm)</td>
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<td>7.0</td>
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<td>5.0</td>
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<td><strong>Soft tissue</strong></td>
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<td></td>
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<tr>
<td>U lip to E-line</td>
<td>-0.7±1.8</td>
<td>-3.0</td>
<td>-1.0</td>
<td>-1.0</td>
<td>-1.0</td>
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<tr>
<td>L lip to E-line</td>
<td>0.9±2.2</td>
<td>-0.5</td>
<td>1.7</td>
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</table>
Maxillary protraction is a treatment option for patients with skeletal Class III maxillary deficiency.\(^{10-12}\) The principle of maxillary protraction is to apply tensile force on the circumaxillary sutures and then bone apposition occurred in the suture areas. The maxillary teeth become the site where the force is applied,\(^{13,14}\) and the facial bone (forehead, chin, zygoma) or occipital area are the anchorage sources.\(^{15,16}\) Animal studies have strongly suggested that the outcome of research related to RME could be applied in human subjects. Dramatic skeletal changes could be obtained in animal studies with continuous protraction forces to the maxilla. Not only the point A carried forward through incisal advancement movement but also the entire maxilla is displaced forward. The significant effects of forward movement could be observed in the location as far posteriorly as in zygomaticotemporal suture.\(^{17-19}\)

In our case, after treatment with RME and facemask, the upper facial height increased (from 50 to 51 mm), indicating maxillary downward displacement; the maxillary length was increased (from 88.5 to 91.0 mm), which could be due to maxilla forward displacement; the mandibular plane angle was increased (SN-MP, from 29.5° to 30.5°; PP-MP, from 22.0° to 24.0°), indicated mandible downward rotation; the upper incisors were proclined (U1-SN, from 125.0° to 126.0°; U1-PP, from 131.5° to 133.3°); and the lower incisors were retroclined (L1-MP, from 92.0° to 86.5°) (Table 1).

Therefore, the question was raised to ask when would be the best time to start the facemask protraction of the maxilla. The main objective of early facemask treatment is to enhance forward displacement of the maxilla by sutural growth. Melsen B and Melsen F indicated that the midpalatal suture was broad and smooth during the “infantile” stage (8–10 years of age) and the suture became more squamous and overlapping in the “juvenile” stage (10–13 years) in histologic findings.\(^{21,22}\)

Early intervention facilitates growth modification, but the treatment effects may be difficult to retain through the whole growth period. It requires patients’ compliance and long-term observation.\(^{20}\) Orthopedic treatment during the prepubertal and pubertal periods can shorten treatment time, and if mandibular growth is directed properly after treatment, favorable anterior occlusion can be obtained.\(^{14,15}\)

The improvement of the facial profile is not as effective as the achievement in surgical orthodontics because excessive mandibular length in skeletal Class III malocclusion cannot actually be reduced through the orthopedic treatment.\(^{23,24}\) In this case, we observed the growth of this patient and achieved a good occlusion result with the two-phase orthodontic treatment. Long-term monitoring of the dentoskeletal changes is required to confirm the ultimate treatment outcome.

**CONCLUSION**

Developing Class III malocclusion is one of the most challenging problems confronting the practicing orthodontists.

The effects of maxillary protraction that revealed from the cephalometric analysis indicated forward and downward movement of the maxillary bone and dentition, lingual inclination of mandibular teeth, and downward and backward rotation of the mandible.\(^{26,27}\) These effects tend to turn Class III malocclusion into Class I occlusion and achieve an orthognathic profile in a short period. However, whether the maxillary protraction can actually stimulate growth remains unclear in prepubertal or pubertal subjects. Further studies are required to answer this basic question.

The protraction facemask in conjunction with an RME appliance has been used to correct patients with maxillary deficiency and/or mandibular prognathism.\(^{29-32}\) In previous clinical studies, most investigators reported a combination of skeletal and dental contributions to overjet correction,\(^{29-32}\) and an average of 2 to 3 mm of anterior movement of the maxilla.\(^{33-37}\) The mandible is usually positioned downward and backward in response to changes in the maxilla.
The use of palatal expansion in conjunction with maxillary protraction helps to “disarticulate” the maxilla and initiate the cellular response in the sutures. The sutural effect could enhance a more positive reaction of the midface to the protraction forces.

REFERENCES


