

## Case Report

# New treatment modality for maxillary hypoplasia in cleft patients

### *Protraction facemask with miniplate anchorage*

Seung-Hak Baek<sup>a</sup>; Keun-Woo Kim<sup>b</sup>; Jin-Young Choi<sup>c</sup>

#### ABSTRACT

**Objective:** To present cleft patients treated with protraction facemask and miniplate anchorage (FM/MP) in order to demonstrate the effects of FM/MP on maxillary hypoplasia.

**Materials and Methods:** The cases consisted of cleft palate only (12 year 1 month old girl, treatment duration = 16 months), unilateral cleft lip and alveolus (12 year 1 month old boy, treatment duration = 24 months), and unilateral cleft lip and palate (7 year 2 month old boy, treatment duration = 13 months). Curvilinear type surgical miniplates (Martin, Tuttlinger, Germany) were placed into the zygomatic buttress areas of the maxilla. After 4 weeks, mobility of the miniplates was checked, and the orthopedic force (500 g per side, 30° downward and forward from the occlusal plane) was applied 12 to 14 hours per day.

**Results:** In all cases, there was significant forward displacement of the point A. Side effects such as labial tipping of the upper incisors, extrusion of the upper molars, clockwise rotations of the mandibular plane, and bite opening, were considered minimal relative to that usually observed with conventional protraction facemask with tooth-borne anchorage.

**Conclusions:** FM/MP can be an effective alternative treatment modality for maxillary hypoplasia with minimal unwanted side effects in cleft patients. (*Angle Orthod.* 2010;80:783–791.)

**KEY WORDS:** Maxillary protraction; Facemask; Miniplate

#### INTRODUCTION

In Class III malocclusion patients with mild to moderate maxillary hypoplasia, the protraction facemask has been used to stimulate sutural growth at the circum-maxillary suture sites in growing patients.<sup>1–3</sup> To transmit the orthopedic force from the protraction facemask to the maxilla, intraoral devices such as a labiolingual arch, quad helix, and rapid maxillary expansion (RME) have been used. However, the use of the upper dentition as anchorage cannot avoid

unwanted side effects such as labioversion of the upper incisors, extrusion of the upper molars, counterclockwise rotation of the upper occlusal plane, and eventual clockwise rotation of the mandible.<sup>3–6</sup> Therefore, labial inclined maxillary incisors and/or a vertical facial growth pattern would be contraindications for facemask therapy with tooth-borne anchorage.

To allow the direct transmission of orthopedic force to the circum-maxillary sutures, intentionally ankylosed primary canines, osseointegrated implants, and orthodontic miniscrews have been used as skeletal anchorage for protraction facemasks.<sup>7–11</sup> Since surgical miniplates are a reliable means for applying orthodontic and orthopedic forces,<sup>12</sup> Kircelli et al.,<sup>13</sup> Cha et al.,<sup>14</sup> and Kircelli and Pektas<sup>15</sup> introduced the protraction facemask with miniplate anchorage (FM/MP) therapy to treat Class III malocclusion with maxillary hypoplasia and hypodontia (Figure 1).

The protocol of FM/MP is as follows: (1) After an approximate 1–2 cm horizontal vestibular incision is made just below the zygomatic buttress area under local anesthesia, the zygomatic buttress is exposed with a subperiosteal flap. (2) Curvilinear type surgical miniplates (Martin, Tuttlinger, Germany) are bent according to the anatomical shape of the zygomatic buttress. (3) The distal end hole of the miniplate should

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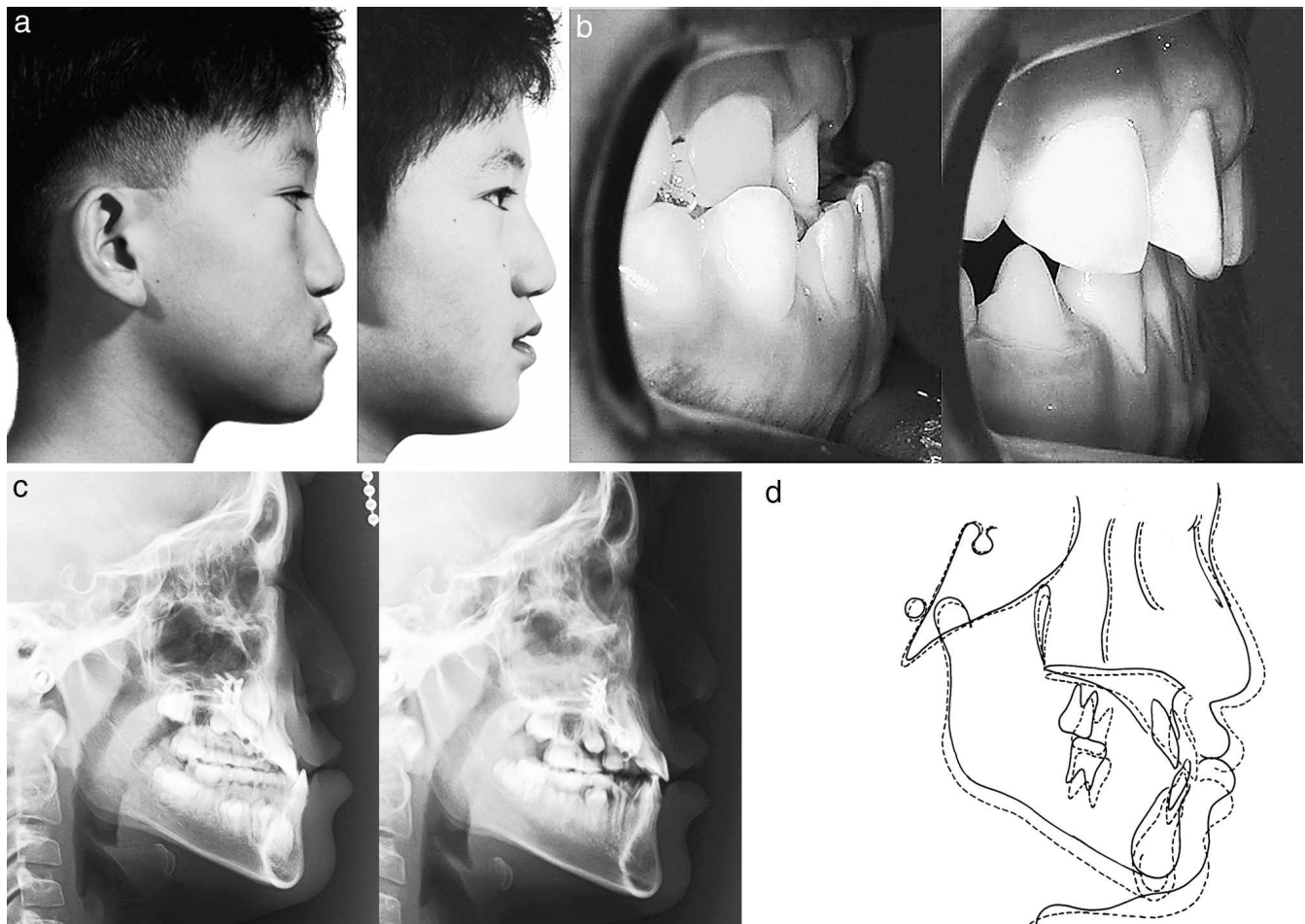
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**Figure 1.** Comparison of pretreatment (left) and posttreatment (right) in patient with Class III malocclusion. (a) Facial photographs. (b) Intraoral photographs. (c) Lateral cephalograms. (d) Superimposition (solid line: pretreatment; dotted line: posttreatment).

be cut to make a hook for elastics. (4) After the miniplates are placed into the zygomatic buttress areas, three self-tapping type screws are used per side to fix the miniplates (Figure 2a). (5) The distal end of the miniplate should be exposed through the attached gingiva between the upper canine and first premolar to control the vector of elastic traction (Figure 2b). (6) Four weeks after placement of the miniplates, their mobility is checked and the orthopedic force (500 g per side, 30° downward and forward from the occlusal plane) is applied for 12 to 14 hours per day. (7) It is recommended to overcorrect the malocclusion into positive overjet and a slight Class II canine and molar relationship.

Cleft patients often develop Class III malocclusion with maxillary hypoplasia and vertical facial growth pattern due to the combined effects of the congenital deformity itself and the scar tissues after surgical repair.<sup>16</sup> These are contraindications for conventional facemask therapy. However, little research has been done on the use of FM/MP in cleft patients. Therefore, the purpose of this case report is to present three cleft

patients who were treated with FM/MP and to demonstrate the effect of FM/MP on maxillary hypoplasia in cleft patients.

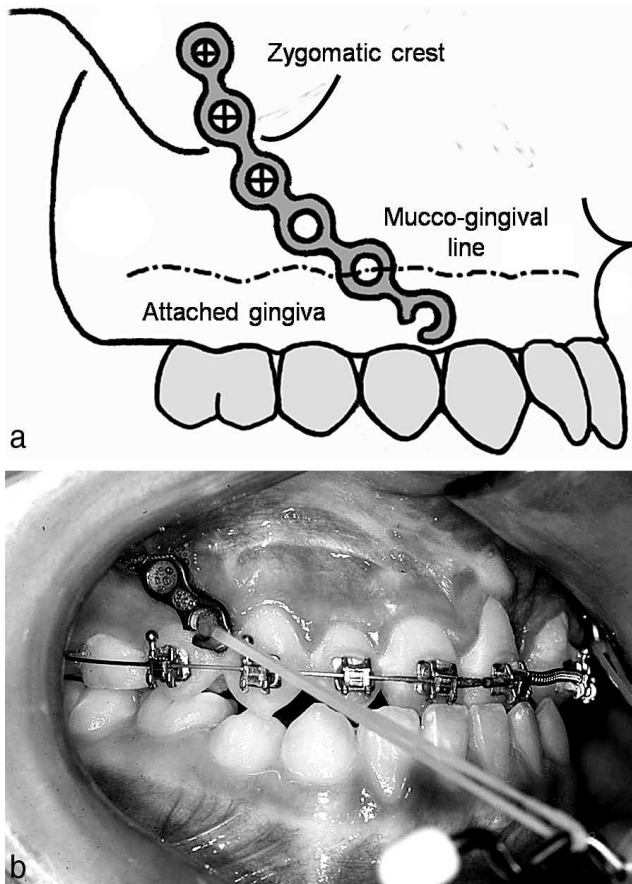
## CASE REPORTS

### CASE 1

Skeletal Class III malocclusion with cleft palate (CP) and anterior open bite (Figure 3, Table 1).

### Diagnosis

The patient was a 12 year 1 month old girl with CP only. She presented with concave facial profile, anterior crossbite (−9 mm overjet), and anterior open bite (−2 mm overbite). Cephalometric analysis showed skeletal Class III malocclusion with maxillary hypoplasia (ANB, −5.4°; A to N perp, −3.4 mm), steep mandibular plane angle (FMA, 32.7°), and a skeletal age after the pubertal growth spurt according to the cervical vertebrae maturation index (CVMI, stage 4).<sup>17</sup> Her condition was one of the contraindications for conventional facemask therapy.



**Figure 2.** Schematic drawing of the surgical positioning (a) and intraoral position of the miniplate (b).

### Treatment Plan

Although growth observation and reassessment after 2 years were proposed, her parents wanted to receive the FM/MP therapy. The possibility of orthognathic surgery after pubertal growth was explained.

### Treatment Progress

FM/MP therapy was started 4 weeks after placement of the miniplates according to the protocol. During protraction, the fixed appliances were placed to align the dentition.

### Treatment Results

After 16 months of FM/MP therapy, there was significant forward movement of the point A ( $\Delta A$  to N perp, 5.6 mm). The ANB angle was changed from  $-5.4^\circ$  to  $2.9^\circ$ , and a Class II canine and molar relationship, normal overbite, and overjet were obtained. A slight counterclockwise rotation of the occlusal plane angle ( $-1.8^\circ$ ) was interpreted to mean that there was almost no side effect such as extrusion of the upper molars. Although the FMA was increased  $4.3^\circ$ , the

anterior open bite was corrected by downward and forward movement of the maxilla. Slight labial tipping of the upper incisors ( $\Delta U1$  to SN,  $2.0^\circ$ ) occurred after correction of anterior crossbite and open bite.

### CASE 2

Skeletal Class III malocclusion with unilateral cleft lip and alveolus (UCLA) and vertical facial growth pattern (Figure 4, Table 1).

### Diagnosis

The patient was a 12 year 1 month old boy with UCLA on the left side. Although he presented with a straight facial profile, he had an anterior crossbite ( $-2.5$  mm overjet), upper anterior crowding, and peg laterals on the cleft side. Although the anteroposterior skeletal relationship (ANB,  $1.4^\circ$ ) was within normal range and the upper and lower incisors were lingually inclined (U1 to SN,  $95.1^\circ$ ; IMPA,  $86.9^\circ$ ), a vertical facial growth pattern (FMA,  $33.2^\circ$ ) existed. His skeletal age was before his pubertal growth spurt according to the CVMI (stage 3).<sup>17</sup>

### Treatment Plan

Conventional facemask protraction with a tooth-borne anchorage device was not appropriate because the patient had a vertical facial growth pattern. Therefore, the FM/MP was used to avoid unwanted side effects.

### Treatment Progress

Initially, the fixed orthodontic appliance was placed to correct the anterior crowding in the upper arch. The FM/MP therapy was started 4 weeks after placement of the miniplates according to the protocol.

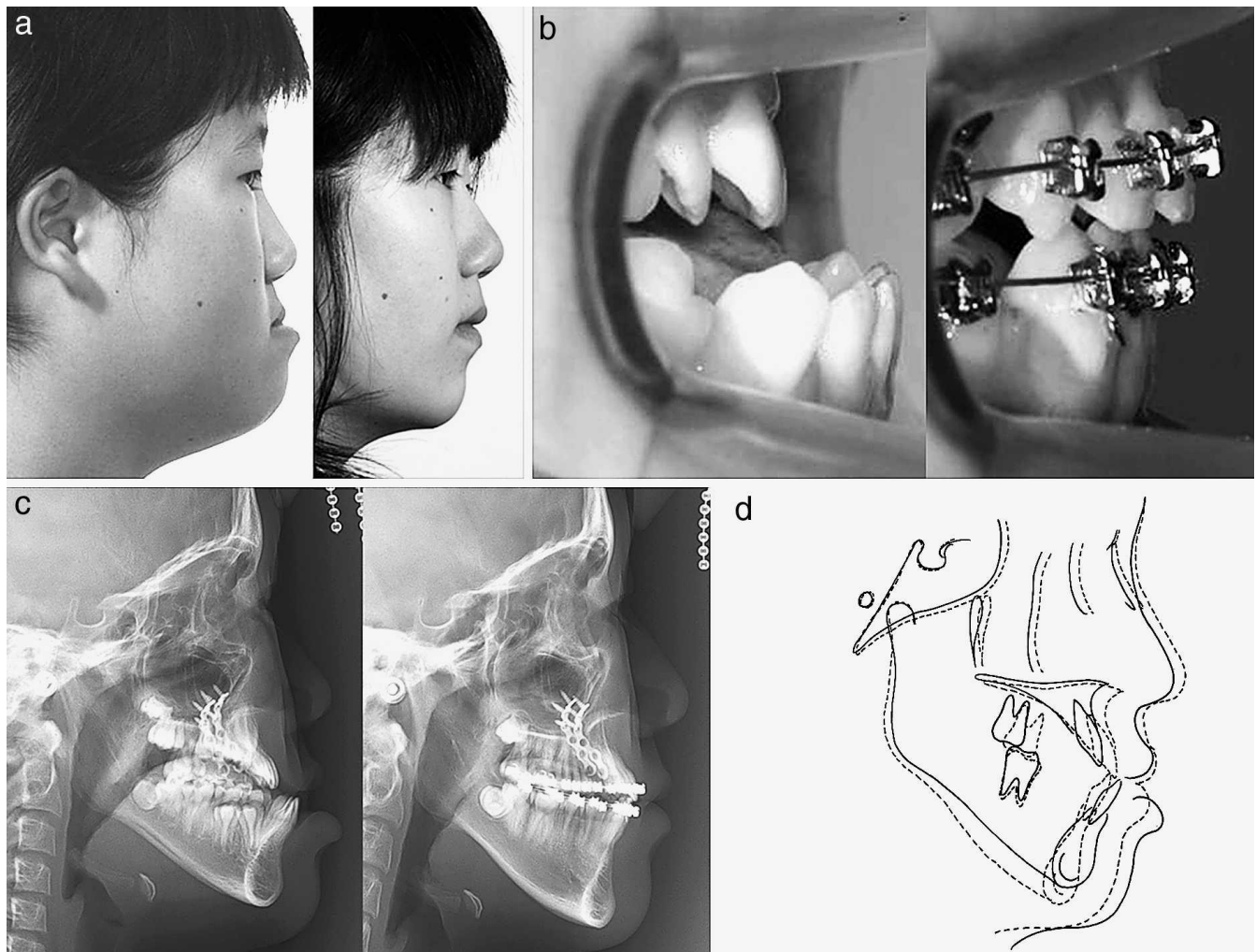
### Treatment Results

After 24 months of FM/MP therapy, there was a 3.1-mm forward movement of point A ( $\Delta A$  to N perp). ANB angle was changed from  $1.4^\circ$  to  $3.5^\circ$ , and a Class II canine and molar relationship was obtained. The finding that there was a negligible counterclockwise rotation of the mandibular plane ( $0.4^\circ$ ) and occlusal plane angle ( $-0.9^\circ$ ) indicated that there were almost no side effects such as extrusion of the upper molars and bite opening. Labial tipping of the upper incisors ( $\Delta U1$  to SN,  $4.9^\circ$ ) occurred due to alignment.

### CASE 3

Skeletal Class III malocclusion with unilateral cleft lip and palate (UCLP) and vertical facial growth pattern (Figure 5, Table 1).





**Figure 3.** Comparison of pretreatment (left) and posttreatment (right) in patient with cleft palate (case 1). (a) Facial photographs. (b) Intraoral photographs. (c) Lateral cephalograms. (d) Superimposition (solid line: pretreatment; dotted line: posttreatment).

### Diagnosis

The patient was a 7 year 2 month old boy with a UCLP on the right side. Although he presented with a straight facial profile, he had an anterior crossbite ( $-2.7$  mm overjet). Although the anteroposterior skeletal relationship (ANB,  $1.6^\circ$ ) was within normal range and the upper incisors were lingually inclined (U1 to SN,  $93.9^\circ$ ), a vertical facial growth pattern existed (FMA,  $34.6^\circ$ ). His skeletal age was before his pubertal growth spurt according to CVMI (stage 2).<sup>17</sup>

### Treatment Plan

FM/MP was planned to maximize protraction of the maxilla and to avoid unwanted side effects.

### Treatment Progress

FM/MP therapy was started 4 weeks after placement of the miniplates according to the protocol.

### Treatment Results

Similar to Case 2, there was a 3.0-mm forward movement of point A ( $\Delta A$  to N perp) after 13 months of protraction facemask therapy. The ANB angle was changed from  $1.6^\circ$  to  $3.1^\circ$ , and Class II canine and molar relationships were obtained. Although there was a slight counterclockwise rotation of the mandibular plane ( $-0.9^\circ$ ) and occlusal plane angle ( $-2.5^\circ$ ), there was no bite opening in the anterior teeth. Some labial tipping of the upper incisors ( $\Delta U1$  to SN,  $2.7^\circ$ ) occurred after correction of the anterior crossbite.

### DISCUSSION

#### Site for Placement of Miniplates

The zygomatic buttress area was used as the site for placement of the miniplates due to following reasons: (1) It has enough thickness and adequate bone quality.<sup>18</sup> (2) It is near to the center of resistance of

**Table 1.** Comparison of the Skeletal, Dental, and Soft Tissue Variables Between Pretreatment (T0) and Posttreatment (T1)

Variable	Case 1		Case 2		Case 3	
	T0	T1	T0	T1	T0	T1
Anteroposterior skeletal relationship						
SNA (°)	76.0	80.6	74.9	77.1	78.5	80.4
SNB (°)	81.4	77.7	73.5	73.6	76.9	77.3
ANB (°)	-5.4	2.9	1.4	3.5	1.6	3.1
A to N perp (mm)	-3.4	2.2	-5.2	-2.1	-3.3	-0.3
Pog to N perp (mm)	4.7	-0.6	-12.2	-10.2	-8.0	-8.0
Wits appraisal (mm)	-15.5	-3.6	-5.2	-1.9	-5.4	-2.5
Vertical skeletal relationship						
Bjork sum (°)	403.7	408.2	403.2	403.6	402.3	401.5
Saddle angle (°)	128.4	125.4	120.7	122.1	116.9	117.2
Articular angle (°)	143.9	154.1	152.4	152.8	150.1	151.1
Gonial angle (°)	131.4	128.7	130.1	128.7	135.3	133.2
Facial height ratio (%)	55.7	52.7	58.6	58.1	60.4	61.6
Palatal plane angle (°)	-2.3	-1.5	2.7	2.9	2.2	1.8
FMA (°)	32.7	37.0	33.2	32.7	34.6	33.7
Mandibular plane to SN plane angle (°)	43.7	48.2	43.2	43.6	42.3	41.5
Occlusal plane to SN plane angle (°)	21.6	19.8	24.6	23.7	23.2	20.7
Dental relationship						
U1 to SN (°)	106.4	108.4	95.1	100.0	93.9	96.6
IMPA (°)	88.2	76.3	86.9	87.5	86.8	82.2
Soft tissue						
Nasolabial angle (°)	105.8	107.3	117.4	119.0	115.4	109.3

the nasomaxillary complex so that the force vector can be placed close to the center of rotation of the nasomaxillary complex.<sup>12,19</sup>

### Vector Control

The direction of force vector was 30° downward and forward from the occlusal plane. Tanne et al.<sup>20</sup> and Miyasaka-Hiraga et al.<sup>21</sup> reported that downward and forward force produced uniform stretch and translatory repositioning of the nasomaxillary complex in an anterior direction. However, conventional dental anchorage usually results in counterclockwise rotation of the palatal plane, and clockwise rotation of the mandible, which would be unfavorable in a patient with vertical growth pattern.

The miniplate can transmit the orthopedic force directly to the maxilla and minimize rotational effect. Although there was a slight increase of FMA (4.3°) in Case 1, Cases 2 and 3 showed negligible changes of the palatal plane angle, FMA, and mandibular plane to SN angle (Table 1).

### Conjunction with RME

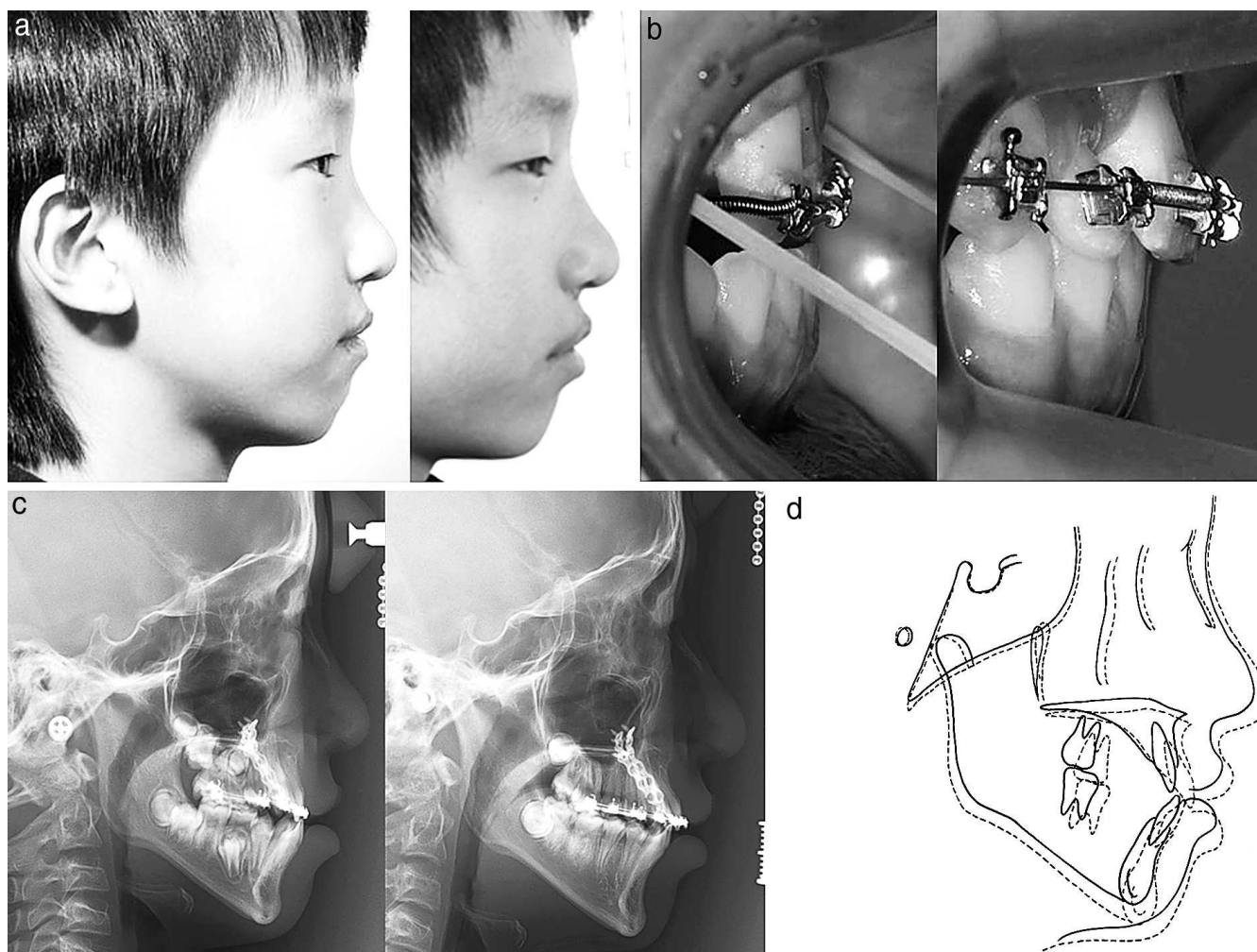
Expansion of the maxilla before or during protraction of the maxilla has been performed to facilitate protraction by disarticulating the circum-maxillary sutures and initiating a cellular response in these sutures.<sup>1,3,5</sup> Baik<sup>4</sup> reported that there was more forward

movement in the maxilla when protraction was in conjunction with RME compared with protraction without RME. Liou and Tsai<sup>22</sup> presented the combined use of repeated rapid maxillary expansion and constriction and intraoral springs for maxillary protraction and concluded that significant advancement of the point A could be obtained.

However, a recent prospective, randomized clinical trial<sup>23</sup> showed that facemask therapy, with or without RME, produced equivalent changes in the dentofacial complex and insisted that RME might not be indispensable to maxillary protraction unless a transverse deficiency exists. In our cases, we did not use RME because cleft lip and palate patients do not have some or whole parts of the midpalatal suture. Since this could affect the amount of maxillary advancement in cleft patients, further studies will be necessary.

### Timing of Treatment

There are numerous articles that advocate the protraction therapy at an early stage.<sup>5,24-28</sup> Because the palatomaxillary suture becomes highly interdigitated with increasing age, it becomes difficult to disarticulate the palatal bone from the pterygoid process.<sup>29</sup> After the pubertal growth peak, side effects such as tooth movement and/or mandibular rotation rather than maxillary protraction are likely to be the major response to treatment.<sup>5,30</sup> However, Baik<sup>4</sup> and Sung and Baik<sup>31</sup> insisted that there was no statistical



**Figure 4.** Comparison of pretreatment (left) and posttreatment (right) in patient with unilateral cleft lip and alveolus (case 2). (a) Facial photographs. (b) Intraoral photographs. (c) Lateral cephalograms. (d) Superimposition (solid line: pretreatment; dotted line: posttreatment).

difference when changes due to treatment were compared according to ages.

On the other hand, Kircelli and Pektas<sup>15</sup> reported that protraction using the FM/MP in relatively older patients (11 to 13 years) was successful with minimum dentoalveolar side effects. We also confirmed that there was a significant maxillary protraction with fewer dentoalveolar side effects using the MP/FM in the patient after the pubertal growth peak and menarche (Case 1, CVMI stage 4).<sup>17</sup>

### Comparison of the Amount of Maxillary Advancement

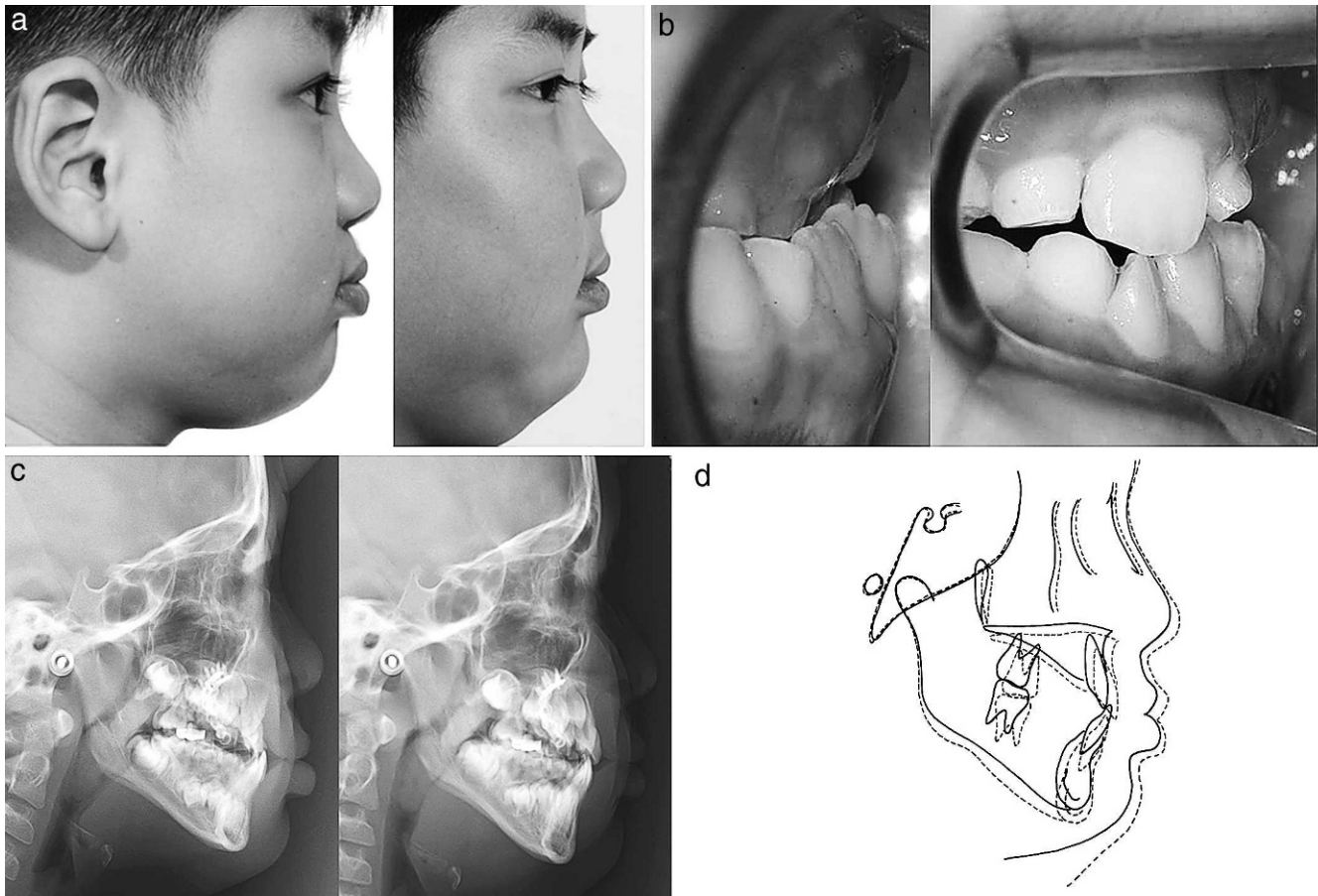
In cases of untreated Class III malocclusion with maxillary hypoplasia, Shanker et al.<sup>32</sup> reported that point A came forward only 0.2 mm over a 6-month period. With conventional facemask therapy, Kim et al.<sup>33</sup> from meta-analysis, reported that it produced

0.9 mm to 2.9 mm advancement of the point A. So<sup>25</sup> insisted that the effect of protraction facemask therapy on the maxilla was two thirds skeletal and one third dental changes.

In cases with facemask and skeletal anchorage, amounts of the maxillary advancement have been reported to be 4.0 to 4.8 mm.<sup>9,15,34</sup> Therefore, maxillary advancement can be enhanced by skeletal anchorage rather than conventional dental anchorage in growing patients.

In our cases, although a similar treatment protocol was used, the amounts of maxillary advancement varied according to cleft types (approximately 3.0 mm–5.6 mm). Since the duration of protraction (approximately 13–24 months) was relatively longer than in the other studies,<sup>9,15,34</sup> the scar tissues of cleft patients can be one of the reasons for variations in the amount of maxillary protraction. This result was in accordance with Buschang et al.<sup>35</sup> concerning limited protraction results in cleft patients.





**Figure 5.** Comparison of pretreatment (left) and posttreatment (right) in patient with unilateral cleft lip and palate (case 3). (a) Facial photographs. (b) Intraoral photographs. (c) Lateral cephalograms. (d) Superimposition (solid line: pretreatment; dotted line: posttreatment).

### Overcorrection

Ngan et al.<sup>36</sup> and MacDonald et al.<sup>37</sup> insisted that facemask therapy does not normalize the forward growth of the maxilla and that patients resume a Class III growth pattern by deficient maxillary growth during the follow-up period. Therefore, overcorrection into Class II canine and molar relationships is mandatory to compensate for deficient posttreatment maxillary growth.

Cleft patients seem to need more overcorrection than ordinary Class III malocclusion cases with maxillary hypoplasia because there are limitations in the amounts of maxillary advancement and a high relapse rate due to scar tissues.<sup>38</sup> If the amount of maxillary advancement is large and the patients and parents want a relatively short-term treatment, distraction osteogenesis during adolescence or orthognathic surgery in adulthood can be recommended.

### Advantages of FM/MP in Cleft Patients

In adolescent cleft patients, multiple orthodontic treatment procedures such as alignment, leveling, arch expansion, and preparation for bone graft surgery

are needed. Because the miniplates are independent from dentition, simultaneous orthodontic treatment and maxillary protraction is an attractive advantage.

The FM/MP can be used over a relatively longer period than conventional facemask because it is independent of the upper dentition. According to Ishikawa et al.,<sup>39</sup> the effects of conventional facemask therapy were significantly less in the second year, and no benefit from any treatment longer than 1 year was established. However, we confirmed that FM/MP could result in uniform advancement of the maxilla during the entire treatment period (Table 1).

In addition, cleft patients have more vertical growth pattern than noncleft patients,<sup>40</sup> and excessive clockwise rotation of the mandible during facemask therapy can worsen the facial profile. FM/MP can minimize clockwise rotation of the mandible and prevent aggravation of the facial profile.

### CONCLUSION

- FM/MP can be an effective alternative treatment modality for cleft patients with maxillary hypoplasia with minimal unwanted side effects.

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