Induced ankylosis of primary canines for absolute anchorage in the treatment of a patient with Class III malocclusion and cleft soft palate

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This case report describes the induced ankylosis of the primary canines for use as absolute anchorage for maxillary protraction. The patient was a young boy with Class III malocclusion and cleft soft palate. The final occlusion was esthetic, functional, healthy, and stable 4 years after treatment. (Am J Orthod Dentofacial Orthop 2019;155:398-410)

Cleft palate is a congenital deformity occurring the third most frequently after clubfoot and cleft lip. Cleft of the secondary palate alone affects 1 in 2500 live births worldwide.[1,2] The secondary palate includes the hard and soft palate. The soft palate is a fibromuscular shelf made up of 5 muscles attached as a sling to the posterior portion of the hard palate, aiding in breathing, blowing, swallowing, and phonation.[3-5] The cleft soft palate (CSP), with cleft uvula as a microform,[6] can lead to speech distortion, hearing disorder, maxillary dimension reduction as well as deficiency in midface development causing a Class III tendency, resulting in low self-esteem and difficulties in social interactions.[3,7-9]

Early surgical corrections are usually performed to improve esthetics and function for these patients. However, patients who undergo surgical treatment may show growth impairment of the midface, and palatoplasty has been suggested to be the main reason for this retroposition, producing secondary deformities of the jaw and malocclusion.[10] In young skeletal Class III CSP patients, a retrognathic maxilla can be effectively improved by means of maxillary protraction, an orthopedic technique that has been used to stimulate sutural growth by the application of force from an external face frame to the circummaxillary sutures.[11-13] To transmit the orthopedic force to the maxilla, upper dentition is often used as anchorage for devices such as a labiolingual arch, quad helix, or maxillary expansion appliance.[13-16] However, unwanted side-effects, such as proclination of the maxillary incisors, extrusion of the maxillary molars, retroclination of the mandibular incisors, counterclockwise rotation of the upper occlusal plane, and eventual clockwise rotation of the mandible, are frequently seen owing to the tooth-borne anchorage design.[16-19]

To allow the direct transmission of orthopedic force to the circummaxillary sutures, an absolute anchorage system was designed that includes the use of intentionally ankylosed maxillary deciduous canines, osseointegrated implants, onplants, miniscrews, and miniplates.[20-25] Unlike other invasive treatment, intentional ankylosis seems to be biocompatible and more easily accepted by the patients to some extent.

In the present case report, postpalatoplasty orthopedic treatment with the use of intentionally ankylosed deciduous canines as anchorage and the ensuing orthodontic treatment for a 7-year-old boy with CSP is described.

DIAGNOSIS AND ETIOLOGY

The patient was a 7-year-old boy who was referred to our practice with the chief complaint of crossbite and unesthetic smile (Fig 1). Medical history revealed a cleft soft palate associated with cleft uvula that had been repaired by palatoplasty and posterior pharyngeal flap transplantation at the age of 4 years, followed by speech training 1 month after the operation. His general

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Fig 1. Pretreatment facial and intraoral photographs.

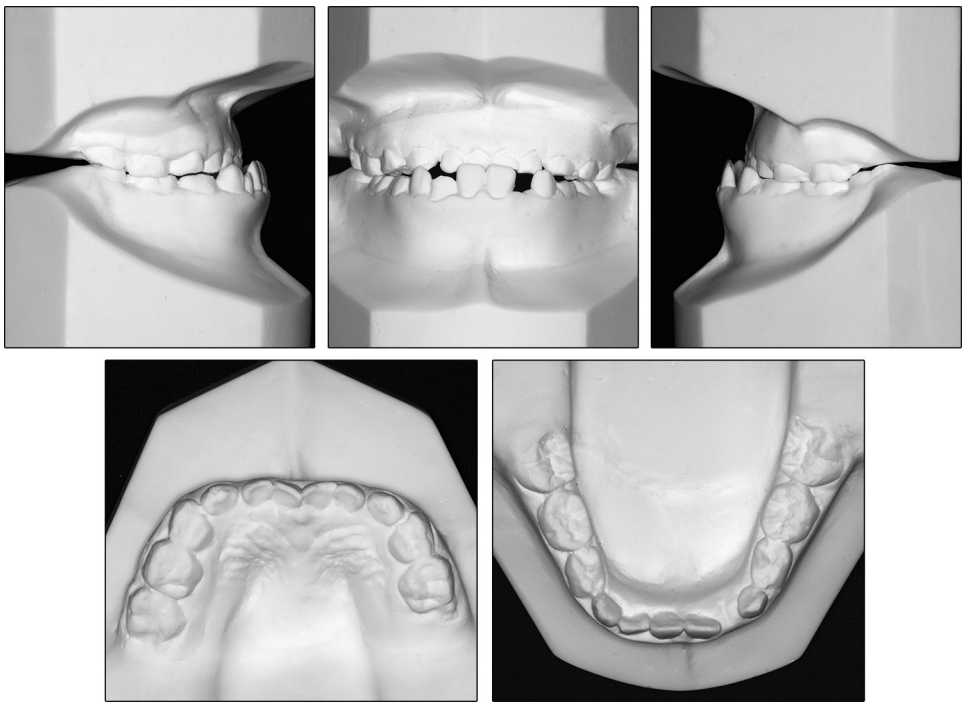

Fig 2. Pretreatment dental casts.

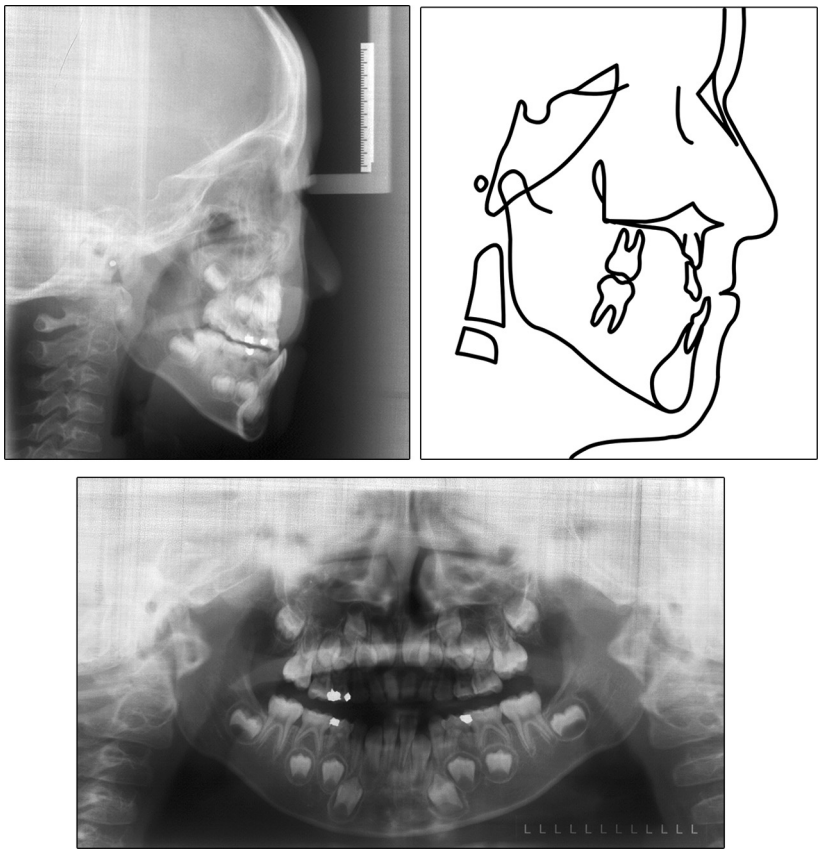

Fig 3. Pretreatment lateral cephalogram and tracing and panoramic radiograph.

Table. Cephalometric measurements

Measurement	*Initial*	*After protraction*	*Final*	*4-year retention*
SNA (°)	73.2	77.1	76.2	76.6
SNB (°)	73.9	73.1	73.8	75.9
ANB (°)	−0.7	4	2.4	0.7
Z-angle (°)	75.9	54.1	54.9	57.5
FMA (MP-FH) (°)	37.1	40.8	38.4	36
L1-MP (°)	79.8	80.2	91.3	93.1
U1-SN (°)	82	94	105.9	109.9
UA-SN (°)	93	105.2	–	–
LAFH (Me-MxP) (mm)	54.5	56.2	65.6	77.7
Ramus height (Ar-Go) (mm)	36.8	38.7	38.9	48.6

conditions appeared good, with normal hearing, speech, and language function. Physical examination showed a severe concave profile with a generally symmetric face, short and flabby upper lip, and tensed mentalis.

Intraoral examination revealed a normal shaped soft palate, including uvula with slight surgical trace at the soft palatal surface (Fig 1), and Class III malocclusion with anterior deep crossbite and mild crowding of anterior teeth (Fig 2). There were no temporomandibular joint symptoms or other functional anomaly. The mandible could not be set back to edge-to-edge position, suggesting no functional shift. Panoramic radiography revealed that all tooth germs existed (Fig 3). Cephalometric analysis (Table) showed skeletal Class III due to maxillary retrusion. The morphology of cervical vertebra in the lateral cephalogram revealed great growth potential.

TREATMENT OBJECTIVES

The treatment objectives included stimulation of the maxillary growth with maxillary protraction and correction of the anterior crossbite to obtain normal overjet and overbite. In addition to establishing a stable and functional occlusion, improvement of the patient's facial profile was also desired.

TREATMENT ALTERNATIVES

Two main treatment options were presented to the patient and his parents. The first option was to apply

Fig 4. Intentionally ankylosed deciduous canines and deciduous incisors as anchorage for protraction.

Fig 5. Facial and intraoral photographs after protraction.

the facemask therapy combined with orthodontic treatment to correct the anterior crossbite. The possibility of the future orthognathic surgery after facemask therapy was also raised in case the growth tendency was out of control. The second option was to wait until the growth was completed to perform the surgical-orthodontic combined treatment to resolve both the skeletal and dental deformities. Because the boy and his parents preferred active treatment instead of observation, the facemask therapy was chosen. Four alternatives were considered to apply traction force directly to the maxilla: (1) a removable appliance, (2) a bonded device cemented on the posterior teeth, (3) osseointegrated implants to provide absolute anchorage, and (4) purposefully ankylosed deciduous canines as a method of direct transmission of force to the maxilla. After discussion with the patient and his parents, facemask therapy with the use of purposefully ankylosed deciduous canines as anchorage was decided.

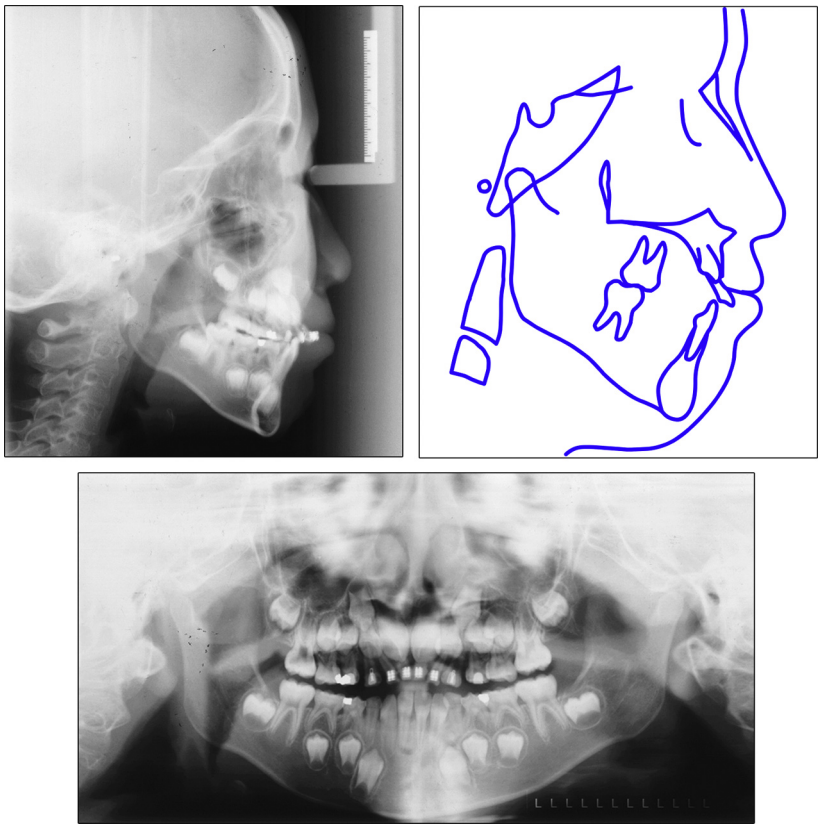

Fig 6. Lateral cephalogram and tracing and panoramic radiograph after protraction.

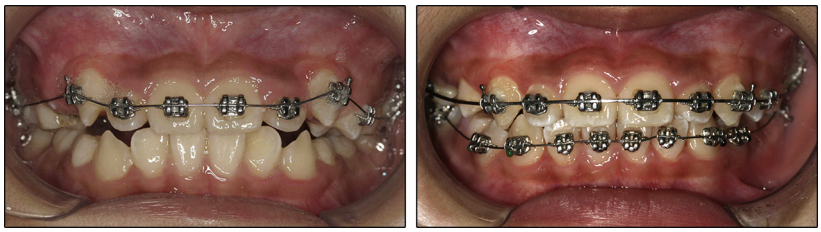

Fig 7. Treatment progress.

The final protocol included: (1) replant intentionally avulsion maxillary deciduous canines to induce ankylosis; (2) alternately use the maxillary deciduous canines and maxillary deciduous incisors as abutments for maxillary protraction to encourage anterior maxilla growth; (3) guide normal eruption of the permanent teeth; (4) leeway space management, teeth alignment, and occlusal adjustment.

TREATMENT PROGRESS

Treatment was started with intentional ankylosis of the deciduous canines (Fig.4). The maxillary deciduous canines were loosened under local anesthesia. To induce ankylosis, a rigid splint was bonded to fix the teeth and left for 3 months. Then the brackets were cemented to the maxillary deciduous incisors and a 0.020 × 0.025-inch stainless steel sectional archwire with continuous ligation was used. Maxillary protraction was applied by alternate use of maxillary deciduous canines and incisors as abutments, with a force level of 300 cN per side applied 12-14 hours per day. At the onset of the dental transition of the maxillary deciduous incisors, the maxillary protraction was removed. The eruption of permanent teeth was first observed, and then early treatment to align and level

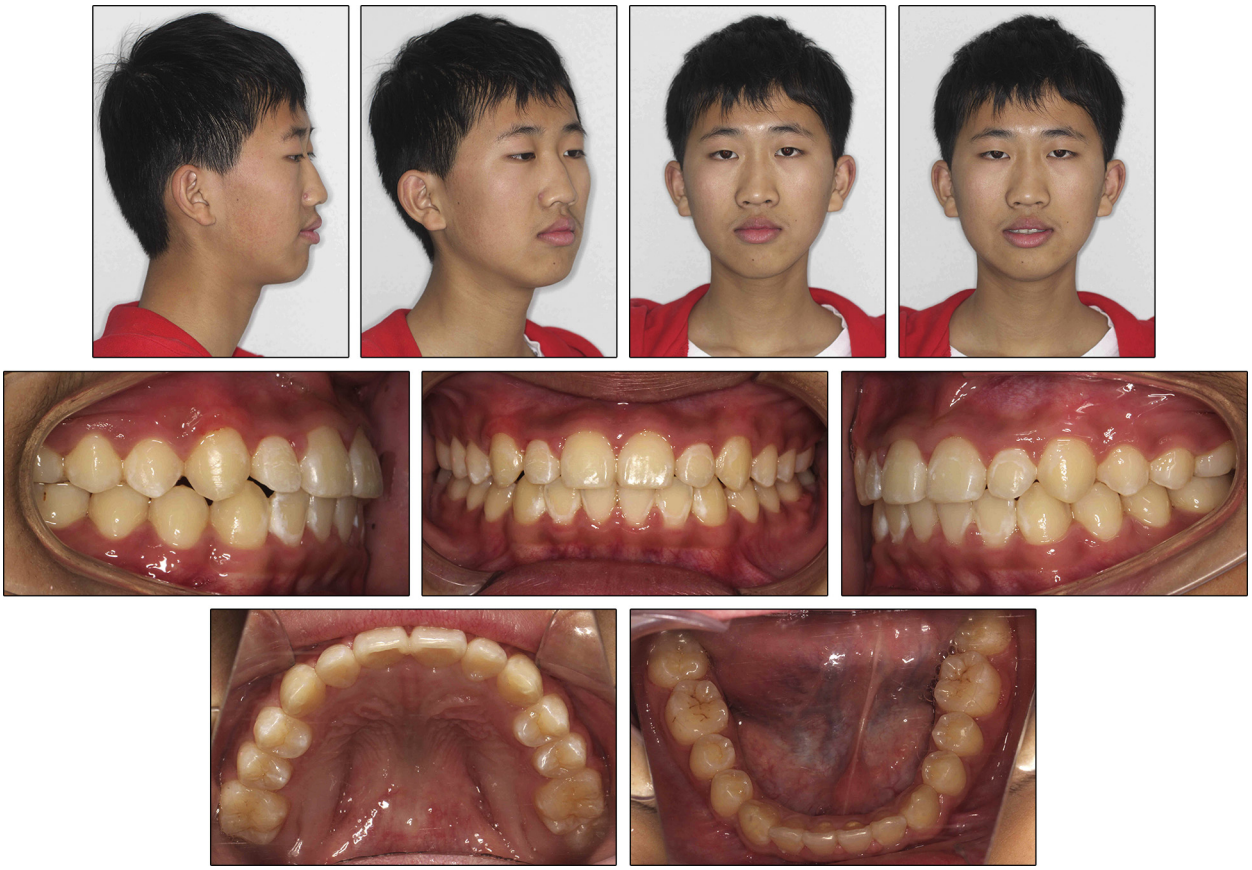

Fig 8. Posttreatment facial and intraoral photographs.

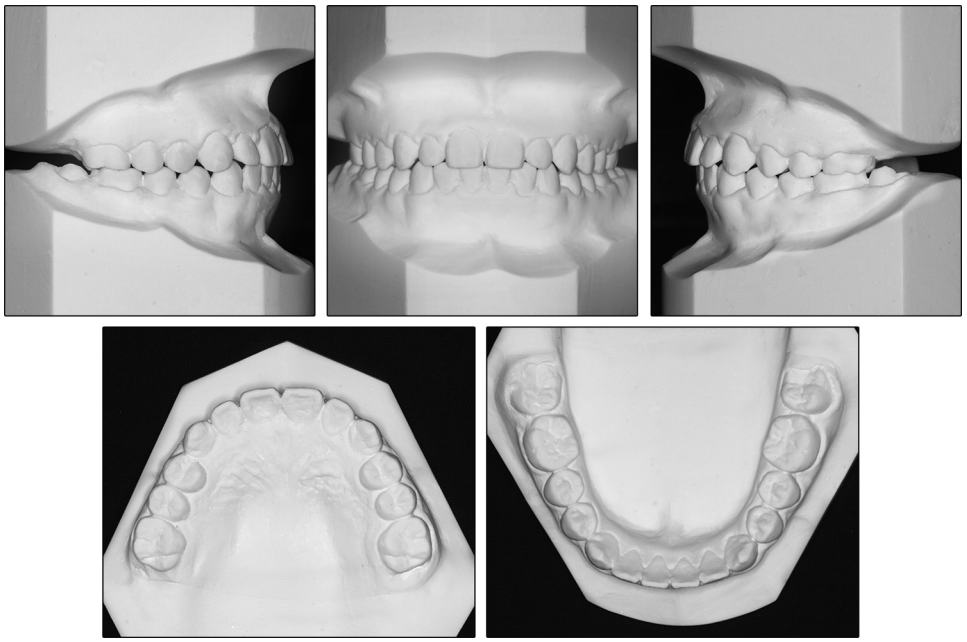

Fig 9. Posttreatment dental casts.

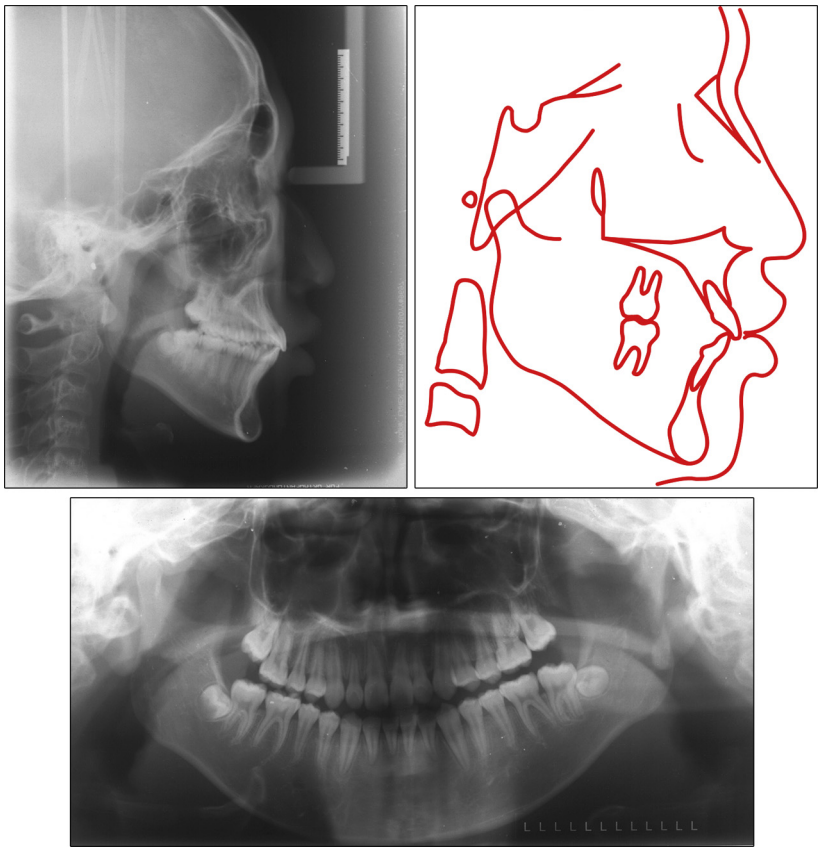

Fig 10. Posttreatment lateral cephalogram and tracing and panoramic radiograph.

the malpositioned maxillary incisors and canines was conducted with the use of leeway space. Comprehensive orthodontic treatment was performed after the mixed dentition to achieve ideal alignment and occlusion (Figs 5-7).

TREATMENT RESULTS

Besides well aligned dentition, a more balanced profile and improved facial symmetry were achieved (Figs 8-10). After 2 and 4 years of retention, the results remained stable (Figs 11-13). Cephalometric analysis and superimposition of pretreatment, after-protraction, posttreatment, and 4-year retention cephalometric tracings showed differential forward growth of the maxilla and the mandible as well as compensation of the incisors to the skeletal growth (Fig 14; Table).

After maxillary protraction, SNA increased from 73.2° to 77.1° and SNB showed little change (from 73.9° to 73.1°). Though the inclination of the maxillary primary incisors increased from 93.0° to 105.2°, the inclination of the maxillary permanent incisors was maintained within the normal limits (94.0°; the initial and progress cephalometric data were measured through the long axis of the incisor germ). Superimposition showed clockwise mandibular rotation with the mandibular plane angle increased from 36.2° to 40.3°.

The posttreatment cephalometric analysis showed that after fixed appliance treatment, the maxillary protraction result was generally maintained (SNA from 77.1° to 76.2°) and skeletal Class I relationship was achieved (ANB 2.4°; Table). The posttreatment panoramic radiograph showed good root alignment (Fig 10). The occlusion and anterior overjet remained stable, and satisfactory facial profile was maintained at 2-year and 4-year recalls (Figs 11 and 12, respectively). The superimposition of the posttreatment and 4-year retention radiograph tracings showed slight growth of both maxilla and mandible (SNA from 76.2° to 76.6°, SNB from 73.8° to 75.9°, ANB from 2.4° to 0.7°) associated with slightly proclined upper and lower incisors (L1-MP from 91.3° to 93.1°, U1-SN from 105.9° to 109.9°; Fig 14).

Fig 11. Two-year postretention facial and intraoral photographs.

DISCUSSION

Cleft soft palate is a congenital deformity of the orofacial cleft with the continuity of the lips and hard palate maintained, leading to speech distortion, skeletal discrepancy, and dental abnormalities.[8-10,26] The treatment for such patients is complicated, and multidisciplinary work is essential with the help of otolaryngologists, oromaxillofacial surgeons, dentists and orthodontists, speech pathologists, etc.[27] And the success depends on the extent of the cleft, the timing and technique of surgical procedures, skeletal growth pattern, individual growth potential, timing of orthodontic or orthopedic intervention, and the patient's cooperation.[28-30]

The present patient, a 7-year-old boy, received the initial palate reparative surgery at the age of 4 years. Because of the possible influence of cleft palate and surgery, CSP patients can have relatively deficient maxillary development with a tendency for Class III malocclusion even after palatal repair, with or without mandibular anomaly.[3,9,10,28] The treatment strategy for such Class III patients is to continuously evaluate skeletal and occlusal discrepancy with growth. When the patients are in the primary or early permanent dentition, maxillary protraction, an orthopedic method which belongs to phase I therapy, would be chosen to stimulate maxillary growth to set up the skeleton frame. Although these patients might still have to receive surgery in adulthood, the difficulty of maxillary surgery could be reduced and sometimes mandibular surgery alone can be performed. It is noteworthy that the age of the skull is an essential element that affects the mechanical property of the skeletal suture.[31,32] Because the palatomaxillary suture becomes highly interdigitated with increasing age, it becomes difficult to disarticulate the palatal bone from the pterygoid process.[33] In addition, side-effects such as tooth movement or mandibular rotation rather than growth modification are likely to be the major response to treatment after the pubertal growth peak.[14,34] The advantages of early orthopedic treatment before the pubertal growth spurt can minimize such effects[16] and have been reported to obtain favorable changes.[35,36] After phase I therapy, the relationship between maxilla and mandible needs to be reevaluated. If it is relatively

Fig 12. Four-year postretention facial and intraoral photographs.

harmonious, we might decide whether to perform orthodontic phase II therapy to compensate for skeletal discrepancy or to wait until the completion of growth after negotiation. The decision is difficult, especially when severe deformity or progressive mandibular growth is observed, and we might choose to wait. Even if phase II therapy is accomplished, observation at regular intervals is necessary to monitor the mandible growth to decide whether to undergo phase III orthodontic camouflage treatment to compensate for the skeletal discrepancy or to receive orthognathic surgery.

The patient and his parents wanted to improve the boy's appearance sooner, so they chose not to wait another 10 years to have surgical treatment. Therefore, maxillary protraction was chosen. For the extraoral part, a reverse headgear was used.[37-39] For the intraoral part, intentionally ankylosed deciduous canines with deciduous incisors were used as anchorage for protraction. Orthopedic force on the nasomaxillary complex was directed along the occlusal plane, rather than at the center of resistance of the maxilla. If permanent anterior teeth were used as an anchor for the distraction forces, labial tipping of the maxillary incisors could not be avoided, which would result in undesirable profile changes (concave facial profile with maxillary incisor proclination). The other choice was to use temporary anchorage such as osseointegrated implants or surgical miniplates.[40-43] The advantage of using such a unit as anchorage is that the maxilla moves forward with no apparent tooth movement.[14-16] Even though such absolute anchorage can successfully change the skeleton structure, it is an invasive method and contains metal material, with the potential risk of soft tissue inflammation, damage of anatomic structures, lack of stability, and implant fracture.[44-46] Some patients might refuse to accept such an invasive method.

To replace the temporary anchorage devices, induced ankylosed primary teeth can be used to obtain anchorage during orthodontic treatment.[21,40,47] An induced ankylosed tooth has maximum biocompatibility, leading to low risks of inflammation and damage of anatomic structures during replantation because the

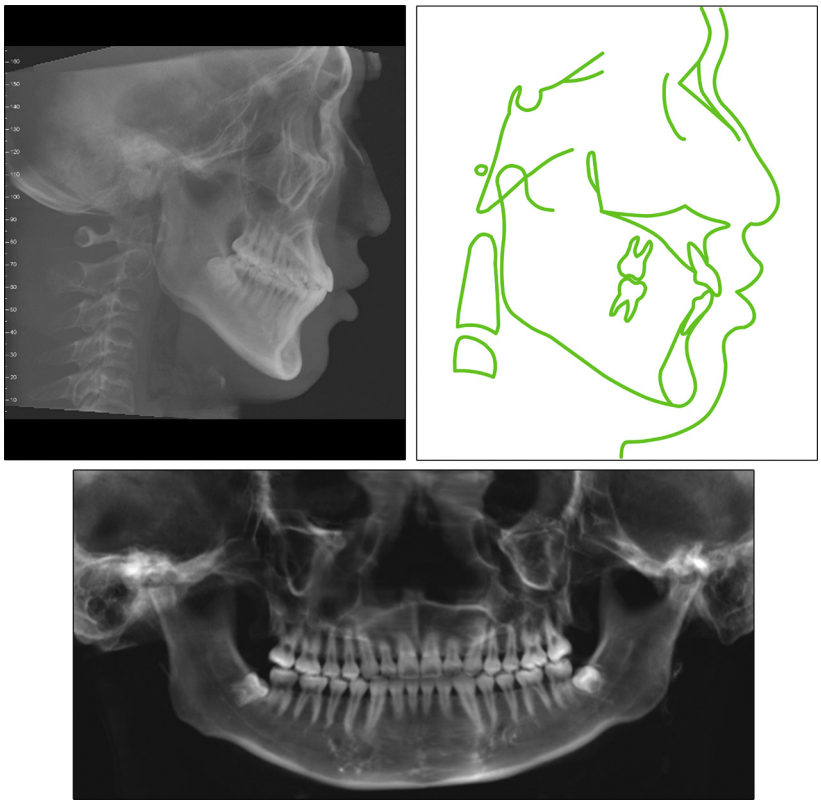

Fig 13. Four-year postretention lateral cephalogram and tracing and panoramic radiograph.

tooth is put in the existing socket. It is important to note that even if ankylosis fails to develop, other options are still open, because the tooth can be extracted and treatment can continue using other methods.[48] In the present patient, we purposely ankylosed maxillary deciduous canines. However, the anchor teeth inevitably resorb as their permanent successors erupt, which limits the time available for treatment and restricts the facemask option to a younger age group.[48,49]

Counterclockwise rotation of the palatal plane and downward and backward rotation of the mandible, which might cover up the real maxilla-mandible relationship, is usually associated with maxillary protraction.[50-52] Overcorrection is necessary to achieve a better orthopedic result because maxillary rebound and vertical relapse can often be seen after the removal of the appliance, not only because of the relapse of the protraction effect, but also as a result of continued growth. Therefore, the molar relationship was set as Class II relationship after the maxillary protraction therapy, and we could see Class II molar relationship in superimposition (Fig 14), with ANB angle 4.0°. As we can tell from the superimposition, the crossbite was corrected by maxillary growth and alveolus reconstruction (SNA from 73.2° to 77.1°) after protraction, as well as by proclining the maxillary incisors (UA-SN from 93.0° to 105.2°, U1-SN from 82° to 94°). After the whole treatment process, malocclusion was adjusted to Class I, with ANB angle 2.4°. We could also see the rotation process of the mandible, with FMA 36.2° (initial), 40.3° (progress), and 39.3° (final; Fig 14; Table).

Although the treatment results was encouraging, we should consider long-term changes. The termination of growth of the maxilla was found to occur at the average ages of 15 years in girls and 17 years in boys, and that of mandible was at the average ages of 17 years in girls and 19 years in boys.[53,54] After 4 years of retention, the occlusion remained stable and relatively harmonious growth was observed in the present patient when he reached 18 years old.

The esthetic improvement obtained in this Class III CSP patient was impressive as a result of maxillary advancement and mandibular incisor compensation. The application of the purposefully ankylosed deciduous teeth as absolute anchorage could provide an opportunity for achieving more skeletal effect from maxillary protraction in patients who do not accept metal anchorage.

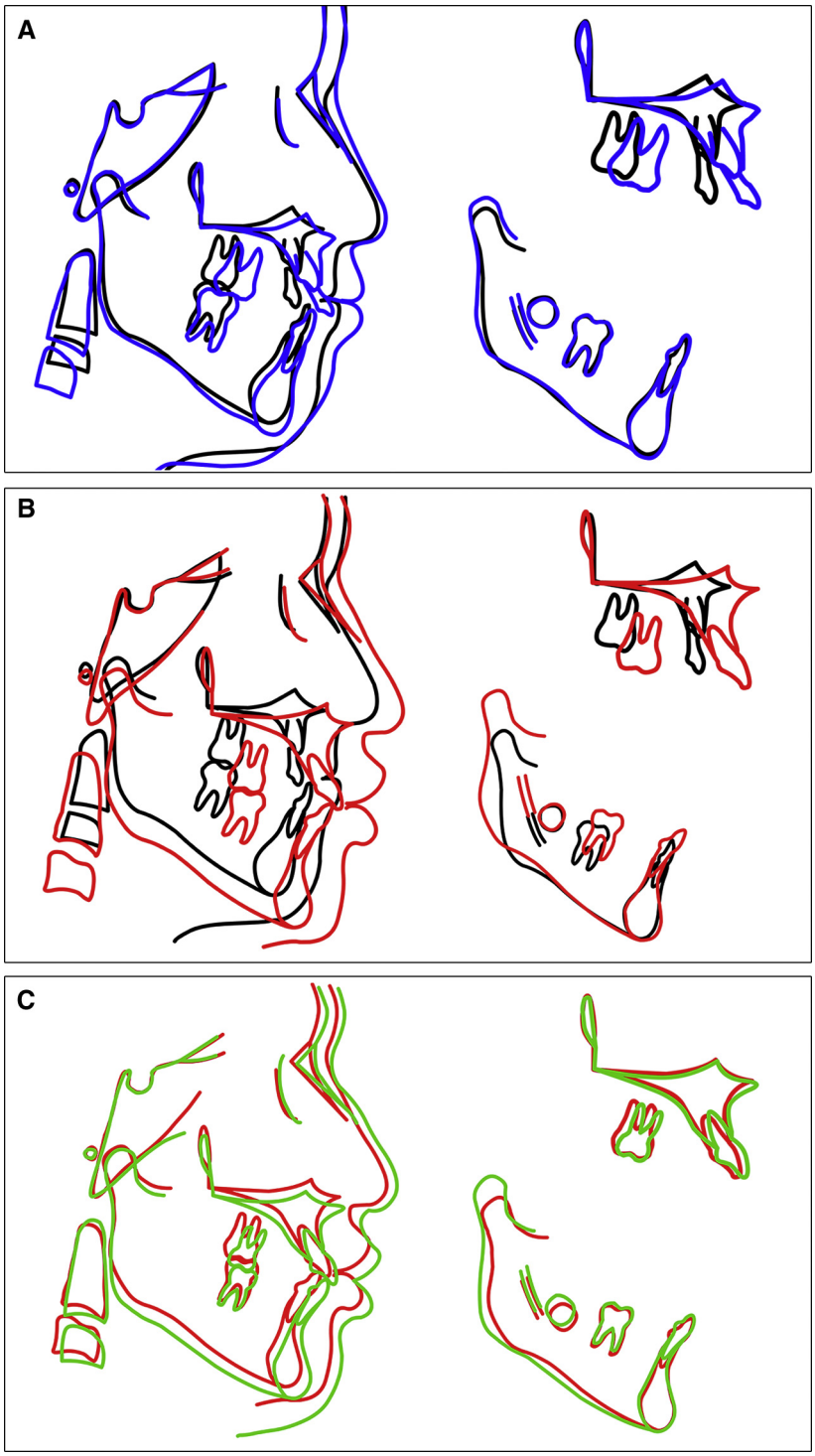

Fig 14. Superimposed cephalometric tracings: **A,** initial and progress; **B,** initial and final; **C,** final and 4-year retention; *black*: pretreatment; *blue*: after protraction; *red*: posttreantment; *green*: 4-year retention.

CONCLUSION

In this case report, the challenging treatment of a CSP patient with the use of primary surgical repair was described. Intentionally ankylosed deciduous teeth were used instead of metal anchorage to serve as the absolute anchorage for maxillary protraction. The

satisfactory result was achieved by combined early orthopedic intervention (maxillary protraction) and second-phase orthodontic treatment (fixed appliance). The final occlusion was esthetic, functional, healthy, and stable.

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