Orthodontic treatment of a patient with unilateral orofacial muscle dysfunction: The efficacy of myofunctional therapy on the treatment outcome

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The orofacial muscle is an important factor in the harmony of the occlusion, and its dysfunction significantly influences a patient's occlusion after craniofacial growth and development. In this case report, we describe the successful orthodontic treatment of a patient with unilateral orofacial muscle dysfunction. A boy, 10 years 0 months of age, with a chief complaint of anterior open bite, was diagnosed with a Class III malocclusion with facial musculoskeletal asymmetry. His maxillomandibular relationships were unstable, and he was unable to lift the right corner of his mouth upon smiling because of weak right orofacial muscles. A satisfactory occlusion and a balanced smile were achieved after orthodontic treatment combined with orofacial myofunctional therapy, including muscle exercises. An acceptable occlusion and facial proportion were maintained after a 2-year retention period. These results suggest that orthodontic treatment with orofacial myofunctional therapy is an effective option for a patient with orofacial muscle dysfunction. (Am J Orthod Dentofacial Orthop 2016;150:167-80)

The harmonization between the teeth and the orofacial muscles is an important factor in an adequate occlusion, and suitable occlusal forces have been reported to play a significant role in keeping the teeth in balance.[1,2] This stabilizing effect was evident in a patient who could not squeeze his teeth together: the absence of occlusal forces allowed the teeth to extrude and tip, and to be generally unmanageable.[3,4]

The masticatory muscles influence craniofacial growth and development.[5] Strong muscles form the face, whereas the facial form in persons with weak muscles is more varied because the muscles exert less influence.[5,6] Some studies have shown morphologic improvements in children with open bites who practice chewing exercises.[7,8] Therefore, facial exercises are useful, to some extent, in reversing the adverse effects of a lack of adequate orofacial muscle force on facial skeletal growth.

Orofacial myofunctional therapy (OMT) or other muscle training and habituation exercises for patients have been a major proactive intervention modality that a dentist or an orthodontist can use. Although the efficacy of OMT is still unclear,[9-18] it is thought to facilitate remediation for open-bite patients.[10,19,20] In this case report, we present the treatment of a patient with an anterior open bite and weak facial muscle force, particularly on the right side, treated with orthodontic appliances combined with OMT. The treatment results were satisfactory, and the patient achieved a good smile and occlusion. An acceptable occlusion and facial proportions were maintained after the 2-year retention period.

DIAGNOSIS AND ETIOLOGY

A boy, 10 years 0 months of age, came to the outpatient clinic of Okayama University dental hospital. His chief complaint was an anterior open bite. The facial photographs showed a symmetric face and a straight profile. However, when he smiled, he could not lift his lip on the right side, which was in a flaccid state (Fig 1). Although the origin of his facial soft tissue

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Fig 1. Pretreatment facial and intraoral photographs. The patient's occlusion was unstable, and he had a left posterior crossbite when he pulled the retractors because of weakness of his right orofacial muscles.

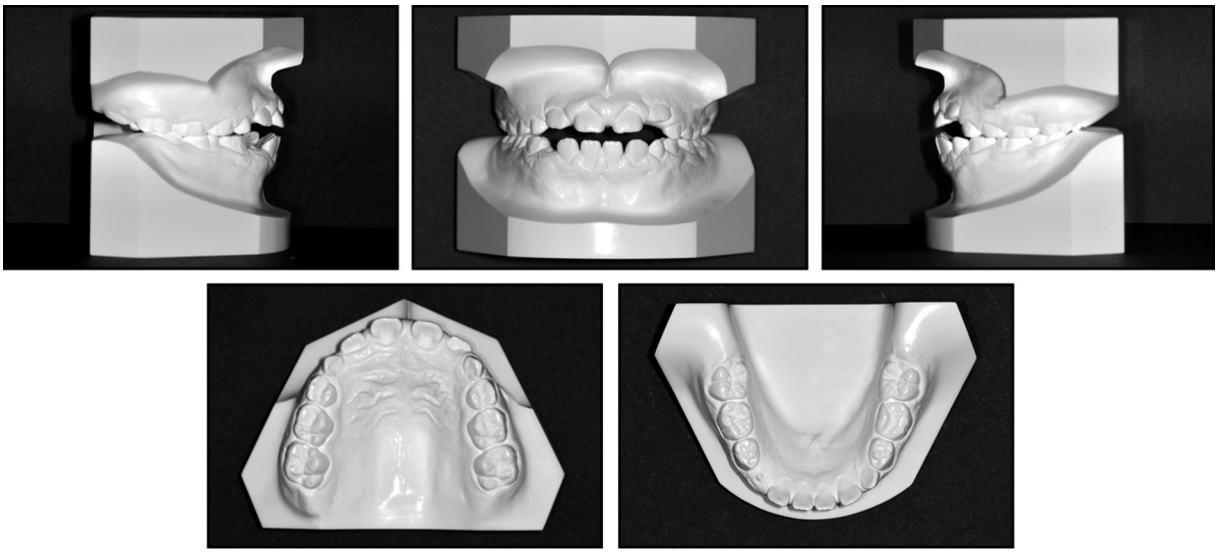

Fig 2. Pretreatment dental casts in centric occlusal position.

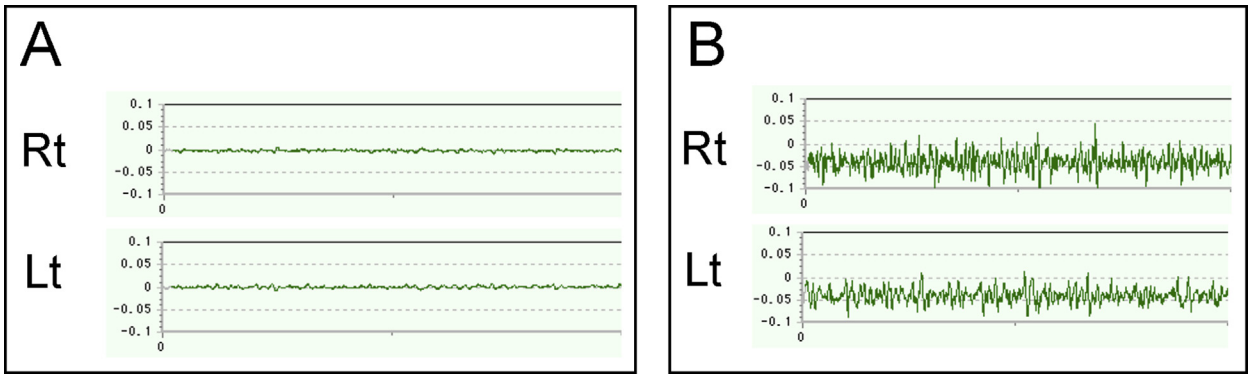

Fig 3. Electromyographic recordings of the masseter in the biting position: **A,** pretreatment; **B,** postretention.

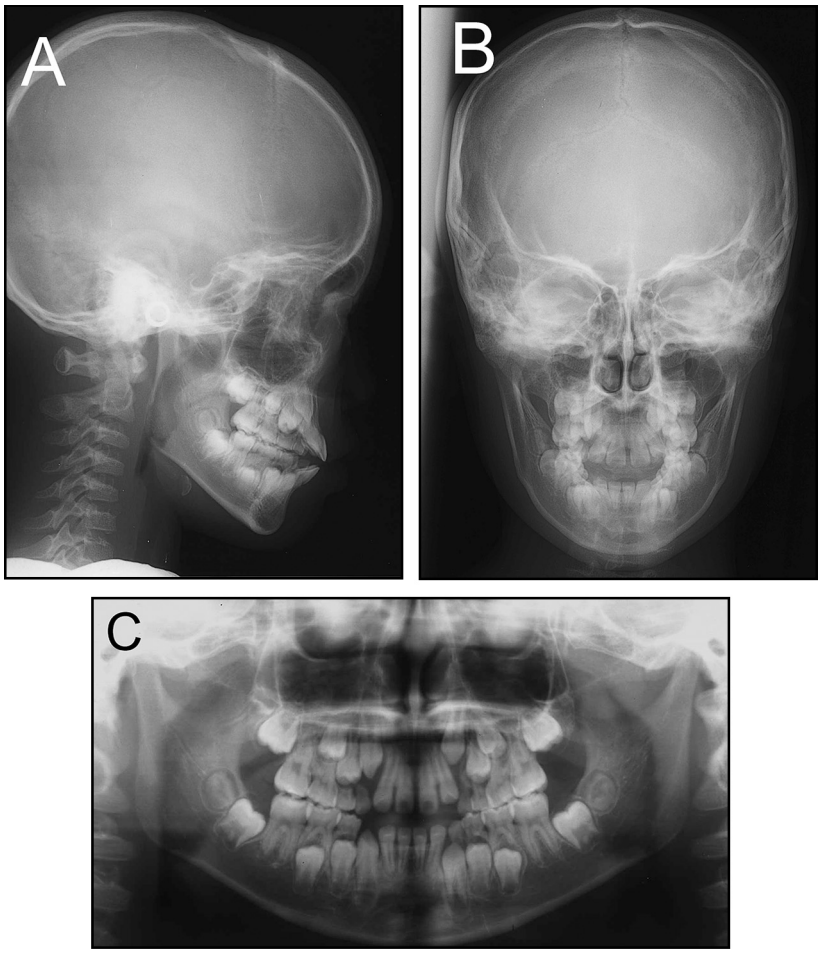

Fig 4. Pretreatment radiographs: **A,** lateral cephalogram; **B,** posteroanterior cephalogram; **C,** panoramic radiograph.

Table I. Cephalometric summary

Variables	*Mean (10 y)*	*SD*	*Mean (adult)*	*SD*	*Pretreatment*	*Before edgewise treatment*	*Posttreatment*	*Postretention*
Angular (°)								
ANB	4.2	1.8	3.2	2.4	1.6	2.5	2.1	1.3
SNA	80.8	3.4	81.5	3.3	81.2	83.5	81.6	81.6
SNB	77.9	3.1	78.2	4.0	79.6	81.0	79.5	80.3
Mp-FH	30.5	4.3	28.0	6.1	28.2	26.1	27.1	27.1
Gonial	122.1	5.2	120.9	6.5	121.1	123.6	124.2	124.1
U1-FH	112.3	4.7	112.4	7.6	122.3	122.5	117.6	119.5
L1-Mp	93.4	6.8	95.2	6.2	112.4	99.4	100.4	98.7
IIA	123.6	11.2	124.2	8.6	97.1	112.0	114.9	114.8
Occlusal.plane	16.9	3.7	15.5	4.2	16.4	12.4	11.6	12.1
Linear (mm)								
S-N	67.9	2.5	72.2	3.3	71.6	79.0	81.6	81.6
N-Me	125.8	4.1	135.7	4.0	119.3	135.6	140.5	140.8
Me/NF	68.6	3.3	74.6	3.0	67.1	76.3	79.7	79.9
Ar-Go	47.3	2.6	53.2	5.7	48.9	54.9	58.4	58.4
Ar-Me	106.6	3.0	115.6	6.8	103.6	123.2	127.3	127.4
OJ	3.1	1.4	3.3	1.0	1.8	2.6	1.9	2.0
OB	3.3	2.6	3.3	1.7	−4.2	0.4	1.7	1.5
U1-NF	31.0	1.6	32.4	3.1	27.9	28.8	30.5	30.5
L1/MP	44.2	2.1	48.9	2.6	42.4	50.6	54.0	54.1

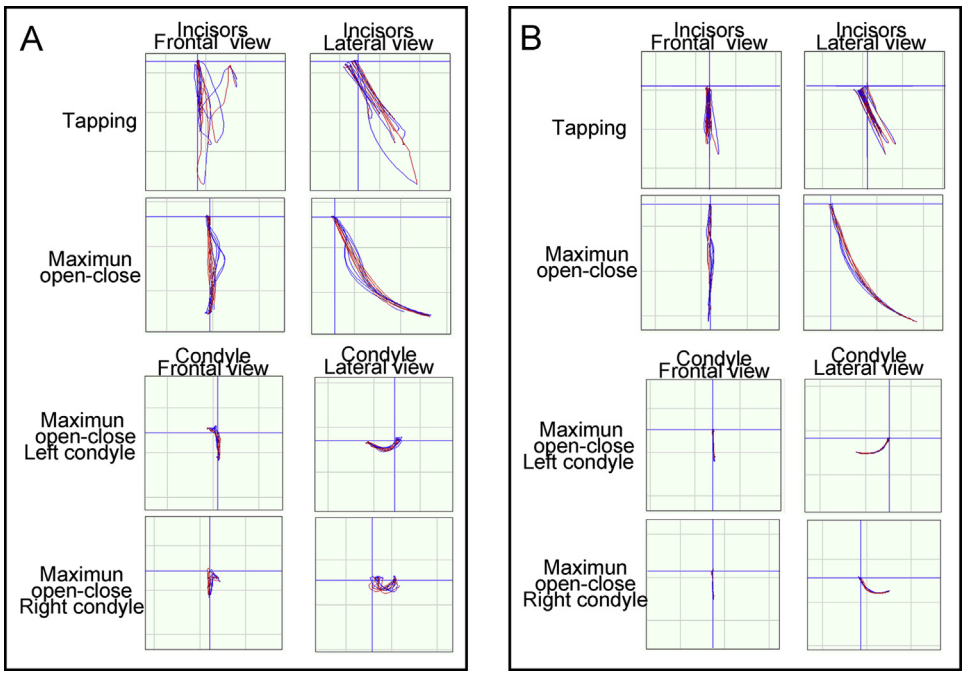

Fig 5. Condylar movement and incisal paths were recorded with the six degrees of freedom jaw movement recording system. The *red lines* indicate the opening phase, and the *blue lines* indicate the closing phase. **A,** Pretreatment; **B,** posttreatment.

asymmetry was uncertain, he had a history of open bite since the deciduous dental period, and his saliva often leaked from the right side of his mouth since he was an infant. His symptoms included not being able to enunciate the sounds "ra, ri, ru, re, ro" in Japanese, not being able to blow up a balloon, and not being able to whistle because of the saliva leaking from his mouth. He was not a thumb sucker. Tongue thrust was also observed, but he could not tense his tongue. Additionally, he could not tense his right-side muscles, and

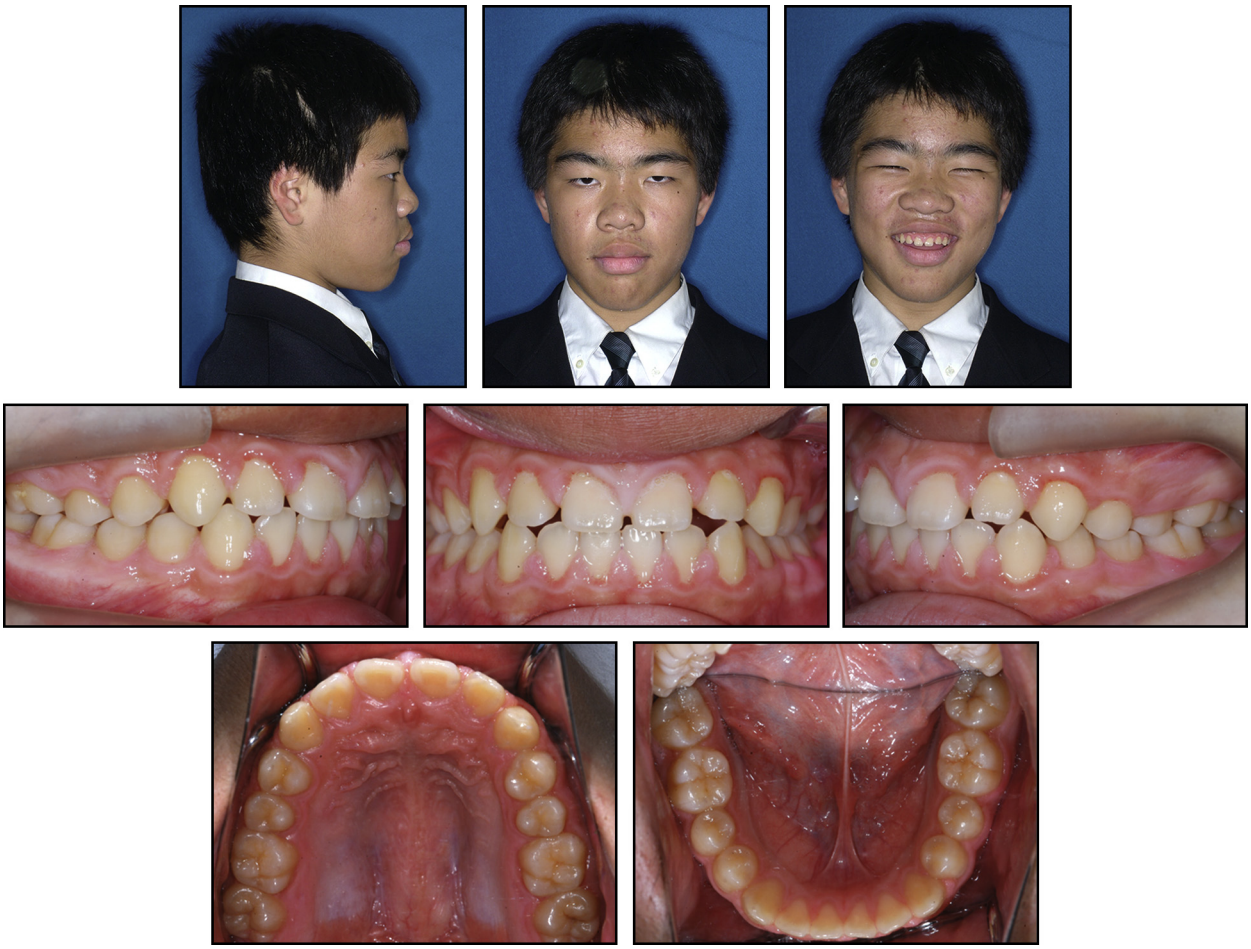

Fig 6. Facial and intraoral photographs at the end of phase 1 treatment.

his mouth was often open. When he stood straight for a while, his head gradually inclined to the right. He had been taking antiepilepsy drugs since his first seizure at 1 year 2 months of age. Although he experienced provoked seizures several times a year until 5 years of age, further seizures were rare from 5 to 10 years of age. His medical and drug use history showed nothing unusual, except for epilepsy. The intraoral photographs demonstrated gingivitis, possibly associated with taking a steady dose of the antiepilepsy drug. An anterior open bite with a mesial step-type relationship on both sides was observed (Fig 2). A crossbite was not observed in the centric occlusal position, and the midline of the mandibular teeth was deviated to the right by approximately 2 mm to the midline of the maxillary teeth. His occlusion was unstable and showed a left posterior crossbite when he pulled the retractors for his oral photograph, most likely because the right orofacial muscles were too weak to resist the force exerted by the pulling of the left retractor. An electromyographic recording showed weak activity of the masseter (Fig 3, *A*). A cephalometric analysis, when compared with the normal results for the Japanese population, showed a skeletal Class III relationship (ANB, 1.6°).[21] The maxillary and mandibular incisors were labially inclined (U1-FH, 122.3°; L1-MP, 112.4°), and the interincisal angle was lower (IIA, 97.1°) (Fig 4; Table I).

The patient was able to perform the opening and closing and tapping movements, but not the right-left or the anterior gliding movement on a 6 degrees of freedom jaw movement recording system (Gnathohexagraph System version 1.31; Ono Sokki, Kanagawa, Japan). Variability in the condylar movement on the right side during the opening and closing movements was observed. Furthermore, the mandibular incisors often moved to the left during the tapping movement (Fig 5, *A*).

Based on these findings, the patient was diagnosed with a skeletal Class III jaw base relationship, an anterior

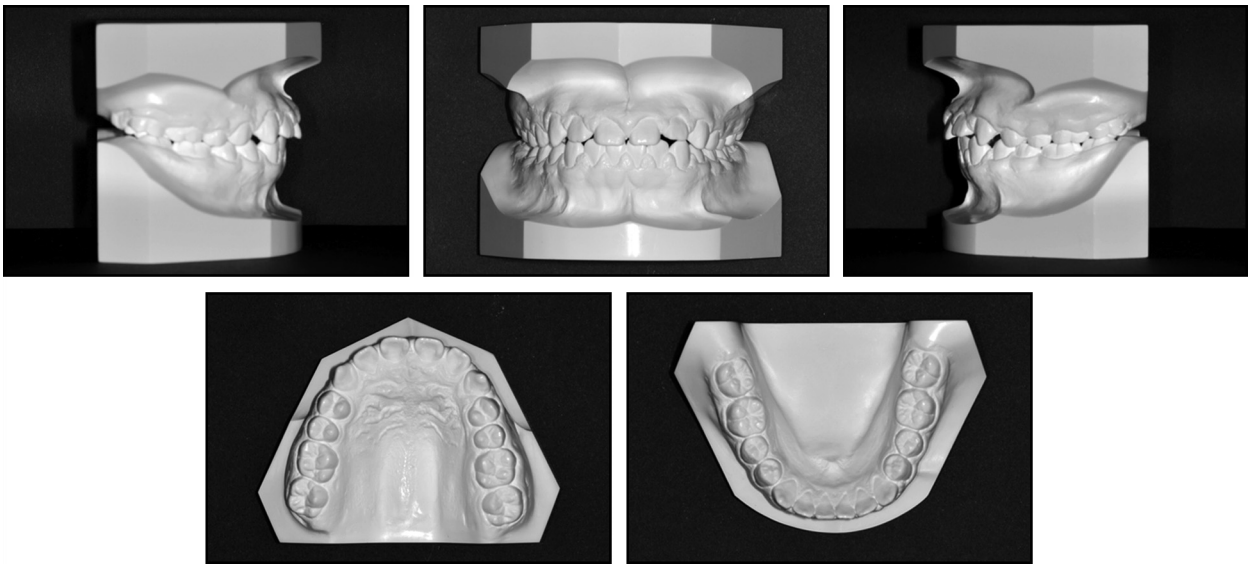

Fig 7. Dental casts at the end of phase 1 treatment.

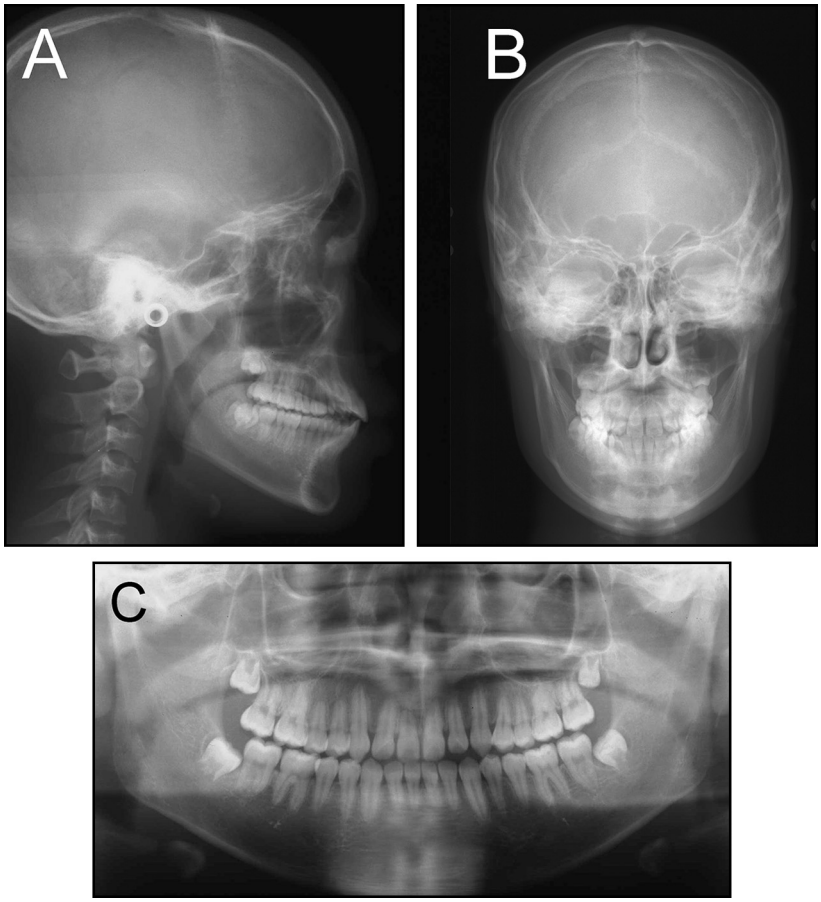

Fig 8. Radiographs at the end of phase 1 treatment: **A,** lateral cephalogram; **B,** posteroanterior cephalogram; **C,** panoramic radiograph.

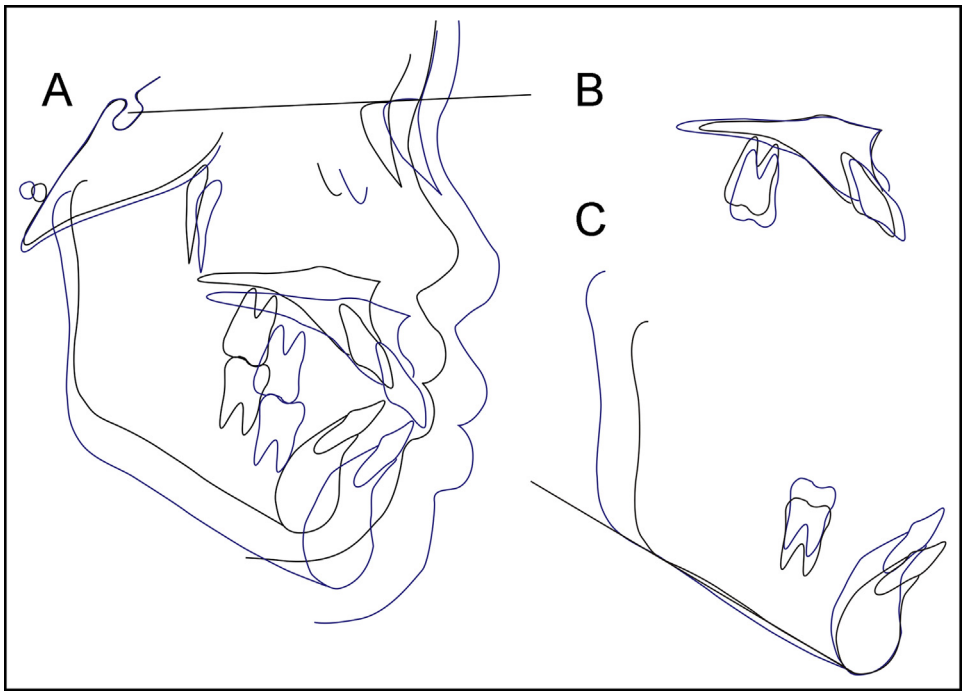

Fig 9. Superimpositions of cephalometric tracings obtained during the pretreatment period (*black*) and at the end of phase 1 treatment (*blue*): **A,** sella-nasion plane at sella; **B,** palatal plane at ANS; **C,** mandibular plane at menton.

open bite, labial inclination of the mandibular and maxillary incisors, and an asymmetrical smile with right perioral muscular weakness.

TREATMENT OBJECTIVES

The treatment objectives were to create more ideal overbite and overjet relationships with good functional Class I molar relationships and obtain a good facial profile and smile with toned up perioral muscles.

TREATMENT ALTERNATIVES

The first option, which was selected by the patient and parents, was an early phase of orthodontic treatment to induce harmonious skeletal growth and improve the facial esthetics followed by a second phase of treatment to correct the remaining crowding, overjet, and overbite problems. The second option was to wait until growth was completed and determine whether the malocclusion could be camouflaged by orthodontic treatment or a combination of surgical and orthodontic treatment. Although skeletal asymmetry was not observed in the frontal cephalometrics before treatment, it was possible that the varied strengths of the right and left muscles would cause skeletal asymmetry during the growth period. In that case, surgical treatment would be required after the growth.

TREATMENT PROGRESS

The patient was instructed to practice OMT (smile exercises, cheek inflating, cheek stretching, and lip stretching) 3 times a day for a minimum of 3 minutes to improve the strength of the right orofacial muscles. Furthermore, we referred him to the Department of Rehabilitation Medicine of Okayama University Hospital to exercise the muscles of the extremities. At 10 years 2 months of age, a tongue crib was placed in the maxillary arch to restrain the tongue in a posterior position and continued for 4 years 9 months. Chewing exercises were also added at 11 years 3 months. At 15 years 9 months, the patient was reexamined for the second phase orthodontic treatment. A nonextraction treatment was chosen, although a gummy smile and flaring of both the maxillary and mandibular incisors were observed. This treatment enabled us to avoid the excessive orthodontic tooth movement required with premolar extraction treatment, decreasing the risk of severe apical root resorption after the orthodontic treatment with fixed

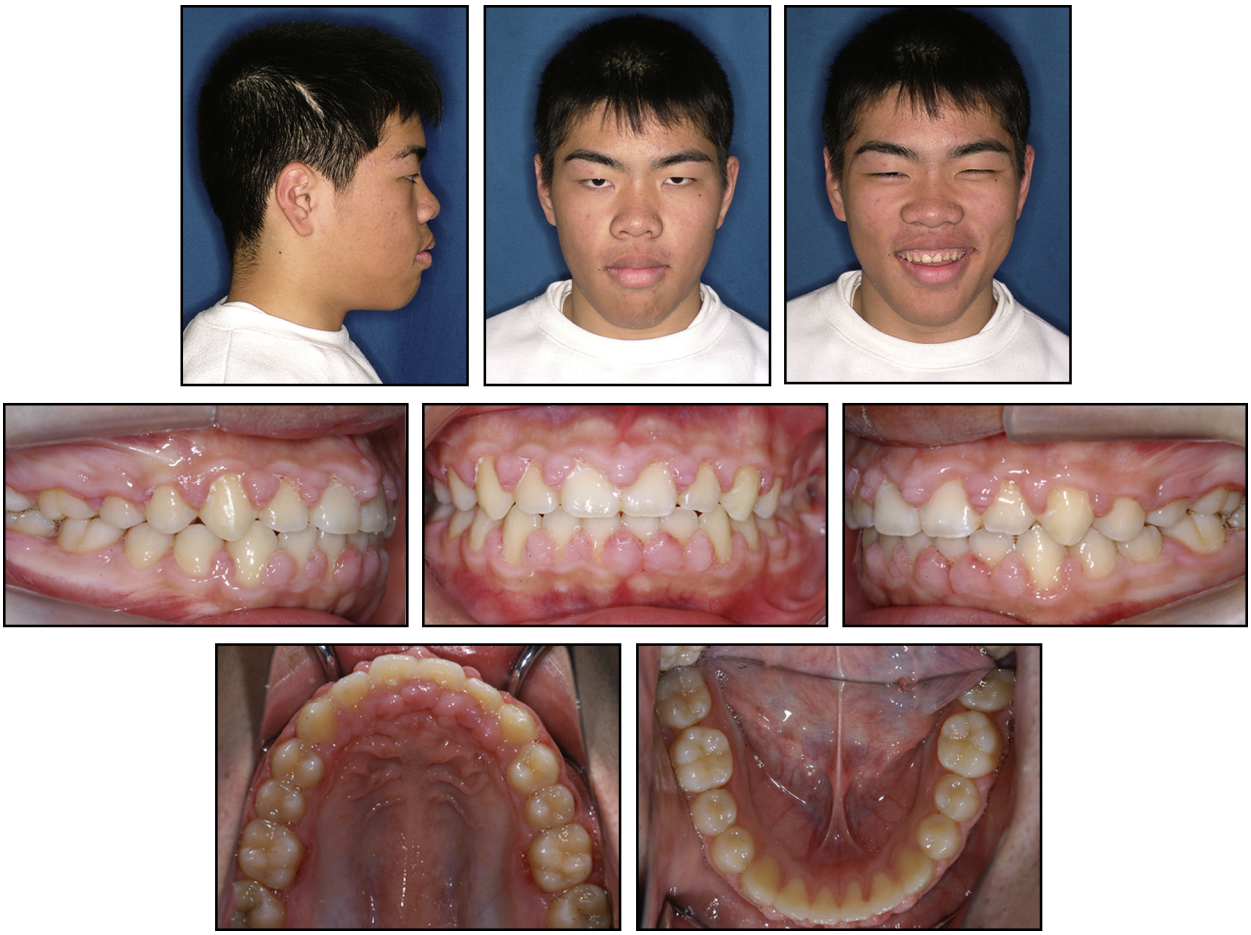

Fig 10. Postorthodontic treatment facial and intraoral photographs.

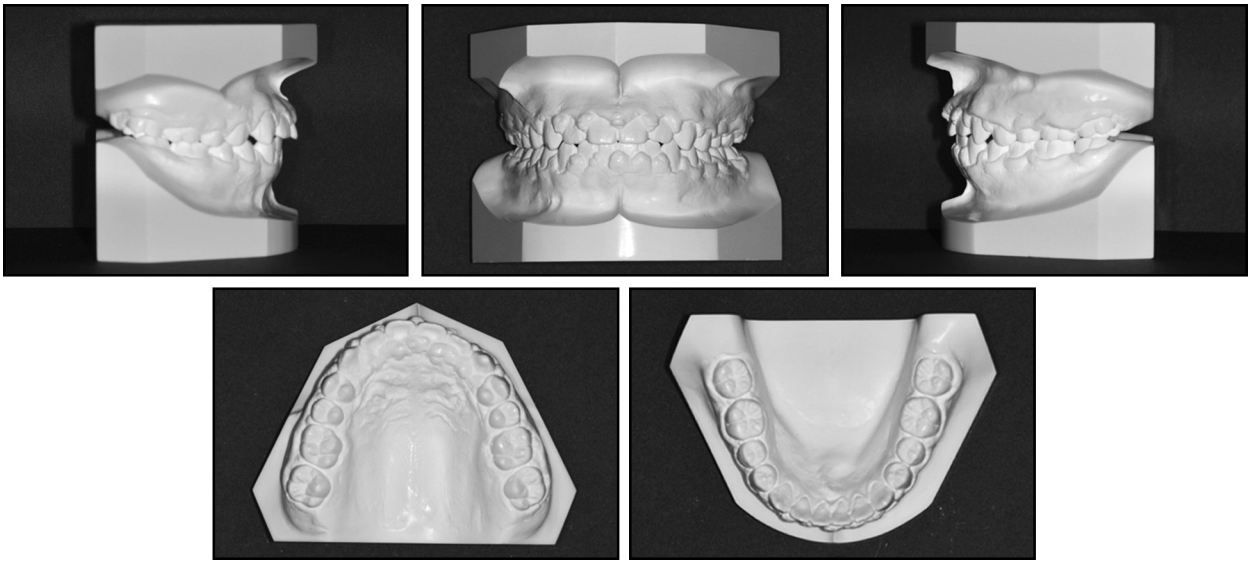

Fig 11. Posttreatment dental casts.

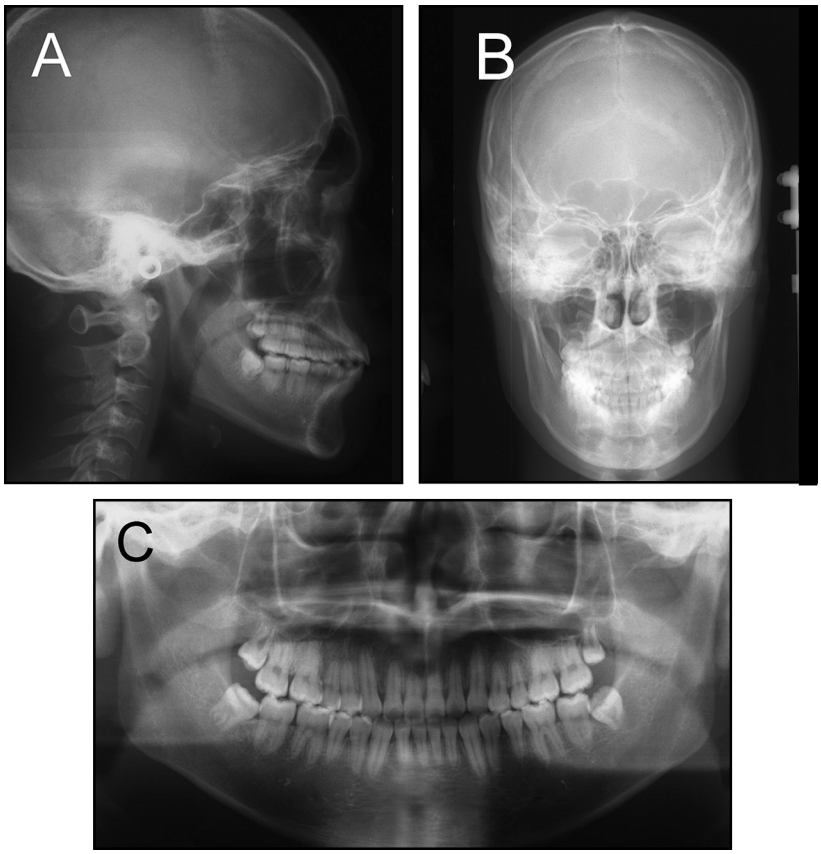

Fig 12. Posttreatment radiographs: **A,** lateral cephalogram; **B,** posteroanterior cephalogram; **C,** panoramic radiograph.

appliances. A preadjusted edgewise appliance with 0.018-in slots was placed on the anterior and mandibular teeth. Vertical, triangular, quarter-inch, 4.5-oz elastics were used in the canine region bilaterally to improve intercuspation. The OMT exercises were continued concomitantly during the edgewise appliance treatment. Overall, the second phase treatment lasted 15 months. After debonding and debanding, wrap-around retainers were placed on the maxillary arch during the day, and modified wraparound retainers with a tongue crib were worn during the night for a year. One year after debonding and debanding, the modified wrap-around retainers with a tongue crib were used during the night.

TREATMENT RESULTS

OMT significantly improved the patient's facial muscle tone, and he was able to keep his occlusion almost in the centric position while pulling his lips while looking into a mirror by the time he was 12 years 0 month of age.

At 12 years 4 months, his occlusion became stable, and he could hold a straw between his lips. Furthermore, at age 12 years 10 months, the leaking of saliva when he blew into a recorder had decreased. Both the lip seal and the tongue posture improved, and the overall soft tissue profile was markedly improved. At the beginning of the edgewise appliances treatment, the corners of the mouth on both sides were elevated when he smiled (Fig 6). His facial profile became straight and showed a slight protrusion of the upper and lower lips, which were thick. His torticollis was slightly improved, but a somewhat arrested feeling in the right hand still remained. He continued to take the antiepilepsy drug, and his gingivae were red and swollen. His occlusal position was stable. Angle Class III molar relationships and a spaced maxillary arch in the anterior region were observed. Overjet had improved from 1.8 to 2.6 mm, and overbite improved from −4.2 to 0.4 mm. The deviation of the dental midline between the maxillary and mandibular teeth was also improved, but the mandibular midline was still deviated to the right by 0.5 mm (Figs 6 and 7). The short root of

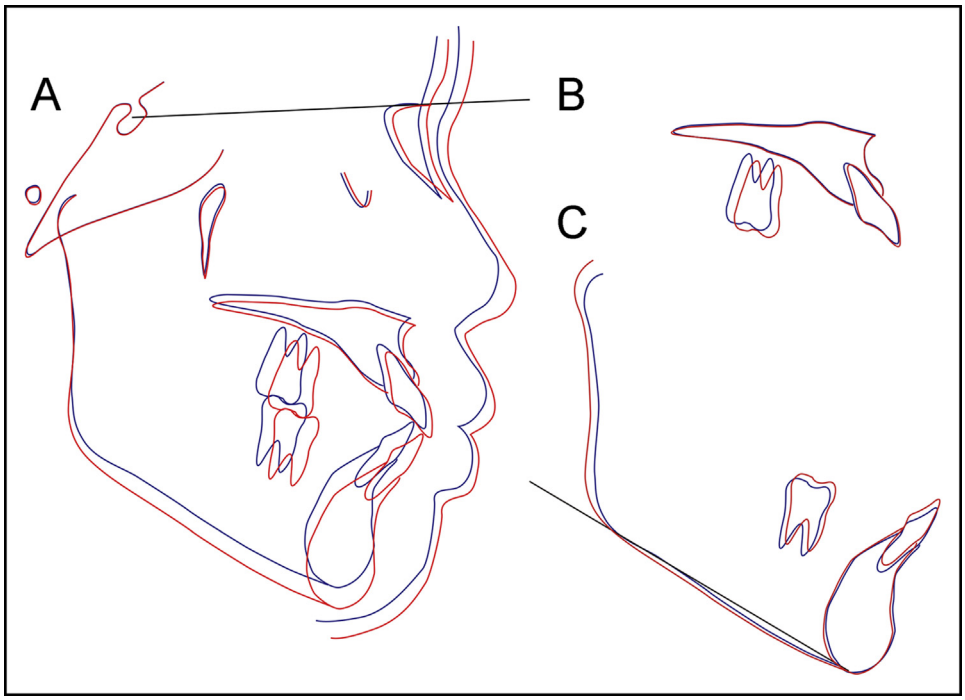

Fig 13. Superimpositions of cephalometric tracings at the end of phase 1 treatment (*blue*) and after the completion of treatment (*red*): **A,** sella-nasion plane at sella; **B,** palatal plane at ANS; **C,** mandibular plane at menton.

Table II. Changes in occlusal function during orthodontic treatment

	Occlusal force (N)	*Occlusal contact area (mm^2)*
Pretreatment	274	6.4
Posttreatment	414	10

the maxillary central incisor was observed on the panoramic tomography x-ray (Fig 8).

On the cephalometric superimposition, the ANB angle increased from 1.6° to 2.5°. The mandibular anterior teeth were lingually inclined (L1-MP, 99.4°), and incisal extrusion was achieved in the arch; this possibly affected the tongue crib (Fig 9; Table I). The severity of the malocclusion was reduced after interceptive orthodontic treatment and the orofacial myofunctional exercises, and the second phase of treatment was implemented to complete the correction of the malocclusion.

The phase 2 treatment results showed adequate molar and canine relationships, normal overjet and overbite, and improvement of the occlusion (Figs 10 and 11). The maxillary and mandibular teeth were leveled and satisfactorily aligned. Furthermore, the dental midline corresponded between the maxilla and the mandible. Gingival swelling was still observed; it might have been caused by the antiepilepsy drug and inadequate brushing because of his disabled hands. The radiographs confirmed adequate root parallelism, and no changes were observed in the short roots of the maxillary right anterior teeth. The patient had a slight absorption of the root of maxillary left lateral incisor, and 4 unerupted third molars (Fig 12). The posttreatment cephalometric analysis showed modest skeletal changes (ANB, −2.1°). The maxillary anterior teeth were lingually inclined (U1-FH, 117.6°), and the mandibular anterior teeth were labially inclined (L1-MP, 100.4°) (Fig 13; Table I). On a 6 degree of freedom jaw movement recording system, the unstable sideways movement during opening and closing of the mouth also improved (Fig 5, *B*). The movement of the right condyle, which was particularly unstable, was significantly improved, and the movement of the left condyle also became stable. Furthermore, the movements of both condyles were smoother than before treatment (Fig 5, *B*). The occlusal force and the occlusal contact areas were also increased after treatment (Table II).

Fig 14. Postretention facial and intraoral photographs.

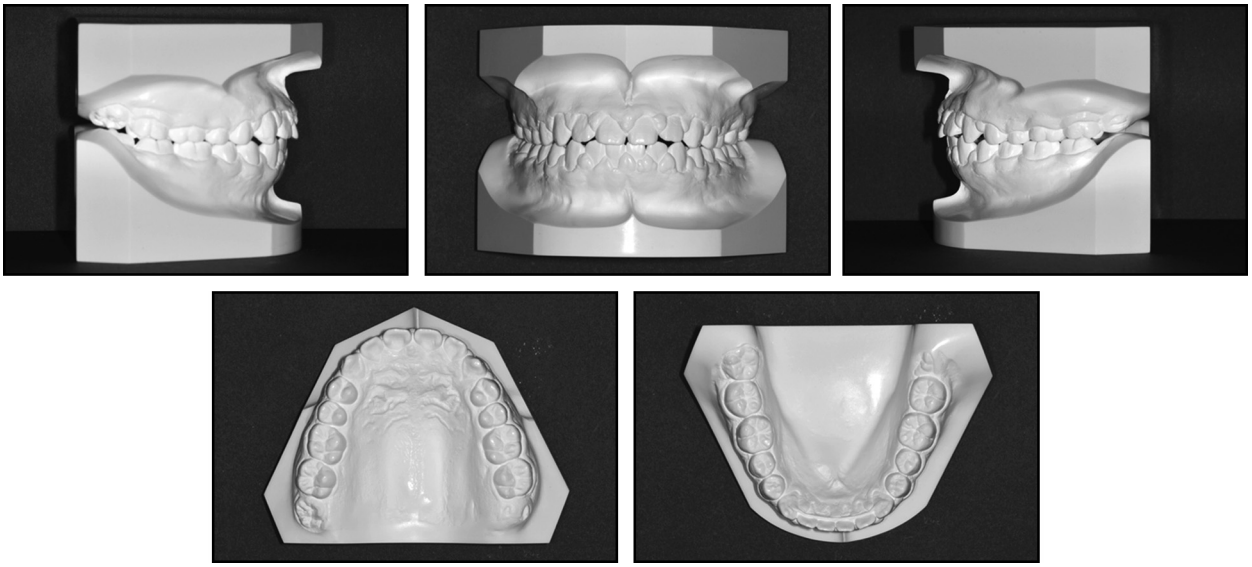

Fig 15. Postretention dental casts.

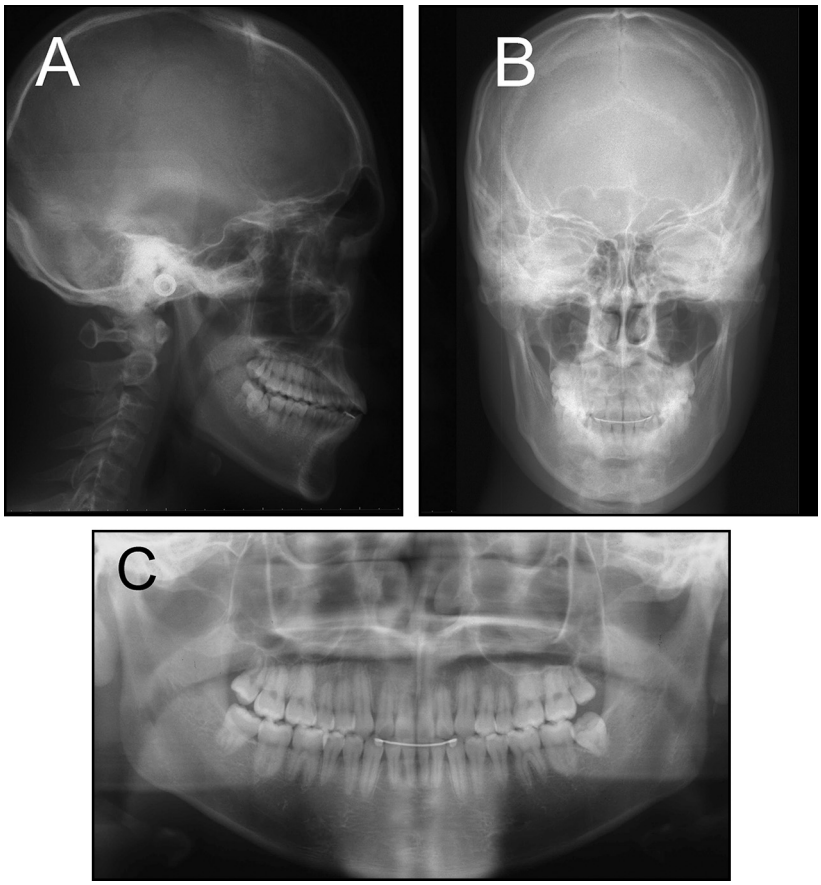

Fig 16. Postretention radiographs: **A,** lateral cephalogram; **B,** posteroanterior cephalogram; **C,** panoramic radiograph.

The patient was pleased with his smile, since he became able to lift both corners of the mouth symmetrically. After 2 years of retention, an acceptable occlusion and facial profile were maintained (Figs 14-17; Table I). A postretention electromyographic recording showed that the masseteric activity was significantly increased after the orthodontic treatment, although there was still a muscular imbalance (Fig 3, *B*). Now, after 6 years of retention, the patient's occlusion is still stable, and he is still being followed.

DISCUSSION

Orofacial muscle dysfunction presents a special consideration for orthodontists because it greatly contributes to occlusal and craniofacial problems. Our patient was initially unable to lift the right corner of his mouth upon smiling. His occlusion was unstable and showed a left posterior crossbite as the mandible got drawn to the right side when pulling the cheeks with retractors for oral photography owing to the weak right orofacial muscles. Furthermore, in addition to the weak orofacial muscles, all of the patient's muscles on the right side of his body were unexplainably weak.

In this patient, the movement of the right condyle was especially unstable, and the mandibular incisors often moved to the left during the tapping movement (Fig 5, *A*), suggesting asymmetrical jaw movement possibly associated with orofacial muscle dysfunction. This may have had a detrimental effect on his skeletal growth throughout the growth period. Patients with facial musculoskeletal asymmetry have a higher incidence of morphologic changes and internal derangement of the temporomandibular joint on the shifted side compared with the nonshifted side.[22] Although this patient showed no skeletal asymmetry in the pretreatment stage, we aimed to achieve symmetrical function through orthodontic treatment combined with OMT.

The patient was instructed to practice OMT to achieve growth and improvement of the facial and

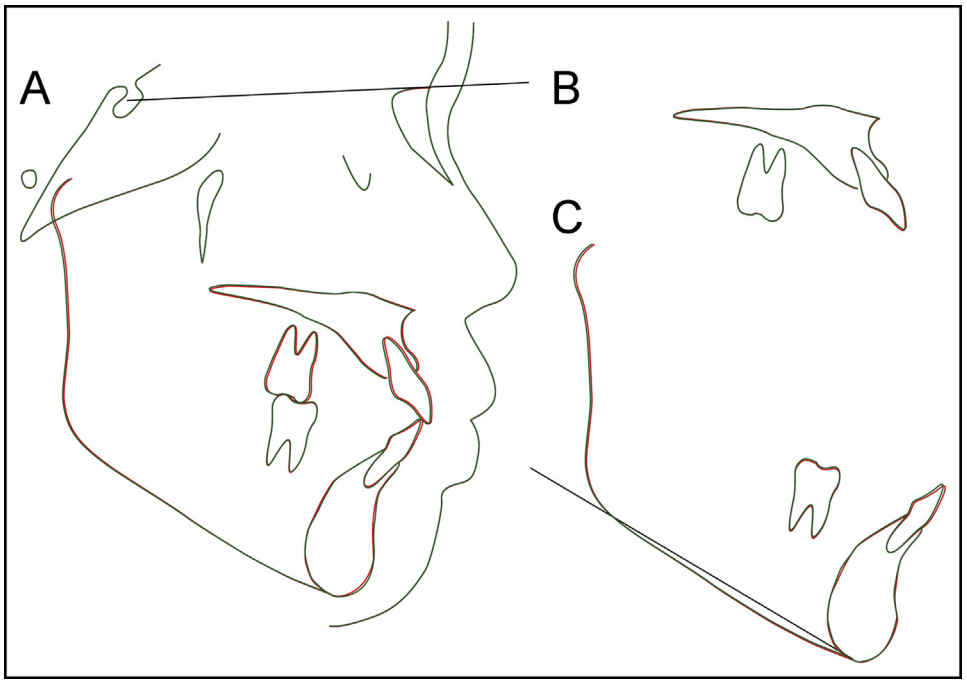

Fig 17. Superimposed cephalometric tracings showed the changes from posttreatment (*red*) to postretention (*green*): **A,** sella-nasion plane at sella; **B,** palatal plane at ANS; **C,** mandibular plane at menton.

masticator muscles. As a result, his right facial muscles were toned, and he was able to lift both corners of his mouth upon smiling. Additionally, his orofacial muscles became strong enough to resist the pulling force exerted by the retractors. Furthermore, once the unstable occlusion became stable, some of the inconveniences in his daily life, such as leaking saliva when playing the recorder, were resolved. An adverse effect on the skeletal growth, especially facial asymmetry, was not observed during the growth period. Correcting the patient's soft tissue imbalance might have been improved with only orthodontic management and growth and maturity. In this patient, however, we combined OMT and orthodontic treatment because we thought this therapy would provide additional improvement in his orofacial muscle dysfunction.

The occlusal force is said to influence facial appearance.[5] An asymmetric lateral force has been shown to result in growth modification on the distal surface of the condyle after 6 months,[23] and the authors of a study on rats found that the lateral forced bite influenced the structure and shape of the mandible and the composition of the masseter muscle.[24] In this patient, OMT improved the muscle tone on the right side, preventing his facial appearance from becoming asymmetric during the growth period. He was also introduced to a rehabilitation specialist to strengthen the muscles of the whole body to resolve the disabled feeling in his extremities.

In the second phase, orthodontic treatment involving tooth extractions was one treatment choice to correct the slightly protruded teeth and the gummy smile. However, the root of the maxillary central incisor was short, and the patient chose nonextraction treatment. Although there was no change in the facial profile, the result showed minimal resorption of the roots of the maxillary incisors because of the minimal movement of the incisors and the minimal time to mount the edgewise appliances.

Since OMT is reported to decrease the degree of relapse when implemented with anterior open bite treatment, it was used concomitantly with anterior open-bite treatment in this patient.[19] We used wrap-around retainers modified with a tongue crib for the maxilla during the night because a removable retainer with a crib has been reported to be effective.[25] Our patient's occlusion was stable after 2 years of retention, although a slight relapse was observed in the incisors. It has now been 6 years into the retention period, and the occlusion is still stable. We plan to continue with follow-up observations.

CONCLUSIONS

A patient with a Class III jaw base relationship, an anterior open bite, and unilateral orofacial muscle dysfunction was treated. Orthodontic treatment combined with OMT provided significant improvements in the functional occlusion and the facial balance. The resultant occlusion and facial profile were stable after 2 years. These findings suggest that orthodontic treatment with OMT is an effective approach for obtaining a functionally stable occlusion in patients with an orofacial muscle dysfunction.

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