CASE REPORT

Nonsurgical and nonextraction treatment of skeletal Class III open bite: Its long-term stability

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Two female patients, aged 14 years 5 months and 17 years 3 months with skeletal Class III open bite and temporomandibular dysfunction are presented. They had previously been classified as orthognathic surgical cases, involving first premolar removal. The primary treatment objective was to eliminate those skeletal and neuromuscular factors that were dominant in establishing their malocclusions. These included abnormal behavior of the tongue with short labial and lingual frenula, bilateral imbalance of chewing muscles, a partially blocked nasopharyngeal airway causing extrusion of the molars, with rotation of the mandible and narrowing of the maxillary arch. Resultant occlusal interference caused the mandible to shift to one side, which in turn produced the abnormal occlusal plane and curve of Spee. As a result, the form and function of the joints were adversely affected by the structural and functional asymmetry. These cases were treated by expanding the maxillary arch, which brought the maxilla downward and forward. The mandible moved downward and backward, with a slight increase in anterior facial height. Intruding and uprighting the posterior teeth, combined with a maxillary protraction, reconstructed the occlusal plane. A favorable perioral environment was created with widened tongue space in order to produce an adequate airway. Myofunctional therapy after lingual and labial frenectomy was assisted by vigorous gum chewing during and after treatment, together with a tooth positioner. Normal nasal breathing was achieved. (Am J Orthod Dentofacial Orthop 2000;117:267-87)

In skeletal Class III open bite cases, it may be difficult to achieve an excellent occlusal improvement solely by orthodontic means and to maintain a stable occlusion after treatment. Thus, orthognathic surgery is often combined with conventional orthodontic treatment for occlusal improvement, with surgical treatment performed toward the end of the jaw growth period for optimal stability. In Japan, most patients do not readily accept orthognathic surgery because of potential surgical complications. For this reason, the orthodontic correction of the morphologic and functional problems that adversely affect the patient's psychology at an early stage, along with myofunctional training, could help eliminate the potential inferiority complex and also have a beneficial effect on the general personality development.

The 2 female patients described in this article had skeletal Class III open bite with temporomandibular dysfunction. Both were psychologically compromised. A decision was made to select a treatment modality that would have the least adverse behavioral consequences, with nonextraction if possible, and without orthognathic surgery. Light wire appliances (Begg[1] and Alexander[2] technique) were chosen. Both cases were to be combined with maxillary expansion, maxillary protraction, or both. These skeletal Class III open bite cases were successfully treated orthodontically, creating a favorable perioral environment by normalizing the chewing muscles activity and tongue behavior.

Their occlusion has remained stable with no recurrent temporomandibular disorders.

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CASE 1

A Japanese female aged 14 years 5 months with skeletal Class III open bite, complaining of speech problems, muscle fatigue, headaches, and a dished-in face, presented for treatment. She had allergic rhinitis, and the palatine tonsils became swollen, which caused mouth breathing and compensatory anterior tongue posturing to achieve an adequate airway and produced a narrow maxillary arch. She had apparently inherited a crossbite from her mother.

Diagnosis

Facial findings (Fig 1A). The patient had an asymmetric face, with a long lower face and deviated chin to the right in the frontal view. She had a concave profile with a short and tight upper lip and flattened lower lip.

Intraoral findings (Fig 2A). The molars and canines were Class III, with an open bite in the premolar and anterior segments. The molars were the only teeth in

Table I. Cephalometric analysis of case 1

Angular measurements (degrees) (sex, female)

Variable	*SNA*	*SNB*	*ANB*	*GoA* *Upper*	*Lower*	*SN* | *GoMe*	*SN* | *Pog*	*PalP* | *GoMe*	*FOcp* | *GoMe*
Pretreatment (14 yrs 7 mo)	78.9	83.3	–4.4	130.6	50.0 80.6	36.5	84.0	32.0	21.0
6 months into active treatment (15 yrs 1 mo)	79.0	80.0	1.0	130.6	50.0 80.6	36.0	82.0	31.0	23.0
Posttreatment (16 yrs 10 mo)	84.5	82.1	2.4	130.6	51.6 79.0	36.5	83.5	31.0	25.0
3 years posttreatment (19 yrs 10 mo)	84.5	81.5	3.0	128.50	49.0 79.5	37.0	83.0	32.0	24.0
10 years 10 months posttreatment (27 yrs 8 mo)	84.5	82.0	2.5	124.0	47.0 77.0	33.0	84.0	29.0	25.5
Control adult mean	81.5	78.2	3.2			34.5	78.2	24.6	13.2
SD	3.29	4.02	2.38			6.05	3.93	3.90	3.70

Linear measurements (mm)

Variable *Wits*	*Se-N*	*N-Me*	*A'* | *PTM'*	*PalP* | *Me*	*Go* | *Me*	*cd* | *Go*	*S* | *Go*	*PalP-GoMe* *(on PM line)*
Pretreatment (14 yrs 7 mo)	67.0	129.6	43.3	74.2	80.0	60.3	80.0	48.0 –11.0
6 months into active treatment (15 yrs 1 mo)	67.0	129.6	44.0	74.5	80.5	60.5	82.0	48.0 –1.5
Posttreatment (16 yrs 10 mo)	67.0	129.6	50.0	75.1	83.0	60.7	83.0	46.0 0.0
3 years posttreatment (19 yrs 10 mo)	67.0	133.0	50.0	78.5	83.0	63.0	84.0	49.0 –1.0
10 years 10 months posttreatment	67.0	129.8	50.0	75.0	83.0	63.0	84.0	45.0 0.0

occlusion, and an overjet and overbite were –2.0 mm and –3.5 mm, respectively. The maxillary left canine was blocked out labially with no available space. The mandibular molars were supererupted and tipped mesially, creating an excessive curve of Spee. The maxillary arch was constricted with bilateral crossbite causing occlusal interference in the molar area and with a mandibular deviation of 4.0 mm to the right on occlusion. Neither protrusive nor lateral jaw movement was smooth, but no apparent TMJ clicking was detected at the time of examination. The tongue could not be positioned within the maxillary arch because of a short lingual frenum attachment, causing a narrow maxillary arch and abnormal tongue behavior. The patient had a short upper lip with short upper labial frenum attachment.

Radiographically (Fig 3*A*), all permanent teeth were present, with mesial inclination of the mandibular posterior teeth. The apices of the maxillary incisors were in close proximity to the nasal floor. The left ramus was shorter than the right.

Cephalometric findings (Figs 3A and 4 and Table I). The anteroposterior dimension of the maxilla (A'-PTM') was short and retrognathic (SNA angle: 78.9°), a prognathic mandible (SNB angle: 83.3°), with the ANB difference of –4.4°, and an excessive anterior facial height (S-Go/N-Me × 100 = 60.7%), which was associated with a steep mandibular angle with SN to GoMe of 36.5°. Other dimensions included the palatal plane to GoMe angle of 32.0° and a Gonial angle of 130.6°, indicating the mandible was rotated open.

The maxillary incisors were mildly procumbent, with $\underline{1}$ to SN angle at 111.8°, with a short vertical height (1 to palatal plane of 28.3 mm), while the mandibular incisors were lingually inclined with $\overline{1}$ to

SeN | *PalP*	*FOcp* | *AB*	*SN* | *FOcp*	*1* - *1*	*1* | *SN*	*1* | *GoMe*	*SN* | *CDM line*	*SN* | *F line*	*1* | *DC-L1i line*	*1* | *BP line*	*FOcp* | *CDM line*	
89.0	76.0	19.5	136.3	111.8	75.2	134.0	123.0	110.0	104.0	25.0	
	89.0	85.0	11.5	139.0	109.0	76.0	134.0	118.0	108.0	101.0	35.0
87.0	90.0	7.5	132.5	109.0	81.8	132.0	118.0	102.0	101.0	32.0	
89.0	88.0	7.5	122.0	114.0	87.5	132.0	128.5	99.0	92.0	32.0	
87.0	90.0	7.5	120.0	116.5	89.0	130.0	131.0	94.0	94.0	32.0	
(85.0)	(90.0)		124.2 8.75	106.0 7.49	95.2 6.18			(90.0)	(90.0)	constant	

1 | *PalP*	*1* | *Me*	*1* | *N-Pog*	*1* | *N-Pog*	$SG/_{NMe}$%	*Cast analysis* *Maxilla* *ICL*	*IML*	*AAL*	*Mandibular* *ICL*	*IML*	*AAL*	*OJ*	*OB*
28.3	42.4	–3.0	0.0	60.7	22.0	34.5	15.5	22.5	39.0	17.5	–2.0	–3.5
30.5	43.0	1.0	0.0	63.1	27.9	37.8	19.0	22.5	39.0	16.5	1.0	1.0
34.0	43.1	3.0	1.0	64.3	28.0	38.0	19.5	22.4	39.2	16.5	1.5	2.0
34.5	45.0	3.0	2.0	47.4	28.0	37.5	19.5	22.5	39.0	16.5	1.0	1.0
34.5	44.0	5.5	3.0	64.7	28.3	38.2	21.0	22.5	40.0	17.0	2.5	3.5

GoMe angle at 75.2° and $\overline{1}$ to DC-L1i angle at 110.0°. The Wits appraisal was –11.0 mm.

The frontal cephalometric findings are shown in Fig 6A. The TMJ radiographs (Fig *7A*) showed a large condyle and deep fossa on the right mandibularly deviated side. The two condyles were in different positions on occlusion but were at the crest of the articular eminence at 29.0 mm opening, moving the same amount from occlusion.

Functional findings (Fig 8A). Chewing muscle activity was diminished on the left side in the rest position after 30 minutes of myopulsing. This apparently caused the molars to elongate, resulting in the mandibular open rotation and the thinner ramus, with a smaller condyle and shallower fossa on the left.

It was apparent from these measurements that this skeletal Class III open bite malocclusion, with a combined retruded maxilla and a prognathic mandible, had been aggravated by functional and environmental factors, as well as genetics and aberrant developmental factors.

Treatment Plan

1. To move the maxilla downward and forward and distalize both the mandible and the mandibular arch as much as possible.
2. To establish a stable occlusion[3] by reconstructing the functional occlusal plane and reducing vertical occlusal disharmony by intruding and uprighting the mandibular molars and increasing the vertical height of the maxillary anterior alveolar process. The objective was to maintain the inclination and the vertical position of the mandibular incisors, because they were in a favorable inclination and average vertical position to make a well-balanced lip profile.

Fig 1. Facial changes from pretreatment to 10 years 10 months posttreatment. **A**, Pretreatment (14 years 7 months); **B**, posttreatment (16 years 10 months); **C**, 10 years 10 months posttreatment (27 years 8 months).

3. To create a wider tongue space and improve the airway, to eliminate the abnormal compensatory tongue activity.
4. To normalize chewing muscle activities, as well as tongue behavior by myofunctional training with gum chewing after upper labial and lower lingual frenectomies. A posttreatment flexible tooth positioner would aid in this endeavor.
5. To enlist the aid of an ENT specialist with regard to respiratory and epipharyngeal lymphoid proliferation problems.

Treatment

Active treatment was initiated with the Begg appliance with a maxillary protractor and a quadhelix expansion arch, in conjunction with anterior vertical and short Class III elastics. An upper labial frenectomy was also performed. After 6 months, the maxillary arch was expanded and mandibular deviation to the right as well as the open bite were reduced. A lingual frenectomy was performed, and tongue training with chewing gum was initiated. The tongue assumed normal posture within the upper arch after 1 month. To seat the occlusion, to increase the overbite, and to prevent the extrusion of the lower incisors, in the mandible, light arch wires were used with vertical elastics, together with the muscle training.

Total active treatment time was 27 months; a maxillary protractor was used for 22 months; and vertical and short Class III elastics were used in the anterior and premolar areas for 25 months. The retention period was 5 years with retainers and a tooth positioner. Tongue and chewing muscle myotherapy has been continued until the present.

The treatment and long-term follow-up results (from 16 years 10 months to 27 years 8 months) are apparent from the before and after illustrations.

Facial photographs (Fig 1*B* and *C*) showed a dramatic improvement in the frontal facial appearance, with a

Fig 2. Intraoral photographs and sagittal cross-section of the dental casts from pretreatment to 10 years 10 months posttreatment. **A**, Pretreatment (14 years 7 months); **B**, 6 months into active treatment (15 years 1 month); **C**, posttreatment (16 years 10 months); **D**, 3 years posttreatment (19 years 10 months); **E**,10 years 10 months posttreatment (27 years 8 months).

lengthened upper lip of 7.0 mm and much improved nasal contour and nares size; this continued to improve during the follow-up period resulting in enhanced nasal respiration. The tongue thrust, speech problems, allergic rhinitis, palatine tonsillar hypertropy, jaw muscle fatigue, and headaches resolved spontaneously. The patient became much more upbeat, reflected in the pleasing smile.

Intraoral photographs and the sagittal cross-section of the dental casts (Fig 2*C*, *D*, and *E*) showed a significant occlusal improvement with increased tongue space and Class I canine and molar relationship, with matched midline and a well-seated posterior occlusion. Both the maxillary and mandible arch forms were normal and stable. Later on (18 years 10 months) the patient developed TMD symptoms as a result of the occlusal interferences created by overerupted maxillary second molars as the upper third molars erupted, resulting in a decrease of the overjet and overbite of 1.0

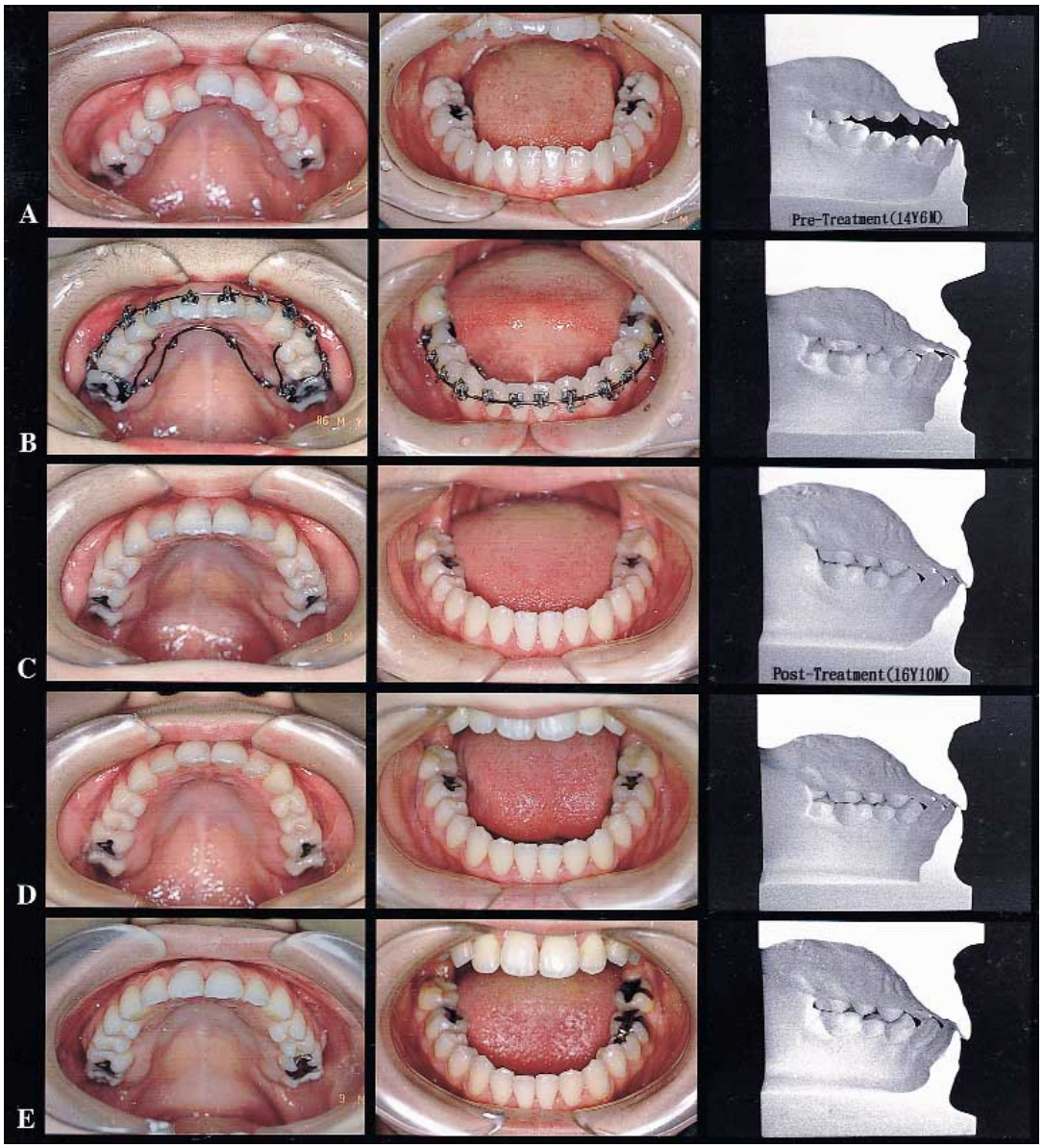

Fig 2 *cont'd.* Intraoral photographs and sagittal cross-section of the dental casts from pretreatment to 10 years 10 months posttreatment. **A**, Pretreatment (14 years 7 months); **B**, 6 months into active treatment (15 years 1 month); **C**, posttreatment (16 years 10 months); **D**, 3 years posttreatment (19 years 10 months); **E**,10 years 10 months posttreatment (27 years 8 months).

mm each. Both maxillary third molars were extracted. A tooth positioner was placed, and myofunctional exercises resumed with gum chewing. The patient has remained free of TMD to date and the overjet and overbite increased by 2.5 mm and 3.5 mm, respectively, as is evident from the sagittal cross section of the casts, taken 10 years and 10 months after treatment. The occlusion and arch form remained stable. Periodontal health and muscle function are excellent.

Analysis of dental casts (Table I) shows very large increases in the maxillary intercanine (ICL), and intermolar width (IMC) during treatment and minimal increase in these parameters for 10 years 10 months after treatment, while there has been little change in these dimensions in the mandibular arch during and after treatment.

Radiographically (Fig 3*B*, *C*, and *D*), all the roots are parallel, with no abnormality in the periodontium

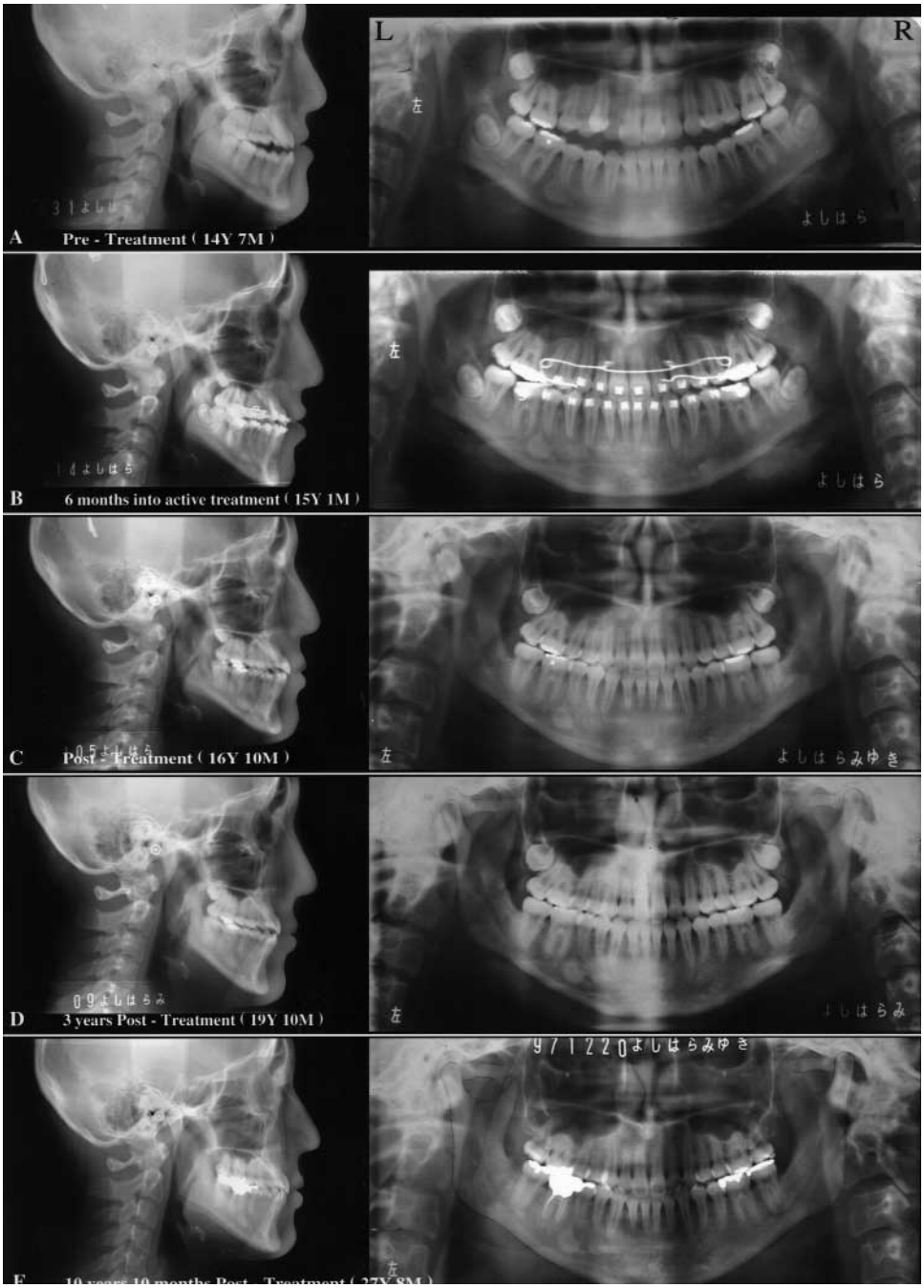

Fig 3. Comparison of lateral cephalograms and panoramic radiographs from pretreatment to 10 years 10 months posttreatment. **A**, Pretreatment (14 years 7 months); **B**, 6 months into active treatment (15 years 1 month); **C**, posttreatment (16 years 10 months); **D**, 3 years posttreatment (19 years 10 months); **E**, 10 years 10 months posttreatment (27 years 8 months).

or roots at 10 years 10 months after treatment. The distance increased from the apices of the maxillary incisors and the nasal floor increased significantly. Differences in condylar size and ramus length between right and left observed in pretreatment were reduced for the 10 years follow-up period.

Cephalometric analysis and the composite tracing findings (Fig 3*B*, *C*, *D*, and *E*, and Figs 4 and 5 and

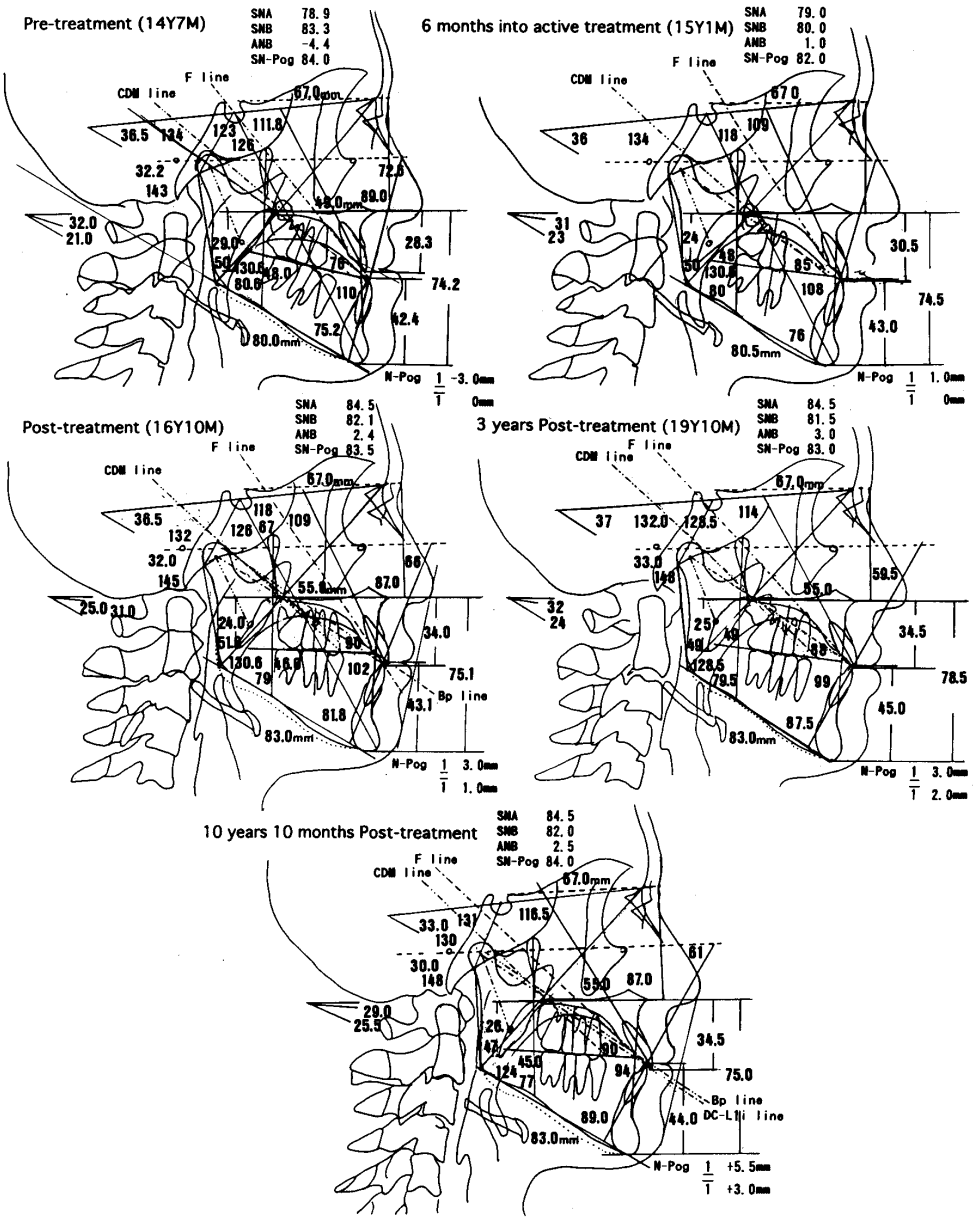

Fig 4. Tracing of cephalograms from pretreatment to 10 years 10 months posttreatment.

Table I) show a favorable downward and forward movement of both maxilla and maxillary arches and a small amount of distalization of both mandible and mandibular arches associated with uprighting and intruding of the mandibular posterior teeth, mostly during treatment. This established favorable anteroposterior and vertical skeletal occlusal relationships, with no extractions and no orthognathic surgery. As a result, A'-PTM' increased 6.7 mm and the ANB angle increased from –4.4° to +2.5°, with a significant increase in SNA angle from 78.9° to 84.5°. There was a slight decrease in the SNB angle of 1.2°. These readings were stable postretention. The SN to GoMe angle and Gonial angle also remained unchanged during treatment.

The functional occlusal plane moved down posteriorly 12.0° during treatment and remained unchanged for the 10 years 10 months follow-up. The long axes of maxillary and mandibular posterior teeth remained perpendicular to the functional occlusal plane.

During postretention, the maxillary incisors continued to tip labially 7.5° for the 10 years 10 months after treatment. Consequently, the axial inclination by 10 years follow-up was quite favorable. The mandibular incisors tipped labially 7.2°. As a result, the overjet and

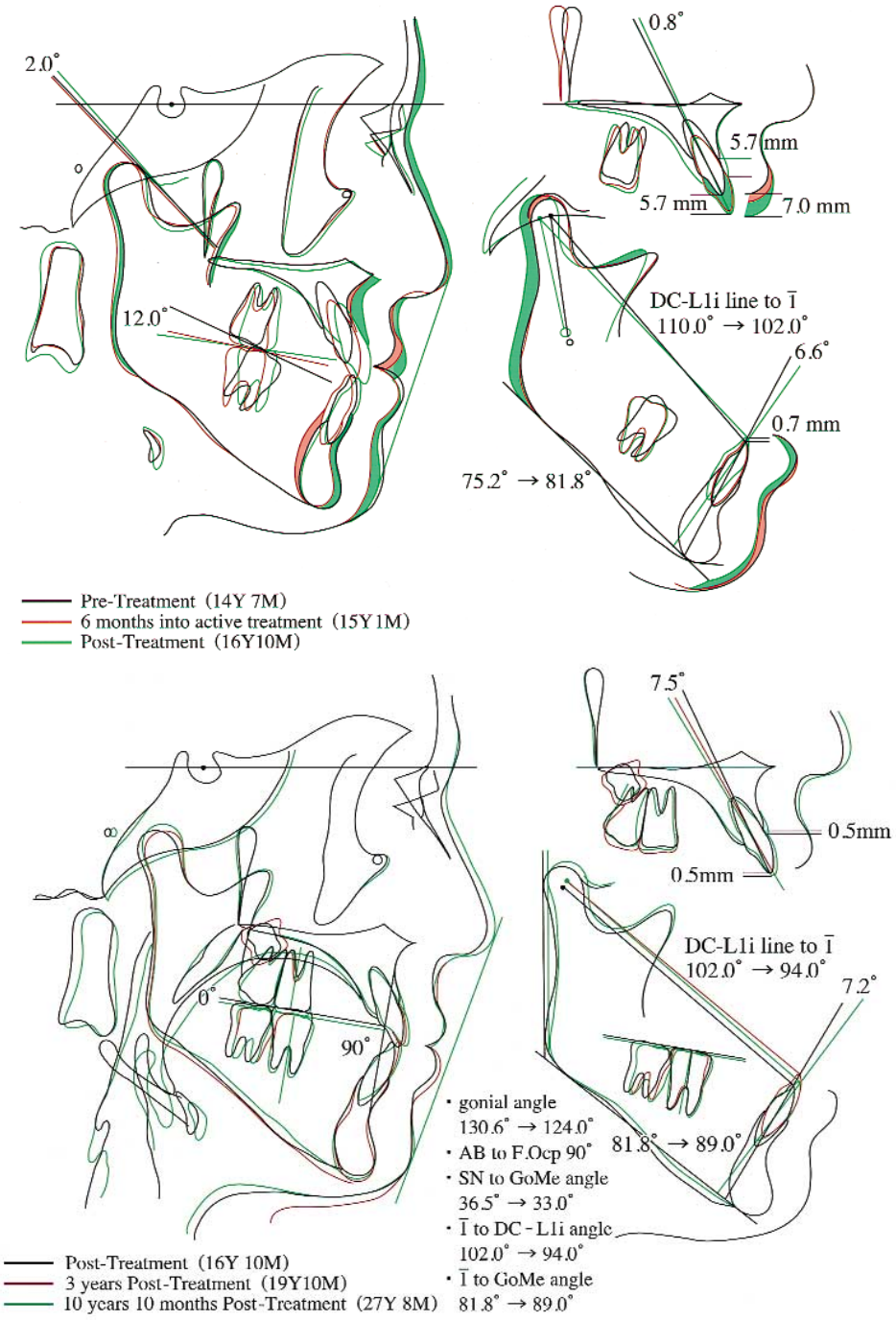

Fig 5. Composite tracings for studying pretreatment, 6 months into active treatment and posttreatment changes (on S-N at S, ANS-PNS at ANS, and GoMe at Gonion); composite tracings for studying pretreatment, posttreatment, 3 years posttreatment, and 10 years 10 months posttreatment changes (on S-N at S, ANS-PNS at ANS, and GoMe at Gonion).

overbite continued to increase until the Bp line[4] and DC-L1i line became parallel with each other, with the mandibular incisor axis nearly perpendicular to both lines by the 10-year follow-up period, creating a favorable vertical position and functional inclination of the mandibular incisors.

Frontal cephalometric findings (Fig 6B and D). Joint radiographic findings (Fig *7B* and *C*) show both

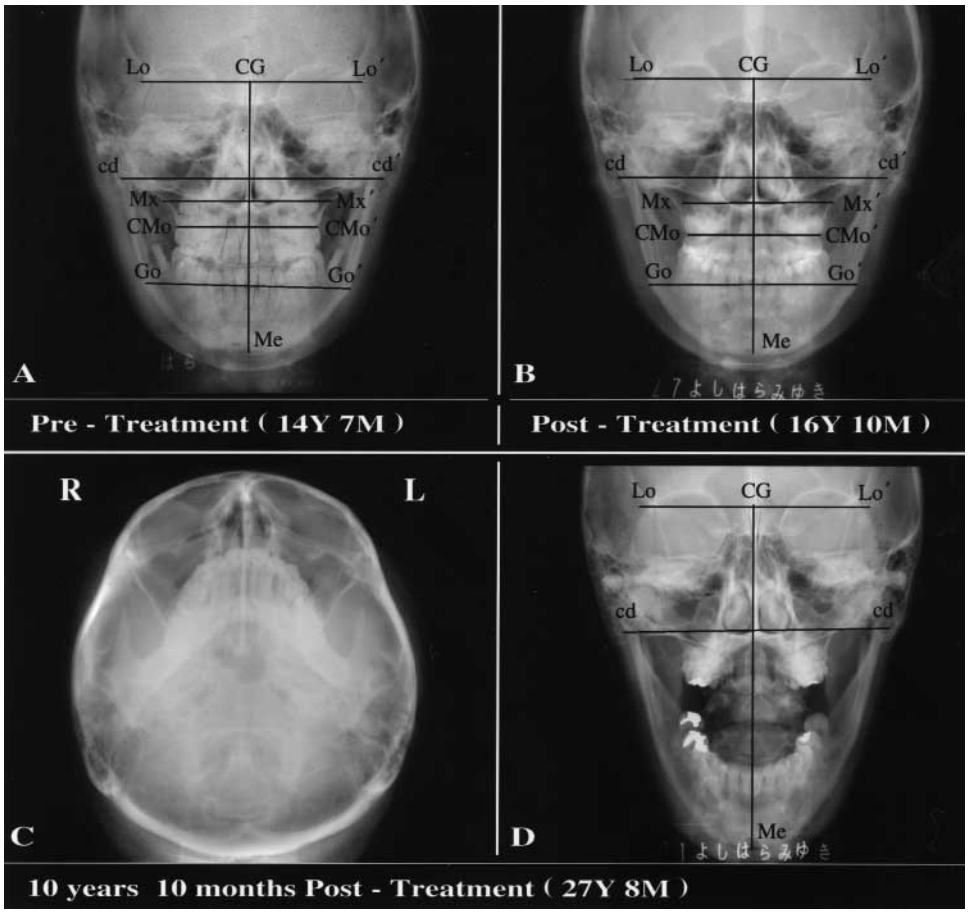

Fig 6. Comparison of posteroanterior cephalograms and axial cephalometric findings. **A**, Pretreatment (14 years 7 months); the mandibular deviated 4.0 mm to the right. A difference in vertical position between the right and left condyles. The ramus was shorter on the left. The maxillary protractor teeth were lingually inclined. **B**, Posttreatment (16 years 10 months). **C** and **D**, 10 years 10 months posttreatment (27 years 8 months). The differences in height of cd and Go between right and left were reduced as the mandibular deviation improved, resulting the upper and lower midlines and Me coincided with the facial symmetry. Adequate buccolingual torque of the both upper and lower posterior teeth was achieved.

condyles in comparable positions in the articular fossae, both on occlusion and wide open, indicating that normal function had been attained by 10 years 10 months posttreatment.

Electromyographically (Fig 8*C*), the masseter and temporalis muscles achieved good bilateral balance by 10 years 10 months posttreatment. It is postulated that the decrease of the SN-GoMe angle and the Gonial angle of 3.5° and 6.6°, respectively, were associated with normalization of jaw movement and chewing muscle activities.

CASE 2

A Japanese girl aged 17 years 3 months with skeletal Class III open bite sought treatment. She also was psychologically unstable, had slurred speech, TMD pain, and sporadic trismus and migraine. She was strongly motivated by these problems, more than the unfavorable esthetics and was opposed to any surgery.

Diagnosis

Facial findings (Fig 9A). This patient had an asymmetric face with a severe long lower face height and poor head posture. Hyperactive mentalis muscle action was evident. The midface was recessed.

Intraoral findings (Fig 10A). The molars were Class III with an open bite in the premolar and anterior segments and a negative overbite and overjet of 2.0 mm each. Mandibular molars were overerupted and mesiolingually inclined. The maxillary

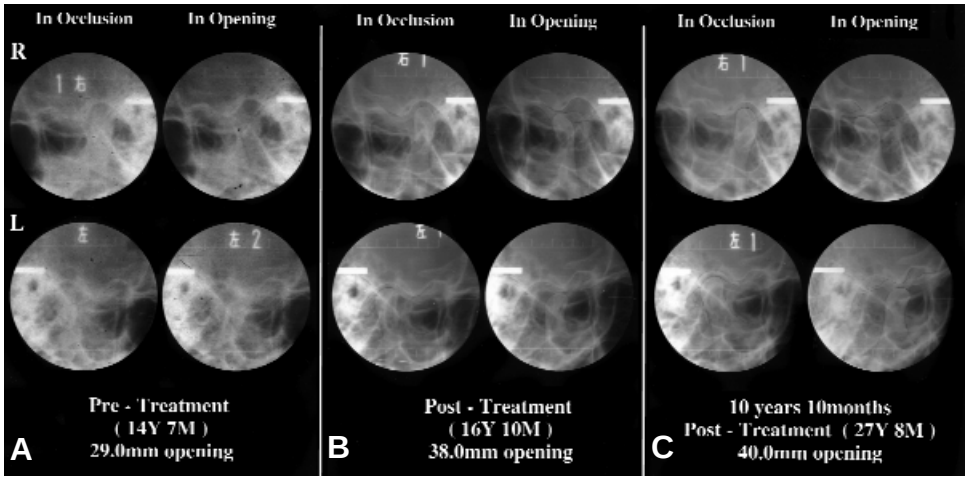

Fig 7. Comparison of joint radiographs at pretreatment, posttreatment, and 10 years 10 months posttreatment. (These radiographs of the joints were taken with Model Tx-90 made by Asahi Roentgen Co. The angle of X-ray beam was directed at 0° laterally and 17° superiorly.)

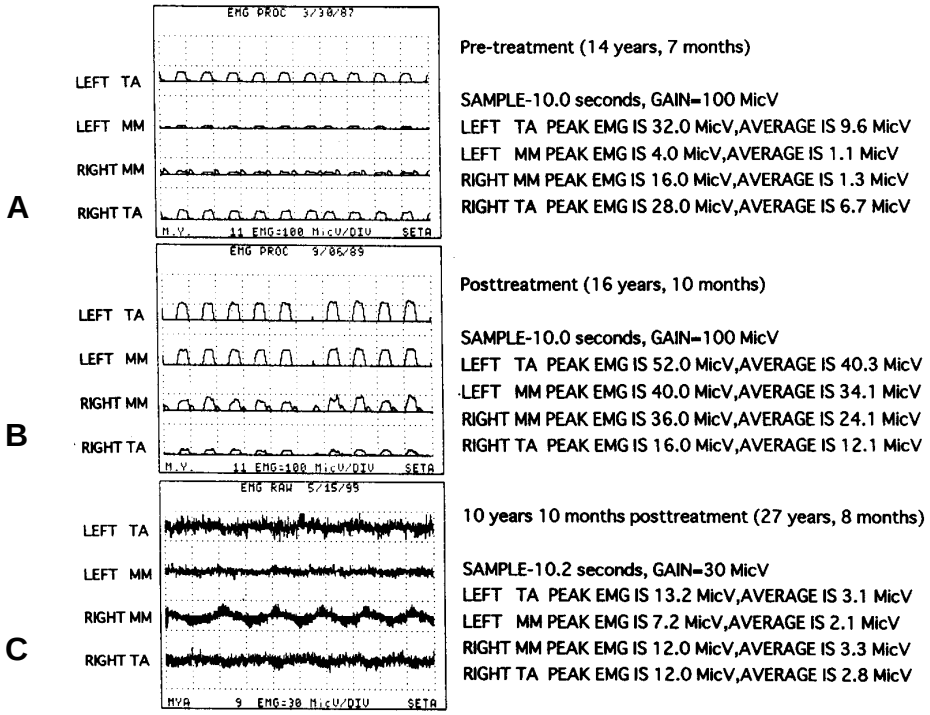

Fig 8. EMG findings of pretreatment, posttreatment and 10 years 10 months posttreatment. (K6 Diagnostic system)

arch was severely constricted with lingually blocked out lateral incisors, causing cross bite in the molars and occlusal interference. The mandible deviated to the right, both on occlusion and on maximum opening of 29.0 mm. The TMJ clicking occurred in both joints at an early stage of opening. The tongue was not able to position within the upper arch because of a short lingual frenum attachment (ie, partial tongue-tie), causing a narrow maxillary arch, severe abnormal tongue behavior, and poor articulation. Heavy tetracycline stain compromised the anterior teeth cosmetically.

Table II. Cephalometric analysis of case 2

Angular measurements (degrees) (sex, female)

Variable	*Sella angle*	*Articular angle*	*SNA*	*SNB*	*ANB*	*GoA*	*SN | GoMe*	*SN | Pog*	*PalP | GoMe*
Pretreatment 28.0 (17 yrs 3 mo)	121.0	158.0	76.5	76.5	0.0	135.0	58.5	75.0	45.0
15 months into active treatment 33.0 (18 yrs 6 mo)	121.0	158.0	77.0	75.0	2.0	135.0	58.0	74.5	45.0
Posttreatment 35.5 (19 yrs 1 mo)	121.0	158.0	78.5	75.5	3.0	135.0	58.0	75.0	45.0
5 years posttreatment 33.5 (24 yrs 1 mo)	121.0	158.0	78.5	75.5	3.0	135.0	58.0	75.5	45.0
Control adult mean			81.5	78.2	3.2		34.5	78.2	24.6
constant									
SD			3.29	4.02	2.38		6.05	3.93	3.90

Linear measurements (mm)

Variable *Wits*	*Se-N*	*N-Me*	*A' | PTM'*	*PalP | Me*	*Go | Me*	*cd | Go*	*S | Go*	*1 | PalP*	*$\overline{1}$ | Me*
Pretreatment –23.5 (17 yrs 3 mo)	55.0	144.0	41.0	85.0	78.0	54.0	76.0	36.0	47.0
15 months into active –9.0 treatment (18 yrs 6 mo)	55.0	144.0	42.0	85.0	78.0	54.5	76.0	38.5	47.5

Radiographic findings (Fig 11A). All permanent teeth were present, except the maxillary left second premolar because of a retained deciduous molar. There was severe mesial inclination of both the maxillary and mandibular posterior teeth. Both rami were short with strong antegonial notching.

Cephalometric findings (Figs 11A, 12, and Table II. The occiput and CV1 were in contact, with a severely proclined cervical spine. The cranial baseline length (S-Ar) was extremely short with a large posterior angle of 141.0°. The anteroposterior dimension of the maxilla (A' to PTM') was shorter, with both the SNA angle and SNB angle at 76.5°, and the ANB difference of 0.0°, indicating that both the maxilla and mandible were retropositioned in relation to the cranium. An excessive anterior facial height (S-Go/N-Me × 100 = 52.%) was associated with a steep mandibular angle with SN to GoMe angle of 58.5°. A palatal plane to GoMe angle of 45.0° and a Gonial angle of 135.0° indicated that the mandible was severely rotated open. Both maxillary and mandibular incisors were mildly lingually inclined with upper 1 to SN angle at 98.5°, lower 1 to GoMe angle at 71.5°. The Wits appraisal was –23.5 mm.

Frontal cephalometric findings (see Fig 13A). TMJ radiography (Fig 14*A*) showed differences in size and shape between right and left condyles and an overly large ramus on the right side, with mandibular deviation to the same side. Differences were observed in the 2 condylar positions in occlusion and in maximum opening of 29.0 mm, indicating abnormal jaw movement and unstable mandibular position. An anterior displacement of the right joint was suspected from these findings.

Functional findings (Fig 15A). Disharmony of the chewing muscles activity between right and left and masseter muscles was noted, with less activity on the left side in rest position after 30 minutes of myopulsing. It appeared that the mandibular deviation to the right side was compensated by the muscles during habitual occlusion.

FOcp | *GoMe*	*SeN* | *PalP*	*FOcp* | *AB*	*1* - *1*	*1* | *SN*	*1* | *GoMe*	*SN* | *CDM line*	*SN* | *F line*	*1* | *DC-Ll1 line*	*1* | *BP line*	*FOcp* | *CDM line*
18.0	81.0	65.0	131.0	98.5	71.5	111.0	115.5	101.5	96.0	
28.0	81.0	70.0	130.0	99.0	72.0	111.0	116.0	99.0	94.0	
29.0	81.0	80.0	131.0	98.0	76.0	111.0	109.0	94.0	93.0	
29.0	81.0	78.0	121.5	104.5	76.5	112.5	112.0	93.0	90.0	
13.2	(85.0)	(90.0)	124.2	106.0	95.2			(90.0)	(90.0)	
3.70		*SG*/*NMe*%	8.75	7.49	6.18					

1 | *N-Pog*	*1* | *N-Pog*		*Cast analysis* *Maxilla* *ICL*	*IML*	*AAL*	*Mandibular* *ICL*	*IML*	*AAL*	*OJ*	*OB*
8.0	10.0	52.7	20.5	30.5	14.5	20.5	36.5	15.5	–2.0	–2.0
10.0	10.0	52.7	25.8	31.4	17.5	22.0	37.0	27.5	0.5	1.0

From these findings, this skeletal Class III open bite malocclusion with TMJ symptoms has been aggravated by functional and environment factors, as well as growth, development, and genetic factors.

Treatment Plan

Early interceptive therapy was needed in this type of a psychologically unstable patient with mandibular dysfunction. Hence the treatment plan is as follows:

1. To use a maxillary expansion plate as the first step to eliminate occlusal interferences and to correct mandibular functional deviation.
2. To establish a stable occlusion by reconstructing the functional occlusal plane, distalizing the mandibular arch, and improving the vertical occlusal disharmony by intruding and uprighting the mandibular posterior teeth, keeping the vertical position of the mandibular incisors that were in an average vertical position.
3. To normalize chewing muscle activities and tongue behavior through myofunctional training with gum chewing after a lingual frenectomy for the tongue tie; a tooth positioner will be used for retention to maintain the good health of the periodontium, assisted by gingival finger massage and proper prophylaxis.
4. To improve the poor head posture and cervical spine by physiotherapy in an orthopedic hospital.
5. To establish a normal psychologic profile.

A decision was made to treat the case by nonextraction and nonsurgery using the Alexander technique and maxillary expansion plate.

Treatment

A maxillary Alexander appliance was placed with a palatal expansion plate. When the molar cross bite was almost eliminated after 2 months, a mandibular Alexander appliance was added and vertical elastics (3/16 inch) in the canine and anterior area were used with the palatal expansion plate.

Fifteen months after the start of treatment (Fig 10*B*), mandibular deviation in opening and closing was

Fig 9. Facial changes from pretreatment to 5 years posttreatment. **A,** Pretreatment (17 years 3 months); **B,** posttreatment (19 years 1 month); **C,** 5 years posttreatment (24 years 1 month).

reduced. An increase in the amount of opening to 38.0 mm was coincident with disappearance of the TMJ symptoms and migraine headache. Ideal arch wires (0.018×0.022 inches) were kept in place for the following 6 months to obtain harmony between the occlusion, the tongue, and the perioral muscles and to retain the expanded maxillary arch form. For the first 4 months, vertical elastics were worn in the canine, anterior, and premolar areas, and the patient was encouraged to do as much chewing and muscle training as possible. For the last 2 months, elastics were discontinued, but myofunctional therapy and gum chewing were maintained. The appliance was removed only after confirming that a very stable occlusion had been achieved, with no recurrent tongue thrust and TMD. Total active treatment time was 22 months; 3 maxillary expansion plates were used for 16 months and vertical elastics were used in the anterior and premolar areas for 20 months. The retention period was 5 years with retainers, and a tooth positioner and tongue and chewing muscles training with gum chewing were continued.

Treatment and Follow-up Results (from 19 years 1 month to 24 years 1 month)

Facial photographs (Fig 9*B* and *C*) show a facial expression full of self-confidence; the pleasing smile showed the patient satisfaction with the treatment result. The migraine, tinnitus, dizziness, and TMJ symptoms disappeared, and the tongue thrust and speech dysfunction were resolved spontaneously as occlusal improvement, widening upper arch, clearing airway for normal breathing, and normalizing head posture occurred.

Intraoral photographs and sagittal cross-sections of the dental casts (Fig 10*B*, *C*, and *D*) showed a significant occlusal improvement with widened tongue space and Class I canines and molar relationship, with matched midline and well-seated canines and posterior teeth. The overjet and overbite were

Fig 10. Intraoral photographs and sagittal cross-section of the dental casts from pretreatment to 5 years posttreatment. **A**, Pretreatment (17 years 3 months); **B**, 8 months into active treatment (17 years 11 months); **C**, posttreatment (19 years 1 month); **D**, 5 years posttreatment (24 years 1 month).

2.0 mm each. Both maxillary and mandibular arch forms were quite stable. Adequate buccolingual torque of both the upper and lower posterior teeth was achieved.

As in the first case, the patient later developed mild TMD symptoms. These apparently also resulted from the occlusal interferences created by the effect of erupting third molars on the second molar teeth, creating prematurities in this area. This is an important observation for all treated patients, supporting the concept of long-term posttreatment observation. A decision was made to extract both maxillary second molars with dental caries and replace them with the third molars as their morphology appeared almost normal. The patient has remained free of TMD to date. The occlusion has remained extremely stable with normal function for the follow-up period of 5 years; the overjet and overbite increased to 3.0 mm each during this time as is evident on the sagittal cross-section of the dental casts. The periodontal health has been well-maintained.

Analysis of dental casts (Table II) show significant maxillary intercanine (ICL) and intermolar width (IMC) increase during treatment and almost no change in these parameters for 5 years posttreatment. There is little change in ICL and IMC and in the mandible during and after treatment.

Radiographically (Fig 11*B*, *C*, and *D*), all the roots were parallel with no abnormality 5 years after treatment. The differences in size and shape of condyle and ramus between right and left have been reduced during the 5 year follow-up period.

Cephalometric analysis and the composite tracing findings (Fig 11*B*, *C*, and *D*, Fig 12, and Table II) show

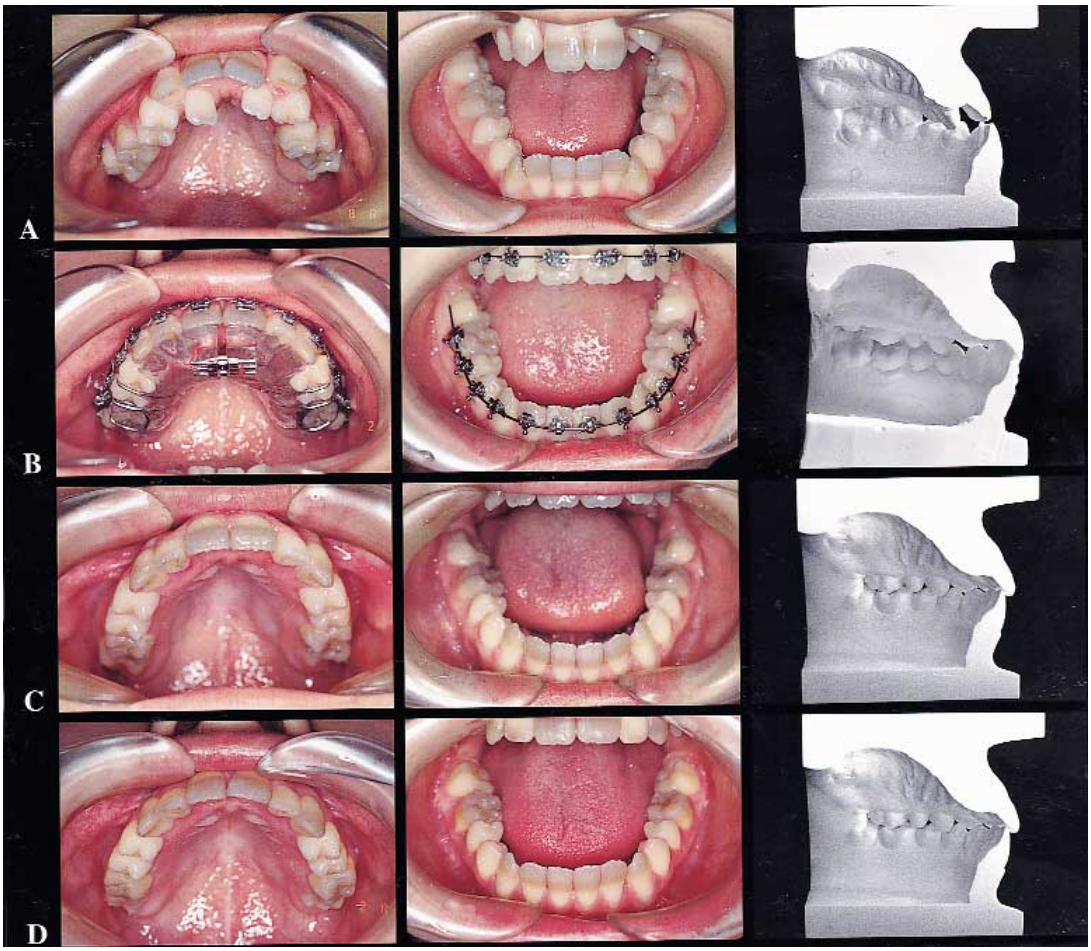

Fig 10. cont'd

a downward and forward movement of the maxilla and a small amount of distalization of both the mandible and the mandibular arch, associated with uprighting and intruding of the mandibular posterior teeth, creating a good occlusal relationship, with no extraction and with no surgical therapy. As a result, the ANB angle increased 3.0°, with an increase in SNA angle of 2.0°, and a little decrease in the SNB angle of 1.0° during and after treatment. The SN to GoMe angle, Gonial angle and palatal plane to GoMe angle and the posterior to anterior facial height ratio were almost unchanged for 5 years posttreatment. The maxillary anterior alveolar process and incisal margin moved down 3.0 mm, and the mandibular incisal edge ($\overline{1}$ to Me) increased only 1.0 mm vertically during treatment, creating a normal overbite and overjet of 2.0 mm.

The functional occlusal plane moved down posteriorly 11.0°, with an increased palatal plane to GoMe angle of 11.0° during treatment, which remained unchanged for 5 years. Thus the long axes of maxillary and mandibular posterior teeth became perpendicular to the functional occlusal plane. During retention, as in Case 1, the maxillary incisors continued to tip labially 6.5°, while the 1 to GoMe angle and 1 to DC-L1i line angle changed only 0.5° and 1.0°, respectively, for 5 years posttreatment, indicating a stable inclination and vertical position of the lower incisors. As in Case 1, a favorable functional situation existed for the upper and lower incisors.

Frontal cephalometric findings (Fig 13). TMJ radiographs (Fig 14*B*) showed that the differences in size and shape of right and left condyles and rami were reduced; both condyles were more mobile and were equal in position posttreatment on habitual occlusion and maximum opening emulating Case 1. This suggests that normal joint function was achieved as a result of occlusal improvement and normalized facial and tongue muscle behavior.

Electromyographically (Fig 15), the chewing muscles achieved good bilateral balance and almost nor-

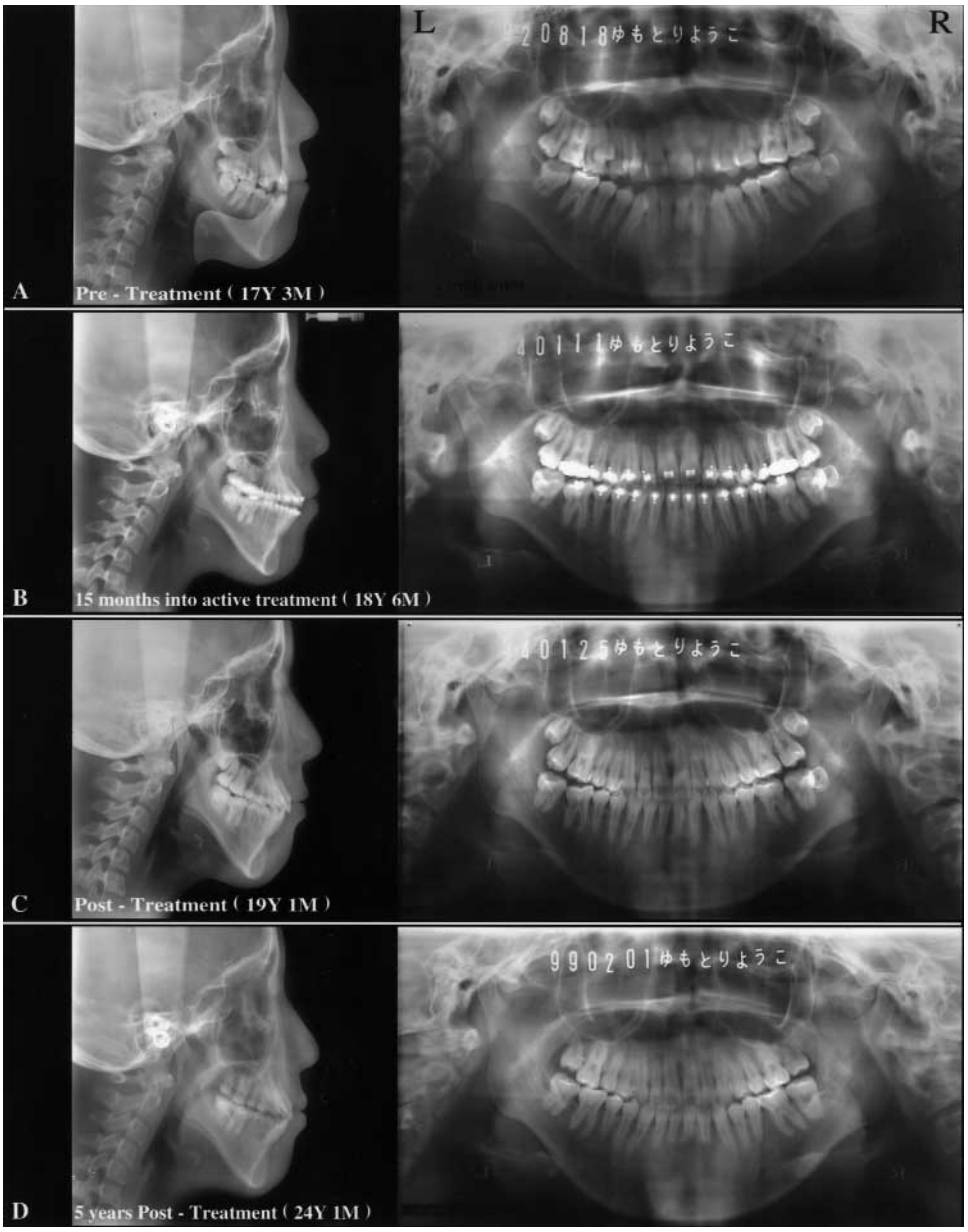

Fig 11. Comparison of lateral cephalograms and panoramic radiographs from pretreatment to 5 years posttreatment. **A**, Pretreatment (17 years 3 months); **B**, 15 months into active treatment (18 years 6 months); **C**, posttreatment (19 years 1 month); **D**, 5 years posttreatment (24 years 1 month).

malized in the rest position after 30 minutes of myopulsing in the 5 years posttreatment record.

DISCUSSION

Graber[5,6] stresses that it is important to normalize the activities of the perioral muscles because the growth, morphology, function, and action of these muscles have significant long-term effects on the overall skeletal development, as well as the position and direction of growth of the jaw and teeth. These cases illustrate this axiom and the importance of long-term observation and interception if need be. General orthopedics follows this dictum; why not dentofacial orthopedics? As Graber stresses, more attention must be paid to head posture, respiration, and abnormal habits that can mitigate against the final result. Constant, vigorous gum chewing during and after treatment, as well as use of a tooth positioner after treatment, stimulate normal

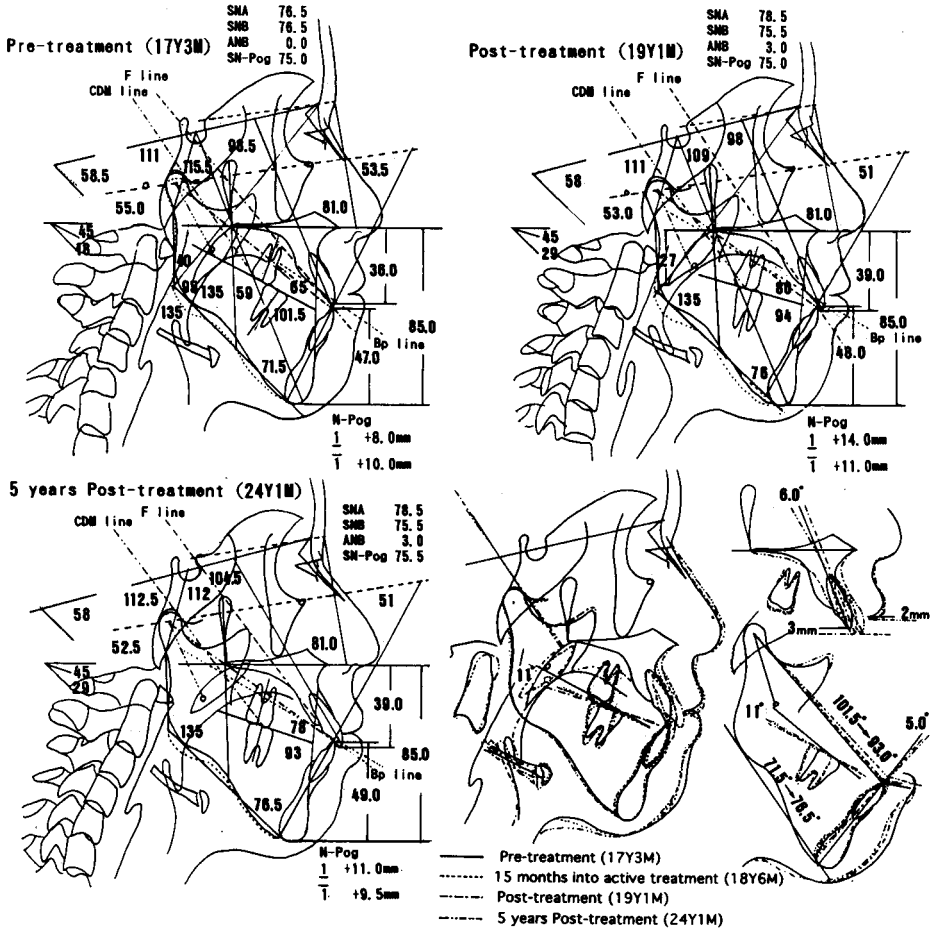

Fig 12. Tracing of cephalograms from pretreatment to 5 years posttreatment and composite tracings for studying pretreatment, 15 months into active treatment, posttreatment and 5 years posttreatment (on S-N at S, ANS-PNS at ANS, and GoMe at Gonion).

function. Furthermore, by favorably influencing subsequent mandibular growth and TMJ adaptation, almost symmetric joint structures and optimal muscle activity have been attained. Posttreatment occlusal interferences can occur with the eruption of third molars, possibly creating TMD. As Graber says, patients should be followed through this period by the orthodontist. Only the orthodontist has the broad knowledge and experience in guiding dentofacial growth and development (Figs 5 and 11). Van der Linden[7] indicates that the stable intercuspation of posterior teeth favorably affects anteroposterior growth of the maxilla and mandible, both early and late.

These cases illustrate the fact that a large percentage of Class III malocclusions are the result of maxillary deficiency. It is important to prevent extrusion of the lower anterior teeth and to accomplish a normal overbite as much as possible through a downward movement of the upper alveolar process, with little change in vertical height of the symphysis, contributing to the excellent improvement of the vertical occlusal relationship of the jaws, creating a well-balanced lip profile as shown in the patient of case 1.

The tongue posture and function are overlooked too often in treating Class III problems. These cases illustrate the importance of normalizing attachments and enhancing normal posture and function, along with orthodontic therapy. The salutary effect of the lingual frenectomy is clearly evident in both cases.

Myofunctional therapy, particularly gum chewing, a neglected regimen, can make an important contribution to establishment and maintenance of normal function and balance. The patients had 5 years of extensive chewing muscle and tongue training with chewing gum. The resulting SN-GoMe angle and Gonial angle continued to decrease while the overjet

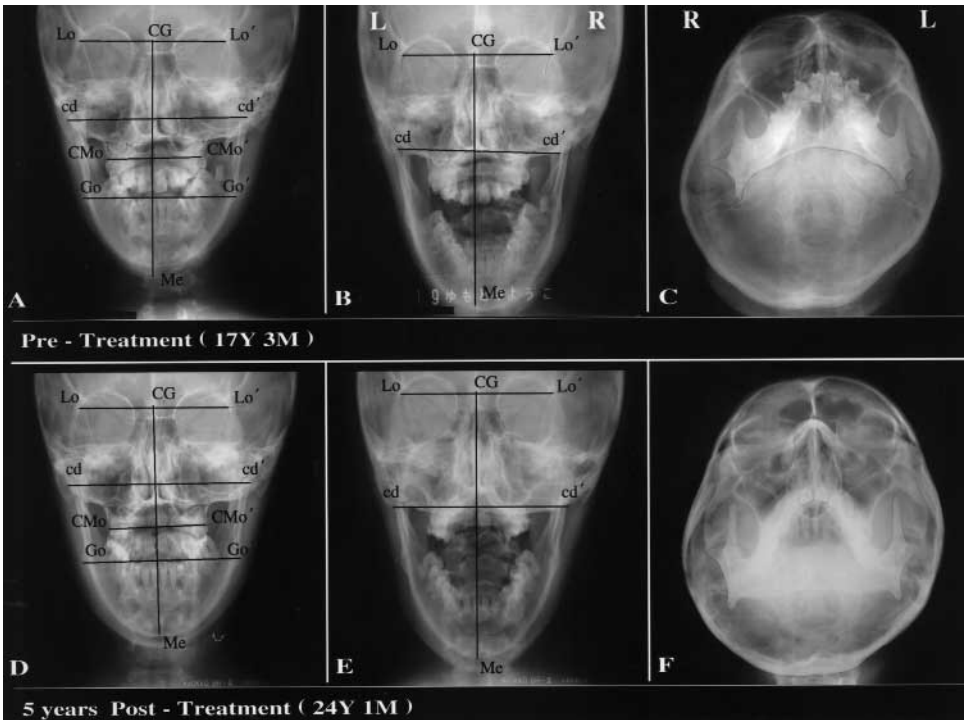

Fig 13. Comparison of posteroanterior cephalograms and axial cephalometric findings at pretreatment and 5 years posttreatment. **A**-**C**, Pretreatment (17 years 3 months): mandibular deviated to the right both in occlusion and in maximum opening of 29.0 mm; maxillary posterior teeth were severely lingually inclined. Difference shape between left and right in the both occipital and temporal bones. **D**-**F**, 5 years posttreatment (24 years 1 month): Mandible that deviated to the right both in occlusion and in opening pretreatment was improved, which resulted in the upper and lower midlines and Me coinciding with the facial symmetry. The lower arch form was lined up along the flew line with adequate buccolingual torque; cranial asymmetry in the occipital and temporal bone still remained.

and overbite increased with labial tipping of the upper incisors until the mandibular incisal edges approached the inflection point (Bp) (Fig 5). This created normal overjet and overbite and provided proper incisal guidance, while allowing freedom of mandibular movement in all directions. As the great anatomist Harry Sicher said, "Whenever there is a struggle between muscle and bone, bone yields!"

CONCLUSION

In the two cases presented here, which were originally classified as surgical cases, successful treatment was obtained by nonextraction orthodontic treatment, with attention to the skeletal demands and neuromuscular challenges while maintaining long-term occlusal stability.

The following factors may have contributed to long-term occlusal stability:

1. Creation of a favorable perioral environment with normalized tongue space, posture, and function and normal perioral muscle activity, as well as normal breathing. These were assisted by a widening of the tongue space and myofunctional therapy including actual daily use of sugarfree chewing gum.
2. Results were achieved despite ignoring orthognathic, surgical, and tooth sacrifice recommendations. Three-dimensional improvement produced a favorable inclination of both upper and lower incisors and a stable mandibular position in balance with the intraoral and extraoral musculature, which produced normal morphology and function of the TMJs.
3. A tight intercuspation was established, with proper contact point alignment in three dimensions, and produced an optimal occlusal functional plane that became perpendicular to the axes of both upper and lower posterior teeth, resulting in an increase of posterior occlusal support with minimal and balanced loading of the TMJs.
4. The upper incisor crowns continued to incline labially until the F line and CDM line became parallel to each other and the long axes of the mandibular incisors became perpendicular to Bp line, providing proper incisal guidance and freedom of mandibular movement in all directions.

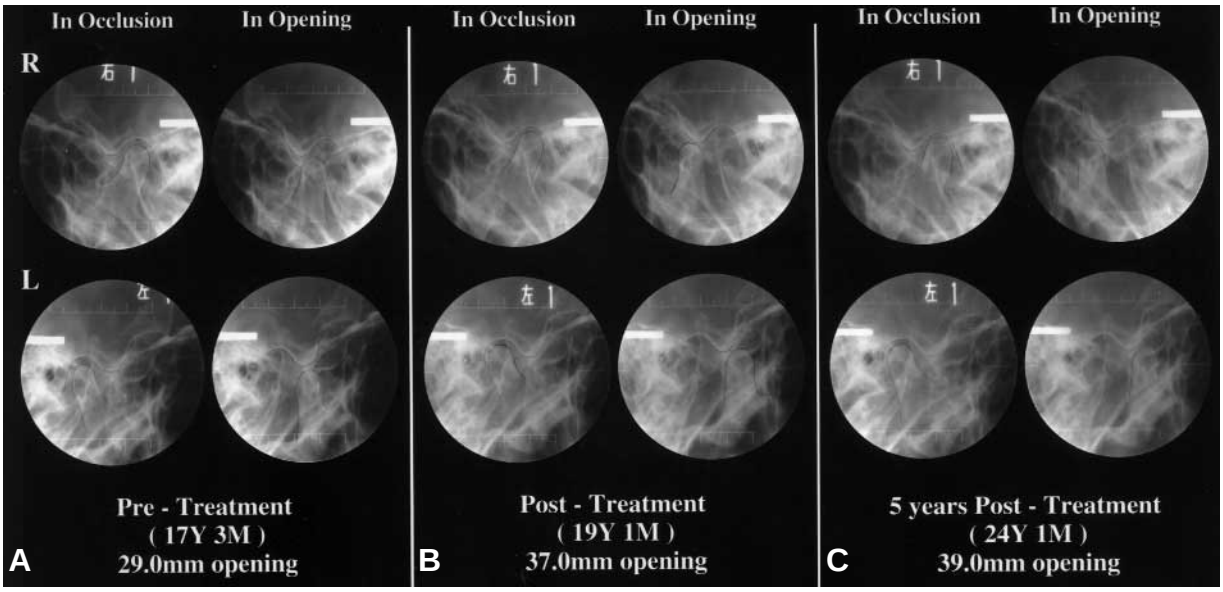

Fig 14. Comparison of joint radiographs at pretreatment, posttreatment, and 5 years posttreatment. (These radiographs of the joints were taken with Model Tx-90 made by Asahi Roentgen Co. The angle of x-ray beam were directed at 0° laterally and 17° superiorly.

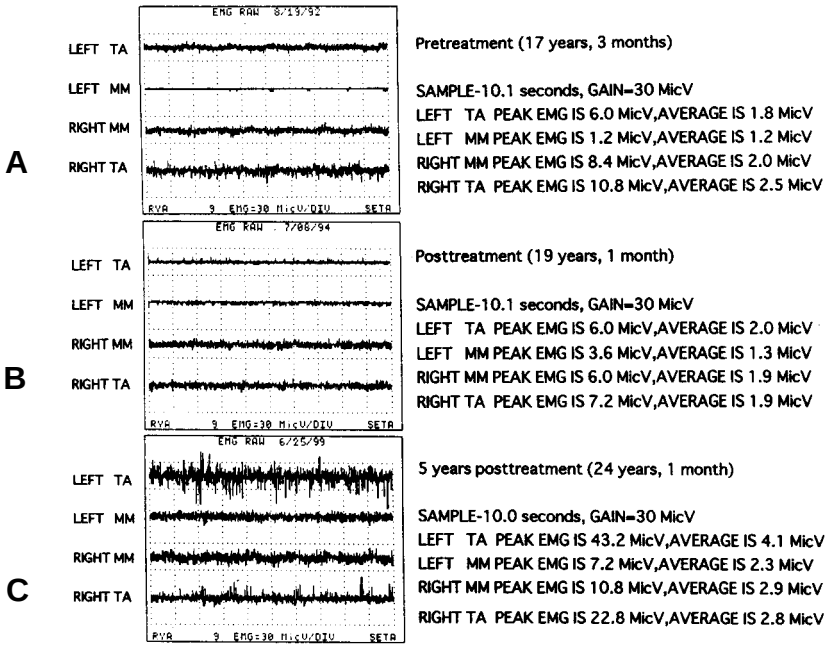

Fig 15. EMG findings of pretreatment, posttreatment, and 5 years posttreatment (K6 Diagnostic system).

5. Periodontal health was not only maintained, but improved long term by providing an optimal morphologic and functional environment, assisted by intraoral and extraoral myofunctional therapy.
6. Temporomandibular problems were solved by establishment of optimal functional loading and elimination of prematurities.
7. Psychosocial impairment was eliminated during the critical "teenage years," strengthening the rapport between the patient and orthodontist, and producing

maximum compliance for a demanding exercise regimen, not only during active treatment but 10 years beyond!

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REFERENCES

1. Begg PR, Kesling PC. Begg orthodontic theory and technique. Philadelphia: WB Saunders; 1977.
2. Alexander RG. The Alexander discipline. Orange, CA: Ormco Co; 1986.
3. Kondo E. Occlusal stability in Class II, Division 1, deep bite cases followed up for many years after orthodontic treatment. Am J Orthod Dentofacial Orthop 1998;114:611-30.
4. Kubein-Meesenburg D, Nagerl H. Biomechanical aspects of stability of occlusion: retention and stability in orthodontics. Philadelphia: WB Saunders; 1993. p. 171-202.
5. Graber TM. Orthodontics principles and practice. Philadelphia: WB Saunders; 1966. p. 249-325.
6. Graber TM. Dentofacial orthopedics with functional appliances. St Louis: Mosby; 1997. p. 3-12.
7. Van der Linden FG (translated by Miura F, Kuroda T). Facial growth and facial orthodontics. Tokyo: Quintessence; 1988. p. 58,215.