



CASE REPORT — THE COURSE OF TREATMENT OF A CLASS III SKELETAL OPEN BITE CASE AND ITS ANALYSIS

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Key Words

- * Skeletal Class III Openbite
- * Nonextraction
- * Nonsurgery
- * Maxillary alveolar process downward
- * Force system
- * Protractor
- * Short Class III elastics
- * abnormal perioral environment

Introduction

The deterioration of skeletal Class III open bite conditions is reported to occur when the upper and lower second molars start to come into occlusion or when the upper and lower third molars are erupting¹⁾.

It is also reported that the mandible grows twice as much vertically as anteroposteriorly in both males and females from twelve to twenty years age²⁾. This period coincides with the time when the upper and lower second molars start to come into occlusion and when the upper and lower third molars begin to erupt. It is said that if one has an abnormal perioral environment due to nasopharyngeal disease, enlarged palatine tonsils, adenoids and abnormal lingual frenum attachment during this period of rapid vertical mandibular growth, these factors interact in a complex way, giving rise to such problems as disturbed nasal breathing, constant anterior placement of the tongue to secure an airway, mouth-breathing tendency and backward rotation of the mandible³⁾. If this is accompanied by a large amount of vertical mandibular growth during this period, the upper and lower second molars would elongate vertically, causing lower facial height and occlusal vertical dimension to increase⁴⁾. As a result, a dental malocclusion may develop into a skeletal problem, and a skeletal problem may become more severe with growth and development. For these reasons, skeletal Class III open bite is thought to be aggravated by the perioral soft tissue environment during the time when the second molars come into occlusion or when the third molars erupt⁵⁾. Therefore, it is considered important to treat nasopharyngeal disease and to establish a favourable perioral soft tissue environment in treating skeletal

Class III open bite, in addition to the improvement of anteroposterior and vertical occlusal disharmonies of the upper and lower jaws.

Anteroposterior and vertical occlusal disharmonies are often so pronounced in skeletal Class III open bite cases that it may be difficult to achieve a good occlusal improvement only by orthodontic means and to obtain a stable occlusion after treatment. Because of these difficulties, orthognathic surgery is often combined with orthodontic treatment for occlusal improvement, and good results are generally obtained after surgery. However, if time factors are set aside, some of these cases seem to be treatable without surgery by orthodontically eliminating those factors causing anteroposterior and vertical occlusal disharmonies of the jaws.

The author has successfully treated a female skeletal Class III open bite patient aged 14 years 7 months at the start of treatment, who was classified as a surgery case according to Valko's criteria⁶⁾ by creating a favourable perioral environment including the tongue, bringing the maxilla forward and downward and the mandible backward, moving the maxillary alveolar process downward, and intruding and uprighting the molars. Her occlusion has remained stable after treatment. This skeletal Class III open bite case will be presented in this paper, and the diagnosis, treatment forecasts, treatment plan, course of treatment and retention will be discussed.

II. Case: skeletal Class III open bite

Age at initial visit: 14Y5M
Sex: female

Age at the start of treatment:
14Y7M

Active treatment time: 27 months

Retention time: 34 months

1) Case analysis and diagnosis

a) General findings

- Chief complaint: Chewing and speech disturbance due to open bite and aesthetic problems.

- Case history: The patient began to notice her open bite during the last couple of years in primary school, experiencing difficulties chewing with the front teeth and pronouncing some syllables clearly. Her open bite became more pronounced when she was in junior high school, causing fatigue of the jaw and headache after long hours of talking. Conversing with others became a stress because of unclear pronunciation.

- Family history: The patient is the second eldest of three sisters. Her elder sister had a crossbite, while her younger sister had a crossbite with a constricted upper arch, very similar to the problems the patient had when she was younger (Fig. 1). Her mother had an edge-to-edge bite with tongue habits. It appeared that the children had inherited the crossbite from their mother.

- Facial findings: The patient had a slight asymmetry in the frontal view with the mandible deviating to the right, a concave profile with a



Fig. 1. Left: intraoral photograph of the patient's younger sister (8Y0M). Right: the patient's intraoral photograph at her initial visit (14Y5M). According to their mother, the patient's tooth alignment at her younger ages was very similar to her younger sister's, and her open bite became more noticeable in the last couple of years in primary school with incorrect pronunciations. From the mother's observations, it seems that her open bite condition deteriorated when the second molars began to come in occlusion.



Fig. 2. Facial photographs at her initial visit (14Y5M).



Fig. 3. (Upper row) In occlusion: the mandible deviates 4mm to the right. (Bottom row) In opening: upper and lower midlines coincide. Intraoral photographs and OPG at initial visit (14Y5M). Though the mandible deviates to the right in occlusion. The upper and lower midlines almost coincide in opening. The lower molars are mesially inclined.

pronounced protrusion of the chin, and a long face. Both upper and lower lips were strained in closing.

b) **Intraoral and occlusal findings** (Fig. 3)

The patient had abnormal upper labial and lingual frenum attachments. Both upper and lower second molars had erupted. There were no missing teeth. The upper left cuspid was high and labially blocked out with no available space for the tooth to erupt in the arch. Both cuspid and molar relationships were Angle Class III. The upper arch was constricted. Molars were the only teeth in occlusion, and the bite was open in the premolar and anterior areas. Her overjet was -2.0mm and overbite -2.0mm.

c) **Functional findings** (Fig. 3)

The patient had severe tongue habits. Her pronunciation of "s" and "t" sounds was very obscure. She suffered from allergic rhinitis. The tongue had to be lowered and brought forward to secure an airway, and the mouth had to be kept open for breathing. The palatine tonsils became swollen at times.

The mandible shifted 4.0mm to the right in occlusion, but the upper and lower midlines almost coincided in opening (Fig. 3).

d) **OPG findings** (Fig. 3)

All the teeth from 7 to 7 were vital. All four third molars were present. All the lower molars were mesially inclined.

e) **Cephalometric findings**

1. **Lateral cephalometric findings** (Fig. 4, Table 1)

● **Skeletal pattern:** A'-PTM', an anteroposterior dimension of the maxilla, was more than 2 S.D.s shorter with SNA of 78.9°, indicating that the maxilla is posteriorly positioned in relation to the cranium. Mandibular length was more than 1 S.D. larger with SNB of 83.3°, facial angle of 89.5° and ANB of -4.4°, suggesting that the mandible was positioned anteriorly in relation to the cranium. Vertically, facial height was more than 1 S.D. shorter, while lower facial height was more than 1 S.D. larger. Ramus height was slightly shorter, though within 1 S.D. Gonial angle and FMA were more than 2 S.D.s excessive, and

Table 1: ROENTGEN CEPHALOMETRIC ANALYSIS

(F,14Y7M)

	DATA	MEAN	S.D.
FACIAL ANGLE	89.5	84.83	3.05
CONVEXITY	188.1	172.42	4.95
A-B PLANE	5.8-	4.81	3.50
MANDIBULAR PLANE	32.2	28.81	5.23
Y-AXIS	63.6	65.38	5.63
OCCULUSAL PLANE	8.8	11.42	3.68
INTERINCISAL	136.3	124.09	7.63
L1 TO MANDIBULAR	75.2	96.33	5.78
FH TO SN	4.4	6.19	5.89
SNP	83.1	78.70	2.98
SNA	78.9	82.38	3.45
SNB	83.3	78.90	3.45
ANB	4.4-	3.39	1.77
U-1 TO FH PLANE	116.2	111.13	5.54
U-1 TO SN PLANE	111.8	104.54	5.55
GONIAL ANGLE	130.6	121.20	4.61
RAMUS INCLINATION	81.6	87.07	4.40
FMA	32.2	28.81	5.23
IMPA	75.2	96.33	5.78
FMIA	72.5	54.63	6.47
Z-ANGLE	79.4	71.25	5.82
U-1 TO NA	32.9	22.10	7.00
L-1 TO NB	15.2	29.50	5.50
PP TO MANDIBULAR	32.0	24.10	3.90
OP TO MANDIBULAR	21.0	13.20	3.70
OP TO A-B PLANE	76.0		
A-B TO MANDIBULAR	61.0	71.30	4.40
SAB	133.0	125.0	7.00
ODI	59.0	71.95	5.29
APDI	90.5	81.64	4.35

LINEAR ANALYSIS

	DATA	MEAN	S.D.
N - S	69.2	68.43	2.42
N - ME	129.6	125.62	4.63
N - ANS	53.2	55.27	2.66
ANS - ME	76.2	72.18	3.62
S' - PTM'	16.3	19.14	2.90
A' - PTM'	43.3	48.33	2.52
IS - IS'	30.4	31.87	2.00
MO - MS	25.9	24.20	1.99
GN - CD	125.7	119.33	4.33
POG' - GO	82.5	77.20	3.83
CD - GO	60.3	62.35	4.88
II - II'	40.0	44.52	1.50
MO - MO'	28.1	33.79	2.22
U-1 - NA	7.6	5.40	2.20
L-1 - NB	1.9	7.40	2.40
U1 - ANS	28.0	40.10	
U1G - ANS	17.0		
L1 - MP	42.0	45.70	
LIG - MP	33.0		
Wits	-11.0	-1.93	2.53
E-Line - UL	-9.0	±0.02	2.08
E-Line - LL	-2.0	±2.02	2.44

palatal plane to mandibular plane angle was more than 3 S.D.s larger, indicating the mandible was rotated open. Anteroposteriorly, this case can be described as skeletal Class III open bite with a combination of a posteriorly-positioned maxilla and

an anteriorly-positioned mandible.

● **Denture pattern:** U1-SN and IMPA were 111.8 and 75.2°, respectively. The upper incisors were labially inclined, while the lower incisors were lingually inclined.

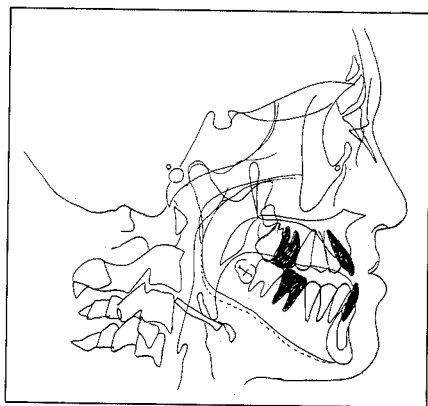


Fig. 4. Lateral cephalometric tracing at initial visit (14Y5M). Antero-posterior dimension of the maxilla is 2 S.D. shorter with ANB of -4.4 and SNA of 78.9° , suggesting the cranium is located posteriorly in relation to the cranium. SNB and facial angle are 83.3 and 89.5° , respectively, indicating the mandible is positioned anteriorly. By Wylie's analysis, anteroposterior dysplasia value is 23.28 . This is a surgery case according to Valko's criteria.

Vertical position of the upper incisors ⁷⁾ was 28.0mm (mean -46.0mm) and more superiorly positioned than the mean. The upper alveolar process was very short vertically. The vertical position of the lower central incisors was 42.0mm (mean -43.15mm) and close to the mean. The lower molars were severely tipped mesially.

According to Kim's classification⁸⁾, ODI and APDI are 59.0 and 909.5° , respectively, suggesting a skeletal Class III open bite pattern with both anteroposterior and vertical problems. With Wylie's analysis⁹⁾ (based on the Japanese norms shown by Sakamoto and Miura⁷⁾), anteroposterior dysplasia value was $+23.28$. The case is classified as a surgery case according to Valko's criteria.

2. Posteroanterior cephalometric findings (Fig. 5)

In relation to the midline constructed by drawing a line perpendicular to the reference plane, Lo-Lo' line, which goes through CG, the neck of the crista galli, the mandible was located 4.0mm to the right in occlusion. The upper and lower midlines were almost on the constructed midline in openings (11.0 and 29.0mm). When a line

parallel to Lo-Lo' line was drawn from the left condyle, Cd, and gonial angle, Go, the contralateral Cd and Go were located slightly above the line. In openings (11.0 and 29.0mm), Cd and Go on both sides were at the same height. It is likely that the mandible is displaced to the right in occlusion due to occlusal interferences in the molar area. Both C-Mo-C-Mo' line and Mx-Mx' line were almost parallel to Lo-Lo' line, indicating that there was no difference in vertical height of the upper denture base between left and right.

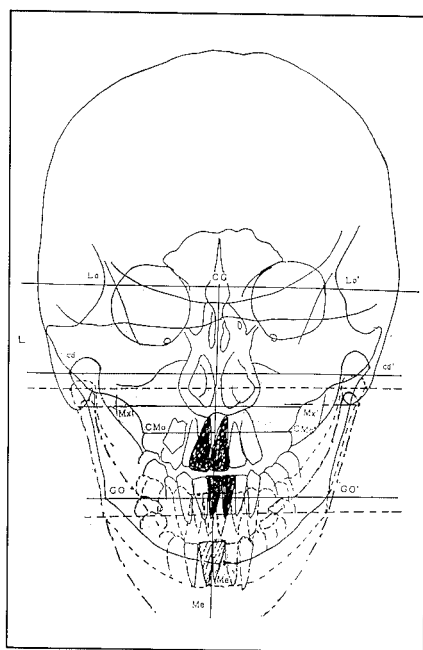


Fig. 5. Posteroanterior cephalometric tracings at initial visit (superimposed at 11 and 29mm openings on Lo-Lo line at CG). The mandible deviates 4mm to the right. The upper and lower midlines almost coincide in opening. In occlusion, the right condyle Cd and gonial angle Go are slightly higher than the left ones. They are at the same height in opening. It seems that occlusal interferences are causing the mandible to deviate to the right.

(f) Radiographic findings of the temporomandibular joints (Fig. 17) prior to treatment (14Y7M).

The right condyle was located slightly posteriorly in the glenoid fossa in occlusion, while the left condyle was in a slightly anterior position in the fossa. Both condyles are at the top of the eminence in

29.0mm opening, moving the same amount anteriorly. The observation that the two condyles are in different positions in occlusion fits with the intraoral midline deviation and the frontal cephalometric finding of 4mm mandibular shift to the right. All of these features seemed to be caused by occlusal interferences in the molar area. The patient exhibited no TMJ abnormality, but experienced fatigue of the jaw and/or headache after talking for a long time. Although it is not clear whether the mandibular shift to the right (which may have been attributable to occlusal interferences) was a direct cause of these problems, her occlusion, if left untreated, may have induced a TMJ disorder in the future.

(g) MKG and EMG findings

(Fig. 18 and 19) before treatment (14Y7M)

The sagittal recording with the MKG Myomonitor showed that the muscles were trying to bring the mandible to the existing, unphysiologic intercusp position in closing. The mandible was pulled back slightly to the left in closing, showing a small deviation from the rest position to the intercusp position along the closing path. Her habitual opening and closing were unstable. The muscles were moving 'cautiously' in closing. The EMG records show that the temporalis and masseter muscles on the left were very tense. It seemed that the 4mm mandibular deviation caused by the occlusal interferences in the molar area was compensated by the muscles in occlusion. To treat this case, therefore, the occlusal interferences needed to be eliminated to normalize the mandibular position and to achieve a muscular balance between right and left. From these findings, the patient was diagnosed as skeletal Class III open bite with a combination of a posteriorly-positioned maxilla and an anteriorly-positioned mandible with both anteroposterior and vertical problems which have been aggravated by functional and environmental factors as well as growth, development and genetic factors.

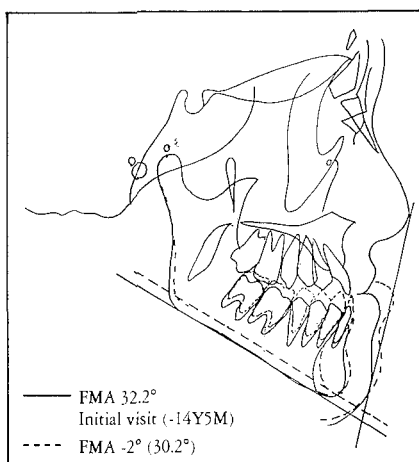


Fig. 6. Forecast A: when the mandible is rotated forward around the top of the condyle, O, to reduce FMA by 2° . Overbite becomes positive, and anterior and premolar open bites would be reduced. However, Class III tendency would be increased. Larger amounts of anterior movement of the maxilla and distal movement of the mandible and a lot of molar intrusion or extraction would be required. Facial profile would be compromised with a disharmony of the upper and lower liplines.

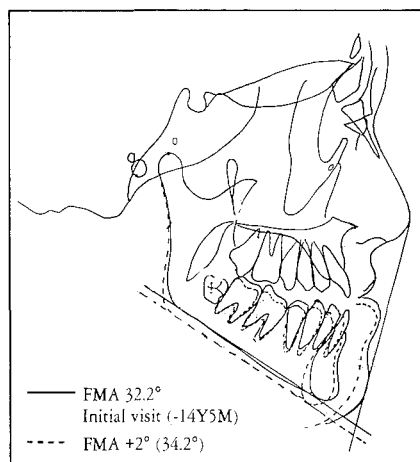


Fig. 7. Forecast B: when the mandible is rotated backward around the top of the condyle, O, to increase FMA by 2° , B point and P point would go back. ANB would be 0° . These changes would solve the anteroposterior disharmony of the jaws, but the anterior and premolar open bites would increase, making the correction of the vertical disharmony even more difficult. The face would get longer. A good occlusion or good profile improvement would be difficult to achieve.

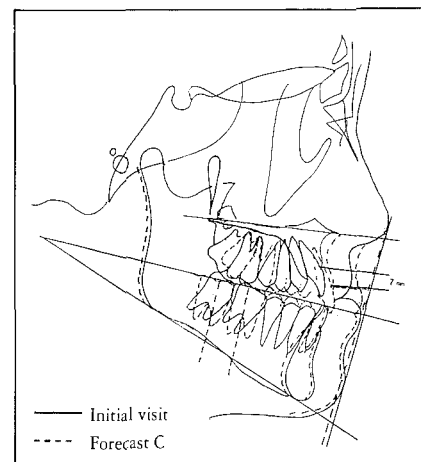


Fig. 8. Forecast C: when the maxilla is moved forward and the mandible is distalized without rotation (no FMA change) the line from the occlusal contact between the upper and lower molars to the lower incisal edge is defined as the occlusal plane. Along this occlusal plane, the maxilla is moved mesially until the molar relationship becomes Class I. If the upper alveolar process is elongated so that anterior overbite and overbite become 1.5 and 2.0mm, 7mm of elongation would be needed. Quite a lot of intrusion and uprighting of the lower molars would also be necessary. If the forward and downward movement of the maxilla is less than this, a larger amount of lower first molar intrusion and a small amount of mandibular distalization would be needed to solve the anteroposterior disharmony of the jaws. A balanced profile with harmonized liplines would be achieved as a result.

III. Forecasts of orthodontic treatment

To improve her occlusion by orthodontic means, it was necessary to correct the mandibular deviation to the right, improve the anteroposterior and vertical occlusal disharmonies of the upper and lower jaws and establish a favourable perioral environment. Especially, the patient had severe tongue habits due to the anterior and low tongue position. It would be desirable to increase the tongue space, which would also give post-treatment stability. Premolar extraction would not be appropriate for this purpose. Second molar extraction at an early stage of treatment would bring about a rapid change in mandibular position, possible affecting the temporomandibular area in an adverse way. This would not have been a proper treatment option, either, in this adolescent, psychologically unstable patient. The following forecasts were made to determine an optimal treatment plan for the best possible occlusal improvement.

- **Forecast A: when the mandible is rotated forward for occlusal improvement** (Fig. 6)

This is a forecast when FMA is reduced 2° for the purpose of alleviating

the vertical occlusal disharmony of the jaws. If the mandible is rotated forward around O, the top of the condyle, until the overbite becomes positive, FMA would be reduced by 2° . The open bite in the anterior and premolar area would be eliminated by this procedure, but the anteroposterior occlusal disharmony would be accentuated with increased Class III tendency. With this treatment approach, a greater anterior movement of the maxilla and quite a large amount of intrusion of the upper and lower molars or the extraction of the second molars would become necessary. At the same time, the facial profile would be esthetically-compromised due to a disharmony of the upper and lower lip lines.

- **Forecast B: when the maxilla is rotated backward for occlusal improvement** (Fig. 7)

This is when FMA is increased $+2^\circ$ to improve the anteroposterior disharmony of the upper and lower jaws. When the mandible is rotated around O, the top of the condyle until ANB becomes 0° , FMA increases by 2° . B point and P point move distally, facilitating the improvement of the anteroposterior occlusal disharmony. However, the open bite in the anterior and premolar areas would be increased,

making it more difficult to improve the vertical occlusal disharmony and creating a longer face. A good facial balance would be difficult to achieve.

- **Forecast C: when the maxilla is moved forward and downward and the mandible is distalized without rotation** (Fig. 8)

Effects of this treatment approach were projected in the following way:

- a. The point where the occlusal surface of the upper molar contacts with that of the lower is connected with the lower incisal edge, and the connecting line is defined as 'forecasting occlusal plane' (the lower incisal edge is used because the lower incisors are in a good position and because the vertical position of the lower incisal edge and the vertical height of the symphysis should be maintained).

b. The lower first and second molars are uprighted and intruded perpendicular to the forecasting occlusal plane. It then becomes clear that the lower second molars need to be intruded significantly.

c. The maxilla is advanced along the forecasting occlusal plane until the molar relation becomes Class I so that a normal anterior overbite is established, the upper alveolar process needs to be elongated 7mm without extruding the upper molars. Judging from this projection (Fig. 8), a good occlusal improvement could be obtained if the following movements can be achieved: a significant forward and downward movement of the maxilla, a small amount of distalization of the mandible, intrusion and uprighting of the lower molars, a 7mm elongation of the upper alveolar process and a vertical movement of the premolar area. This would give the patient a good facial profile improvement with harmonized upper and lower lip lines.

From the above forecasts, A, B and C, the most desirable occlusal improvement would be achieved by moving the maxilla forward and downward, distalizing the mandible, intruding and uprighting the lower molars a significant amount and vertically moving the upper alveolar process and alveolar bone in the premolar area.

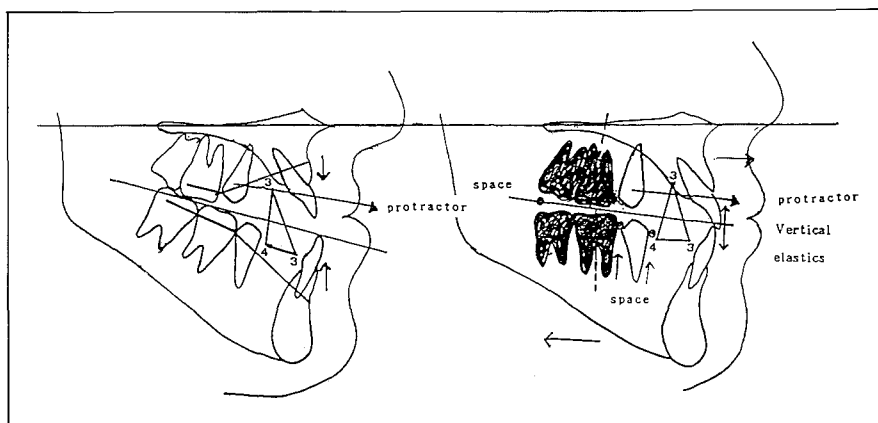


Fig. 9. The action of anchorage bends and elastics. Archwires with anchorage bends are placed in the upper and lower, and vertical elastics and short Class III elastics are used in the anterior and premolar areas. The molars will then be uprighted. When anchorage bends are made more mesially, the molars will be intruded and uprighted at the same time, creating a small space between the upper and lower jaws. When Class III elastics are used during this time, the mandible will move distally a little. The uprighting of the teeth will result in a small amount of space interproximally, which can be used to move the arch distally or mesially with uprighting springs, coil springs or elastics.

IV. Treatment plan

The following treatment plan was made based on the results of the treatment forecasts:

- ① To minimise the rotation of the mandible.
- ② To prevent the tongue space from narrowing mainly by using the force system of the Begg technique (Fig. 9). Premolar extraction must be avoided. The upper arch should be expanded with a quad-helix.

- ③ To intrude and upright the lower molars and move the upper alveolar process down to improve the vertical occlusal disharmony of the upper and lower jaws. The lower incisors, which are already in a favorable position, should be kept from extruding, and the vertical height of the symphysis should also be left unchanged by using an appropriate force system. To move the alveolar bone in the premolar area vertically. To extract the second molar as needed.

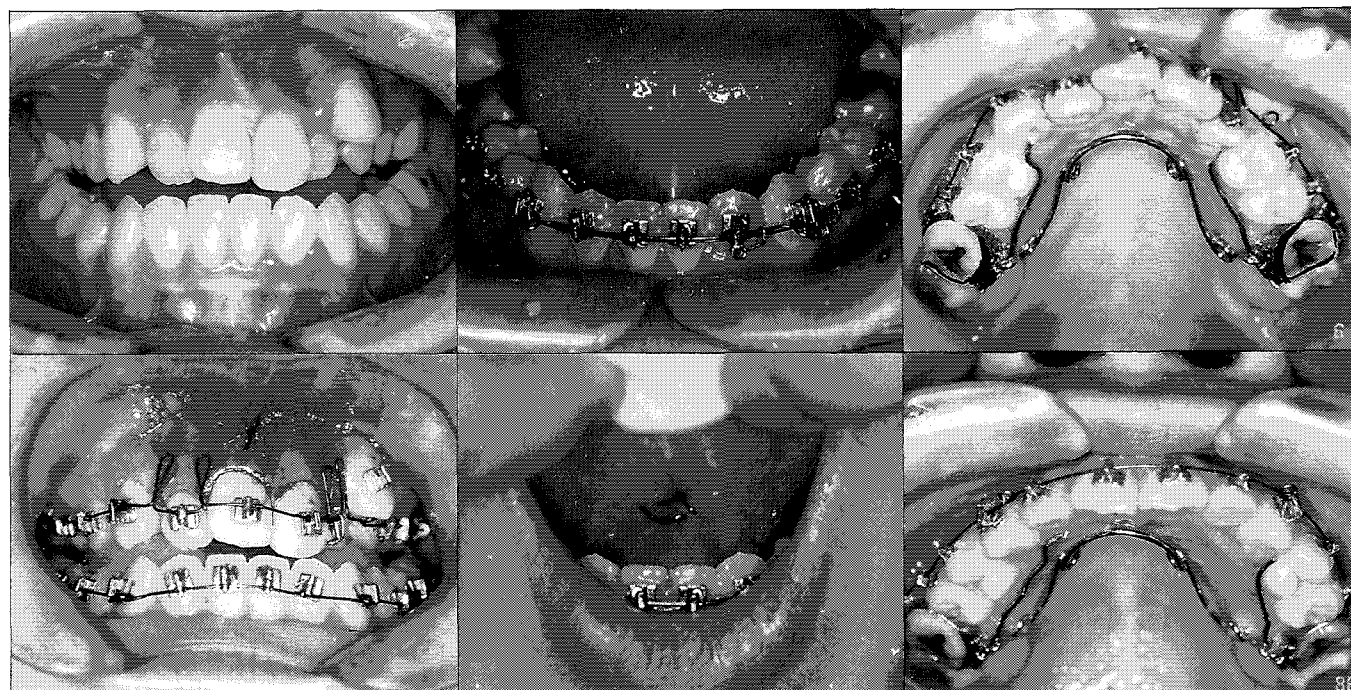


Fig. 10. A quad-helix was used for maxillary expansion and upper labial frenectomy was performed with a quad helix during the first stage. Lingual frenectomy was performed in the second stage after the end of maxillary expansion. The tongue could not reach within the upper arch before lingual frenectomy. The tongue was lifted only to this extent due to a short lingual frenum.

④ To use a maxillary protractor in combination with the Begg appliance to move the maxilla forward and downward and distalize the mandible for improving the anteroposterior occlusal disharmony. To advance the upper arch and distalize the lower arch as much as possible.

⑤ To establish a good perioral environment through tongue and lip training after lingual and upper labial frenectomies. To ask an ENT specialist for cooperation in treating nasal disease and palatine tonsillar hypertrophy.

Orthodontic treatment was initiated based on this treatment plan.

V. The course of treatment (Fig. 10-11)

- **First stage:** three months. (14Y7M-14Y10M) (Fig. 11 - 1st and 2nd rows)

Active treatment was initiated using the Begg appliance together with a maxillary protractor for maxillary advancement and a quad-helix for upper arch expansion. The maxilla was protracted horizontally from the first molars until the anterior teeth were unravelled, which was followed by protraction from the second premolars. 30° anchorage bends were placed in the upper archwire (0.016") to prevent the first molars from extruding. In the lower, the molars were intruded and uprighted after being levelled with a 0.014" archwire. This was followed by the use of 0.016" archwire with 45° bends to prevent the lower incisors from extruding for two months, together with short class III elastics, and vertical elastics in the anterior segment. An upper labial frenectomy was also performed (Fig. 10). After three months of these procedures, the anterior and premolar open bite improved with an increase in overbite. The rapid improvement of open bite helped eliminate the patient's inferiority complex and she became a very cooperative patient.

Although the upper left canine was not yet incorporated into the arch, the upper arch had been expanded significantly and occlusal interferences in the molar area and the mandibular deviation were reduced, bringing both canine and molar relations almost into Class I (Fig. 11 - 2nd row of intraoral photographs).

The OPG taken three months after the start of treatment (Fig. 12) shows the intruded and uprighted upper first

molars. The radiographs of the temporomandibular joints (Fig. 17 - 2nd row) show that both condyles are almost centered in the fossae in occlusion, which was an improvement from the pre-treatment unequal condylar positions between right and left.

- **Second stage:** six months. (14Y10M-5Y4M) (Fig. 11: 2nd and 3rd rows of intraorals)

The quad helix was removed. 0.016" archwires were placed with 35° bends in the upper and 45° bends in the lower and with vertical elastics in the anterior and premolar areas. This was done to improve the open bite problem by intruding and uprighting the lower molars, and also by pulling the upper alveolar process down for an overbite increase. In addition vertical alveolar movement in the premolar area was achieved without extruding the lower incisors and without increasing the vertical height of the symphysis.

The upper left canine was brought into the arch 9 months after the start of treatment (Fig. 11 - 3rd row of intraorals), and the anteroposterior and vertical occlusal disharmonies were almost corrected. Lingual frenectomy was performed at this point in time. Tongue training was initiated following the wound healing. The tongue was able to be positioned within the upper arch one month after the frenectomy.

- **Third stage:** eight months. (15Y4M-16Y0M) (Fig. 11 - 3rd and 4th rows of intraorals)

Tubes were placed on the upper and lower second molars. 0.018" archwire was used (with 10° anchorage bends) in the upper, while 0.014" and 0.018" archwires (with 10° anchorage bends) were placed in the lower. Vertical elastics were used in the anterior and premolar areas to increase the overbite, seat the occlusion and to intrude the lower molars. When the intrusion and uprighting of the lower molars were almost complete, uprighting springs were used in the premolar area to upright the tooth axes. Horizontal elastics were used at the same time to distalize the lower arch. A lingual archwire was placed in the upper to maintain the expansion and to prevent the molars from extruding.

- **Fourth stage:** ten months. (16Y0M-6Y10M) (Fig. 11 - 4th and 5th rows of intraorals and 3rd row of facials)

The patient was sixteen years old at this stage and it was estimated some growth could still occur. It was also felt that the perioral muscles needed more time to adjust. For these reasons, the lower third molars were extracted, followed by a more gingival bracket positioning on the upper anterior teeth to seat the occlusion and increase the overbite. The tongue thrust and the habit of keeping the mouth open were corrected. The tongue was now kept within the upper arch, which seemed to suggest that it was stable. Therefore, the lingual arch appliance was removed. The patient was then instructed to chew gum hard all the time for training the tongue and peri-oral muscles for five months. The vertical and short Class III elastics were discontinued for the last two months of this training period.

Since the tongue and other perioral muscles seemed to have adapted to the new environment, active treatment was brought to an end. Total active treatment time was 27 months, during which a maxillary protractor was used for 22 months. Vertical and short Class III elastics were used in the anterior and premolar areas for 25 months. Active treatment was followed by retention with Begg retainers worn in both upper and lower arches during the day. Tailor-made positioners fabricated by the T.P. Co. were used at night for two years. At the end of two-year retention (at the age of 18Y10M), the patient presented with a stable occlusion without the relapse of tongue habits and with a good profile improvement (Fig. 11 - 4th row of facials and 6th row of intraorals).

However, the patient came back complaining of an abnormal occlusal sensation in the molar area two years after retention, when the upper third molars began to erupt. At present, five months after third molar extraction (three years and nine months after retention: 20 years and seven months of age), her occlusion remains stable with no such abnormal sensation (Fig. 11 - 5th row of facials and 7th row of intraorals).

VI. Treatment results

- 1) **Facial findings** (Fig. 11: 3rd row of facials)

- Laterally, the concave appearance of the midface and the protrusive appearance of the chin were eliminated. The short upper lip was lengthened by

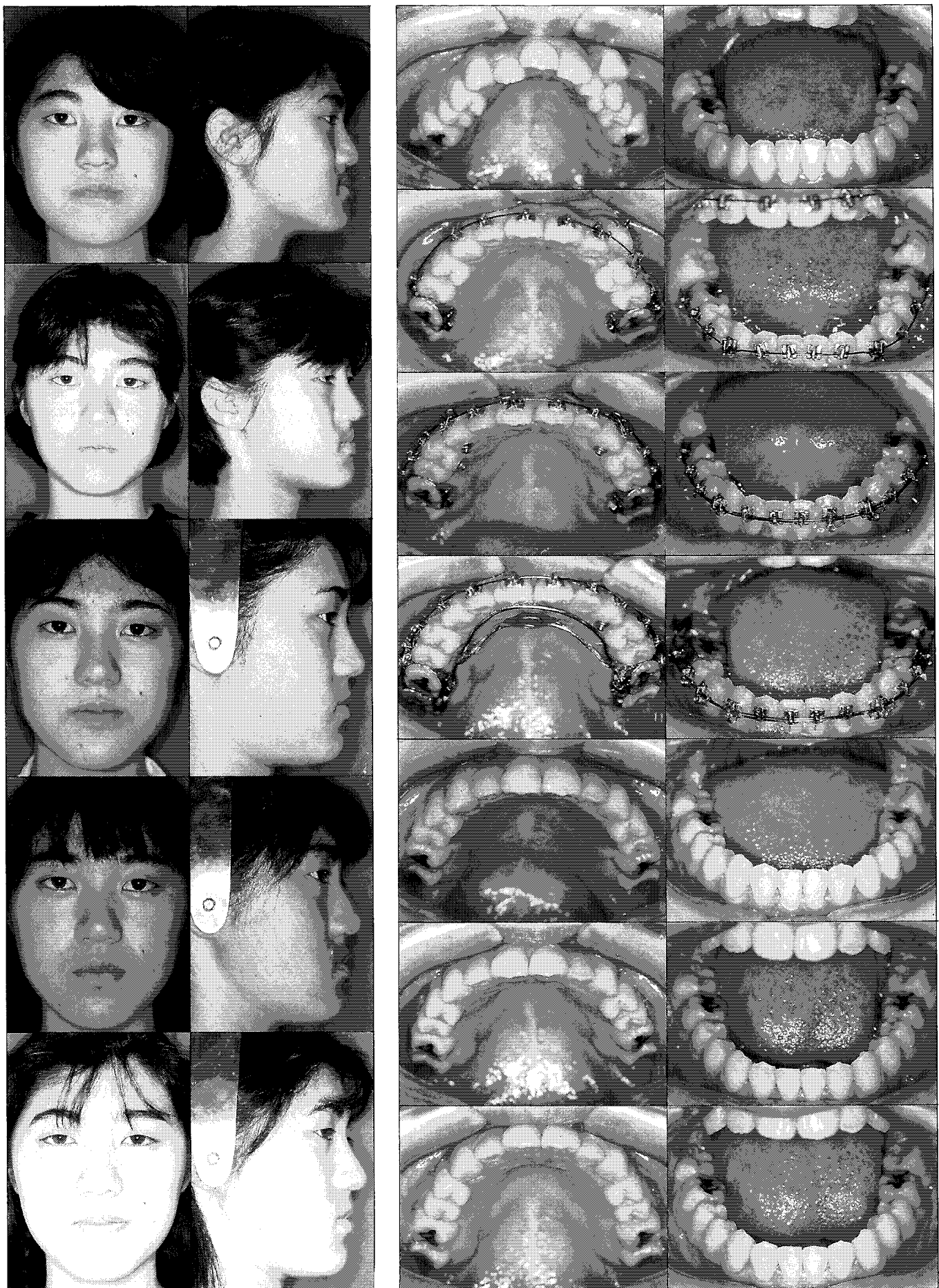


Fig. 11. Facial and intraoral photographs during and at the end of treatment and after retention.

Facial photographs. 1st row: at the initial visit (14Y5M); 2nd row: 3 months after the start of treatment (14Y1M); 3rd row: at the end of active treatment (16Y10M); 4th row: 2 years after retention (18Y10M); 5th row: 3 years and 9 months after retention (20Y7M).



Intraoral photographs. 1st row: at the initial visit; 2nd row: 3 months after the start of treatment; 3rd row: 9 months after the start of treatment; 4th row: 22 months after the start of treatment; 5th row: at the end of active treatment; 6th row: 2 years after retention; 7th row: 3 years and 9 months after retention.

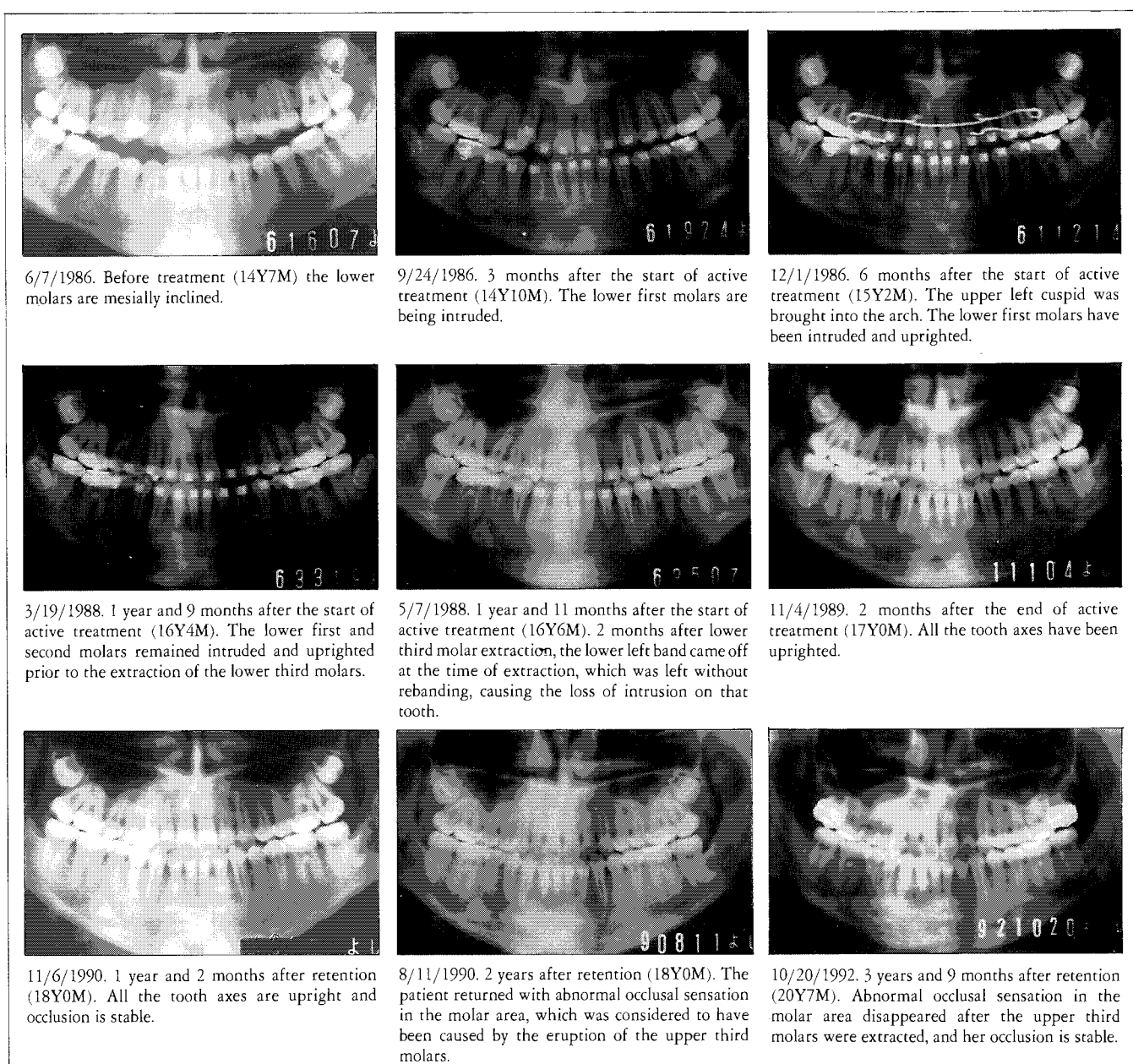


Fig 12. OPG findings during treatment and after retention.

7.0mm. The upper and lower lips are now in harmony.

- Frontally, the patient no longer has a lip strain. The mandibular deviation to the right in occlusion was corrected and the face is now symmetrical.

- The upper incisal edges are 1.5mm below the line connecting the left and right corners of the mouth.

2) Intraoral and occlusal findings (Fig. 11: 6th and 7th rows of intraorals)

- The mandibular deviation to the right in occlusion was corrected. The molars and premolar are now in Class I with an overjet of 1.5mm and an overbite of 2.0mm.

- The tongue space was widened through the expansion of the upper arch. Abnormal behavior of the tongue was eliminated after a lingual frenectomy. There has been no relapse of tongue habits, three years and nine months after retention.

3) Lateral cephalometric findings (Fig. 13, 14, 15, Table 2)

① Antero-posterior changes of the maxilla and mandible (Fig. 13)

a. SNA and antero-posterior distance of the maxilla increased 5.4° and 6.7mm, respectively, resulting in a forward and downward movement of the maxilla.

b. SNB decreased by 1.2° . FMA and

N-S remained almost unchanged. As a result, the mandible was distalized a little.

c. ANB changed from -4.4° to $+2.4^{\circ}$ as a result of the forward and downward movement of the maxilla and the distalization of the maxilla. WITS measurement changed from -11.0mm to 1.5mm.

These results indicate that the improvement of the antero-posterior jaw relation was skeletal in nature.

② Vertical changes of the jaws (Fig. 14)

a. Vertical measurements were made using Palatal Plane as a reference to obtain the following results:

- The maxillary alveolar process

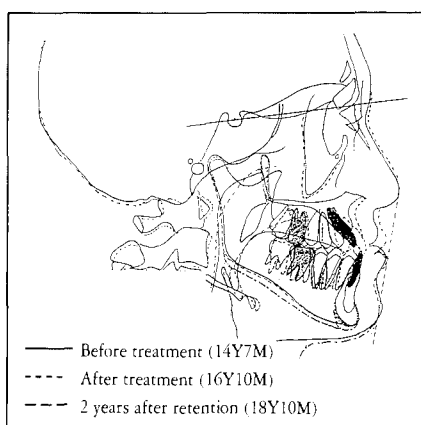


Fig. 13. Superimposition of lateral cephalograms before and after treatment and 2 years after retention (on S-N at S) SNA and the anteroposterior dimension of the maxilla increased 5.6° and 6.7mm, respectively, resulting in forward movement of both maxilla and upper arch. SNB decreased 1.2° , while FMA and N-S distance remained almost unchanged, resulting in a minimal distalization of the mandible and a distal movement. All of these changes led to a skeletal improvement of the anteroposterior occlusal relationship of the jaws. The upper alveolar process descended and the alveoli in the buccal segments moved vertically with little extrusion of the lower incisors or little increase in height of the symphysis, contributing to the improvement of the vertical occlusal relationship of the jaws.

moved down 6.0mm. Along with this movement, the upper incisal edges also moved down 6.0mm, contributing to the improvement of the open bite.

- The upper and lower alveoli in the premolar area moved vertically, which was accompanied by 2.0mm vertical movement of the premolars, improving the open bite in the premolar area.

b. The lower incisors elongated 1.0mm during treatment, followed by no further change.

c. Although the mandible grew little during orthodontic treatment it grew downward during retention (16Y10M-18Y0M) and the height of the symphysis increased 2mm. There was no further mandibular growth subsequently.

d. Along with the increased symphysis height, anterior lower facial height also increased 2.0mm.

e. Mandibular length remained unchanged during treatment, but increased

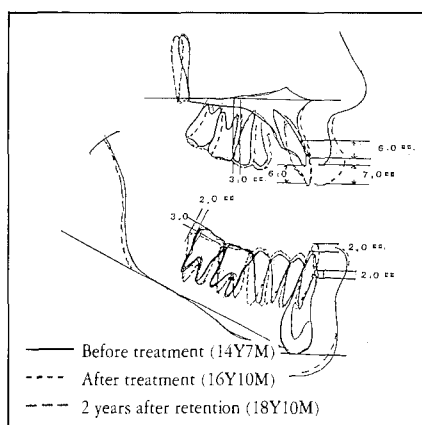


Fig. 14. Superimposition on palatal plane before and after treatment and 2 years after retention (on ANS-PNS at ANS, mandibular plane at menton). The upper alveolar process descended 6mm, which was followed by 6mm of downward movement of the upper incisal edge and close to 7mm of upper lip lengthening. The anteroposterior dimension of the maxilla increased 6.7mm. The upper arch moved mesially about 3mm. That is, the maxilla as well as the upper arch moved forward and downward. The lower molars were uprighted, intruded quite a large amount and distalized 2mm. The height of the symphysis remained the same. The lower incisors extruded about 1mm. The mandible grew downward during retention, causing the height of the symphysis to increase 2mm.

2.5mm during the eruption of the upper third molars, followed by no further change.

f. There were no major changes in FMA or occlusal plane angle.

③ Changes in denture pattern (Fig. 13, 14, 15, Table 2)

a. U1-S1 changed from 116.2° to 113.6° . IMPA increased from 75.2° to 81.8° , which slightly decreased to 79.3° two years after retention. However, the lower incisal roots are almost centered buccolabially within the symphysis.

b. The upper first molars moved mesially 3.0mm with little elongation, while the lower first and second molars intruded 3.0mm and distalized 3.0mm (Fig. 14).

c. As a result of the above, the upper and lower arch lengths increased with the upper arch coming forward and the lower arch moving distally.

d. The vertical distance from the lower incisal edge to Menton increased

1.0mm during treatment which led to an increase in overbite.

e. Occlusal plane to A-B plane was 76.0° before treatment and 89.0° at the end of active treatment, increasing to 90.0° two years after retention. The occlusion remained stable. The results of lateral cephalometric analyses before treatment, at the end of active treatment and up to two years post retention revealed that the improvement of the anteroposterior and vertical occlusal disharmonies between the jaws resulted from a significant amount of mesial movement of the maxilla and maxillary arch and a small amount of distalization of the mandible and mandibular arch. The vertical disharmony was improved particularly as a result of the intrusion and uprighting of the lower molars and the vertical movement of the upper alveolar process and upper and lower alveoli in the premolar area. This also helped produce a normal overbite.

4) Results of posteroanterior (frontal) cephalometric analysis (Fig. 16)

① The mandibular deviation to the right observed before treatment was a dental, functional problem. The deviation and frontal facial asymmetry was corrected through the elimination of occlusal interferences in the molar area.

② When the line going through CG was defined as a midline in relation to Lo-Lo' line, Menton coincided with the midline at the end of active treatment.

③ The pretreatment differences in height of Cd and Go between right and left were corrected as the mandibular deviation improved.

④ The superimposition of posteroanterior (frontal) cephalogram tracings before treatment and at the end of active treatment on Lo-Lo' at CG shows the improvement of the vertical disharmony of the jaws as a result of a significant downward movement of the maxillary alveolar process.

5) Soft tissue findings and psychological changes

① The tight upper lip became more relaxed and its length increased 7.0mm, giving the patient a balanced lip profile (Fig. 13, 14).

② Abnormal tongue behaviour was also eliminated. There has been no relapse of tongue habits, three years and nine months after retention.

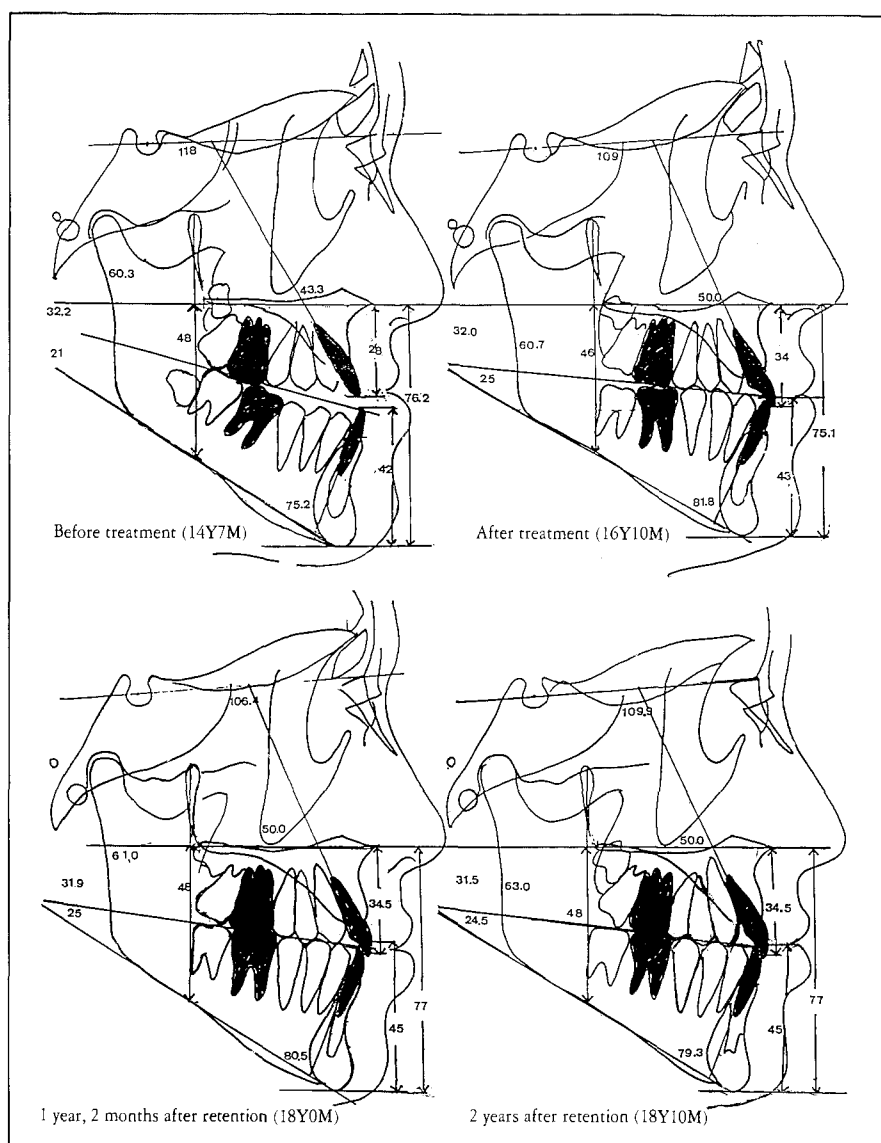


Fig. 15. Changes on lateral cephalograms before and at the end of active treatment, 1 year and 2 months and 2 years after retention. Vertical measurements were made in relation to palatal plane, which showed that the anterior and buccal open bite improved as a result of a vertical movement of the maxillary alveolar process and alveoli in the buccal segments. The vertical height of the symphysis changed little before and after treatment, but increased approximately 2mm during retention from 16Y10M to 18Y0M, which was accompanied by 2mm of lower facial height increase. No further change followed. Ramus height (Cd-Go) increased 2mm during retention from 18Y0M to 18Y10M in 10 months. FMA and occlusal plane angle remained almost unchanged.

③ Chewing and speech functions also improved.

④ Allergic rhinitis and palatine tonsillar hypertrophy resolved spontaneously as occlusion improved.

⑤ Because the aesthetic problems which had adversely affected the patient psychologically improved early in treatment, she became a cheerful individual and the inferiority complex was eliminated. She also became very cooperative in treatment.

As occlusion improved, the fatigue in the jaw and headache experienced during

conversation were eliminated and her complexion improved.

6) Radiographic findings of the temporomandibular joints (Fig. 17)

① The difference in condylar position between right and left observed before treatment disappeared three months after the start of treatment when the elimination of occlusal interferences led to a stable mandibular position.

② The patient came back complaining of abnormal occlusal sensation in the

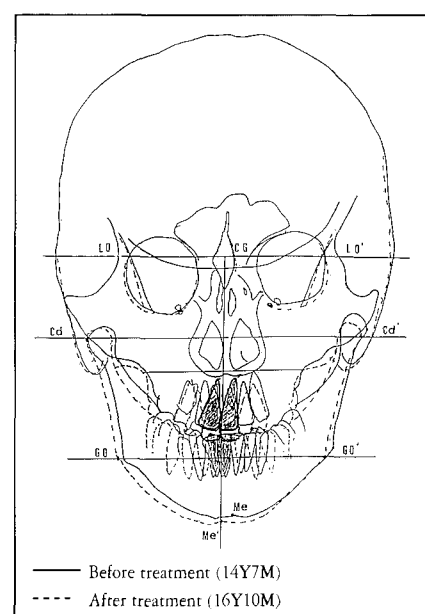


Fig. 16. Superimposition of posteroanterior cephalograms tracings before and after treatment (on LO-LO line at CG). In relation to the midline, a line drawn perpendicular to Lo-Lo line through CG, the mandible, which deviated to the right in occlusion before treatment, is now centered. The differences in height of Cd and Go between right and left were reduced as the mandibular deviation improved and became symmetrical on the frontal headfilm.

molar area two years after retention (18Y10M). The x-rays of the temporomandibular joints showed no abnormality.

7) MKG and EMG findings (Fig. 18, 19)

• MKG findings

① The velocity of habitual opening and closing increased as a result of orthodontic treatment. She showed smooth vertical kinematic patterns after treatment.

② Frontally, lateral deviation was reduced, and the muscles of mastication began to move smoothly.

③ The MKG records taken when she referred with abnormal occlusal sensation in the molar area two years after retention showed a slower habitual opening and closing and a very small amount of deviation from rest position to occlusal position on the closing path.

④ The velocity of habitual opening and closing increased five months after the extraction of the upper third molars.

Table 2: ROENTGEN CEPHALOMETRIC ANALYSIS

	(14Y7M)	(16Y10M)	(18Y0M)	(18Y10M)	MEAN	S.D.
FACIAL ANGLE	89.5	87.0	87.0	87.1	84.83	3.05
CONVEXITY	188.1	179.5	177.3	179.8	172.42	4.95
A-B PLANE	5.8	2.9	2.0	2.2	4.81	3.50
MANDIBULAR PLANE	32.2	32.0	31.9	32.2	28.81	5.23
Y-AXIS	63.6	63.4	63.4	63.2	65.38	5.63
OCCULUSAL PLANE	8.8	10.4	11.1	10.2	11.42	3.64
INTERINCISAL	136.3	132.5	136.6	132.9	124.09	7.63
L1 TO MANDIBULAR	75.2	81.8	80.5	79.3	96.33	5.78
FH TO SN	4.4	4.7	4.6	5.9	6.19	5.89
SNP	83.1	83.3	83.3	83.2	78.70	2.92
SNA	78.9	84.5	84.7	84.3	82.32	3.45
SNB	83.3	82.1	82.2	82.3	78.90	3.45
ANB	4.4	2.4	2.5	2.0	3.39	1.77
U-1 TO FH PLANE	116.2	113.6	111.1	115.7	111.13	5.54
U-1 TO SN PLANE	111.8	109.0	106.4	109.9	104.54	5.55
GONIAL ANGLE	130.6	130.6	129.5	130.4	121.20	4.61
RAMUS INCLINATION	81.6	81.4	82.4	81.7	87.07	4.40
FMA	32.2	32.0	31.9	31.5	28.81	5.23
IMPA	75.2	81.8	80.5	79.3	96.33	5.78
FMIA	72.5	66.2	67.7	68.6	54.63	6.47
Z-ANGLE	79.4	76.4	76.1	77.5	71.75	5.82
U-1 TO NA	32.9	24.4	21.7	26.5	22.10	7.00
L-1 TO NB	15.2	21.7	20.2	19.6	29.50	5.50
PP TO MANDIBULAR	32.0	30.0	32.0	32.0	24.10	3.90
OP TO MANDIBULAR	21.0	25.0	25.0	24.5	13.2	3.70
OP TO A-B PLANE	76.0	89.0	89.0	90.0		
A-B TO MANDIBULAR	61.0	65.0	65.0	65.0	71.3	4.40
SAB	133.0	125.0	125.0	125.0	120.0	7.0
ODI	59.0	65.0	65.0	65.0	71.95	5.29
APDI	90.5	85.0	84.9	86.1	81.64	4.35

LINEAR ANALYSIS

	(14Y7M)	(16Y10M)	(18Y0M)	(18Y10M)	MEAN	S.D.
N - S'	69.2	69.5	69.3	69.1	68.43	2.42
N - ME	129.6	129.8	129.4	130.6	125.62	4.63
N - ANS	53.2	54.1	54.2	53.9	55.27	2.66
ANS - ME	76.2	75.1	77.0	77.0	72.18	3.62
S' - PTM'	16.3	18.1	17.7	16.2	19.14	2.90
A' - PTM'	43.3	50.0	50.0	50.0	48.33	2.52
IS - IS'	30.4	34.2	34.2	34.0	31.87	2.00
MO - MS	25.9	26.8	26.1	26.5	24.20	1.99
GN - CD	125.7	127.1	127.2	128.0	119.33	4.43
POG' - GO	82.5	85.0	83.4	83.5	77.20	3.83
CD - GO	60.3	60.7	60.5	63.0	62.35	4.88
II - II'	40.0	41.6	41.6	43.0	44.52	1.50
MO - M1'	28.1	28.0	28.9	31.7	33.79	2.22
U1 - NA	7.6	2.8	2.8	4.6	5.40	2.20
L1 - NB	1.9	3.7	3.4	3.2	7.40	2.40
U1 - ANS	28.0	34.0	34.5	34.5	40.1	
U1G - ANS	17.0	23.0	23.5	23.5		
L1 - MP	42.0	43.0	45.0	45.0	45.70	
L1G - MP	33.0	33.0	35.0	35.0		
Wits	-11.0	-1.5	-1.5	-1.5	-1.93	2.53
E-Line $\perp$ UL	-9.0	3.0	3.0	3.0	± 0.02	2.08
E-Line $\perp$ LL	-2.0	0	0	0	± 2.02	2.44

● EMG findings

① The EMG records taken two years after retention when the patient complained of abnormal occlusal sensation in the molar area (during the eruption of the upper third molars) showed a very

high level of tension in the left masseter. The masseter muscles exhibited a major imbalance of activity between right and left.

② The EMG findings three years and nine months after retention or five

months after the extraction of the upper third molars (at the age of 20Y7M) show well-balanced activities of both masseter and temporalis muscles, suggesting a stable mandibular position and a stable occlusion after retention.

VII. Discussion

According to Valko's criteria, this case having a value of +23.28 is classified as one requiring surgery. This type of case would normally be treated towards the end of growth to achieve post-surgical stability⁽¹⁾. However, Enoki⁽¹²⁾ has stated that the patient's awareness of his or her inferiority complex due to morphological abnormalities caused by the malocclusion, especially disharmony of facial profile, may progress to a psychological disorder. The morphological abnormalities resulting from Class III open bite greatly affected the psychological state of this patient in adolescence, a period when greater importance is attached to aesthetics than to speech, chewing or other aspects. It would have been detrimental to the patient to leave the morphological and functional abnormalities untreated thus allowing the patient to spend every day with an unresolved inferiority complex during this important adolescent period when the child's growth is active both psychologically and physically. For this reason, if it is possible to improve the morphological and functional problems which are adversely affecting the patient's psychology at an early stage by means of orthodontic treatment; this would help eliminate the complex and have a beneficial effect on personality development.

Summary

A skeletal Class III open bite case was examined for orthodontic treatment to identify the factors aggravating the symptoms of the malocclusion⁽³⁾. Those inducing factors included abnormal behavior of the tongue and perioral muscles in the presence of a blocked nasopharyngeal airway, resulting in extrusion of the molars and opening of the gonial angle. In addition there was a distally-positioned and anteroposteriorly short maxilla in relation to the cranium, and reduced vertical heights of the upper alveolar process and alveolar bone in the posterior segment.

It was thought that the improvement of these factors in this case would not be

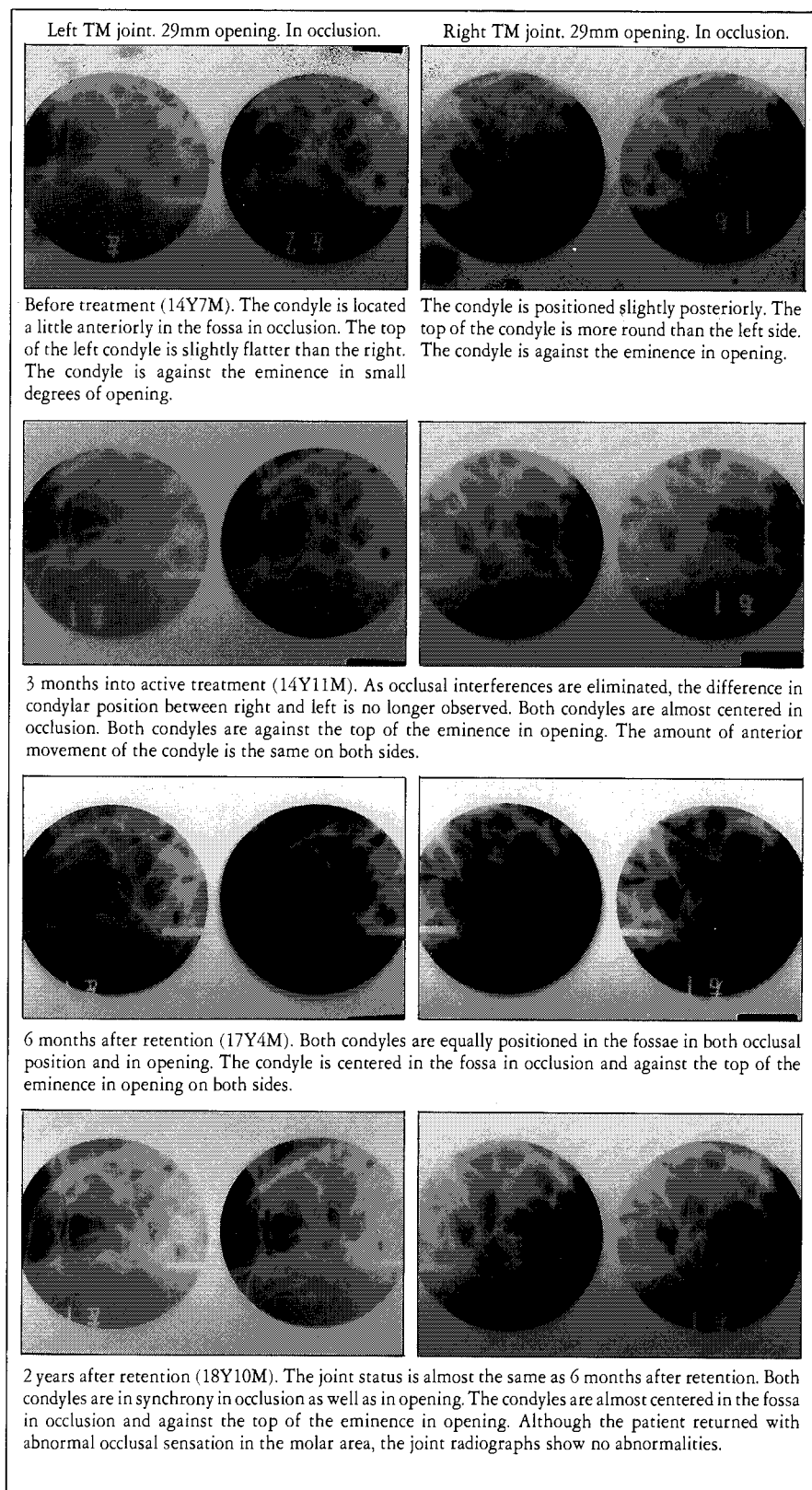


Fig. 17. Comparison of joint radiographs before and during treatment and after retention. These radiographs of the joints were taken with Model Tx-90 made by Asahi Roentgen Co. The angles of X-ray beam were directed at 0° laterally and 17° superiorly.

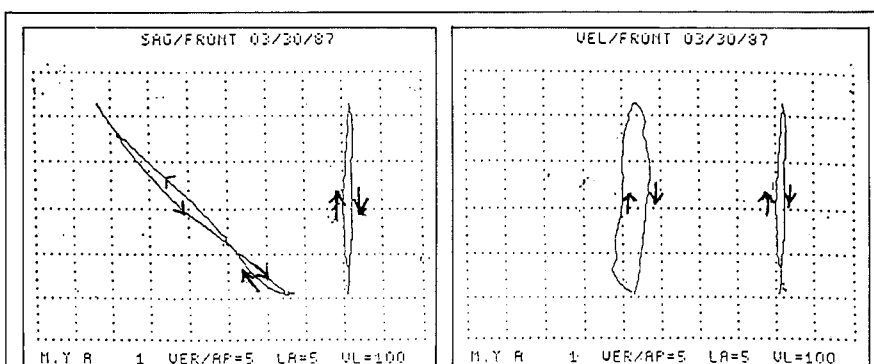
impossible, although it was questionable if the maxilla could be brought forward with the use of a protractor at this age (14Y7M at the start of treatment). However, it seemed possible to improve the anteroposterior occlusal disharmonies of the jaws to a certain extent, if the

upper arch could be moved mesially, and the lower arch and the mandible distally. With the help of short Class III elastics and the perioral musculature, the mandible was slightly distalized and the mandibular position corrected. In the anterior segment, vertical elastics were used to

bring down the maxillary alveolar process, with which the upper incisors came down in a synchronous manner, contributing to the reduction of the open bite. These improvements accomplished at an early stage of treatment helped eliminate the patient's inferiority complex and establish a rapport with the author. Although there was doubt about the efficacy of maxillary protraction, SNA increased 5.6° as a result of the protraction for 22 months. The anteroposterior dimension of the maxilla (A'-PTM') increased as much as 6.7mm. The maxilla and upper arch also move anteriorly and downward. It seemed that maxillary protraction was effective, because the patient had some maxillary growth left at the age of fourteen years and seven months¹⁴. Upper labial frenectomy also seemed to have favorably affected the maxillary protraction.

The inclination of the upper incisors decreased 2.8° at the end of active treatment. The use of vertical elastics in the anterior segment in combination with protraction seemed to have stimulated a forward and downward growth of the maxilla¹⁵ while controlling the flaring of the upper incisors¹⁶. $0.018''$ and $0.014''$ archwires were used in the mandible, which were combined with the force system of anchorage bends and vertical elastics with wired segments to prevent the extrusion of the lower anterior teeth and to accomplish a normal overbite through a downward movement of the upper alveolar process with little change in vertical height of the symphysis. In the premolar area, the open bite was improved by a vertical movement of the alveolar bone, resulting in a better intercuspation. The vertical movement of the alveolar process and alveolar bone is similar to the phenomenon observed in routine clinical practice when a tooth is lost. Tongue training has the same effect¹⁷. Light elastic force could easily induce vertical movement in the absence of the tongue thrusting between the upper and lower teeth. Even in a severe skeletal Class III open bite case similar to this patient's, vertical occlusal disharmony of the jaws could be corrected relatively easily, if a properly-selected force system is used with a modern orthodontic technique.

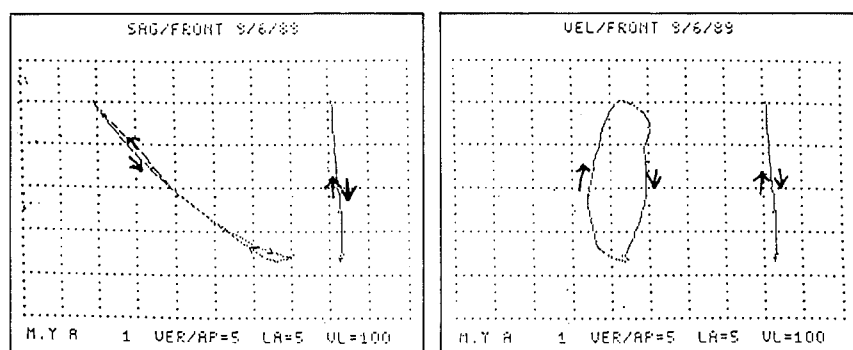
Post-retention stability has been achieved in this case. The factors contributing to the stability seemed to include the creation of a favorable perioral en-



Before treatment (14Y7M)

Sagittally, the muscles are pulling the mandible distally toward the existing unphysiologic ICP. Frontally, the muscles are pulled back a little, displacing the mandible slightly to the right to go back to ICP. A minor deviation from rest position to occlusal position is seen on the closing path.

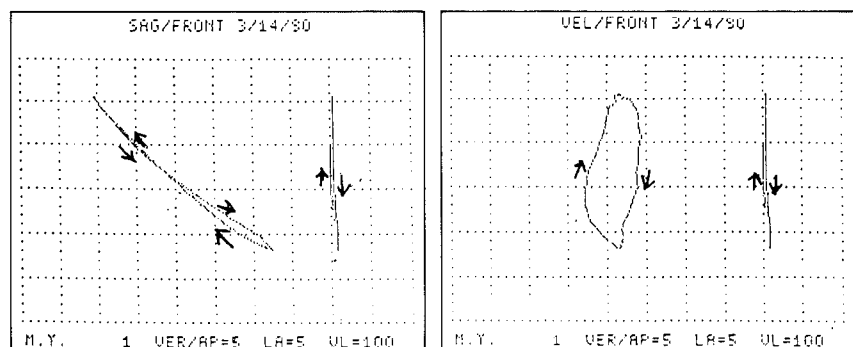
The velocity of habitual opening and closing is fluctuating, suggesting that the muscles are moving cautiously in closing.



10 months after retention (17Y8M)

Frontally, opening and closing paths are overlapping, which is favourable. Sagittally, the deviation from rest position to occlusal position has also improved.

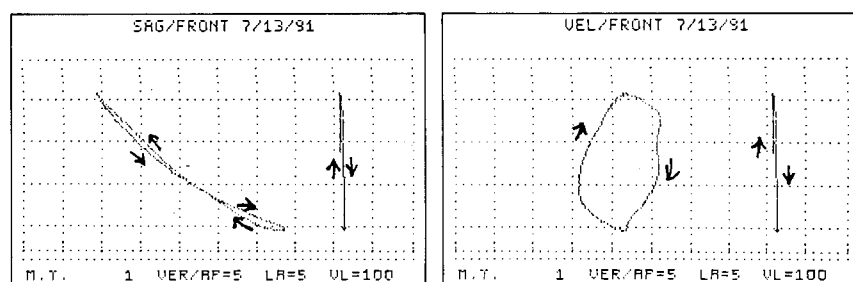
The velocity of habitual opening and closing increased and the movement is smooth. Frontally, there is little lateral deviation. The chewing muscles are moving smoothly.



2 years after retention (18Y10M) during upper third molar eruption.

A minimal displacement from rest position to occlusal position has begun to be seen on the closing path.

The velocity decreased slightly during upper third molar eruption.



3 years and 9 months after retention (20Y7M) after upper third molar extraction.

A minimal deviation from rest position to occlusal position is observed.

The velocity is increased and the movement is smooth.

environment with a widened tongue space and the adaptation of the tongue and perioral musculature through tongue training and constant vigorous gum chewing during a five month observation period prior to appliance removal, which seemed to have led to occlusal stability. To instruct the patient to chew gum seemed to be effective in restoring the behaviour of the tongue and perioral muscles to normal and correcting the open bite. Sakamoto¹⁸⁾ reported that it is desirable to enter into an observation period after the age of fifteen in girls for post-treatment stability. This patient's active treatment was finished at the age of sixteen years, ten months, which seemed to have added to occlusal stability after treatment. However, the patient underwent a vertical growth of the mandible during retention from the age of sixteen years, ten months to eighteen years, zero months, and the symphysis increased 2.0mm in vertical height. Ramus length (Go-Cd) increased 2.5mm from eighteen years, zero months to eighteen years, ten months (Fig. 15). This coincided with the period of upper third molar eruption. The patient complained of abnormal occlusal sensation during this time. The MKG and EMG records taken during this time also showed abnormalities, especially a major imbalance of masseter activities between right and left. The abnormal sensation disappeared five months after upper third molar extraction, which was also reflected in the MKG and EMG recordings showing a significantly improved balance of temporalis and masseter activities between right and left. These findings seemed to suggest that the presence of third molars affects post-treatment occlusion in some way. Third molar management would be needed after retention, if possible.

Fig. 18. MKG findings (K6 Diagnostic System). The velocity of habitual opening and closing increased as a result of orthodontic treatment. The mandibular deviation from rest position to occlusal position on the closing path is improved. However, when the patient came back with abnormal occlusal sensation during the eruption of the upper third molars (2 years after retention), the velocity of habitual opening and closing decreased on the MKG records. The velocity increased again 3 years and 9 months after retention or 5 months after upper third molar extraction.

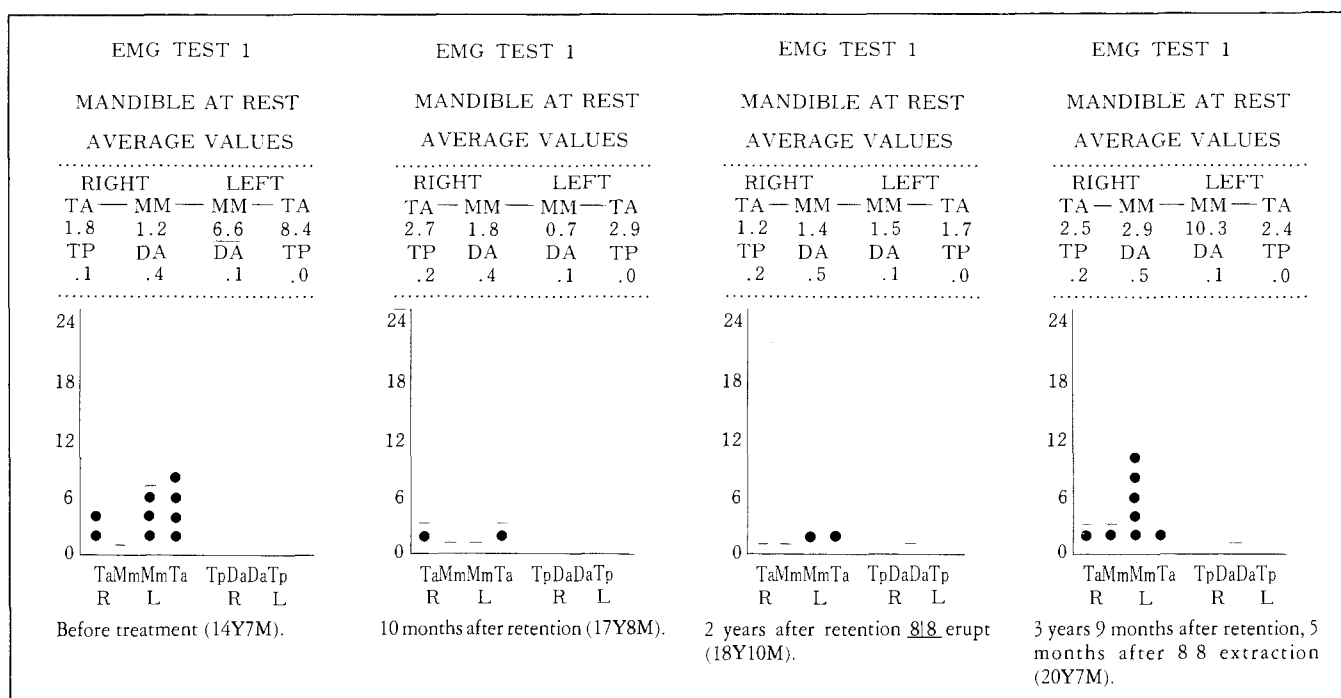


Fig. 19. EMG findings (K6 Diagnostic System). The imbalance of activities of the temporalis and masseter muscles, which were observed before treatment, improved after treatment. However, when the patient came back complaining of abnormal occlusal sensation in the molar area during the eruption of the upper third molars (2 years after retention: 18Y10M0) the EMG record shows a high retention in the left masseter. The balance of activities between right and left are very good 3 years and 9 months after retention (5 months after the extraction of the upper third molars), suggesting a stable mandibular position and a stable occlusion after retention.

It has been reported that the relapse which occurs in a skeletal Class III open bite case during retention after the end of mandibular growth is caused by a vertical relapse rather than an anteroposterior relapse of the upper and lower jaws¹⁹⁾. However, it was fortunate that a vertical relapse of the jaws did not occur in this case. This seemed to be related to several factors, firstly, the improvement of vertical occlusal disharmony, not by premolar extraction, but by non-extraction to maintain continuity of the arch. Also, vertical movement of the maxillary alveolar process and upper and lower alveoli in the premolar area, together with a concurrent vertical movement of the anterior and premolar teeth, adequately uprighed molar and premolar tooth axes and gained occlusal support in the posterior segment²⁰⁾. The widening of tongue space through maxillary arch expansion, resulting in the normal function of tongue and perioral muscles, was accompanied by a spontaneous resolution of allergic rhinitis and nasopharyngeal obstruction caused by the palatine tonsillar hypertrophy. All of these factors contributed to occlusal stability and the prevention of relapse. It remains unknown why allergic rhinitis and palatine tonsillar hypertrophy have resolved spontaneously. This could be

because of an improved perioral environment as a result of occlusal improvement or changes occurring with age. However, it seemed that the occlusal improvement and widened tongue space have favorably affected these symptoms in some way.

The patient and the author felt truly happy about the fact that the patient, classified as a surgical case, could be successfully treated only by orthodontic treatment to achieve occlusal and profile

improvements. This patient with a severe problem spared no effort, endurance and cooperation because of her strong desire to get well as soon as possible and to avoid surgery as much as possible. She won this good occlusion herself. She no longer has the complex she had before treatment. She gained confidence and more positive attitudes. Her expression shows a brightness which was never seen before treatment. Nothing is so rewarding to the operator.

Rate of Angle Class III Malocclusion

Race	general population	Rate of all the orthodontic patients
Caucasians	4~6% (Susami, Enomoto)	2.0% (my office Tokyo)
White	1~4 (Newman, Hotz)	

The incidence of Class III malocclusion among the Japanese is from 4% to 6%, but of all the orthodontic patients, Class III malocclusion accounts for anywhere from 20% to 30%. It has been reported that, in a certain dental office in the northern part of the country, the incidence rate of this type of malocclusion is as high as 55% to 65%.

In Japan we have more Class III patients than any other country of the world. The major reason is that Japanese are brachycephalic and have poor longitudinal maxillary growth. The white-skinned races are more dolichocephalic and have narrow dental arches.

This high incidence rate, as compared with the white race, creates a challenge to the Japanese orthodontist. Needless to say, depending upon how severe the cases happen to be, some form of surgical or orthopaedic operation is jointly used with orthodontic treatment.

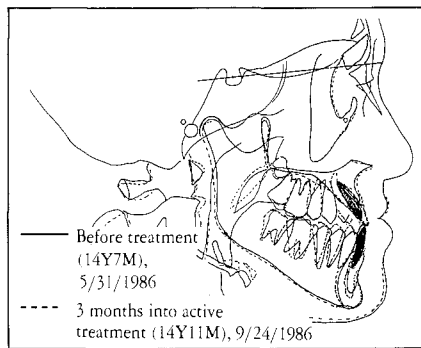


Fig. 20. Superimposition of lateral headfilms before and 3 months into treatment (on S-N at S). The upper and lower molars were uprighted and intruded 3 months after the start of treatment, creating a small clearance between the upper and lower arches in the molar area. As a result, occlusal interferences were eliminated and the mandible was freed. Short Class III elastics, the perioral muscles and other actions contributed to a slight distalization of the mandible. The maxilla moved forward and downward with the use of a protractor and vertical elastics in the anterior segment, eliminating most of the antero-posterior disharmony.

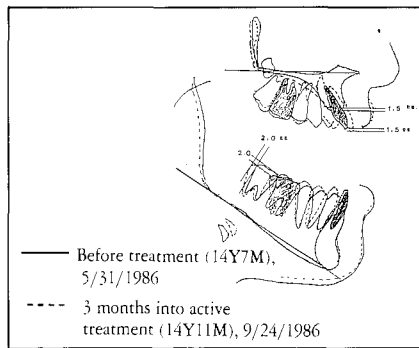


Fig. 21. Superimposition of palatal plane and mandibular plane before and 3 months into active treatment (on ANS-PNS at ANS, on mandibular plane at menton). The maxilla and upper arch moved slightly mesially. The mandible was distalized slightly. The lower molars were uprighted and intruded at the same time, causing the lower arch to move distally by a small amount. Anterior open bite was reduced as a result of a 1.5mm of descent of the upper alveolar process which was followed by 1.5mm of downward movement of the upper incisal edge, and 1mm of elongation of the lower incisor.

Acknowledgements:

I wish to take this opportunity to express my sincerest appreciation to the many prominent practitioners of the Begg technique for their guidance and strong support which have enabled me to pursue my rewarding career as an orthodontist of the Begg technique and which also gave me this honorable chance to present some of my recent work and cases treated with the Technique.

My special thanks go to Drs. Enoki and Motohashi of the Nippon Dental University; Drs. Begg and Sims of the Adelaide University, for their teaching; and to Drs. Enoki and Ohno for their guidance in the writing of this paper.

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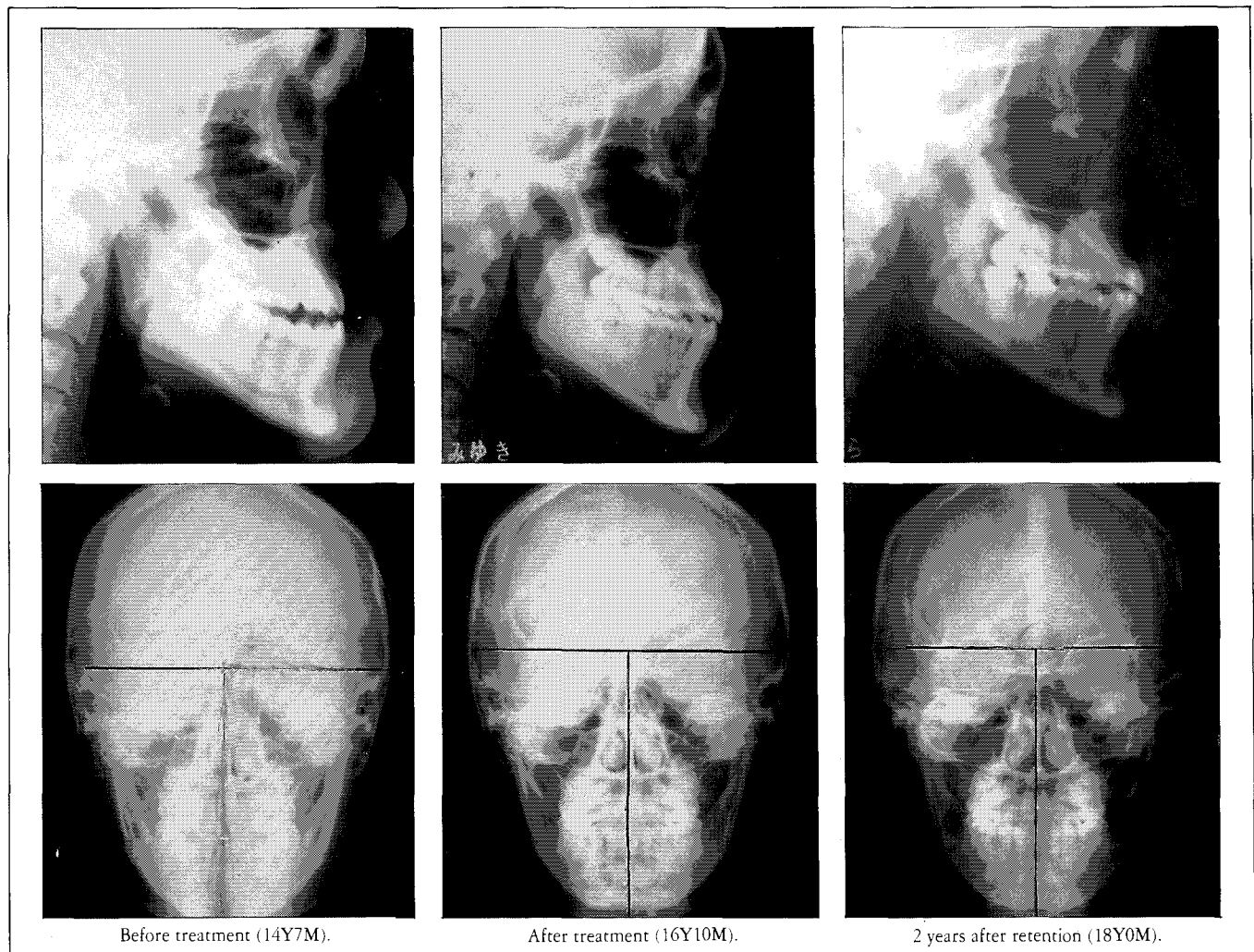


Fig. 22. Cephalometric changes from before treatment to 2 years after retention.

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