Manual for the Clinical Application of MEAW Technique

MEAW Orthodontic Therapy Using Multiloop Edgewise Arch-Wire

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Preface

It has been more than 20 years since the Multiloop Edgewise Arch-Wire (MEAW) was introduced in Japan. It was primarily used to treat open bite conditions but its usage has gone far beyond what it was originally designed for. It is now being used for the treatment of almost all types of malocclusions. In fact, most of the dentists and orthodontists in Japan use MEAW to treat their orthodontic cases. However, textbooks about the use of MEAW for orthodontic treatment have not been available and numerous practitioners have been requesting for it. Indeed there is a great demand for such a book and I had relayed this request to Dr. Young H. Kim, the author and proponent of MEAW, but unfortunately, due to his hectic schedule he was not able to complete it. Thus, the publication of a book on MEAW did not materialize.

Thus, for this reason, this textbook on the use of MEAW in orthodontic treatment was published with the help of Daiichi Shika Publications. This book does not contain the MEAW Technique and the philosophy of Dr. Y.H. Kim but it contains the basic concept and technique of using MEAW in the treatment of malocclusion.

Needless to say that the most important aspect in the treatment of malocclusion is the knowledge about it. If one lacks the knowledge about the strategic treatment and problem points of each malocclusion, the condition will not improve even with the use of MEAW. Dr. Y.H. Kim once said that MEAW is only a tool for treatment and nothing else. The use of MEAW is only significant once a treatment plan has been established based on the understanding of the malocclusion and its accurate diagnosis.

In this book, the treatment procedures applied with the use of MEAW in various types of malocclusion will be the center of discussion and illustrations as well as pictures were used for easier understanding. Nevertheless, the procedures and methods that are discussed in this book are not the only possible methods. Though treatment methods may vary from the ones discussed here, the ones used on each patient in this book were based on the patients’s condition.

Lastly, the publication of this book has been made possible with the encouragement and advice of Mr. Fujiwara of the Daiichi Shika Publications, Inc. and I would like to thank him from the bottom of my heart.

Sadao Sato
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1. Structure and Function of MEAW

(Sadao Sato)
1. STRUCTURE OF MEAW

Multiloop Edgewise Arch-Wire (MEAW) is an archwire with horizontal loops positioned at the interproximal spaces of each tooth from the distal part of the lateral incisors up to the posterior teeth (figure 1.1). The archwire is usually made up of 0.016” x 0.022” rectangular wire. The length and the loop size of the archwire are dependent upon the type of the patient’s case but basically, its structure is as shown in figure 1.2.

The reasons for bending the horizontal loops in the archwire are as follows:

1. Decrease the load / deflection rate, providing a low but continuous orthodontic force on the teeth.
2. The horizontal loop allows an easier control of movement for each tooth.
3. Makes the alignment and intrusion of the supraerupted tooth as well as the torque adjustment easy.
4. With the aid of elastics, it can reconstruct the occlusal plane.

Fig 1-3 shows the horizontal loop and its parts. Their functions will be discussed later.
1. Horizontal loop: the major part of the archwire; it relieves the vertical force and regulates the vertical movement of the tooth.

2. Breaker: it regulates the horizontal movement of the tooth and simultaneously moves each tooth and detailing may be done as well.

3. Loop base: it regulates the tip back bends and torque control.

4. Horizontal part of the archwire: This part is inserted into the bracket slot where the wire force is transmitted to the teeth.

   To create an ideal arch with the horizontal loop, the ideal archwire length is 2.5-3x the length of the usual archwire. This would decrease the orthodontic force by 1/5 and at the same time continuously applies an orthodontic force to the teeth. This allows tertiary regulation in the wire promoting an ideal tooth movement of the entire dentition.

II. MEAW Function

MEAW as shown in figure 1-4 consists of a tip back bend. The tip back bend varies from one patient to another depending on the treatment approach to the occlusal plane. But usually the tip back bend on each tooth is 2° – 3° and 15° - 20° for the entire dentition. The application of this archwire introrally and the use of elastics in the anterior teeth will improve the entire dentition.
The following are the variations in the elastic position (Fig 1-5 a-f)

1. Vertical elastics (a)
2. Short class II elastics (b)
3. Short class III elastics (c)
4. Triangular elastics (d)
5. Box form elastics (e)
6. Check elastics (f)

The synergistic effect of MEAW and elastics provide the following:

1. Alignment of the dentition
2. Control tipping of the occlusal plane
3. Control vertical dimension
4. Establish good intercuspalation
5. Control the tooth axis especially those with mesial tipping
III. Modifications of MEAW

MEAW is such a versatile wire and can be used in different types of malocclusion. The following are the different modifications of MEAW, each one applicable to a specific type of malocclusion.

1. The different types of adjustments (fig 1.6a-e)
   a. No adjustment
   b. Tip back bend
   c. Tip back bend (for no occlusal plane changes)
   d. Continuous step bend
   e. Partial step bend

During the treatment period, adjustment of the horizontal loop to a certain degree is possible when needed. (fig 1.7a-d).

Fig. 1.6 Types of bend adjustments
Fig. 1.7 MEAW loop adjustments
2. Modified Offset Arch Wire (MOAW) (Fig 1-8)
MEAW with offset in the premolar region is used in patients where vertical control and correction of the molars are needed. This is the first step of treatment for patients with class III high angle, crowding, or open bite conditions.

3. Sectional Modified Offset MEAW (SMOM) (Fig 1-9)
When sectional MEAW is attached to the premolar and molar teeth, vertical control can be applied to the said teeth, while with the application of an offset MEAW, there is anteroposterior control to the anterior teeth. This can be used for TMD cases with retruded mandibular position to obtain occlusal support and anterior guidance for the mandible.
2. Bending Method Used in MEAW

(Sadao Sato)
I. The Basic Structure of MEAW

MEAW consists of horizontal loops with an arch form similar to the ideal arch used in the final phase of edgewise treatment (fig 2-1). Therefore, the anatomical morphology of the dentition (i.e. the labial and buccal surfaces of teeth) is incorporated in the MEAW.

1. First Order Bend: bend in the horizontal direction of the dentition, it includes the lateral inset, canine offset (eminence) and molar offset.

2. Second Order Bend: the bend following the first order bend. Horizontal loop is incorporated in this step.

3. Third Order Bend: passive and active torque to control the tooth angulations.
   a. Passive torque: Torque incorporated into the archwire to prevent any changes to the angulations of the teeth. The purpose of the torque is to conform the shape of the wire to the labial and buccal surfaces of the teeth.
   b. Active torque: the wire is twisted/bent to change the tooth angulations.

II. Instruments Needed in MEAW construction

1. 0.016 x 0.022 inch rectangular wire (stainless steel or Blue Elgiloy wire)
2. Arch turret (arch former)
3. Pliers
   a. Kim pliers
   b. Tweed pliers
   c. Nance pliers
III. First Order Bend

Get the midline of the wire and with the use of an arch turret (arch former) create a mild curve in the anterior teeth. Then create an inset between the central and lateral incisors by marking the part to be bent and using a Tweed plier, bend the wire inwards mesially and outwards distally bilaterally. Determine the degree of inset at this stage.

IV. Second Order Bend (horizontal loop)

The procedure in creating a horizontal loop, which is the basic element in MEAW, is shown in fig 2-2a. The plier to be used in this procedure is the Kim plier. The horizontal loop of the upper and lower wire is around 18-20 degrees. After placing the first order bends and horizontal loops in the archwire, it is important to have symmetry of the right and the left side of the archwire.

Fig. 2.2a MEAW bend
Fig. 2.2b MEAW bend
Fig. 2.2c MEAW bend
V. Third Order Bend (torque bend)

When MEAW is bent and the torque for the entire dentition has been planned, use an arch former to get the shape of the dentition and use the torque slot to twist the wire. However, there are cases where torque adjustment is needed during the orthodontic treatment procedures. In this regard, the principle behind the torque bend has to be understood.

There are basically 3 elements for torque bend.

1. Dental curve (First order bend)
2. Straighten the curve of the first order bend
3. Twist of wire

To do a labial crown torque in the anterior part of the MEAW, make a slight curve in the anterior region of the archwire as shown in fig 2-3. Twist inward the wire starting from the distal of the first loop. The degree of the torque adjustment at this stage is dependent on the curve strength. Then tightly clamp the legs of the first horizontal loop located at the distal surface of the lateral incisors and bend to vertically straighten the first loop that has tipped distally.

VI. Heat Treatment for MEAW

To activate the wire, it is subjected to a 5-10 minute heat treatment at 500°C, with the use of an electropolishing treatment, before the MEAW is inserted into the patient’s mouth. In the absence of a furnace, an alcohol lamp can be used. Heat the wire until the color changes to golden brown. Make sure that the color is even.
3. Adjustment Methods Used in MEAW

(Sadao Sato)
MEAW Adjustment

Various types of bends like the tip back and step bend can be utilized in the treatment depending on the patient’s case. These types of bends may initiate either activation for the progression of the treatment or could be adjusted for deactivation purposes. The basic adjustment techniques are discussed below.

1. **Tip-back activation**
   
   In order to incorporate tip back bends into the archwire, adjust the horizontal loop of the MEAW from a right angle to an acute angle (fig 3.1). Use the plier to bend and the other hand to hold the loop.

2. **Tip-back deactivation**
   
   Deactivation is done by weakening the tip-back bend when the alignment of the entire dentition has been completed. Tip back deactivation starts from where the tip back bends were placed.

![Fig. 3.1 MEAW adjustment, Tip-back bend](image-url)
3. **Step-down bend**

To selectively extrude a tooth, MEAW is adjusted through a step bend. To do this, expand the horizontal loop using the plier and bend the anterior portion of the horizontal loop to lower the loop base.

To make a step bend during the treatment, insert the plier into the horizontal loop and create a new permanent shape (fig 3-2). In case the degree of step is insufficient, do the adjustment as shown in fig 3-3.
4. **Selective tooth intrusion**

A step up bend can be done for selective tooth intrusion. A step down bend is adjusted to its opposite direction to form a step up bend.

5. **Tip-back bend without changing the occlusal plane**

When aligning the tooth axis without changing the occlusal plane, step-down bend and tip back bend adjustments can be done as shown in fig 3-4.

6. **Curve of Spee**

At the last procedure of treatment, an anteroposterior compensatory curve bend is placed to the dentition and the adjustment is shown in fig 3.5.
4. Patient Evaluation and Treatment Plan

(Sadao Sato)
I. Records Needed for the Diagnosis

Below are the records needed for the case analysis of a patient with malocclusion.

1. Patient’s dental history
2. Intra-oral photos
3. Facial profile photos
4. Panoramic radiograph
5. Cephalometric radiograph
6. Diagnostic dental cast (mounted)
7. Record of condylar movement (axiograph)
8. Others: TMJ x-ray, MRI etc.

The basis for the morphological characteristics of the patient at this stage is not sufficient but can be substantiated by doing a cephalometric analysis.

II. Kim’s Method of Analysis

1. ODI (Overbite Depth Indicator)

This is used as an indicator for vertical types of malocclusion which are the open bite and deep overbite conditions. In ODI, the main element for measurement is the AB-MP angle. This angle is a reliable indicator of the vertical dimension of malocclusion. More specifically, there is a strong correlation of the vertical dimension of malocclusion and the lower facial area especially the adaptation of the mandible. Therefore, the angle measurement should be understood as a figure representing the correlation of skeletal adaptation in occlusal function.

Two greatest factors which decreases ODI

1. High angle open bite condition resulting from mandibular hyperdivergence
2. Class III condition resulting from the anterior adaptation of the mandible

Either of these two factors may affect the vertical dimension of malocclusion. To determine whether a case is a low or high angle is not the only important aspect in diagnosis. What is more significant is to be able to discover the cause of such conditions.
2. **APDI (Anteroposterior Dysplasia Indicator)**

APDI, as the word implies, is the indicator of the antero-posterior relationship of the upper and lower jaw. This figure, as shown in figure 4-1, is a result of the statistical analysis of Kim where it determines the combination of the facial plane angle, AB-MP angle, and FH-PP angle which is geometrically equivalent to the PP-AB. Therefore PP-AB is apparently the antero-posterior relationship of the upper and lower jaw. This is self-explanatory.

3. **CF (Combination Factor)**

CF is a combination of ODI and APDI. CF represents the tendency of the mandible to open. A high CF indicates a tendency for low angle but when the CF is low, it shows the tendency for high angle. According to Dr. Kim, this serves as an indicator to determine the need for tooth extraction prior to the orthodontic treatment. Thus, when the CF is low, the need for tooth extraction is higher.
III. Denture Frame Analysis (Fig 4-2)

Denture frame is the occlusal component of the basic facial skeleton which consists of the palatal plane in the basal plane of the maxilla, the AB plane in the anterior limit of the upper and lower jaw, and the mandibular plane (MP), known as the triangular pattern. The balance of this triangular pattern is closely related to the tipping of the occlusal plane and the vertical dimension in the functional plane of the occlusal system. Therefore it is possible to find out the balance of the triangular plane by checking the relationship of the occlusal plane to the patient’s characteristics.

Fig. 4-2. Denture frame analysis

IV. Occlusal plane and the Denture Frame

Occlusal plane is the most important plane for the function of the masticatory organ. The mandible functionally adapts to this occlusal plane. Therefore, any change in the occlusal plane will affect the mandibular position as well as the balance of the denture frame.

Below are the characteristics of the denture frame.

1. Class III Malocclusion (Fig 4-3 a,b)

In a class III skeletal pattern, the occlusal plane is flat. Since the vertical dimension is excessively high, the mandible adapts through an anterior rotation resulting to Class III High Angle. However, when the vertical dimension is low with an anteriorly over-rotated mandible, the possible result would be a closed bite condition resulting to a Class III Low Angle. It is therefore important to understand clearly each patient’s characteristics in creating a treatment plan.

2. Open bite (Fig 4-4 a,b)

Open bite is divided into two major types, the Class III and Class II open
bite conditions. The basic treatment method for each type varies. Therefore, it is very important to distinguish one from the other. Class III open bite is characterized by lingual tipping of the anterior teeth due to a flat occlusal plane while Class II open bite displays a posterior rotation of the mandible related to a steep occlusal plane.
3. **Class II Malocclusion** (Fig 4-5a, b)

The common type of class II malocclusion is usually characterized by a steep occlusal plane. This type of Class II problem, therefore, resulted from the failure of the mandible to adapt anteriorly.

However, in patients with sufficient occlusal support due to the excellent vertical growth of the mandibular ramus, the maxilla rotates anteriorly allowing occlusal adaptation. The occlusal plane, in this case, is flat.

4. **Lateral Displacement of the Mandible** (Fig. 4-6)

In patients manifesting a lateral displacement of the mandible, the occlusal plane on both sides usually differs. The mandible is displaced to the side where a steep occlusal plane is evident. In addition, there is also a functional disorder of the TMJ usually on the displaced side. It is important to consider these factors in establishing a treatment plan.
5. Treatment of Class III Malocclusion (High Angle)

(Akiyoshi Shirasu)
I. General Characteristics of Class III Malocclusion (High Angle)

Class III Hyperdivergent Malocclusion is the skeletal reversed occlusion that is associated with an open bite condition. This is the type of malocclusion where heredity constitute the strongest etiologic factor and is considered to be one of the most difficult orthodontic cases to treat. Generally, the morphological characteristics of this malocclusion are poor antero-posterior growth of the maxilla and excessive growth of the mandible. The usual treatment for this type of malocclusion is through the use of a maxillary protraction device, chin cap appliance and surgery.

When this patient is examined carefully, the maxillary occlusal plane is flat. This resulted from molar crowding (posterior discrepancy) related to the insufficient eruption space caused by the insufficient antero-posterior diameter due to an increased vertical growth of the maxilla. Consequently, it caused the supraeruption of the molars resulting to an open bite condition bringing about a high vertical dimension. This phenomenon could cause some molar interference and will give rise to the anterior rotation and displacement of the mandible resulting to a skeletal reversed occlusion.

Malocclusion cannot be simply considered as an abnormal skeletal growth alone but rather a functional abnormality as well.

II. Morphological Characteristics of Class III Malocclusion (High Angle)

The morphological characteristics of Class III malocclusion are: excessive vertical dimension, flat occlusal plane, and reversed Curve of Spee in the lower molars due to posterior discrepancy, a short antero-posterior diameter of the maxilla, mandibular anterior displacement, weak bone tissues and an obtuse FH-MP angle. The eruptive force of the tooth is intense and the tooth crown length is long. Moreover, labial tipping of the maxillary teeth, lingual tipping of the mandibular teeth, poor antero-posterior growth of the neurocranial base, narrow cranial angle (especially the occipital bone angle) are symptoms of the disharmony of the entire craniofacial skeleton.
III. General Treatment Objectives for Class III Malocclusion (High Angle)

The treatment objective for Class III reversed occlusion (High Angle) includes the attainment of a dynamic harmony of the craniofacial skeleton by restoring a functional mandibular movement and a harmonious skeletal framework. This can be done through an approach that focuses on the occlusal system. This requires an understanding of the dynamic mechanism of the entire craniofacial skeleton and the morphological characteristics of malocclusion.

There are two treatment objectives for this type of case which are:
1. To eliminate posterior discrepancy
2. To steepen the occlusal plane (tipping the occlusal plane and decreasing the vertical dimension in the molar area)

IV. Treatment Procedure for Class III Malocclusion (High Angle) (Fig. 5-1)

Elimination of posterior discrepancy is initially needed. In order to attain this, the mandibular 3rd molars, and the maxillary 2nd (or 3rd molars) are extracted.

The treatment procedures are as follows:
1. **Step 1. Leveling.** Attach the brackets and tubes to the entire dentition, and start leveling using an 0.014-inch roundwire. (Fig 5-1a)
2. **Step 2. Elimination of Interference.** Attach the MEAW appliance to the upper and lower teeth, use a tip back bend activation from the premolar to the molar areas. Elimination of the interference in the molar area can be done through alignment and intrusion. (Fig 5-1b)
3. **Step 3. Establish mandibular position.** Strengthen the tip back bend in the molar area, remove the tip back bend in the premolar area and use a step up bend instead to erupt the teeth. This will establish a stable mandibular position. (Fig 5-1c)
4. **Step 4. Occlusal Plane Reconstruction.** Remove the tip back bend in the entire MEAW appliance and use a step up bend in the molar area of the lower jaw to steepen occlusal plane. Step down bend can be added to the anterior teeth of the upper jaw for occlusal reconstruction. (Fig 5-1d)
5. **Step 5. Obtain a physiologic occlusion.** Do a tooth axis control (torque control), adjust the occlusal guidance and obtain a good intercuspatio. (fig 5-1e)
Fig 5-1 Illustration of the Treatment Procedure for Class III Malocclusion (High Angle)

a. Leveling
b. Elimination of interference
c. Establish the mandibular position
d. Reconstruction of the occlusal plane
e. Obtain a physiologic occlusion
1. **Patient History**

   Chief Complaint: lower jaw protrusion
   Age: 12y 9mos.  
   Sex: Female

   Facial profile: face is oblong, mild protrusion of the chin. (Fig 5-2)

   Intra-oral photos: The occlusal relationship of the canine and molars is Angle’s class III with an overjet of –1.4 mm, and an overbite of –0.2 mm. (fig 5-3)

   Cephalometric radiogram: SNA 77.1°, SNB 77.6°, ANB – 0.5°, showing a protrusion of the mandible. FH-MP is 38.1°, PP-MP is 40.9° showing a tendency for High Angle. Antero-posterior dimension of the maxilla A’-P’ is 46.2 mm, UOP (P) 81.1°, displaying a flat occlusal plane.
According to Kim’s analysis, an ODI of 49.0°, APDI 87.3°, CF 136.3° is indicative of a class III high angle condition with a low CF value. This will require tooth extraction (fig 5-17a, b, chart 5-1 pre-treatment).

Panoramic x-ray: Absence of upper 3rd molars, and presence of only the left mandibular 3rd molar (fig 5-4).

2. Diagnosis and Treatment

This patient was diagnosed to have a skeletal class III High Angle condition due to an FH-MP of 38.1°, which is obtuse, and a PP-MP of 40.9°. The anteroposterior diameter of the maxilla A’P’ is short, 46.2 mm. It was observed that the upper 3rd molars are not present and only the lower left 3rd molar is present. This is considered to be a case of a strong skeletal factor.

In this type of case, the usual or traditional treatment of choice for the skeletal problem is through the use of a chin cap appliance for the inhibition of mandibular growth, and the facemask to stimulate maxillary growth. However, a significant treatment effect cannot be expected from these types of appliance in terms of improving the disharmony of the entire craniofacial skeleton.

The treatment objectives after the extraction of the lower 3rd molar were to obtain a dynamic harmony of the craniofacial skeleton, restore the dynamic mandibular movement through stabilizing the disharmonized craniofacial skeleton and the active approach to improve the occlusal system through the use of the upper and lower MEAW.
3. Progress of Treatment

Step 1: Leveling
Standard edgewise brackets and tubes were attached to the upper and lower teeth. Leveling was started with the use of a 0.014-inch super elastic wire.

Step 2: Elimination of occlusal interference
A month later, MEAW was applied to both the upper and lower dentition in order to eliminate the molar interference. Alignment and intrusion was started through a progressive tip back bend of 5° from the premolar teeth to molar area using a vertical elastic and a short class III elastic (3/16 inch, 6 oz) in the anterior teeth (fig 5-6).

Step 1

Fig. 5-5 Intra-oral pictures during the start of leveling

Step 2

Fig. 5-6 1st month: Stage of interference elimination with MEAW
Two months later, an additional 5° tip back bend in the molar area was done and alignment and intrusion were continued. Moreover, a step down and a step up bend was done in the upper and lower premolar areas respectively, where infraversion of the said teeth are apparent. The increase of the vertical dimension in this area was started. Mandibular position was distalized due to the decrease of vertical dimension in the molar area (fig 5-7).

Step 3: Establishing mandibular position

On the 3rd month, after the interference has been eliminated through alignment and intrusion in the molar area, mandibular position was distally guided through the decrease of vertical dimension in the molar area. The anterior teeth overlap has primarily deepened. To erupt the infra-erupted premolars, a step down bend in the lower anterior and canine teeth was done. The tip back bend in the molar area and the rest was adjusted. A vertical elastic was used in the anterior teeth (fig 5-8). On the 5th month, a step up bend was done in the anterior and canine area of the upper dentition to obtain an appropriate vertical dimension and to physiologically guide the mandible to a stable position. The anterior teeth overlap was improved by obtaining a physiologic vertical dimension. The tip back bend was removed in the upper molar area. A vertical elastic was used in the anterior teeth (fig 5-9).
Step 3

Fig. 5-6 3rd month: Stage where mandibular position was established

Fig. 5-9 5th month: Stage where mandibular position was established
Step 4

Fig. 5-10: 6th month: Stage of occlusal plane reconstruction

Fig. 5-11: 7th month: Stage of occlusal plane reconstruction
Step 4: Occlusal plane reconstruction

On the 6th month, the tip back bend in the lower molar area was removed and the MEAW was flattened because the molar interference has been eliminated, vertical dimension in the premolar area was improved, a physiologically stable mandibular position was obtained. The step up bends in the anterior teeth, canine and premolar areas of the maxilla were also removed. A short class III elastic and a short class II elastic was used in the right and left side respectively, to improve the midline (fig 5-10).

Seven months since the start of treatment, a step down bend was placed in the upper canine and anterior area to initiate the steepening of the maxillary occlusal plane. A Mulligan appliance was used to expand the maxillary dental arch. In addition to that, the Curve of Spee was placed to actively erupt the lower molars. To maintain a stable mandibular occlusion, the step up bend was removed in the lower dentition except on the anterior area. A better intercusption was achieved due to the removal of the step up bend. Vertical elastic and a short class II elastic was used in the right and left side respectively (fig. 5-11).

Step 5:

On the 10th month, the reverse bend in the lower molar area was replaced with a step down bend. The improvement of occlusal guidance and intercusption was done through torque control and detailing. A good occlusal relationship was then attained. A vertical elastic was used in the anterior area (fig 5-12).

Fig. 5-12 10th month: Attainment of a physiologic occlusion stage
During the 11th month, the step up bend in the lower molar area was removed and the intermaxillary elastic was discontinued (fig. 5-13).

**Step 6: Retention**

A stable occlusion was obtained on the 13th month of the treatment period. The entire appliance was removed and a tooth positioner was used to start the retention (fig. 5-14).
4. Treatment Results

An approach to the occlusal system and improvement of the disharmony of the entire maxillofacial skeleton was done even if this case has a strong skeletal factor. The facial profile has changed to mesocephalic type and the mandibular protrusion was improved (fig 5-15). Intra-oral findings were Angle’s class I canine and molar relationship, overjet of 3.5 mm, overbite of 1.0 mm, showing a significant improvement (fig. 5-16). The lateral cephalometric radiogram showed an improvement in the mandibular protrusion with an SNA of 79.0°, SNB 76.6° and ANB of 2.4° (fig 5-17c, d, chart 5-1 post treatment). UOP (P) of 71.1° shows the tipping of the occlusal plane, functional movement of the mandible was restored and dynamic harmony of the craniofacial skeleton was attained.
Fig. 5-17 Lateral cephalometric radiogram and superimposed tracings

a. Tracings (pre-treatment)  
b. X-ray (pre-treatment)  
c. Superimposed tracings of pre and post-treatment  
d. X-ray (post-treatment)  
e. X-ray (2 years after retention)
There are no significant changes in the intra-oral findings (fig 5-18) and lateral cephalometric radiogram (fig 17 e, chart 5-1 2 years post-tx) 2 years post retention. As shown in the occlusal photos and panoramic x-ray, the upper molar has erupted normally obtaining a stable occlusion (figs. 5-18 and 5-19).
Fig. 5-18 11th month: Intra-oral pictures showing the occlusal condition 2 years post-retention

Fig. 5-19 Panoramic x-ray showing the occlusal condition 2 years post-retention
6. Treatment of Class III Malocclusion (Low Angle)

(Akiyoshi Shirasu)
I. General Characteristics of Class III Malocclusion (Low Angle)

Class III malocclusion (low angle) also known as functional reversed occlusion, shows an insufficient vertical growth in the maxilla, insufficient vertical dimension in the posterior area and a steepening of the occlusal plane in the upper molar area. Therefore, there is a disharmony in the relationship between the vertical dimension and the vertical growth of the mandibular condyle.

Normally, the antero-posterior growth of the maxilla is not the problem. The deep overbite reversed occlusion is due to the excessive anterior rotation of the mandible related to the insufficiency of the vertical dimension.

This problem is generally or traditionally corrected through the use of a FKO appliance, which is a functional orthodontic appliance, a chin cap appliance for growth control, and alveolar movement for occlusal reconstruction. However these appliances deliver an enormous load to the patient and lengthen the treatment period.

The main problem of these cases is the disharmony of the vertical dimension which ought to be addressed and improved.

II. Morphological Characteristics of Class III Malocclusion (Low Angle)

In class III malocclusion (Low Angle), the vertical growth of the mandibular condyle is very active due to an insufficient vertical growth of the maxilla, comparatively longer antero-posterior diameter of the maxillary basal bone than high angle cases, mild posterior discrepancy, tipping of the occlusal plane in the upper molar area, significant Curve of Spee, and insufficient vertical dimension, showing a deep anterior overbite and a reversed occlusion due to the excessive anterior rotation of the mandible.

Below are the morphological characteristics:

1. Thick bone tissue, weak eruptive force of the teeth, and clinically short tooth crown length.
2. Excellent growth of the mandibular condyle, but low vertical dimension.
III. The General Treatment Objectives for Class III Malocclusion (Low Angle)

The usual treatment approach in this type of malocclusion is correction of the negative overjet through the movement of the dento-alveolar bone with the use of a finger spring, lingual arch appliance, and FKO appliance. However, these are not the appropriate treatment methods for this type of malocclusion.

The treatment objective for this case should be the inhibition of an excessive functional mandibular rotation by increasing the vertical dimension and maxillary height. If the occlusal support is secured with the increase of intermaxillary distance, the growth of the sphenoid and ethmoid bones are stimulated through the maxillary and temporal bones due to mastication and various functions of the oral cavity. This secondarily restores the harmony of the craniofacial skeleton.

Below are the treatment objectives for this case:
1. Increase maxillary height
2. Increase vertical dimension (flatten the occlusal plane which is steep in the upper molar area)
3. Inhibit excessive functional anterior rotation of the mandible

IV. Treatment Procedure for Class III Malocclusion (Low Angle) (fig 6-1)

To flatten the occlusal plane, the lower 3rd molars, and either the upper 2nd or the 3rd molars can be extracted. The upper 2nd and lower 3rd molars were extracted in the case presented below and the following were the treatment procedures:

1. **Step 1. Leveling.** Attach the brackets to the entire dentition (tubes on the terminal molars) and start leveling using a 0.014-inch roundwire. (fig. 6-1 a)

2. **Step 2. Elimination of Interference.** Place the MEAW on both the lower and upper dentition and put a tip back bend in the molar area to eliminate molar interference, through alignment and intrusion. Make a step bend in the premolar area to improve the vertical dimension and raise the bite. (fig 6-1b)

3. **Step 3. Establishing mandibular position.** Strengthen the tip back bend in the molar area. In addition, strengthen the step bends in the premolar area in order to obtain the appropriate vertical dimension. Establish a physiologically stable mandibular position through bite-raising and the eruption of the premolar teeth. (fig 6-1c)

4. **Step 4. Occlusal Plane Reconstruction.** After the improvement of the physiologic vertical dimension and the attainment of a stable mandibular position, the tip back bend in the MEAW is entirely removed. A step down bend is then done to flatten the occlusal
plane in the upper molar area, which erupts the molar teeth, and reconstruction of the occlusal plane is being done. (fig 6-1d)

5. Step 5. Attainment of Physiologic Occlusion. Do tooth axis control (torque control), regulate the occlusal guidance and attain a good intercuspation. (fig 6-1e)
1. Patient's History

Chief Complaint: Protrusion of the mandible
Age: 14       Sex: Female
Facial profile: Face is small, and shows protrusion of the lower jaw (fig. 6-2)
Intra-oral findings: the occlusal relationship of the canine and molar teeth is Angle Class III, overjet is –2.5mm and overbite is 6.0mm. (fig. 6-3)
Facial cephalometric radiogram: SNA 81.7°, SNB 82.2°, ANB –0.5°, indicative of a mandibular protrusion. FH-MP is 22.1°, PP-MP is 21.9°, a low angle tendency. The antero-posterior diameter of the maxilla A’-P’ is 46.8mm, UOP is 61.9° showing a steepening of the occlusal plane. Based on Kim’s analysis, ODI is 63.8°, APDI 94.4°, CF 158.2°, displaying an Angle’s class III condition (fig 6-17a, b, chart 6-1 pre-treatment).

Panoramic x-ray: upper and lower 3rd molars are present (fig 6-4).

2. Diagnosis and Treatment Plan

This patient was diagnosed to have a class III reversed occlusion (low angle) with the following characteristics: anterior rotation of the mandible, insufficient vertical dimension and steepening of the posterior occlusal plane as evident in the FH-MP of 22.1°, and UOP (P) of 61.9°.

The main treatment objective was to improve the anterior teeth overlap through dental movement. However, the more important goal in treating this patient is to inhibit the excessive functional rotation of the mandible by increasing the vertical dimension and maxillary height, consequently restoring the craniofacial harmony by achieving a physiologic intermaxillary distance.

Therefore, as part of the treatment plan, alignment is done on the lower molar area, where mesial tipping is evident, and extraction of the lower 3rd molars is done for bite raising in the premolar area. Extract both the upper 2nd molars to facilitate the correction of the maxillary occlusal plane.
3. Progress of Treatment

Step 1: Leveling

The molar tubes and standard edgewise brackets were attached to the upper and lower dentition. Leveling was started with the use of an 0.014-inch super elastic wire (fig 6-5).

Step 2: Elimination of occlusal interference

MEAW was placed a month after the onset of treatment, and alignment and intrusion in the molar area was started by using a tip back bend of 25° to eliminate molar interference. In addition, a step down and step up bend was done in the premolar area to improve the vertical dimension. A vertical elastic and a short class III elastic (3/16 inch, 6 oz) was used in the anterior teeth (fig

Fig. 6-5 Intra-oral pictures during the start of leveling

Fig. 6-6 1st month of treatment: Elimination of interference stage and MEAW illustration
6-6). On the 2nd month of treatment, alignment and intrusion was continued with an increase of 5° on the tip back bend of the molar area. Vertical dimension was also improved by increasing it through strengthening of the step up bend in the lower and step down bend in the upper premolar areas. This initiated the opening of the mandible and its movement to a distal position. A short class III elastic and a class III component box type elastic were used for premolar teeth eruption (fig 6-7).

**Step 3: Establishing mandibular position**

On the 3rd month, a step up bend was created in the anterior and canines to obtain an appropriate increase of the vertical dimension in the premolar area, increasing the opening of the mandible thus establishing a stable mandibular position. The tip back bend in the molar area was removed because the interference has been eliminated through alignment and intrusion. Improvement of the anterior teeth overlap was done by opening the bite in the molar and anterior area. A vertical component box type elastic was used to obtain a mandibular position and to erupt the premolars (fig 6-8). On the 4th month, the appropriate vertical dimension was obtained and a stable mandibular position was achieved. Furthermore, anterior negative overjet was improved. The step up bend between the molar and premolar teeth was removed and the occlusion was allowed to stabilize. A class III elastic and a vertical component box type elastic was used on the right and left side respectively to stabilize the occlusion in the premolar area and obtain the proper mandibular position (fig 6-9).
Step 3

Fig. 6-8 3rd month: Stage in establishing the mandibular position

Fig. 6-9 4th month: Stage in establishing the mandibular position
Step 4

Fig. 6-10 5th month: Occlusal plane reconstruction stage

Fig. 6-11 6th month: Occlusal plane reconstruction stage
Step 4: Reconstruction of occlusal plane

On the 5th month, the step bend between the upper canine and premolar teeth as well as the bend between the lower molar and premolar teeth were removed to flatten the occlusal plane in the upper and lower molar areas. Anterior overbite has deepened securing a stable occlusion. A vertical component box type elastic was used (fig 6-10). On the 6th month, the step up bend in the maxilla was entirely removed and a reverse bend was used in the molar area to flatten the occlusal plane. The step up bend in the lower dentition except the anterior area was removed to flatten the occlusal plane. Removal of the step up bend allowed a closer occlusal relationship in the anterior area. A vertical elastic was used in the anterior area (fig 6-11).

Step 5: Attainment of a physiologic occlusion

On the 7th month, the step up bend in the lower anterior area was maintained but the reverse bend in the upper molar area was removed. Axis control was done to obtain a good intercuspsation and to adjust the occlusal guidance, rendering a closer occlusion. The intermaxillary elastic was discontinued (fig 6-11).

On the 8th month, the step up bend was entirely removed (fig 6-13).

Fig. 6-12 7th month: Stage of attaining a physiologic occlusion
Step 6: Retention

On the 9th month of the treatment period, the brackets were entirely removed because a stable occlusion has been achieved and retention was started with the use of a tooth positioner (fig 6-14).
4. Treatment results

After 9-months of treatment aimed at inhibiting the excessive functional mandibular movement and actively increasing the maxillary length and vertical dimension, the facial profile has changed to a mesocephalic type, and the mandibular protrusion has improved (fig 6-15). Intra-oral findings showed an Angle’s class I canine and molar relationship, overjet was 3.5 mm, and overbite was 1.1mm showing an improvement (fig 6-16). The lateral cephalometric radiograph showed an ANB of 1.0º with an SNA of 81.1º and SNB 80.1º, showing an improvement in the mandibular protrusion. FF-MP was 24.2º, and PP-MP became 23.7º. UOP (P) was 85.4º, evident of a flat occlusal plane.
Fig. 6-17 Facial cephalometric radiogram and the superimposed pre and post-treatment tracing

- a. Pre-treatment tracings
- b. Pre-treatment x-ray
- c. Superimposed tracings of pre and post-treatment
- d. Post-treatment x-ray
- e. X-ray after a 2-year retention
### Chart 6-1 Cephalometric Analysis

<table>
<thead>
<tr>
<th>Denture Frame Analysis</th>
<th>Norm</th>
<th>Pre-TX</th>
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<th>2 years Post-TX</th>
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<tr>
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(fig 6-17c, b chart 6-1 post treatment).

There were no significant changes in the intra-oral findings and the cephalometric radiograph even after the 2-year retention period (fig 6-17c, chart 6-1, 2 years treatment). The intra-oral x-rays even showed the normal eruption of the maxillary 3rd molars (fig 6-19) and a stable occlusion.
Fig. 6-18 Intra-oral photos showing the occlusal condition after 2-years of retention

Fig. 6-19 Panoramic x-ray showing the occlusal condition after 2-years of retention
7. Treatment of Class I Open Bite

(Susumu Akimoto)
1. General Characteristics of Class I Open Bite

Class I open bite has a normal antero-posterior occlusal relationship. Occlusion is just not possible because of the vertical gap in the upper and lower anterior teeth, best described as a negative overbite (fig 7-1).

An open bite condition during the permanent dentition period is one of the most difficult malocclusions to treat. However, this can be easily managed upon consideration of the factors mentioned below.

1. **Main causes for open bite condition**

   There are various factors that could lead to an open bite condition. The most common causes are as follows:

1. Bad habits: thumbsucking, tongue biting, lip biting, abnormal swallowing etc.
2. Respiratory: tonsillar enlargement, enlargement of the adenoid, oral respiration, allergic rhinitis etc (fig. 7-2)
3. Posterior discrepancy: insufficient eruptive space for the molars (fig. 7-3). This could lead to their supruration.
4. Others: Incorrect dental treatment (restorative material is too high), large tongue, heredity etc.

![Fig. 7-1 Cephalometric tracing of a patient with an open bite condition](image1)

![Fig. 7-2 Cephalometric radiogram showing the areas of soft tissue defect (T: enlargement of the tonsils, A: adenoid enlargement, E: allergic rhinitis)](image2)
The greatest difference between the traditional method of treatment using the multi-bracket system and the treatment approach being introduced in this book is that premolar extraction is hardly done. Though the mechanism of the multi-bracket system is quite related to the mechanism of MEAW, the difference lies in the diagnosis. With the traditional mechanics of premolar extraction, the molar can be moved mesially to use the extracted space. This in turn results to the decrease in the vertical dimension which is useful in improving the negative overbite in the anterior teeth. However, this is considered a symptomatic approach to treatment. The most important aspect in all types of orthodontic treatment is to identify the cause and eliminate it. Thus providing an extremely simple kind of treatment possible. In this case, one of the most important aspects to consider is the close relationship of the open bite and the presence of the 3rd molars. In this light, posterior discrepancy is the cause of the open bite condition.

2. Abnormalities due to Open Bite

1. Facial asymmetry
2. Functional abnormalities: mastication, swallowing, pronunciation, tongue, lips etc.
3. Psychological abnormalities
II. The Morphological Characteristics of Class I Open Bite

The morphological characteristics of this condition are, small ODI, a steepening of mandibular plane, obtuse mandibular angle, excessive anterior facial height, excessive low posterior facial height, flat occlusal plane, upward tipping of the lower occlusal plane, upward tilting of the palatal plane etc.

III. Evaluation of the Occlusal Plane

The examination of occlusal plane is important especially during the treatment of an open bite condition. Normally, the occlusal planes of the upper and lower dentitions coincide. However, in this case, the occlusal plane for each of the dentition has to be evaluated (fig 7-4).

1. Normal occlusal plane
   - The incisal edge of the upper central incisors should be 3-4mm below the lip line (when the mouth is closed) while the incisal edge of the lower central incisors should be within the same level of the lip line. Once the line connecting the midpoint of the upper and lower central incisal edge and tip of the mesial cusp of the molar, also known as the occlusal plane, is extended, this will almost pass through the center height of the mandibular ramus.

2. Maxillary occlusal plane
   - This is evaluated by connecting the line between the upper 1st molar and the incisal edge of the upper central incisors.

3. Mandibular occlusal plane
   - This is evaluated by connecting the line between the lower 1st molar and the incisal edge of the lower incisors.

4. Occlusal plane evaluation in both the upper and lower dentition of the patient
   - Both the upper and lower occlusal plane is examined in each patient based on the standard normal occlusal plane. MEAW is only applied to the area where occlusal plane needs to be corrected. In case where the occlusal plane has to be corrected in both the upper and lower jaw, MEAW is then applied to both arches.
IV. Treatment Objectives for Class I Open Bite Malocclusion

1. Leveling

The first step in treatment is leveling. In patients with tooth crowding, refer to the leveling method used in Chapter 11. In patients without tooth crowding, proceed to leveling.

2. MEAW application

Apply MEAW to the part where occlusal plane has to be corrected as per previous examination. Adjustments of the MEAW can be done for activation in combination with the use of a vertical elastic (3/16 in., 6 oz) in the anterior teeth. In the part where occlusal plane correction is not needed, a plain archwire can be applied. A kobayashi hook or a consolidation arch can be applied to the area adjacent to the canine (fig 7-5).

Normally, a negative overbite can be improved in 2-3 months. As the overlap in the incisors becomes normal, the posterior teeth start to disocclude or open up. Once the overbite is normal, adjustments in the MEAW can be done to establish an occlusal support. The use of the vertical elastic can be continued during the improvement of posterior teeth disocclusion.

3. Completion

In the final stage of treatment, ideal archwire is utilized. However, MEAW can be continuously used as an ideal arch.
4. Precautions

The use of a vertical elastic to improve the negative overbite is indispensable. In case the negative overbite does not show any improvement despite treatment or the open bite condition worsens, this is solely due to the problem with the manner the vertical elastic was used. Determine the patient’s compliance in terms of the usage of the vertical elastic, and determine appropriately as to why this has happened.

V. Treatment Procedures for Class I Open Bite

In an open bite condition during the permanent dentition period, elimination of posterior discrepancy is important. Normally, the maxillary and mandibular 3rd molars are extracted but the upper 2nd molars can be extracted in young patients. In case the patient practices some bad habits, a myofunctional therapy (MFT) can also be done. Desired results will not be attained when these factors are not considered during the treatment period. Once these factors are disregarded, this could become the cause of relapse even if treatment was successful.

1. Patient’s history

Age: 25 y 8 mos. old
Sex: Female
Chief complaints: Incorrect bite, pronunciation is not normal
Patient’s history / Present symptoms: had tonsillectomy at age 24 y 11 mos. old. Has chronic fever and tonsillitis.
Facial profile: Face is oval-shaped, profile is straight (fig 7-6).
Intraoral findings: overjet = +4 mm, overbite = -3 mm, a case of Angle class I open bite (fig 7-7).
Panoramic x-ray: All 3rd molars have erupted, with complete set of teeth (fig 7-8).
Cephalometric radiogram: Infraversion of the upper and lower central incisors (fig 7-9).

Cuspal interference in the right 3rd molar was observed through the SAM articulator. It was also observed that there was distraction and compression in the right and left TMJ respectively. Based on Kim’s analysis, ODI was 71°, which is almost the average value for the Japanese population. With this data, treatment is considered to be comparatively simple.

2. Diagnosis and Treatment Plan

To eliminate the cause and prevent relapse, all the 3rd molars were extracted. MEAW was then applied to both the upper and lower dentition simultaneously to control the maxillo-mandibular occlusal planes.
3. Progress of Treatment

Since the degree of tooth crowding in this patient was mild, MEAW was used at the start of treatment. MEAW was adjusted for alignment and intrusion of the molars of the upper and lower arches. Vertical elastic was used in the anterior teeth (fig 7-10).

3 months later, the negative overbite was improved. It was also observed that there was a mild disocclusion on the 2nd molars (fig 7-11).

On the 6th month, a positive overbite was observed. The adjustment made in the MEAW (i.e. tip back bends) was discontinued to attain an occlusal support because the gap between the molars has increased (fig 7-12).

A stable occlusion was observed on the 8th month. Only the wire was removed. Two months later, bracket debonding was done (fig 7-13).

At 10.4 month, after debonding, it was noted that there was a slight decrease in the overbite. However, the occlusal condition remained to be relatively normal (fig 7-14).

The active treatment period was 8.6 months.
Fig. 7-10 Pre-treatment intra-oral photos

Fig. 7-11 Intra-oral photos 3 months from the start of treatment

Fig. 7-12 Intra-oral photos 6.5 months from the start of treatment

Fig. 7-13 Intra-oral photos 2.2 months post treatment

Fig. 7-14 Intra-oral photos 10.4 months post treatment
4. Comparison of the pre and post treatment values (chart 7-1, fig 7-15)

As shown in the chart, the ODI improved to 75° from 71° and the MP closed by 1°. The occlusal plane in both the upper and lower dentition has remarkably changed. There was a 4° and 8° change in the upper and lower dentition respectively.

Based on the superimposed tracings, lingual tipping in the upper anterior teeth as well as the labial tipping in the lower anterior teeth has slightly increased. Moreover, supraeruption of the upper and lower 1st molar was not observed, instead alignment was apparent.
8. Treatment of Class II Open Bite
I. General Characteristics of Class II Open Bite

This is classified as the type of malocclusion where the antero-posterior growth of the maxilla is poor and the ability of the mandible for an anterior adaptation is insufficient. This can be due to the cuspal and occlusal interference in the posterior teeth related to their excessive elongation caused by posterior discrepancy. In an open bite condition associated with a mandibular disoclusion, it does not mean that excessive elongation of the molars is always present. There are instances where the adaptive force is insufficient due to the posterior rotation of the mandible related to the steepening of the occlusal plane in the molar area.

II. Morphological Characteristics of Class II Open Bite

1. Excessively high anterior facial height
2. Excessively low posterior facial height
3. Steep mandibular plane
4. Obtuse mandibular angle
5. Growth tendency of the mandible is in an inferior direction with posterior rotation
6. Excessive vertical dimension
7. Excessive elongation of the molars (supraversion)
8. Two occlusal planes
   • Occlusal plane in the upper anterior teeth area is flat
   • Occlusal plane in the upper posterior area is steep
9. Abnormal curve of Spee (reverse curve)
10. Asymmetrical maxillo-mandibular dental arch width
11. Cuspal interference in the molar area
12. Occlusal interference in the molar area
13. Unstable occlusal support
14. Absence of anterior guidance
III. Treatment Objectives for Class II Open Bite

1. Habit modification (i.e. abnormal swallowing and tongue thrusting, etc.) In cases when the tongue is observed to be large, glossectomy can be done.
2. For respiratory-related problems, address the enlargement of the pharynx and tonsils, oral respiration, allergic rhinitis and other otorhinologic related diseases.
3. Eliminate the functional factor and obtain a physiologic condylar and mandibular position.
4. Stimulate an anterior rotation of the mandible (during the growth period, anterior position can be expected through mandibular growth guidance).
5. Eliminate posterior discrepancy (intrusion and extraction of upper and lower molars) to control the vertical dimension within the denture frame.
6. Align every single tooth based on the appropriate curve of Spee. Flatten the occlusal plane in the molar area.
7. Eliminate discrepancy of the upper and lower dental arch.
8. Retract the upper dental arch to its appropriate position and improve the molar class II relationship.
9. Allow to a certain degree anterior teeth elongation to improve the negative overbite (open bite).
10. Obtain an occlusal support and stabilize occlusion.
11. Obtain an appropriate occlusal and anterior guidance.
12. Improve midline discrepancy.
15. Consider over-correction for slight relapse and choose a stable retention method.

IV. Treatment Procedures for Class II Open Bite

1. Patient’s History

   Age: 16 y.o.           Sex: Male
   Chief complaints: Cannot bite well due to an open bite condition in the anterior teeth
   Facial profile: frontal is oval in shape, lateral is convex in shape, relaxed upper and lower lip during the resting phase (fig 8-1)
   Intra-oral findings: labial tipping of the upper anterior teeth, overjet of +2mm, overbite of -10mm. Discrepancy in the upper and lower dental arch width was observed. Curve of Spee in the mandible was also observed to be reversed (fig 8-2).
Fig. 8-1 Facial Photos before treatment

Fig. 8-2 Pre-treatment intra-oral photos

Fig. 8-3 Pre-treatment Panoramic x-ray
Panoramic x-ray results: The four 3rd molars were impacted (fig 8-3).

Cephalometric radiogram findings: There was no abnormal antero-posterior position of the maxilla observed in the lateral cephalometric radiogram. A severe hyperdivergence was noted due to the opening of the mandibular angle and excessive mandibular height. The mandible showed a posterior rotation. This can be classified into a Dolichocephalic facial type. The maxillary molars were suspected to have supracerupted. Presence of mesial tipping in the upper and lower molars were also observed (fig 8-4). Based on the cephalometric tracings, it was observed that there was steepening of the occlusal plane in the upper posterior area (6-7), and flattening of the occlusal plane in the upper anterior area (1-5) (fig 8-5). The mandible showed a slight displacement to the right side as shown in the frontal view cephalometric radiogram (fig 8-6).
2. Diagnosis and Treatment Plan

In this patient, anterior rotation of the mandible is not possible because of the supraeruption of the molars caused by posterior discrepancy. This was classified into a skeletal open bite condition. To improve the open bite condition, elongation of the anterior teeth at a certain degree has to be done and intrusion of the molars is important to correct their supraeruption.

In patients with class II open bite, reconstruction of the occlusal plane in the molar area is important. The anterior rotation of the mandible as a result of the occlusal reconstruction is desired. First, eliminate the cuspal interference in the posterior molar area. To stimulate anterior rotation of the mandible, extract molars when needed. Then eliminate interference by alignment and intrusion of the lower 2nd molars thus flattening the occlusal plane in the lower molar area. And finally, flatten the occlusal plane in the upper molar area to do the final occlusal reconstruction. Illustration of the treatment plan and tooth movement phase is shown in fig 8-7.
3. Progress of Treatment

Step 1: Distal movement and intrusion of the upper and lower posterior teeth to reconstruct the occlusal plane in the maxillo-mandibular molar area.

Fig 8-8 shows the intra-oral pictures after 2 months of treatment. A MOAW (Modified Offset Arch-Wire, 0.016 x 0.022 inch, blue elgiloy wire) was installed.

To improve class II relationship and crowding, distal movement and intrusion of the upper molar teeth are done. The use of leveling for the anchorage of upper anterior teeth crowding was held back. In order to eliminate excessive flaring in the upper anterior teeth area, a lingual arch was used to reinforce anchorage. On the other hand, alignment was in progress while applying an intrusive force to the lower molar area.

Fig 8-9 shows the adjustment method done in MOAW with this patient.
Step 2: Leveling and reconstruction of the occlusal plane in the upper and lower molar area

Fig 8-10 shows the intra-oral pictures 4 months following the start of the treatment. Alignment was in progress and intrusion of the lower 1st molar with the use of MOAW. In order to improve the crowding in the upper anterior area, the lingual arch was removed. An 016-inch NiTi wire and open coil was used for leveling. Alignment and intrusion was continued in the lower dentition with the use of MOAW and anterior vertical elastics.

Fig 8-11 shows the intra-oral pictures 6 months following the start of treatment. MEAW was applied to simultaneously align the anterior teeth in the upper and lower arches. Buccal tubes were bonded on to the upper 3rd molars to allow eruption and at the same time induce their mesial tipping. A plain MEAW (Multiloop Edgewise Arch-Wire: 0.016 x 0.022 inch, blue elgiloy wire) was installed in the upper and lower dentition for simultaneous alignment. The open bite condition in the incisor area has improved. The gap in the upper molar was used to eliminate crowding. Vertical elastics were used in the anterior teeth.

Fig 8-12 shows the intra-oral pictures 9 months since the start of treatment. To improve the class II relationship, MOAW was applied in the maxilla with the objective of eliminating cuspal interference in the posterior molar area through intrusion and distal movement of the 3rd molar with mesial tipping. After which, the upper 1st molar distally moved again through the upper MOAW. To flatten the mandibular occlusal plane, a slight reverse curve was applied to the MEAW. Vertical elastics were used in the anterior teeth.
Step 3: Attainment of a physiologic condylar and mandibular position

Fig 8-13. Intra-oral pictures after 12 months of treatment. Up to this point, the mandible continues to be displaced to the right side. MEAW was used in both the upper and lower dentition. While torque was being controlled, the upper and lower arches were being aligned. Short class II elastic was used in the anterior teeth.
Fig 8-14 shows the intra-oral pictures 14 months following the start of treatment. The mandibular displacement to the right was corrected through the MEAW. The mandibular midline was moved to the left to be in line with maxillary midline. To correct the discrepancy of the vertical dimension in the left and right side of the maxilla, a step down bend was done in the horizontal loop of the upper right canine. Since there was discrepancy in the upper and lower dental arch width, a Mulligan arch was used to gradually expand the maxillary dental arch width in order to align with the lower dental arch width. At this time, the mandible anteriorly rotated associated with a reverse occlusion in the anterior area. A short class II elastic and box elastic was used at the left and right side respectively.
**Step 4: Detailing, harmonizing of the upper and lower occlusal planes**

Fig 8-15 Intra-oral pictures 17 months following the start of treatment

Fig 8-16 Intra-oral pictures during the completion of the dynamic treatment, after 20 months of treatment

Fig 8-15 shows the intra-oral pictures 17 months following the start of treatment. The lateral displacement of the mandible has been corrected and the upper and lower midline was in place. A step down bend was done in the plain MEAW of the maxilla to flatten the occlusal plane in the upper molar area. A box elastic was used in both the left and right molar area to establish the premolar intercuspatation.

Fig 8-16 shows the intra-oral pictures 20 months following the start of treatment. A lingual fixed retainer was used in the upper and lower anterior segment to prevent the recurrence of crowding. In addition, lingual buttons were applied to the upper and lower lateral incisors. Vertical elastics in the anterior area was used in the evening to prevent relapse. Moreover, a bionator (to close) was used together with the vertical elastics.
4. Treatment Results

During the 20-month treatment period, MOAW was used for 6 months and MEAW for 12 months in the upper dentition. In the mandibular dentition, MOAW was used for 4 months and MEAW was 15 months. Intermaxillary elastics were used for 18 months.

Fig 8-17 shows the panoramic x-ray during the completion of the dynamic treatment. Fig 8-18 shows the lateral view of cephalometric radiogram.
Based on the lateral cephalometric radiogram, the root apex of the upper 1st molar was intruded into the maxillary sinus. When looking at the lateral cephalometric tracings, closure of the anterior openbite by 2.5 mm and a 2 mm anterior position of the chin were observed due to the anterior rotation of the mandible (fig 8-20, 8-21a).

When comparing the superimposed cephalometric tracings of pre and post treatment, the upper molar has distally moved by 3 mm and intruded by 2 mm as shown in the palatal plane. The upper premolar teeth has distally moved by 2 mm and intruded by 2 mm. Upper anterior teeth have elongated by 2.5 mm (fig 8-21b). In the lower dentition, the 2nd molar has been intruded by about 1 mm in the distal area. In addition, elongation in the lower 1st molar was not observed. The lower anterior teeth have elongated by 7 mm (fig 8-21c). As a result, the steep occlusal plane in the molar area has flattened and the reverse curve of Spee in the mandible was also improved obtaining a stable intercuspal position. Overjet was +2mm and overbite was +2mm. The step bends in MEAW regulates the vertical dimension of both the left and right side. With that, the mandibular position has been corrected as shown in fig 8-19. Overall results showed a corrected condylar position, improved TMJ function, and attainment of an excellent profile (fig 8-22).
Fig. 8-23 Intra-oral pictures 1-year post retention

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There was no apparent sign of relapse 1-year post retention. Because of that, the use of intermaxillary elastics was discontinued and only the lingual anchorage in the upper and lower anterior area was retained for retention (fig 8-23). Chart 8-1 shows the results of the cephalometric radiogram analysis.
5. Important Points and the Treatment Method Used for this Patient

1. Avoid surgical operation as treatment for a severe open bite condition with a skeletal factor. However, load to the teeth and periodontal tissue cannot be avoided when planning for the individual’s orthodontic treatment. Therefore, it is important to examine the periodontal condition pre-treatment to determine whether it can withstand the treatment.

2. Plan for the habit modification
   Myofunctional therapy restores the oral lip closure function and trains the masticatory muscles as well as the muscles surrounding the oral cavity. This will allow the mandible to adapt through anterior rotation.

3. In order to eliminate posterior discrepancy, the upper 2nd molars were extracted after determining through the x-ray that the 3rd molars could serve to replace the 2nd molars. The 3rd molars started to erupt after a month following the 2nd molar extraction and after 7 months had reached the line of occlusion especially because buccal tubes were bonded to them. At age 16, eruption of the upper 3rd molars started a month following the upper 2nd molar extraction suggesting that this was the result of posterior discrepancy.

   Extraction of the upper 2nd molar and lower 3rd molar can also be done to attain the correct vertical dimension.

4. There are cases where there is a need to use a maxillary expansion device to allow harmony of the symmetry of the upper and lower dental arch. In this case, the devices used are Mulligan arch, Quad Helix, Rapid Expansion, and Trans-palatal bar.

5. Leveling (strategic leveling)
   In this patient, correction of the upper and lower occlusal planes was done during the leveling period. In other words, the final flattening of the occlusal plane in the upper molar area was done. Initially, a MOAW (Modified Offset Arch-wire : 0.016 x 0.022 inch blue elgiloy wire) was used to intrude and distally move the upper first molars. This is also effective in improving the class II molar relationship. At this point, reinforcement of anchorage (lingual arch) was done in the upper premolar area of both the left and right side. The anchorage unit was from the premolar teeth to the anterior segment. At this stage, crowding was not yet eliminated. During the improvement of the upper anterior crowding, the needed space was obtained first to avoid flaring and elongation after which leveling was done. The use of intermaxillary elastics was necessary. The lingual arch in the upper premolar area was removed. After which MEAW (Multi-loop edgewise archwire : 0.016 x 0.022 inch blue elgiloy wire) was applied for alignment and distal movement of the maxillary dentition. In the mandibular dentition, MOAW was applied to avoid flaring and excessive elongation of the
anterior teeth through the alignment and intrusion of the lower 2nd molar. MEAW was then applied to simultaneously align the mandibular dental arch. A flat MEAW was initially used instead of a MEAW with a tip back bend. The reason for that is because mesial tipping is possible even with the use of a plain MEAW. Moreover, the use of an intermaxillary elastic (class II, vertical or check elastic) for 24 hours must be determined. After confirming the proper usage of the intermaxillary elastics, a tip back bend of about 10° can be done for alignment.

- In case of a moderate discrepancy, a 0.016-inch of NiTi wire or a 0.016-inch of a round Australian wire can be used. After leveling, distal movement and simultaneous alignment (uprighting) of the entire dentition through MEAW can be done.

- In case of a severe discrepancy, the concomitant use of a round Australian wire with open coil spring can be done or else a MOAW can be used. Alignment and distal movement is done from the 2nd molar, which is the terminal molar. Then conduct a strategic leveling. That is why, before improving the anterior teeth crowding, do leveling only after the space needed for anterior teeth alignment has been obtained and the posterior molar area is aligned. Which is then followed by the distal movement and simultaneous alignment of the entire dentition through MEAW.

6. Intrusion of the molar teeth through the use of extra oral force

If needed, use an extra oral anchorage appliance (high pull headgear) to apply an intrusive force to the upper molar teeth. However, molar intrusion is difficult because of the closeness of the upper alveolar bone and the basal maxillary sinus. An orthodontic implant, which will serve as an anchorage unit to intrude the molar area, is known to be an effective method. At this point, it is important to consider how the occlusal plane will be reconstructed before the operation.

7. The use of intermaxillary elastic

The appropriate use of the intermaxillary elastic is indispensable. Therefore it is important to let the patient understand and cooperate well with its usage. Excessive elongation due to intermaxillary elastic can possibly cause gum recession, induce involution or cause tooth root resorption. When using elastics, consider the thickness of the alveolar bone of the upper and lower anterior teeth and the thickness of the gums.

8. Thoroughly clean the oral cavity to prevent the occurrence of caries. Good oral hygiene procedures will help maintain the healthy condition of the periodontal tissues.
9. Treatment of Class II Deep Overbite

(Atsushi Matsumoto)
I. General Characteristics of Class II Deep Overbite

This is classified as a type of malocclusion where the vertical growth of the maxilla is insufficient. Because of this, the vertical dimension in the molar area is insufficient resulting to the disharmony of its relationship to the vertical growth of the mandible. Though there is not much of a problem with the anteroposterior diameter of the maxilla, there is a characteristic sudden tipping of the occlusal plane in the molar area. With the steepening of the occlusal plane in the posterior, the mandible cannot adapt anteriorly. Instead it adapts posteriorly due to the occlusal interference in the molar area.

II. Morphological Characteristics of Class II Deep Overbite

1. Lip incompetence
2. The reverse rotation of the lower lip during the resting phase
3. Excessively small vertical dimension
4. Insufficient eruption of the molar teeth (infraeruption)
5. Accentuated Curve of Spee
6. Two occlusal planes
   - Flat occlusal plane in the upper anterior area
   - Steepening of the occlusal plane in the upper posterior area
7. Discrepancy in the upper and lower dental arch width
8. Labial tipping of the upper anterior teeth
9. Occlusal interference in the molar area
10. Insufficient occlusal support
11. Functional failure due to poor anterior guidance

III. Treatment Objectives for Class II Deep Overbite

1. Habit modification like tongue thrusting and abnormal swallowing.
2. For patients with respiratory problems, treatment of enlarged pharynx and tonsils, oral respiration, allergic rhinitis and other otorhinologic related diseases.
3. Eliminate the functional factor and obtain a physiologic condylar and mandibular position.
4. Increase the maxillary height and vertical dimension.
5. Eliminate the discrepancy in the upper and lower dental arch width through lateral expansion of the maxilla.
6. Improve the class II molar relationship by retraction of the upper dental arch to its appropriate position.
7. If the patient seeks treatment during the growth period, obtain anterior position of the mandible through growth guidance.
8. Align every single tooth based on the appropriate curve of Spee. And finally, flatten the occlusal plane in the molar area.
9. Increase the vertical dimension through upper and lower molar eruption. Obtain an occlusal support.
10. Improve overbite (deep bite).
11. Obtain an appropriate occlusal and anterior guidance.
12. Obtain normal intercuspation.
13. Attain an excellent profile.
14. Consider relapse as over-correction.

**IV. Treatment Procedures for Class II Deep Overbite**

1. **Patient’s History**
   - Age: 16 y/o  
   - Sex: Male  
   - Chief complaints: Protrusion of the anterior teeth  
   - Facial profile: Brachycephalic and convex profile, overjet is +11mm, overbite is +11mm (fig 9-2).  
   - Panoramic x-ray: all the four 3rd molar teeth are impacted (fig 9-3).  
   - Cephalometric radiographic findings: Based on the lateral view, there is a slight anterior position of the maxilla, and posterior position of the mandible. Mandibular angle is small because of the excessively low mandibular height. This is also classified as brachycephalic facial type (fig 9-4). It was observed through the lateral cephalometric tracings that there was a severe curve of Spee showing a steepening of the occlusal plane in the molar area and a remarkable labial tipping of the occlusal plane in the upper anterior teeth (fig 9-5). Fig 9-6 shows the frontal view cephalometric radiogram.
Fig. 9-1 Facial profile during the initial examination

Fig. 9-2 Intra-oral pictures during the initial examination

Fig. 9-3 Panoramic x-ray during the first examination
Fig. 9-4 Lateral cephalometric radiogram during the initial examination

Fig. 9-5 Lateral cephalometric tracings during the initial examination

Fig. 9-6 Frontal view cephalometric radiogram during the initial examination
2. Diagnosis and Treatment Plan

In this patient, it was noted that the curve of Spee was deep with steep occlusal plane in the molar area, showing an interference in the posterior region. Therefore it resulted to class II because of the inability of the mandible to anteriorly adapt leading to its retraction. The occlusal support is also insufficient because of the excellent vertical growth of the mandibular ramus, leading to occlusal adaptation, allowing the maxilla to anteriorly rotate.

In class II deepbite, the anterior rotation of the mandible through occlusal reconstruction is best desired. First, it is important to eliminate the functional causes of the mandibular retraction (cuspal and occlusal interference). In this case, a physiologic condylar and mandibular position can be attained. With this, posterior molar interference is eliminated with the alignment of the lower 2nd molar, correcting the excessive curve of Spee. Secondly, it serves to flatten the occlusal plane in the upper molar area. In order to get a sufficient occlusal support, the upper and lower molar teeth are supra-erupted to increase vertical dimension. With this process, the class II molar relationship is improved due to the appropriate maxillary position through alignment and retraction of the maxillary dentition. Fig 9-7 shows the illustration of the treatment plan and tooth movement.
3. Progress of Treatment

Step 1: Correction of the Upper Dental Arch/Reconstruction of the Occlusal Plane in the Lower Posterior segment

Fig 9-8 shows the intra-oral pictures a month following the start of treatment. A Quad helix was used to laterally expand the maxillary dental arch width. An 0.016-inch round Australian wire was placed in the mandible and elimination of the curve of Spec was started. Retraction of the upper anterior teeth has not yet started.

Fig 9-9 shows the intra-oral pictures 5 months following the start of treatment. The intercanine width of the maxilla was expanded through the use of Quad helix. Retrusion of the upper anterior area has not yet started. Brackets were bonded and leveling was started. An 0.016-inch round Australian wire and a Utility arch made from an 0.016 x 0.016 inch blue elgiloy was used in the...
mandible for bite rising and elimination of the curve of Spee as well as for closure of spaces. (Note: At this stage, the use of MEAW in the mandible is also possible).

**Step 2: Closure of Space and Occlusal Plane Reconstruction in the Upper and Lower Molar Area**

Fig. 9-10 shows the intra-oral pictures 10 months following the start of treatment. A consolidation arch of 0.016 inch green elgiloy was used to close the spaces in the maxilla. Improvement for the excessive curve of Spee in the mandibular arch was continued. A reverse curve was done in the 0.016 x 0.016 inch blue elgiloy applied in the mandible. (Note: At this stage, the use of MEAW in the mandible is also possible).

Fig. 9-11 shows the intra-oral pictures 15 months following the start of treatment. MEAW (Multiloop edgewise archwire: 0.016 x 0.022 inch, blue elgiloy) was applied to the maxilla for space closure, alignment of the dental
arch, and bite rising. Improvement of the curve of Spee in the mandibular dental arch was continued. A reverse curve was done in the 0.016 x 0.016 inch blue elgiloy applied in the mandible. The space in the mandible has almost closed. (Note: At this stage, the use of MEAW in the mandible is also possible).

**Step 3: Bite Raising / Molar Relationship Correction**

Fig. 9-12 shows the intra-oral pictures 19 months following the start of treatment. A step down bend was done in the MEAW (0.016 x 0.022 inch blue elgiloy wire) for maxillary bite rising. A reverse curve was done in the 0.016 x 0.016-inch blue elgiloy wire in the mandible. Space in the mandible has closed and the mandibular arch has been aligned. (Note: At this stage, the use of MEAW in the mandible is also possible).

Fig. 9-13 shows the intra-oral pictures 24 months following the start of treatment. A DAW (double archwire) of 0.016 x 0.016-inch blue elgiloy was
Fig. 9-14 Intra-oral pictures 27 months following the start of treatment

Fig. 9-15 Intra-oral pictures 32 months following the start of treatment

Fig. 9-16 Intra-oral pictures during the completion of the dynamic treatment, 34 months following the start of treatment
applied for bite rising in the maxillary dental arch. A step down bend was done in the horizontal loop of the upper right canine (upper sectional arch 3-5). A plain MEAW (Multiloop edgewise archwire: 0.016 x 0.022 inch blue elgiloy wire) was applied to the mandible to simultaneously align the dentition.

**Step 4: Bite Rising / Detailing**

Fig. 9-14 shows the intra-oral pictures 27 months following the start of treatment. The four upper anterior teeth have intruded. Step down bend was done to simultaneously align the dentition. In the mandible, a step up bend and reverse curve was done to the MEAW for bite rising.

Fig. 9-15 shows the intra-oral pictures 32 months following the start of treatment. A step down bend was done in the MEAW of the maxilla for bite rising. In the mandible, a step down bend was done in the MEAW (Multi-loop edgewise archwire : 0.016 x 0.022 inch, blue elgiloy wire) for bite rising.

Fig. 9-16 shows the intra-oral pictures 34 months following the start of treatment. MBA of the upper and lower jaw was removed.
4. Treatment Results

The dynamic treatment period lasted for 34 months. The use of Quad helix in the maxilla lasted for 7 months, DAW was 3 months, and MEAW was 17 months. In the mandible, utility arch was used for 5 months and 16 months for MEAW. The use of intermaxillary elastic lasted for 24 months.

Fig. 9-17 shows the panoramic x-ray during the dynamic treatment. Fig 9-18, and 9-19 show the lateral and frontal cephalometric radiogram respectively. Based on the cephalometric tracings, the vertical dimension has increased (fig 9-20). The superimposed tracings of the pre and post treatment (fig 9-21a) show a corrected mandibular position with a 6mm-increase of the vertical dimension through the movement of the occlusal system. Based on the superimposed tracings of the maxillary palatal plane, the upper molar teeth have moved anteroposteriorly with a 3mm elongation. The incisal edge of the central incisors has retruded by 12 mm and extruded by 4 mm (fig 9-21b). The center of alignment was the 2nd premolar teeth in the lower dentition as shown in the mandibular plane of the superimposed tracings. This means that there was no anteroposterior movement of the molar tooth.
crown. Instead, it aligned while elongating by 3mm. Moreover, the lower anterior teeth were intruded by 3mm (fig 21c). As a result, the steep occlusal plane in the molar area, has flattened and the dual occlusal plane, which was causing the deep curve of Spee, was improved. Overjet was +3mm and overbite was +5mm. A stable occlusion was attained as well as the excellent facial profile due to the correction of mandibular position (fig 9-22).

A Begg type retainer was used for retention at daytime and a bionator (to open) was used at night, which lasted for a year. Since there was no sign of relapse, the patient was subjected to a periodic examination. Fig 9-23 shows the facial profile 5 years later and fig 9-24 shows the intra-oral pictures confirming a stable occlusion. Fig 9-25 is the panoramic x-ray and fig 9-26, 9-27 shows the lateral and frontal cephalometric radiogram respectively. Results of the cephalometric analysis are shown in chart 9-1.

![Fig. 9-23 Facial profile 5 years post retention](image)

![Fig 9-24 Intra-oral pictures 5 years post retention](image)
Fig. 9-25 Panoramic x-ray 5 years post retention

Fig. 9-26 Lateral cephalometric radiogram 5 years post retention

Fig. 9-27 Frontal cephalometric radiogram 5 years post retention
5. Treatment Method Used and Some Important Points to Consider in the Treatment of Class II Deepbite Malocclusion

1. Remove the functional cause and obtain a physiologic condylar and mandibular position. To do that, it is important to define the plans for habit modification. Furthermore, the use of myofunctional therapy (MFT) restores the function of oral lip closure and trains the masticatory muscles including the tongue and the muscles surrounding the oral cavity. This stimulates the adaptational capacity of the mandible to rotate anteriorly.

2. Expect anterior mandibular rotation (During the growth period, obtain anterior mandibular position through growth guidance).

3. Control the vertical dimension in the denture frame and flatten the occlusal plane in the molar area.

4. Improve the dental arch through a maxillary lateral expansion device in case the patient is manifesting inappropriate maxillary dental arch and retrusion of the mandible. This will allow more leeway for mandibular movement, obtaining a physiologic mandibular position. (Combination of MBA and Mulligan arch, Quad helix, expansion screw plate appliance used for bite rising, Rapid expansion)
5. In raising the bite, erupt the molar teeth and intrude the upper and lower anterior teeth. A Double Archwire can be used at this time. Generally, the intermediate tooth is extracted to increase the vertical dimension however this has been known to be difficult. It is best to always refrain from doing a premolar extraction.

6. In occlusal reconstruction, eliminate the curve of Spee and flatten the occlusal plane in the molar area. Simultaneously align each tooth through the use of MEAW. At this point, bite raising was also accomplished (tip back bend, step bend, Reverse MEAW etc).

7. In the retraction of the maxillary dentition, improve the class II molar relationship by using the entire mandibular dental arch as an anchorage unit with the use of intermaxillary elastics. In case of severe maxillary protrusion or absence of mandibular growth, extrusion of the upper posterior teeth and distal movement can be done. At this point, an extraoral anchorage appliance can be used (MOAW, MEAW, Headgear, J-hook, GMD, pendulum, Jones jig).

8. Obtain occlusal support and stabilize occlusion.

10. Treatment of Mandibular Lateral Deviation

(Susumu Akimoto)
1. Definition of the Mandibular Lateral Deviation

Mandibular lateral deviation is the lateral displacement of the chin to either the left or right side (fig 10-1).

1. Main Causes of Mandibular Lateral Deviation

   1. Bad habits: One-sided mastication, resting the chin on one's hand, one-sided posture.

   2. Posterior discrepancy (fig 10-2): Unilateral eruption space deficiency in the posterior area. This could lead to the supraeruption of the molars.

   3. Others: Poor dental treatment (Difference in the height of the restorative material in the left or right side), TMJ arthrosis, history of external trauma, etc.

2. Abnormalities Caused by the Lateral deviation of the Mandible

   1. Facial asymmetry
   2. Functional abnormality: masticatory dysfunction, TMJ arthrosis etc.
   3. Psychological

Fig. 10-1 The P-A cephalometric tracing of a patient suffering from lateral deviation of the mandible. The chin is usually displaced on either the left or right side. Occlusal plane in the molar area of the displaced side is low. The condyle of the contralateral side is relatively positioned higher compared to the other side (condyle position of the other side is lower).

Fig. 10-2 In this patient, the eruptive direction of the upper right 3rd molar is observed to be abnormal. This led to the supraeruption of the 2nd molar and eventually displacement of the mandible to the left side occurred due to the interference.
II. Characteristics of Mandibular Laterodeviation

1. Morphological Characteristics of Mandibular Lateral Deviation

I. Frontal view (Fig 10-13)

Facial asymmetry is apparently severe especially with the displacement of the chin towards either side. This is usually associated with TMJ arthrosis compared to other types of malocclusions as shown, with the difference in the height and size of the eye, tipping of the left and right palatal line, as well as difference in the height of the shoulders.

Fig. 10-3 At age 12, upper and lower midline was centered due to the absence of mandibular displacement. At age 19, the patient came with a chief complaint of mandibular lateral displacement (Fig 10-2 shows the panoramic x-ray of this patient). Superimposed tracings of the frontal view cephalometric radiogram is shown below.
2. Articulator model

In mandibular lateral deviation, the mandible is not the only structure that is displaced but the maxilla as well. With the use of a facebow transfer and articulator mounted model, the difference in the height of the left and right maxilla can be determined (fig 10-4). Normally, the chin displaces to the side where the maxillary height is low just to get an occlusion. More often than not, occlusal interference is observed on the unaffected side and crossbite on the displaced side.

In the buccolinguinal tipping of the molar area, there is lingual tipping in the mandible and buccal tipping in the maxilla of the affected side. On the unaffected side however, there is buccal tipping in the mandible and lingual tipping in the maxilla.

3. P-A cephalometric radiogram (fig 10-1)

There is lateral displacement of the chin as shown in the frontal view cephalometric tracing. The occlusal plane in the molar area of the displaced side is low. The mandibular condyle of the displaced side, when compared to the other side, is relatively higher (the condyle of the unaffected side is lower in position).

2. **Functional Characteristics of Mandibular Lateral Deviation**

1. TMJ arthrosis

   Symptoms are usually present on the affected side but there are instances that symptoms can be seen on both sides.

2. Mandibular movement (General)

   The area of mandibular movement is wider on the affected side. However, in patients where the articular disc of the unaffected side is anteriorly displaced, condylar movement is limited. The condylar angle of the displaced side is bigger as well as the Bennet angle. Intercuspal position is compressed on the displaced condyle, and distraction is present in the unaffected side. The customary masticating side is usually the displaced side.

3. Electromyogram

   The degree of muscle activity during mastication is relatively lower on the displaced side. When occlusion is raised on this side, symmetrical difference will become milder.
III. Treatment Objectives for Mandibular Lateral Deviation

1. Leveling and consideration of the vertical dimension (left and right side)

In this patient, the improvement of discrepancy in the left and right vertical dimension is especially important. Therefore, normal leveling is not necessary at this point. To control the vertical dimension in the molar area, MOAW, which is the appropriate appliance to use to achieve this objective, can be used even at the start of treatment (fig 10-5). So in patients without crowding, application of MEAW at the start of treatment is possible.

It is important to correctly diagnose any lateral difference of vertical dimension in this patient. Increase in height is not the only factor that accounts for the difference of vertical dimension in the left and right side. Below are some variations: (fig 10-6).

a. Vertical dimension of both sides is high but the other side is higher (Bilateral class III)

b. Vertical dimension of both sides is low but the other side is lower (Bilateral class II)

c. Vertical dimension of one side is normal but the other side is higher (Unilateral class III)

d. Vertical dimension of one side is normal but the other side is lower (Unilateral class II)

e. Vertical dimension of one side is high and the other side is low (one-side class III, one-side Class II)

The orthodontic force for each of these is shown in fig 10-6. The discrepancy of the left and right vertical dimension of a patient with mandibular lateral deviation as well as the abnormal anteroposterior relationship of class II and class III are evident.
2. MOAW and MEAW activation

MOAW and MEAW activation in patients with mandibular lateral deviation is mentioned in chapter 3 (Methods of MEAW Adjustments). With reference to the treatment method used in class II and III, it is important to apply a different orthodontic force to both sides. For instance, class II force on one side and class III on the other side.

3. Additional orthodontic force

The use of intermaxillary elastics as an additional orthodontic force device is indispensable. Basically, vertical elastics are used in the anterior area for class I, short class II elastics for class II, and short class III elastics for class III. Moreover, concomitant use of a box type elastic, short class II, or class III in the molar is also possible. Either of these elastics can be used for as long as the vector force (specially the vertical vector) needed is well understood.

4. Final stage

During the final stages, MEAW can be used continuously as an ideal archwire.

5. Precautions

In principle, the use of a midline elastics for midline alignment is not advisable. The midline elastic with consideration of its vertical vector could aggravate the left and right tipping of the occlusal plane. As a result, the left and right side tipping of the occlusal plane will worsen even if the midline has aligned (fig 10-7).

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Fig. 10-7 The use of midline elastic greatly affect the tipping of the occlusal plane despite its positive effect on the alignment of the upper and lower midline.
IV. Treatment Procedure for Mandibular Lateral Deviation

A simple and specific orthodontic treatment for a patient with mandibular lateral deviation during the permanent dentition period is through surgical procedure. However, it has become possible to treat a patient without undergoing surgery to eliminate posterior discrepancy. Cases related to permicious oral habits will require habit modification.

Extraction of the upper and lower 3rd molars is normally done to eliminate the factor of posterior discrepancy. However, like in other types of malocclusions, extraction of the upper 2nd molars in young patients may be done.

1. Patient's history

Age: 24y 2 mos. old
Sex: Female

Complaints: The jaw protrudes during occlusion. The patient requested for surgery to improve the facial asymmetry.

Intra-oral findings: The patient was diagnosed 2-3 years ago by 3 specialists, an orthodontist, an oral surgeon and others and was told that the only treatment possible for this case was through surgical operation. So she waited to reach the age possible for operation. Her difficulty in breathing since age 22 has continued up to this point. A tranquilizer was prescribed by an internist due to hyperventilation syndrome. Other than that, everything was normal.

Facial profile: Face is oval in shape with the left displacement of the chin. Profile is straight (fig 10-8). Intra-oral findings show a 5.5mm mandibular displacement to the left from the maxillary midline. Overjet was 2mm, overbite was 0mm, with a class III occlusal relationship in the molar teeth (more severe on the right side). Canine relationship is class III on the right and class I on the left side. Crossbite was evident in the upper right incisor, left canine and 1st premolar. All the 3rd molar teeth have erupted. Patient has a complete set of dentition (fig 10-9).

Cephalometric radiogram findings: frontal view – occlusal plane in the left side is relatively higher which shows an upward tipping of occlusal plane on the left side (fig 10-10).

Cephalometric radiogram findings: lateral view – skeletally, point B and Pog is positioned anteriorly. Dentally, labial tipping of the maxillary anterior teeth and lingual tipping of the mandibular anterior teeth was observed. In Kim's analysis, ODI was 64° (open bite tendency), and APDI of 92° (reverse occlusion tendency) was observed.

As shown in the SAM articulator model, cuspal interference was observed in the left 3rd molar. TMJ arthrosis on the left side was observed to have started since age 13.
2. Diagnosis and Treatment Plan

Considering the above data, correction of the vertical dimension can be done in altering the tipping of the occlusal plane of the left and right side after posterior discrepancy has been eliminated. Improvement of the open bite and possible reverse occlusion can be simultaneously done. A multi-bracket appliance can be applied to treat the displacement of the mandible to the left, which was the chief complaint.
3. **Treatment Progress**

The midline in the upper central incisors is not coinciding with the lower midline. Since displacement of the mandible to the left is apparent, a plain arch was initially used in the maxilla and a MEAW was used in the mandible. MEAW was bent more tightly on the right side for activation to not only treat the open bite and reversed occlusion and apply intrusion and alignment but primarily for the improvement of mandibular displacement. A short class III elastic was used in the anterior teeth and a class III component with a strong vector was used on the right side to improve the left side displacement of the mandible (fig 10-11). Since there was a difference in the vertical dimension between the left and the right side, the MEAW, which was also applied in the maxilla was bent in order to intrude the right side only. And since this patient had been suffering from left TMJ arthrosis, the upper MEAW is bent on the left side in such a way that it would increase the left vertical dimension (An opposite force system was used to improve the open bite and reverse occlusion).

4 months later, open bite and right lateral incisor crossbite was improved as well as the alignment of the midline (fig 10-12). To continue the treatment, the same force system was used and time was spent on improving the overlap in the left canine. (At this point, a lingual button was bonded on the lingual surface of the upper left canine. An intermaxillary elastic was used to shorten the treatment period).
On the 13th month, the midline was corrected and the severe class III relationship of the right canine was improved. There was no more major problems noted except for a tendency of class III in the right 1st molar teeth.
Fig. 10-14 Intra-oral pictures after the removal of the appliance

Fig. 10-15 Intra-oral pictures 1 year and 1 month following the removal of the appliance

Fig. 10-15 shows the intra-oral pictures 1 year and 1 month following the removal of the appliance. The dynamic treatment period lasted for 1 year and 4 months. The occlusion, 1 year and 1 month after the removal of the appliance, was relatively stable with a slight relapse in the alignment of the midline (fig 10-15).
4. **Comparison of Pre and Post Treatment Results (Fig 10-16)**

Based on the lateral view superimposed tracings, the lips were protruded due to the anterior rotation of the mandible. The anterior teeth overlap has improved with a positive overjet and overbite which was negative prior to treatment.

Superimposed tracings of the maxilla revealed labial tipping in the anterior teeth and a slight mesial tipping in the molar teeth. Based on the superimposed tracings of the mandible, the anterior and molar teeth have been aligned. The movement of these teeth (anterior and posterior teeth), was helpful in the improvement of overlap.

On the other hand, the frontal view superimposed tracings, shows the complete alignment of the midline. Chin alignment, though not perfectly aligned at the center, has greatly improved.
11. Treatment of Crowding

(Sadao Sato)
I. **General Characteristics of Crowding**

Crowding is an abnormality of the dentition that frequently occurs in malocclusion. The degree of crowding varies from one patient to another. Normally, this problem arises due to discrepancy in the size of the teeth and the alveolar bone. The most affected part of crowding starts from the molar area, lower anterior teeth, upper canine area and the upper and lower premolar area. The degree of crowding can be easily determined through a mere dental examination. However, malocclusion cannot be diagnosed that easily. It is important to be cautious about selecting the tooth to be extracted, that is, opting to extract the premolars, almost routinely.

In cases of severe crowding, mesial tipping is usually present in the premolar and molar area. Elimination of crowding through the alignment in these areas is also possible. Though there is a possibility that the treatment of crowding in the molar area is overlooked, it is important to note that the treatment of crowding in the molar area (posterior discrepancy) is more important than the crowding in the anterior teeth.

II. **Morphological Characteristics of Crowding**

All types of malocclusion are associated with crowding. Therefore the skeletal characteristics of crowding are not well defined. However, in general, crowding in high angle open bite and maxillomandibular protrusion is not common. It is because crowding is closely related to the vertical dimension (occlusal support) in the molar area. The increase of vertical dimension in the molar area leads to the anterior tipping of the entire dentition and will result to an anterior open bite or maxillomandibular protrusion to prevent the aggravation of crowding. Therefore it is said that there is a close relationship between an open bite or maxillomandibular protrusion and crowding.

**(Morphological Characteristics)**

1. Skeletal type is usually Class I. In Class III malocclusion, crowding is not frequently seen in the mandibular dentition. On the other hand, crowding is not common in the maxillary dentition in Class II cases.
2. The upper anterior teeth are aligned and usually a steep anterior guidance path is observed.
3. Occlusal plane is usually flat.
4. Impaction or eruption of the 3rd molar is usually difficult.
III. The General Treatment Objectives for Crowding

In planning the treatment for this type of patient, it is important to determine initially the benefit of doing a labial tipping of the anterior teeth. In case of a steepening of the anterior teeth guidance path, alignment starting from the posterior teeth is important. This usually affects the improvement of the anterior teeth. It is because there is a big possibility that during the treatment process, molar alignment could cause open bite in the anterior teeth. However, this is not a problem at all. Since at this point, the vertical dimension in the molar area is sufficient, mandibular displacement and TMJ compression is not observed due to a high vertical dimension, then the second part of treatment can be done, which is the improvement of the open bite through the control of occlusal plane. This will lead to the attainment of a sufficient occlusal support resulting to a stable occlusion post treatment. Long term retention is needed in cases of severe tooth rotation to improve crowding or abnormal tooth position. However, in cases of moderate crowding, retention is similar to other types of patients. In either case, post treatment stability is greatly dependent on the functional element. So the most important factor is to get a stable occlusal support through an appropriate occlusal guidance and an occlusion with the absence of cuspal interference.

IV. Treatment Procedures for Crowding

1. Bond the brackets and buccal tubes to the entire dentition except for $\frac{5}{6} \text{S}$. Start leveling with the use of a 0.014 inch round wire.

2. Replace the round wire with a 0.016 size round wire and insert a coil spring into the area without brackets. Start the alignment of the $\frac{6}{7} \text{S}$.

3. Bond the brackets to the $\frac{5}{6} \text{S}$. Start the alignment of $\frac{5}{6} \text{S}$ by inserting a coil spring into the $\frac{4}{5} \text{S}$.

4. Apply MEAW to the upper and lower dentitions and do a tip back bend to align the entire molar area.

5. Once the molars are aligned, remove the MEAW immediately and re-tie the roundwire to eliminate the crowding in the anterior area.

6. Once the crowding has been entirely eliminated, a final adjustment in the MEAW is done to control the tooth axis (torque control) improving the intercuspation.
1. Patient’s history

Age: 24y 10 mos. old       Sex: Female

Chief Complaints: Teeth crowding as well as pain and clicking in the
TMJ (fig 11-1).

Intra-oral findings: Occlusion in the molars is Class II angle, crowding
in the upper and lower anterior area is severe, palatoversion of the upper
right 2\textsuperscript{nd} premolar, blocked out upper left canine as well as the lower
left 1\textsuperscript{st} premolar (fig 11-2) were observed. Occlusion in the upper and lower
anterior teeth is edge to edge with a crossbite from the left lateral incisor to
the premolar area.

Panoramic x-ray: All the four 3\textsuperscript{rd} molars were present but were
all impacted except for the 3\textsuperscript{rd} molar in the upper right side (fig 11-3).
Fig. 11-3 Panoramic x-ray pre-treatment

Fig. 11-4a Cephalometric tracing pre-treatment

Fig. 11-4b Cephalometric tracing post-treatment

Fig. 11-4c Superimposed tracings of the pre-treatment (dotted line) and post-treatment (solid line)

Fig. 11-5 The mandibular condyle during the mouth opening and closing movement (axiograph)
Cephalometric radiogram analysis: A remarkable skeletal displacement was not observed. SNA was 86.5°, and SNB was 82.5°. With a FH-MP of 31°, ODI of 67° and APDI of 86°, these show a high angle class III type. A CF of 153 suggests the importance of tooth extraction. Discrepancy was very evident because either the Steiner or Tweed's test, a test to determine the importance of tooth extraction, shows positive results (fig 11-4a-c).

Axiograph: Mandibular movement to the anterior and lateral direction is limited. There was no apparent difficulty during the mouth opening and closure exercises but there was an asymmetry in the condylar path (fig 11-5).

2. Diagnosis and Treatment Plan

In this patient, the reason for the crowding and the functional abnormality of the TMJ was the discrepancy in the size of the tooth and the alveolar base. There are also the following signs of a steep upper anterior guidance, mesial tipping in the premolar and molar teeth and retruded mandibular position. As part of the treatment plan, a mild anterior movement of the mandible through correction in the occlusal plane is necessary which will evade the need for premolar extraction. The upper and lower 3rd molars were extracted to eliminate discrepancy and obtain an appropriate occlusal guidance and occlusal support.

3. Treatment Progress

Step 1: An edgewise bracket appliance system was applied to the entire dentition except to the 1st molars. Buccal tubes were bonded onto the 2nd molars. To align the 2nd molars, an open coil spring was attached to the area of the 1st molar and leveling was started through the use of a 0.014-inch Australian wire (fig 11-6, 11-7). Two months later, the current wire was replaced with a 0.016 Australian wire to continue the alignment of the 2nd molars. Three months later, bands were attached to the lower 1st molars and the coil springs were removed. Leveling was done. This process consequently led to an anterior open bite.

Fig. 11-6 Intra-oral pictures during the start of leveling
Fig. 11-7 Force system of leveling. Alignment of 2nd molar through the use of coil spring.

**Step 2**

Fig. 11-8a 4 months since the start of treatment

Fig. 11-8b 7.5 months since the start of treatment

Fig. 11-8c A year since the start of treatment
Step 2: 4 months later, MEAW was applied to both the upper and lower dentitions to align the premolar and molar teeth (fig 11-8a-c). The MEAW in the maxilla was especially modified for the distal movement of the molars (fig 11-9a,b). On the right premolar area, a combination loop was incorporated. A vertical loop in the distal area of the 2nd premolar was placed to allow its distal movement. Vertical elastics were used in the upper and lower MEAW. 9 months later, the palatoverision of the upper right premolar has been corrected, the space for the left canine as well as the closure of the open bite condition in the anterior area has been attained (fig 11-10a-k, 11-11).

Fig. 11-9 The use of combination loop to create space

Fig. 11-10a Occlusal plane during the start of leveling
Fig. 11-10f 11 months following the start of treatment

Fig. 11-10g 1 year and 1 month following the start of treatment

Fig. 11-10h 1 year and 4 months following the start of treatment

Fig. 11-10i 1 year and 8 months following the start of treatment
**Step 3**

1 year and 1 month later, the upper left canines were well within the dental arch. However, the space needed for the right 2nd premolar was quite insufficient so a 0.016-inch Australian wire was replaced into the maxillary dentition and with the use of a coil spring, a space was obtained. At 1 year and 8 months since the start treatment, the entire dentition was aligned (fig 11-10i, fig 11-11).
Step 4: In the last stage of the orthodontic occlusal treatment, a 0.016 inch round Australian wire was used to create the ideal arch for both the upper and lower dentition. At this point, splicing was done in the adjacent surface of each tooth from the 1st molar to the 1st premolar teeth of the upper and lower dentition. A J-hook type headgear and a short class III elastic were used only in the evening to improve the labial tipping of the anterior teeth (fig 11-12a, b). The said force was applied for 4 months. Two years and four months after, all the appliance was removed and the treatment was completed. (fig 11-13, 11-14). Retention with the use of a Hawley type lasted for 6 months (fig 11-13).
4. Treatment Results

Though the crowding was severe, the molar area was aligned through the extraction of the 3rd molars. The space needed for the alignment of teeth and distal movement was acquired. During the final stage of the treatment, the use of J-hook headgear and splicing on the adjacent surface was done. The labial tipping in the anterior teeth was improved and a fine occlusion was attained (fig 11-13, 11-15). In the superimposed tracings of the pre and post treatment cephalometric radiogram, the improvement of the anterior teeth overlap due to the labial tipping of the upper anterior teeth was evident. There was an apparent distal movement of the molars and no remarkable skeletal changes were observed (fig 11-4c).
In the treatment of a patient suffering from crowding, open bite in the anterior area may arise in the middle of the treatment process especially during the tooth alignment period. This should be considered as an essential open bite in the treatment of this condition. This explains the camouflage effect due to the vertical factor in crowding. Therefore, alignment of the molars as well as the tooth leveling consequently induces open bite in the anterior teeth. It is important that the patient is well informed about this fact before treatment begins. This symptom of open bite is improved through the alteration of occlusal plane in the upper and lower dentition. So even if this condition arises in the middle of the treatment, this is not considered a problem at all.
12. Treatment of a Patient with TMJ Dysfunction

(Junzo Yoshida)
I. General Characteristics of a Patient with TMJ Dysfunction

TMJ dysfunction and malocclusion are closely related. Premature contact, occlusal interference, cuspal interference, and loss of occlusal support are the causes of malocclusion. The movement of the mandible in turn avoids these cuspal contacts and the neuromuscular system is activated to allow a wider contact of the upper and lower dentition. Thus, tooth movement and mandibular displacement occurs. The neuromuscular system is stimulated more by the periodontal ligament than the TMJ, and the muscular movement occurs to avoid loading of the teeth. This consequently leads to the structural changes of the TMJ and the abnormalities are evident in the symptoms presented. Therefore the treatment includes countermeasures for pain and abnormal movement as well as establishing a normal mandibular position. Below are three patients with acute disturbance in mouth opening and the methods applied will be discussed accordingly.

II. Distinct Characteristics of a Patient with TMJ Dysfunction

Patient 1: TMJ closed lock (right) due to left mandibular lateral deviation (fig 12-1)

In mandibular lateral deviation to the left, the right TMJ is in a closed lock position. Due to a narrow upper dental arch width, the lower molars show mesiolingual tipping. The low vertical dimension on the left side causes the right condyle to be laterally displaced, and mandibular condyle movement is regulated by the ligaments and articular disc.

Patient 2: TMJ closed lock (left) due to left mandibular lateral deviation (fig 12-2)

In left mandibular lateral deviation, similar to patient 1, the left TMJ is in a closed lock position. In this patient, the maxillary dental arch width, when compared to the mandibular arch width, is narrow leading to the left rotation of the mandible to attain occlusion. Because of that, the left mandibular condyle is postero-medially displaced and the ligaments and articular disc regulates the movement of the mandibular condyle.

Patient 3: Closed lock due to the bilateral loss of occlusal support (fig 12-3)

Both the left and right TMJ is in a closed lock position. However, lateral deviation of the mandible is not quite observed. More compression was present on the side of mandibular condyle where vertical dimension is low, causing the left TMJ to be in closed lock position. Eventually, the right TMJ resulted into a closed lock position.
Fig. 12-1 Patient 1: Pre-treatment
Fig. 12-2 Patient 2: Pre-treatment
III. General Treatment Objectives for a Patient with TMJ Dysfunction

1. Usage of Splint

The use of splint is effective for pain relief during mouth opening by eliminating interference, ensuring a vertical dimension leading to the restoration of the appropriate mandibular position, as well as alleviating masticatory muscle tension and fatigue.

1. Emergency splint

Immediate intervention is needed during an acute trismus. The self-curing resin can be immediately fabricated to serve as a mini-splint in the frontal or molar area. A smooth splint is effective in guiding the mandible to a specific position thus eliminating neuromuscular abnormalities and symptoms related to muscular dysfunction.

2. Repositioning splint

In patients with TMJ dysfunction, the relationship of mandibular condyle and disc is usually abnormal due to incorrect mandibular position. To restore the position of the mandibular condyle and disc, a repositioning splint is usually effective through the guidance of the mandible. This will guide the mandible to restore the physiologic position of the articular disc. The use of axiograph, a device that records mandibular movement, is effective in determining the mandibular position and condition in relation to the use of splint. (fig 12-4).

Repositioning splint restores the mandibular condyle position. In addition, it does not apply load to the masticatory muscles. Besides, it allows average contact of the entire dentition with the objective of creating variance in the occlusal force. When used during an emergency case, this will lessen the pain, improve the closed lock into a non-clicking condition, and restore mandibular movement, like mouth opening, in 2-3 weeks. During this period, changes in the splint can be done to obtain the normal mandibular position (fig 12-5).

Since patient 1 complained of only mild pain and with a mouth opening of 40mm, orthodontic treatment was started without the use of a splint. With patient 2, a splint was used due to a mouth opening of 28mm during the first examination, which became 35mm a month later. Patient 3 also used a splint because of a 24mm mouth opening during the first examination, which increased to 35mm after a month. At this point, the pain was alleviated and orthodontic treatment for each patient was started.
3. **Orthodontic Occlusal Reconstruction**

TMJ dysfunction is usually associated with class I, II, III, as well as crowding, trismus or mandibular displacement. Therefore occlusal reconstruction can be patterned based on the treatment procedures discussed in the previous chapters. However, it is important to understand the structural changes of the TMJ, condition of condyle and articular disc displacement, as well as the status of pre and post treatment.
IV. Treatment Procedures for TMJ Dysfunction

1. Patient’s history

Patient 1: 17y 10 mos. old, female. Complained of pain on the right TMJ during mouth opening associated with trismus (maximum mouth opening 40mm).

Patient 2: 15y 11 mos. old, male. Complained of pain on the left TMJ during mouth opening associated with trismus (maximum mouth opening 27mm).

Patient 3: 18y 2 mos. old, female. Complained of pain on both TMJ during mouth opening (maximum mouth opening 24mm).

Oral examination

Patient 1: Occlusal relationship in the molar area for both sides is Angle Class I. Crowding in the upper and lower anterior teeth. Slight crowding in the upper molar area. Lingual tipping of the lower molars. Lower midline is deviated to the left.

Patient 2: Occlusal relationship is Angle Class I and II for the right and left molars respectively. Though crowding was not observed, there was a slight crowding in the upper molar area. Lower midline is deviated to the left.

Patient 3: Occlusal relationship in the molars for both sides is Angle Class I. Crowding in the upper and lower anterior teeth is apparent. Overbite is 5.5mm.

Panoramic x-ray (fig 12-6, 12-8, 12-10)

Patient 1: Impacted lower 3rd molars

Patient 2: Impacted upper and lower 3rd molars, and slight morphological changes on the left mandibular condyle

Patient 3: Impacted upper and lower 3rd molars

Cephalometric radiogram analysis (fig 12-7, 12-9, 12-11)

Patient 1: Lateral view; ODI 88.0, APDI 79.0. Frontal view; left lateral deviation of the chin and mandibular condyle displacement to the left.

Patient 2: Lateral view; ODI 73.5, APDI 82.5. Frontal view; left lateral deviation of the chin and mandibular condyle.

Patient 3: Lateral view; ODI 72.5, APDI 87.0. Frontal view; displacement was not observed.
Fig. 12-8 Patient 2: a. Pre-treatment
b. Post-treatment

Fig. 12-9 Patient 2: a. Pre-treatment
b. Post-treatment
Axiograph (fig 12-12 to 12-14)

Patient 1: Right side is in closed lock position. Extent of sliding movement of the left side is 12mm. A low 20° condylar rotation was noted.

Patient 2: Left side is in closed lock position. Sliding movement to the right side is not possible due to pain. A low 15° condylar rotation was noted.

Patient 3: Both sides are in closed lock position. A low 15° condylar rotation was noted.

2. Diagnosis and Treatment Plan

Patient 1: Alignment of the entire dentition, increase the left vertical dimension with reference to the right vertical dimension, restore TMJ through securing an occlusal support and an appropriate occlusal guidance without interference.

Patient 2: After the pain was lessened with the use of a repositioning splint, occlusal reconstruction (like patient 1) was done through the movement of the mandible to the right side while the left vertical dimension is increased.

Patient 3: After pain was lessened through the use of a splint, occlusal reconstruction applicable to crowding was done.
Fig. 12-13 Patient 2: Pre-treatment

Fig. 12-14 Patient 3: Pre-treatment
3. Treatment Progress (for Patient 1 only) (fig 12-16)

**Step 1: Start of orthodontic treatment – Leveling** (1998.8.26) (fig 12-15a)

A splint was not indicated for patient 1 because of the mild pain and 40mm mouth opening. Brackets and tubes were bonded to the entire dentition and an ideal arch formed 0.014-inch round wire was used. The continuous use of splint in some patients is allowed to prevent them from worrying. However, due to tooth movement, the splint will no longer be accommodated. At this point, the patient should be informed that the use of the splint is unnecessary (fig 12-17). (Patient requested that only the impacted 3rd molar on the lower right be extracted).

**Step 2:** (1998.9.13-12.9) (fig 12-15b)

A coil spring was used to align the molars and eliminate crowding. Extraction of the lower right 3rd molar was also done. Improvement of the dental arch morphology was done through the use of wire and increase in the vertical dimension is expected due to the alignment of the posterior teeth. (In this step, relationship of the condyle and articular disc was improved in patient 3 where extent of mouth opening was increased to 41mm from 35mm).
Step 3: MEAW Application (1998.12.9) (fig 12-15c)

Though maxillary crowding has been eliminated in step 2, mesial tipping of the lower molars was still evident. However in patients with TMJ dysfunction, the mandible anteriorly adapts to avoid loading of the TMJ, thus flattening the occlusal plane. It is therefore important to secure a high vertical dimension. When the occlusal plane is inclined, the mandible adapts posteriorly. In this patient, flattening of the maxillary occlusal plane was necessary to avoid mandibular retrusion. So the MEAW used in the upper dentition was flat. Moreover, step bend was done in the molar loop to increase the vertical dimension and align the marginal ridge of the adjacent teeth. On the other hand, a progressive tip back bend was done starting from the mesial loop of the lower 1st premolar and a 15° adjustment was done for activation. This will flatten the occlusal plane and align the lower molars. The use of elastics (6 oz, 3/16 inch) on the first tip back bend affects the posterior tip back bend. To align the marginal ridge, a step bend can be done to the specific loop.

Step 4: (1999.1.12-4.25)

During this period, a 0.016 wire without a loop was used because the patient was to take a university examination and the patient was due for extraction of the lower left 3rd molar. However, clicking and a closed lock of the left TMJ occurred.

Step 5: (1999.4.25) (fig 12-15d)

Due to a narrow maxillary dental width, the mandible deviates with lingual tipping of the molars. There are many cases where intercuspatation is
not obtained. At this point, a 0.7mm round overlay wire was applied above
the upper MEAW as shown in fig 12-15d to expand the maxillary arch. In
this patient, expansion was done while waiting for the healing of the extracted
lower 3rd molar. After expansion, buccal movement of the molar teeth was
done after the presence of a space for the alveolar socket in the buccal area
was determined. As a result, only clicking in the left TMJ was noted.

**Step 6 (1999.5.15) (fig 12-15)**

In this patient, the vertical dimension in the left side is lower when
compared to the right side. That is because in the left premolar, 1) tipping
is mesiolingual, 2) the needed space for tooth crown growth is insufficient.
Therefore, the same procedure with that of step 3 was done to the upper
MEAW and right lower MEAW.

**Left side interventions:**

a. To elongate the premolar teeth, a step bend was added to the loop to
   induce balance of the marginal ridge and adjacent canine teeth.

b. To eliminate mesial tipping, an additional tip back bend was done.

c. To eliminate lingual tipping, a wire was used in the left molar area to
   laterally expand.

d. A buccal crown torque was done in the surface of the wire inserted in
   the bracket slot to induce buccal tipping of the tooth crown.
   The reason for MEAW arch width expansion and additional buccal
   crown torque is because the dental arch was narrow and the intermaxillary
   arch will pull the tooth crown into the buccal side from the top part of the
   cusp, and the lingual vector is activated. A measure is needed to deactivate
   this vector.

e. Attach elastics to the mesial loop of the 1st premolar teeth. The flat
   MEAW in the upper dentition eliminates mesial tipping of the occlusal
   plane, guides the anterior rotation of the mandible, and lessens the load
to the TMJ.
Step 7: (1999.6.5) (fig 12-15f)

The occlusal plane flattens and the mandible is adapting anteriorly. The mandible will rotate to the right side due to the increase of vertical dimension in the left side. The anterior rotation is associated with the alignment of the lower midline. Now the lower anterior teeth could push up the lingual side of the upper anterior teeth. This interference will inevitably result to mandibular retrusion, and its correct position will not be obtained, and load to the masticatory muscles and TMJ will not be eliminated. Since this same phenomenon happened to this patient, MEAW was used to expand the upper anterior arch. Lingual tipping in the lower anterior teeth was observed and, expansion should be done on both arches. At this point, the upper dentition has to be prioritized so the use of elastics was considered unnecessary.

Step 8: (1999.7.7) (fig 12-15g)

Mild clicking was still observed in the left TMJ so the following measures were done:

1. Increase vertical dimension and ascertain posterior alignment through intercuspation of 1st and 2nd premolar teeth. To do this, slightly tighten the tip back bend starting from the mesial side of the 2nd premolar.
2. Use elastics to hasten bite raising and improve lower molar intercuspation. Apply this to the 2nd loop of the upper dentition and 2nd and 3rd loops of the lower dentition, thus forming a triangle.

3. When the left vertical dimension has increased, the mandible will rotate to the right side and the lower right canine and premolar teeth will move to the external right side. Therefore set the MEAW for external expansion of the upper right dentition to avoid interference in the right upper canine and premolar teeth. Elastics should not be used on the right side to avoid deterrence to the upper right expansion with the use of MEAW. To align the marginal ridge of the lower left 2nd premolar and 1st molar, a step bend was done in this area.

**Step 9** (1999.7.31-2000.1.8) (fig 12-15h, I)

Though the mild click was already eliminated, left laterodeviation of the mandible was still evident, and treatment was focused on the bite raising of the left side and left molar intercuspation. Tip back bend on the left MEAW was removed and elastics (8mm, 5/16) were used in the 2nd, 3rd, and 4th loops of the upper MEAW with the 3rd, 4th, and 5th loops of the lower MEAW. This is effective in aligning the 5th loop of the upper MEAW and the 5th loop of the lower MEAW. This is because the force of the elastics resists tooth tipping and aids in the right rotation of the mandible.

This application lasted until all the appliances were removed. The treatment period was long because a stable TMJ and occlusion had to be attained.
Fig. 12-16 Patient 1: Adjustments to MEAW

Fig. 12-17 Patient 3: During the start of treatment (a patient still using a splint)
4. Treatment Results (fig 12-18 to 12-20)

Desired results were obtained as shown in the axiograph (fig 12-21 to 12-23), ODI and APDI. Results of the ODI and APDI post treatment are as follows:
Fig. 12-19 Patient 2: Post treatment

Patient 1: ODI 86.0°, APDI 80.0°
Patient 2: ODI 73.0°, APDI 83.0°
Patient 3: ODI 66.5°, APDI 84.0°

The dynamic treatment period lasted for 17 months for patients 1, and 2, and 12 months for patient 2.
Fig. 12-21 Patient 2: Post-treatment

Fig. 12-22 Patient 2: Post-treatment
To obtain a successful occlusal treatment in any type of case, the following 3 points should be established:

1. Restore the appropriate TMJ functions
2. Proper occlusal guidance (fig 12-24)
3. Stable occlusal support with the absence of interference in the molar area.

Patients where restoration of a normal TMJ structure due to the changes in the articular disc and condyle is difficult is attributed to numbers 2 and 3 of this item.

(Details of the case of patient 2 was discussed in quarterly publications of Dental Treatment Autumn 1999, Daiichi Shika Publications)
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