The Versatility and Effectiveness of the Multiloop Edgewise Archwire (MEAW) in Treatment of Various Malocclusions

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Aim: *Treatment of anterior open bite is considered the most difficult task in the orthodontic specialty. These malocclusions are frequently subjected to orthognathic surgery, with questionable results. Multiloop edgewise archwire therapy, however, has been found to be effective in treating open bite malocclusions. Multiloop edgewise archwire therapy has been shown to be versatile and capable of correcting other malocclusions, such as Class II, Class III, deep overbite, and malocclusions with marked midline deviations.* **Methods:** *The biomechanics of multiloop edgewise archwire therapy and pertinent research findings are discussed, and three cases are presented.* **Conclusion:** *Orthognathic surgery was recommended for two of the three cases presented, but successful treatment without surgery was achieved with multiloop edgewise archwire therapy.* World J Orthod 2001;2:208–218.

The multiloop edgewise archwire (MEAW) was created in 1967 to treat severe anterior open bite malocclusions and it has been found to be effective in correcting such malocclusions.[1] It has since evolved to allow MEAW therapy of any malocclusion, especially during the final stage of treatment. In this article, the treatment modality of three cases will be discussed.

The MEAW is constructed of a 15-inch 0.016 × 0.022-inch standard stainless steel rectangular wire (3M Unitek, Monrovia, CA, USA) and is shaped into an ideal arch form with L-shaped loops between the teeth from the distal of the lateral incisor to the posterior end of the dentition. Usually, there are five loops on each side in an arch that consists of 14 teeth (Fig 1). Since this wire is a relatively soft stainless steel wire, it should be heat-treated at about 1000°F for approximately 5 minutes to increase the resiliency. Figure 2 shows examples of upper and lower MEAWs in the ideal arch forms. To upright mesially inclined premolars and molars, 3- to 5-degree tip-back bends are incorporated into the wire, from the first premolars to the second molars, according to the degree of uprighting required (Fig 3). For MEAW therapy, 0.018-inch slot brackets are used.

Since the advent of the MEAW, its treatment modality has been used worldwide and numerous reports of successful results have been published.[2–13] Some orthodontists have described the MEAW technique as “magical” or “unbelievable,” but it certainly is not. The diagnosis and treatment plan must be correct and construction of the MEAW must be precise to deliver the necessary forces to move the teeth to an optimal, stable relationship.

Commonly, severe malocclusions such as open bite, Class III, or even Class II have been subjected to surgical intervention due to the inability to correct them with conventional orthodontic treatment. The MEAW technique can correct a majority of severe malocclusions when no disfiguring facial deformity exists. A variety of orthodontic techniques have come and gone, but most edgewise principles introduced by Edward H. Angle 75 years ago remain viable. Unfortunately, there are too many orthodontists who are not accustomed to bending wires and who instead depend on prefabricated straight archwires. Those who do not wish to bend wires cannot use this technique. Each patient is unique both

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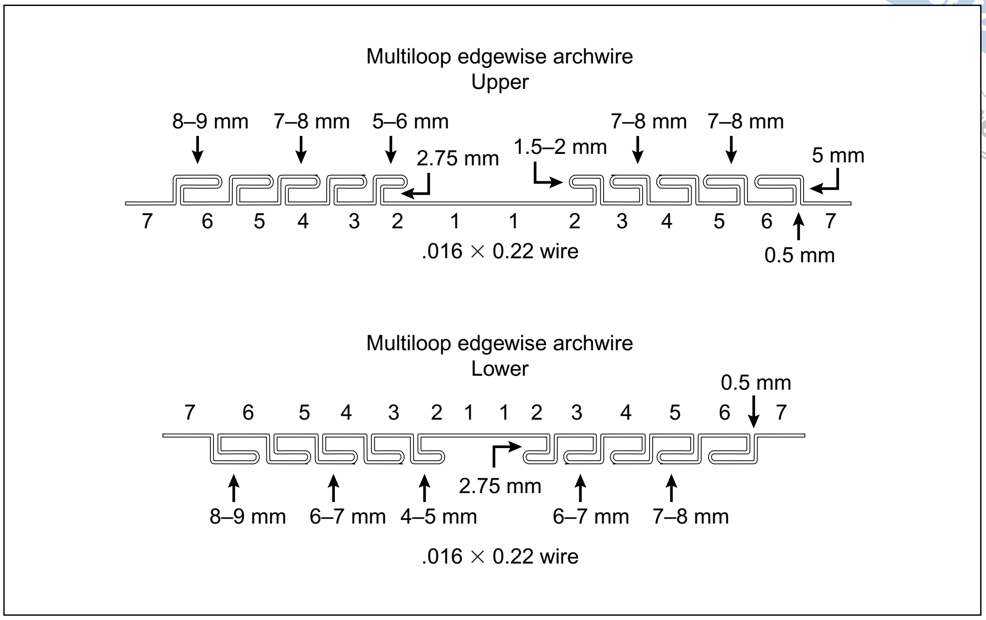

Fig 1 Diagrams of the upper and lower multiloop edgewise archwires (MEAWs).

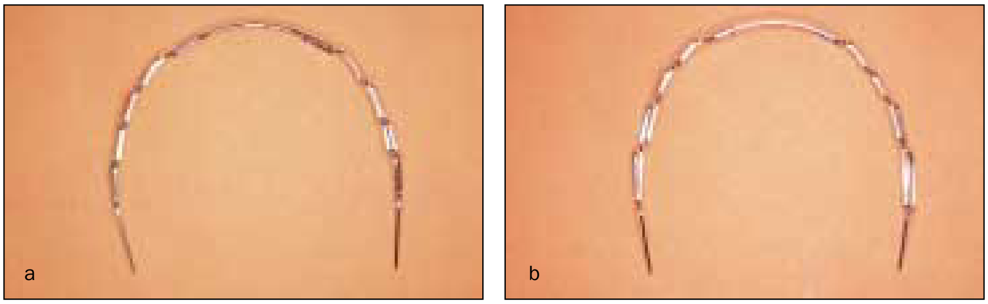

Fig 2 Occlusal views of the MEAWs. **(a)** Upper. **(b)** Lower.

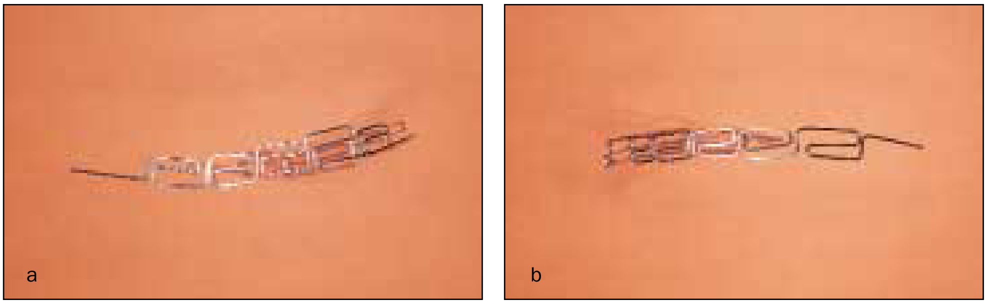

Fig 3 Lateral view of the MEAWs with tip-back activations. **(a)** Upper. **(b)** Lower.

facially and dentally. The dental arch, therefore, must be individualized for that particular patient.

BIOMECHANICS

Vertical and horizontal tooth movement must be controlled in addition to achieving rotations and torque. The MEAW produces individualized movement of the posterior teeth and group movement of the incisors. The objectives of the loops can be characterized as follows:

1. The loops between the teeth significantly reduce the load deflection rate of the wire to as low as one-tenth of a 0.016 × 0.022-inch ideal archwire.
2. The vertical components (anterior and posterior legs) of the loops serve as a breaker between the teeth and allow the teeth to move independently.
3. The horizontal components of the loops allow control of the vertical relationship of each tooth.
4. The rectangular wire (0.016 × 0.022) provides torque control for each tooth, and the loops provide independent torquing tooth movement.
5. The tip-back activations in the posterior segment of the wire produce the uprighting movement of the posterior teeth. Fifteen degrees of molar uprighting produce as much as 4.5 mm of distalization.
6. Along with the tip-back activations, anterior vertical elastics correct the occlusal planes and, in turn, close the open bite.

A photoelasticity study[14] and a study on the Computer Aided Engineering Design System[15] have shown how the MEAW system can precisely distribute the force to an area where tooth movement is required. An experimental study on Rhesus monkeys shows that marked tooth movement, along with considerable bone remodeling cellular activity, was found in the monkey with MEAW therapy, while the control monkey without the MEAW showed signs of root resorption and insignificant cellular activity.[16]

CLINICAL STUDIES

In nongrowing patients, it has been found that the skeletal pattern does not change significantly after the treatment of open bite malocclusion. The open bites, however, were corrected, which indicated that the skeletal pattern does not have to be changed to correct an open bite malocclusion.[17] In a posttreatment follow-up study on open bite malocclusions, −2.27 mm of the average anterior clearance (open bite) in the growing group was corrected to +1.58 mm of the average overbite, a net change of 3.85 mm. Similarly, it was found that −2.23 mm of the average anterior clearance in the nongrowing group was corrected to +1.78 mm of overbite, a net change of 4.01 mm. The posttreatment follow-up evaluation showed that there was an average decrease in overbite of −0.23 mm in the growing group and −0.35 in the nongrowing group. The relapses were not clinically or statistically significant.[18]

CEPHALOMETRIC ANALYSIS

Diagnostically, the cephalometric analysis is obtained by the overbite depth indicator (ODI) for an appraisal of the vertical component[19] and the anteroposterior dysplasia indicator (APDI) as a determinant of the horizontal component.[20] The ODI is a combined measurement of two angles: the A-B plane to the mandibular plane and the palatal plane to the Frankfort horizontal (FH) plane. When the palatal plane slopes upward and forward in relation to the FH plane, it is read as a negative angle. When the palatal plane slopes downward and forward in relation to the FH plane, it is read as a positive angle. Should the palatal plane be a negative value, this value is subtracted from the A-B to the mandibular plane angle. Conversely, if the palatal plane angle is read as a positive value, the angle is added to the A-B to the mandibular plane angle.

The normal mean of the ODI is 74.5 degrees. The ODI had the highest correlation coefficient value of 0.558 and the receiver operating characteristic (ROC) analysis[21] showed that the ODI had the greatest validity in determining the open bite skeletal pattern. The analytic implications of the ODI are that when the figure is less than the mean, the greater chance there is of an open bite or a tendency toward it. On the other hand, if the measurement is greater than the mean, a greater depth of overbite or the tendency toward it is predicted.

The APDI is obtained from three angles: the facial plane angle (Downs), plus or minus the A-B plane angle (Downs), and plus or minus the palatal plane angle in relation to the FH plane. The normal mean of the APDI is 81.4 degrees, with the highest correlation coefficient value of 0.643. The smaller the APDI value relative to the normal mean, the greater probability there is that a Class II malocclusion exists. Conversely, as the APDI value increases above the normal mean, the greater the chance of a Class III occlusal displacement. The ROC analyses on the APDI showed the highest validity in determining Class II and Class III malocclusions.[22,23]

The combination factor (CF) is used to determine the need for tooth extraction in the treatment of malocclusion.[24] The CF is a combined figure of the ODI and the APDI. The mean value of the CF, therefore, is 155.9 degrees. In general, whenever the CF figure is higher than 155 degrees, extractions are not necessary to treat a malocclusion. Conversely, when the figure falls below 150 degrees, extractions are more likely indicated. To verify this, a study was conducted on 226 nonextraction cases and 246 extraction cases and it was found that the mean value of CF was 151 degrees. In other words, nearly all the cases in the nonextraction group showed CF values higher than 151 degrees and the cases in the extraction group fell below that level.[25]

DIAGNOSIS AND TREATMENT MODALITY

Case 1

Figure 4a shows the intraoral photographs of a female patient, 23 years of age, with a severe anterior open bite malocclusion. She had received treatment at an early age, but it markedly relapsed. She experienced temporomandibular joint pain and returned to her orthodontist, who equilibrated the molar cusps to close the bite, but this was not successful. He then recommended a surgical intervention, but the patient was hesitant to undergo surgery. Instead, she was successfully treated with MEAW therapy.

The cephalometric analysis showed a skeletal pattern with an ODI of 69 degrees, an APDI of 79 degrees, and a CF of 148 degrees, indicating a Class II open bite pattern (Fig 5a). The mandibular dentition was mesially inclined. The maxillary occlusal plane sloped upward and forward, whereas the mandibular occlusal plane sloped downward and forward. The occlusal planes and the axial inclinations, therefore, had to be reconstructed to correct this malocclusion.

The third molars, which were causing a wedging effect, had to be extracted. Subsequently, the maxillary and mandibular arches were aligned. After the mandibular second molars were uprighted, the joint symptoms subsided. Four months after the onset of treatment, upper and lower MEAW therapy with 3-degree tip-back activation was applied, along with bilateral 3/16-inch 6-oz anterior vertical elastics from the upper first loop to the lower first loop (Fig 4b). Four months later, the open bite and the overjet were nearly corrected to a normal relationship, but the lower mandibular occlusal plane lacked a natural curve of Spee, which prevented a sufficient overbite. The lower MEAW, therefore, was removed and a curve of Spee was incorporated. The wire was reinserted and bilateral 3/16-inch, 6-oz elastics were applied from the upper first loop to the lower first loop (Fig 4c). These elastics were worn full-time, except while eating, and were replaced with new ones at bedtime. After 6 months of MEAW therapy, a normal occlusion was obtained (Fig 4d). The patient was 24 years of age; the total active treatment time was 11 months.

The posttreatment cephalogram and panoral radiograph showed favorable changes in the axial inclinations and the occlusion (Fig 5b). The pre- and posttreatment superimposition tracings showed that the mandible autorotated upward and forward about 4 degrees (Fig 5c). This result was essentially due to the elimination of the wedging effect achieved by removing the third molars. An examination at 37 months posttreatment revealed excellent stability clinically and radiographically (Figs 4e and 5d). The maxillary right lateral incisor was intruded slightly, which was attributed to a pencil-biting habit.

Case 2

Figure 6a shows the intraoral views of a patient, a boy 13 years of age, with a Class II, Division 1 deep overbite malocclusion. The cephalometric analysis revealed an ODI of 79 degrees and an APDI of 79 degrees, indicating a Class II deep overbite skeletal pattern (Fig 7a). Treatment to align the maxillary and mandibular dentitions was initiated with cervical headgear and a bite plate for 15 months. The Class II relationship, however, showed no signs of improvement. Poor compliance with the headgear may have been the reason for this lack of improvement. The Class II relationship remained the same and there was a bilateral buccal crossbite in the premolar region. At this time, the MEAW therapy was begun with 3-degree tip-back bends in the posterior segments of the maxillary dentition. A rectangular (0.016 × 0.022) ideal arch with gentle second-order tip-back bends was inserted on the mandibular dentition. The patient wore 5/16-inch, 6-oz Class II bilateral elastics from the mandibular second molar hook to the first loop of the upper MEAW (Fig 6b).

Ten months of elastic therapy eliminated this marked Class II malocclusion (Fig 6c). The posttreatment cephalogram and panoral radiograph showed a normal dental relationship (Fig 7b). The posttreatment cephalometric superimposition tracings indicated more downward growth than forward growth of the maxilla and mandible (Fig 7c). These growth changes, in turn, decreased the ODI to 75 degrees and APDI to 78 degrees. A follow-up examination at

Fig 4 Case 1. **(a)** Intraoral photographs showing the severe anterior open bite malocclusion of a 23-year-old female patient. She was treated at an early age, but her occlusion had markedly relapsed. Her orthodontist recommended surgical treatment, but she refused. **(b)** Intraoral photographs showing the MEAW mechanism in place. Bilateral elastics (3/16 inch, 6 oz) were engaged from the upper first loop to the lower first loop. **(c)** Four months later, the open bite was almost corrected. Then, a curve of Spee was incorporated into the lower MEAW to increase the over-bite. Anterior vertical elastics (3/16 inch, 6 oz) were continued. **(d)** Posttreatment intraoral photographs, when the patient was 24 years of age, show the excellent result. The total treatment duration was 11 months. **(e)** Intraoral photographs at 37 months posttreatment, when the patient was 27.1 years of age, show an excellent occlusion and good stability.

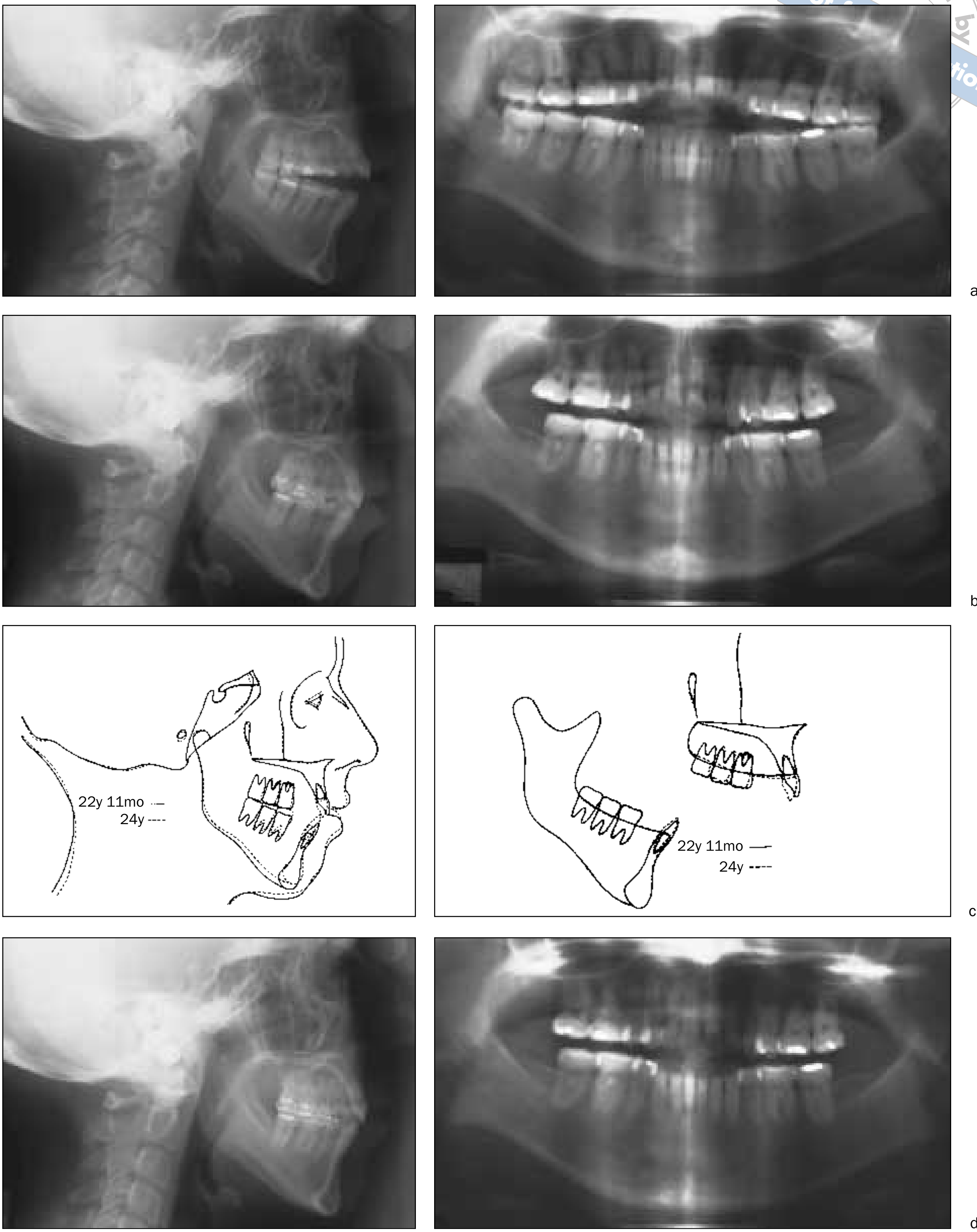

Fig 5 Case 1. **(a)** Pretreatment cephalogram and panoral radiograph. The ODI was 69 degrees and the APDI was 79 degrees. **(b)** Posttreatment cephalogram and panoral radiograph show a normal dental relationship. **(c)** Posttreatment cephalometric superimposition reveals that the molars were uprighted and the mandible autorotated counterclockwise about 4 degrees. **(d)** The 37-month follow-up cephalogram and panoral radiograph show excellent stability.

Fig 6 Case 2. **(a)** Pretreatment intraoral photographs of a boy, 13 years of age, with a marked Class II, Division 1 malocclusion. **(b)** Fifteen months of cervical headgear and bite plate therapy did not correct the Class II relationship. The course of treatment, therefore, was changed to MEAW therapy. The upper MEAW and a lower 0.016 × 0.022-inch ideal archwire with second-order tip-back bends were inserted, along with 5/16-inch, 6-oz Class II elastics. **(c)** Ten months after the Class II elastic therapy, the malocclusion was corrected. **(d)** Photographs at 27 months posttreatment show a slight deepening of the bite, but the occlusion stayed reasonably constant.

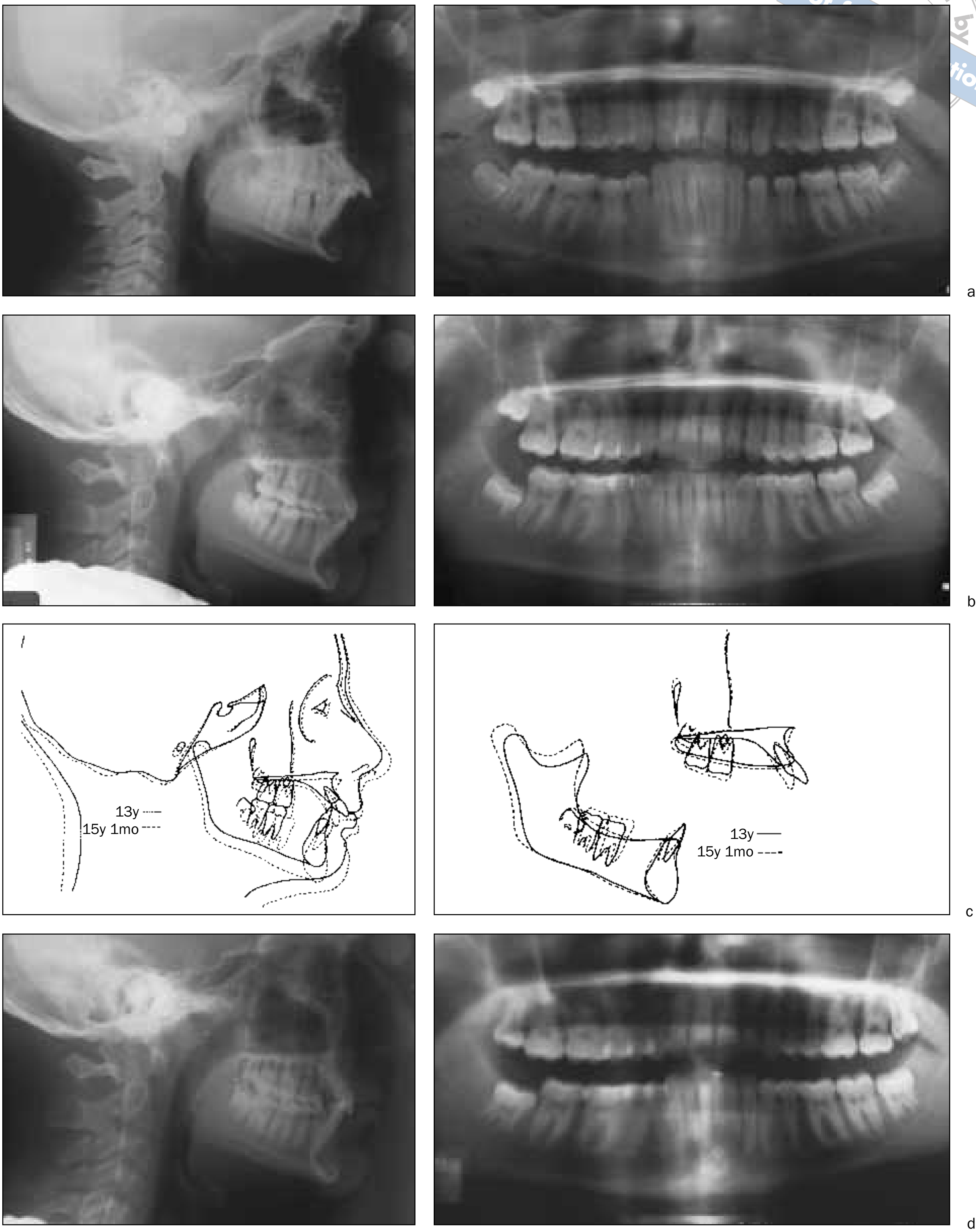

Fig 7 Case 2. **(a)** Pretreatment cephalogram and panoral radiograph. The ODI was 79 degrees and APDI was 70 degrees, indicating a Class II deep overbite skeletal pattern. **(b)** Posttreatment cephalogram and panoral radiograph show a satisfactory result. **(c)** Posttreatment cephalometric superimposition reveals that the maxilla and the mandible grew downward. **(d)** Cephalogram and panoral radiograph, taken 27 months posttreatment, when the patient was 17.5 years of age.

Fig 8 Case 3. **(a)** Pretreatment intraoral photographs of an Asian woman, 20 years 11 months of age, with a Class III malocclusion and a right unilateral posterior crossbite. **(b)** Seven months after the onset of treatment, an upper rectangular ideal arch and lower MEAW with 3-degree tip-back activation were inserted, and 5/16-inch, 6-oz Class III elastics were employed. **(c)** Ten months after the start of MEAW therapy, a normal occlusion was obtained. **(d)** The follow-up photographs at 28 months posttreatment show no changes in the occlusion.

27 months posttreatment showed that although the bite had deepened slightly, the occlusion remained stable (Figs 6d and 7d).

Case 3

An Asian woman, 20 years 11 months of age, had a Class III malocclusion with a slight anterior crossbite and a unilateral posterior crossbite on the right side (Fig 8a). For 4 years, starting at 8 years of age, she underwent chin cap therapy for Class III malocclusion at a university clinic. However, her occlusion later relapsed. Between 13 and 15 years of age, the patient received full orthodontic treatment after extraction of the four first premolars. The occlusion, however, progressively worsened. At 20 years of age, orthognathic surgery was recommended, but she and her parents refused. Her family history was negative for the prognathic mandible.

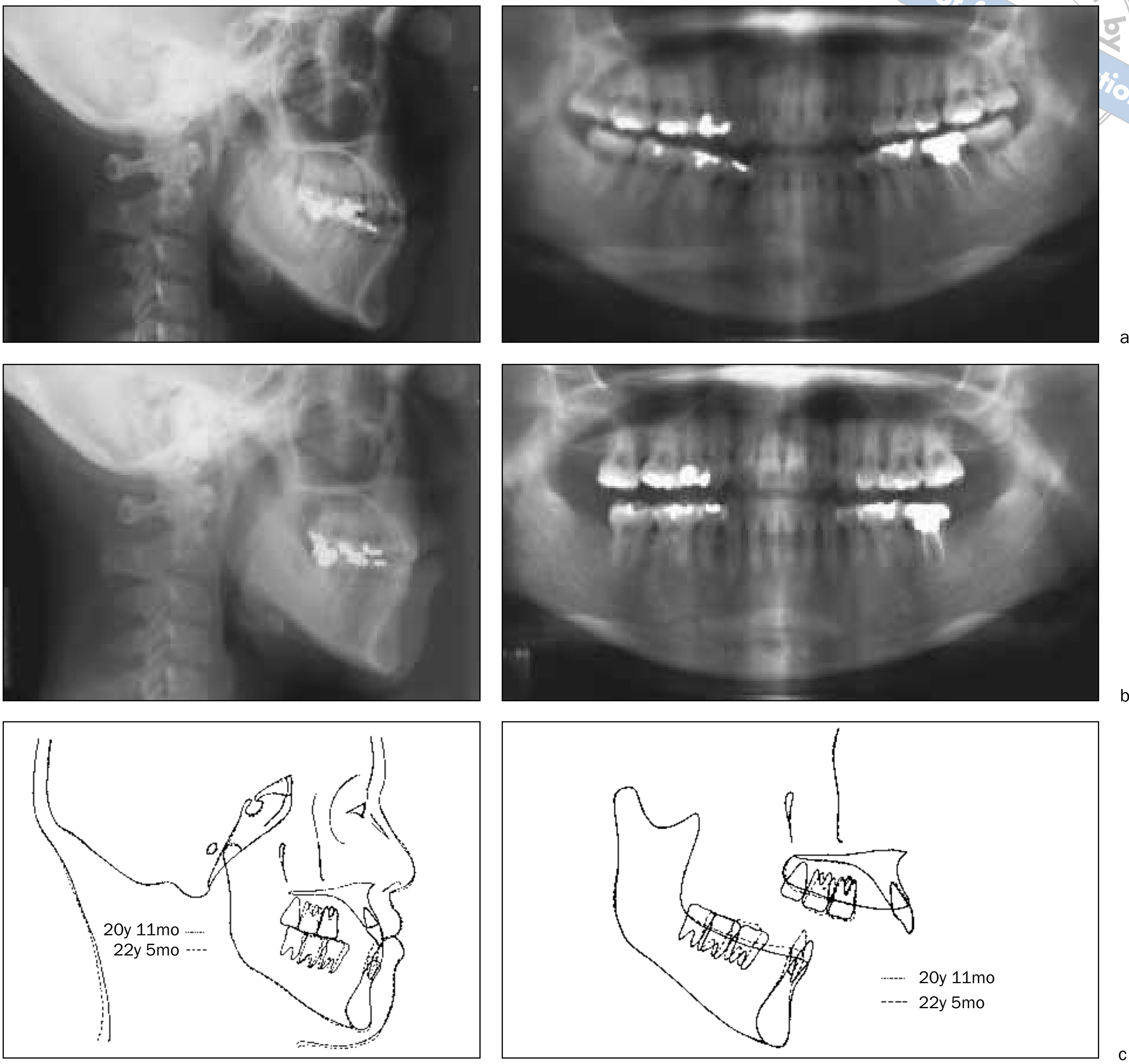

Fig 9 Case 3. **(a)** Pretreatment cephalogram and panoral radiograph. The ODI was 60 degrees and the APDI was 91 degrees. This indicated a Class III skeletal pattern with an open bite tendency. **(b)** Posttreatment cephalogram and panoral radiograph show an excellent dental relationship. **(c)** Posttreatment cephalometric superimposition reveals that there were no changes in the skeletal pattern, but the mandibular dentition was distalized and significantly uprighted.

The cephalometric analysis revealed that her ODI was 60 degrees and the APDI was 91 degrees, indicating a Class III skeletal pattern, with an open bite tendency (Fig 9a). The mandibular posterior dentition was mesially inclined. All four third molars were present but unerupted.

To upright the posterior dentition, the third molars were removed, and the maxillary and mandibular arches were aligned. Seven months after treatment onset, an upper rectangular ideal arch (0.016 × 0.022) with second-order tip-back activations and a lower MEAW with 3-degree tip-back activations were inserted, along with 5/16-inch, 6-oz Class III elastics (Fig 8b). The elastics were engaged from the upper second molar hooks anteriorly to the first loops of the lower MEAW. Ten months after the onset of MEAW therapy, the malocclusion was satisfactorily corrected and the appliances were removed (Fig 8c). The duration of active treatment was 17 months.

The posttreatment cephalogram and panoral radiograph showed a normal dental relationship and an uprighted posterior dentition (Fig 9b). The posttreatment cephalometric superimposition tracings revealed that the mandible had moved slightly downward and backward, while the mandibular dentition was considerably distalized (Fig 9c). The posttreatment ODI and APDI changed slightly, to 58.5 degrees and 87 degrees, respectively. Follow-up examination at 28 months posttreatment revealed an excellent occlusion and good stability of the dentition (Fig 8d).

CONCLUSION

The MEAW mechanism is both versatile and effective in correcting malocclusions such as open bite, deep overbite, Class II, Class III, and malocclusion with a midline deviation. Three cases were presented in this article, and in two of them another orthodontist had recommended orthognathic surgery, but all the patients were successfully treated with MEAW therapy.

The treatment duration with the MEAW is usually short, particularly in cases of open bite malocclusions. It is, however, important to remember that mere insertion of the MEAW does not guarantee treatment success. MEAW therapy requires a keen sense of judgment in diagnosis and treatment planning. Since the MEAW mechanism moves the teeth rapidly, every minute detail of the wire bending must be precise to obtain the optimal result.

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