*Case Report*

# Multiloop edgewise archwire treatment for a patient with a severe anterior open bite and amelogenesis imperfecta

**Ahmed I. Masoud[a]; T. Peter Tsay[b]**

**ABSTRACT**

Amelogenesis imperfecta is a rare hereditary disorder that affects dental enamel and is often associated with an anterior open bite. Orthodontic treatment of a 16-year-old female patient with hypocalcified amelogenesis imperfecta and a 9-mm anterior open bite was presented. Radiographic examination revealed a steep mandibular plane angle, an increased lower face height, a Class II skeletal pattern, and a convex profile. Additionally, the patient had stainless steel crowns on all upper and lower posterior teeth and composite veneers on the upper anterior teeth. The patient was treated nonsurgically using a multiloop edgewise archwire (MEAW). MEAW mechanics allowed for successful correction of the anterior open bite, with significant reduction in the mandibular plane angle and improvement in the patient's profile. No fixed retainers were used, and the results remained stable 78 months after removal of orthodontic appliances. MEAW mechanics should be considered for patients with large anterior open bites, although this technique requires excellent patient compliance. (*Angle Orthod.* 2022;92:137–147)

**KEY WORDS:** Amelogenesis; Intrusion; Extrusion; MEAW; Multiloop; Open bite; Loops; Surgical

## INTRODUCTION

Amelogenesis imperfecta (AI) was first described in 1890 but was not separated from Dentinogenesis imperfecta until 1938 when Finn classified it as a separate disorder called Brown Hypoplastic Enamel.[1,2] Depending on the diagnostic criteria and the population studied, the incidence of AI varies from 1 in 700 to 1 in 14,000.[2–6]

AI is a hereditary disorder that is diagnosed based on inheritance pattern and clinical observations of enamel.[3,6,7] Characteristics of AI include: brown discoloration of the teeth, a decrease in translucency, teeth being resistant to attrition, variable susceptibility to caries, and normal roots and pulp canals.[1,7] On the other hand, characteristics of dentinogenesis imperfecta include: gray to bluish-brown discoloration, teeth that are translucent or opalescent, excessive wear at an early age with irregular or absent enamel, low susceptibility to caries, and roots that are short and blunt with complete or partial obliteration of pulp canals.[1]

There are four main types of amelogenesis imperfecta:

I. Hypoplastic: enamel does not develop to normal thickness and enamel is deficient. Crown size varies and teeth may lack proximal contacts. Enamel contrasts normally from dentin on a radiograph by being more radiopaque.
II. Hypomaturation: enamel is of normal thickness, has a mottled appearance, is slightly softer than normal, and can chip from the crown. Enamel has almost the same radiodensity as dentin on a radiograph.
III. Hypocalcified: initially, enamel develops normal thickness (orange–yellow), but consists of poorly calcified matrix that often chips and is lost, leaving behind dentin cores. Enamel is less radiopaque than dentin on a radiograph.
IV. Hypomaturation-hypoplastic with taurodontism: Enamel is mottled (white–yellow–brown) with pits. Teeth can be small and lack proximal contacts. Teeth may have enlarged pulp chambers and molars have a taurodontic shape. Enamel has the

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Accepted: July 2021. Submitted: March 2021.
Published Online: September 17, 2021

**Figure 1.** Facial and intraoral photographs taken at the initial visit (age 16 years, 3 months).

same or slightly greater radiodensity than dentin on a radiograph.[5]

Anterior open bites are commonly seen in patients with AI and the incidence varies from 24%–60%. Cephalometric skeletal measurements of patients with AI show an increase in gonial angle, facial height, and mandibular plane angle.[8,9] Treatment of anterior open bites with increased facial height in adults is commonly directed toward either surgical superior repositioning of the posterior part of the maxilla with or without simultaneous mandibular advancement,[10] or orthodontic molar intrusion by various methods.[11–13] In this report, a case with a severe anterior open bite and amelogenesis imperfecta is presented and was treated nonsurgically using a multiloop edgewise archwire (MEAW).

The multiloop edgewire archwire (MEAW) was introduced by Dr Kim in 1987 for the correction of open bite malocclusion.[11] The form of this archwire is an ideal archwire with L-shaped loops on each side. These loops reduce the load/deflection rate of the archwire. The vertical component of the loop serves as a break between the teeth and provides horizontal control while the horizontal component of the loop provides vertical control. The completed archwire should show a marked curve of Spee in the upper arch, and a reverse curve of Spee on the lower arch. These curves apply an intrusive force on the anterior teeth, which can worsen the open bite. The anterior intrusive effect is opposed by vertical elastics on the anterior loops to eliminate incisor intrusion and obtain molar intrusion along with incisor extrusion. Constant wear of vertical elastics anteriorly is required to achieve the objectives of treatment, which include proper vertical positioning of the incisors, compatible cant of the maxillary and mandibular occlusal planes, and correction of the inclination of the posterior teeth.[11,14]

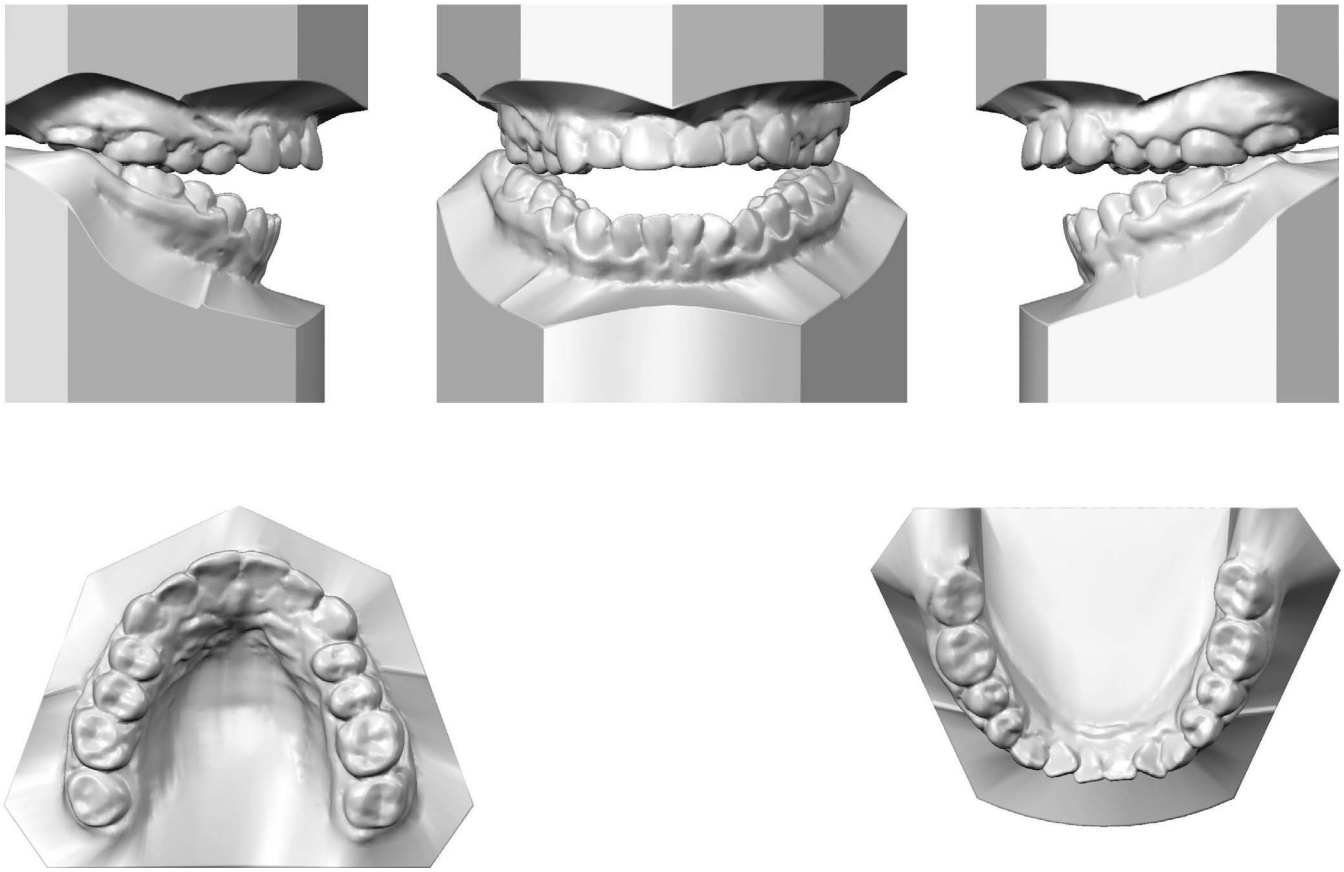

**Figure 2.** Pretreatment dental models.

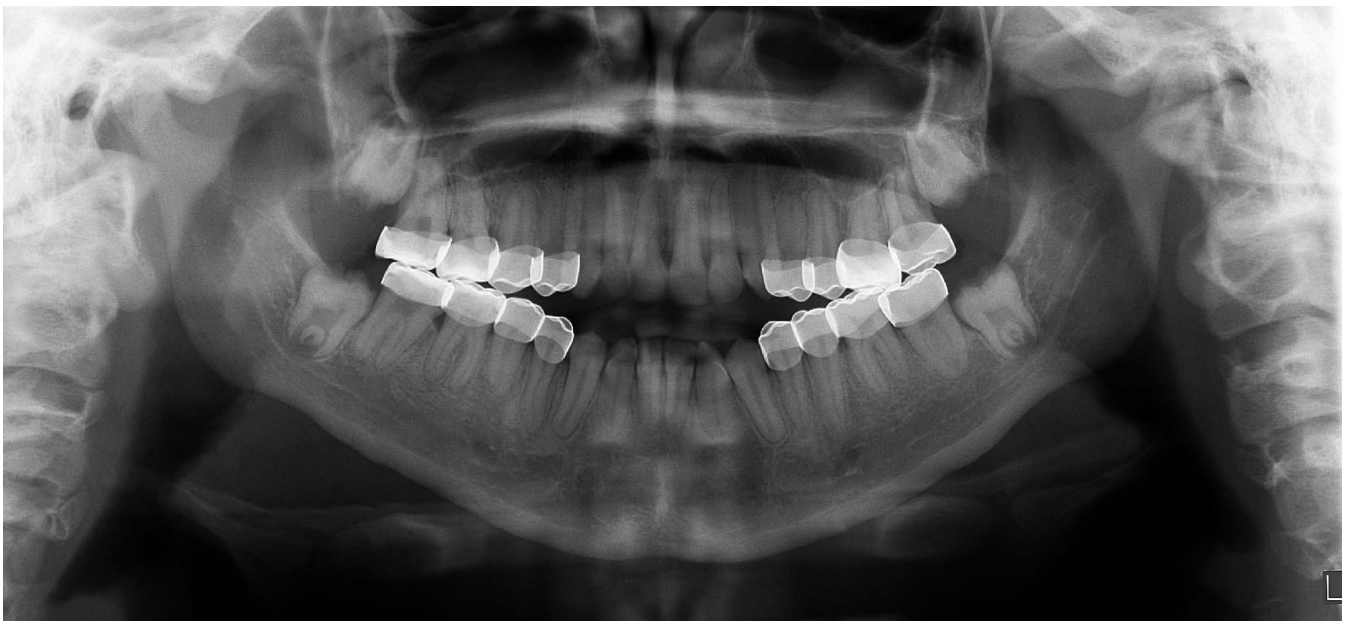

**Figure 3.** Panoramic radiograph taken at the initial visit (age 16 years, 3 months).

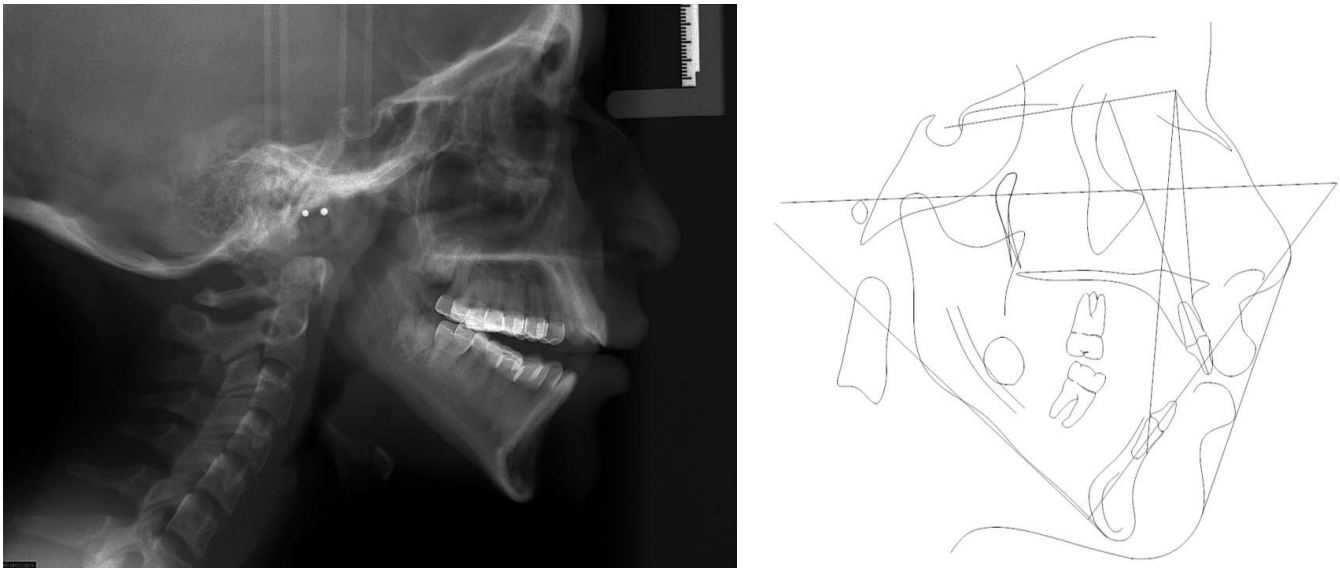

**Figure 4.** Lateral cephalogram taken at the initial visit, and tracing (age 16 years, 3 months).

## Case Report

A 16-year, 10-month-old Hispanic female patient presented with the chief complaint, "I do not like the color of my teeth, and I want to close my bite down." Medical history was noncontributory and the dental history revealed hypocalcified amelogenesis imperfecta with stainless steel crowns and composite veneers to eliminate sensitivity and improve esthetics. The patient and her parents reported no family history of amelogenesis imperfecta.

**Table 1.** Cephalometric Measurements Before and After Treatment

| Measurement | Initial Taken at Initial Visit (16 y 3 mo) | Final Taken at Debond Visit (20 y 4 mo) |
|---|---|---|
| Facial Angle (FH-NPo) (°) | 82.6 | 85.7 |
| Convexity (NA-APo) (°) | 18.8 | 12.2 |
| SNA (°) | 85.4 | 84.7 |
| SNB (°) | 76.3 | 78.2 |
| ANB (°) | 9.1 | 6.5 |
| AB - NPo (°) | 11 | 8.9 |
| FMA (MP-FH) (°) | 44.4 | 37.3 |
| Y-Axis – Downs (SGn-FH) (°) | 68.6 | 64.2 |
| Occ Plane to FH (°) | 15.7 | 15.3 |
| Interincisal Angle (U1-L1) (°) | 123.3 | 125 |
| L1 to Mand Plane -90 (°) | −5.8 | −0.2 |
| U1 - SN (°) | 100.9 | 100.6 |
| U1 Protrusion (U1-APo) (mm) | 8.8 | 8 |
| L1 Protrusion (L1-APo) (mm) | 2.3 | 6 |
| FH - SN (°) | 7.2 | 7.3 |
| Wits Appraisal (mm) | 1.9 | −1.5 |
| Lower Face Height (ANS-Me) (mm) | 69.9 | 63.6 |
| LFH/TFH (ANS-Me:N-Me) (%) | 56.2 | 55.1 |
| Upper Lip to E-Plane (mm) | −1.2 | −2.6 |
| Lower Lip to E-Plane (mm) | −0.3 | 0 |
| Nasolabial Angle (Col-Sn-UL) (°) | 104.3 | 103 |

Extraoral soft tissue examination showed a convex facial profile, retruded chin, incompetent lips, protruded upper lip, and decreased upper incisor display. Upon intraoral examination, the patient had stainless steel crowns on all upper and lower posterior teeth, composite veneers on the upper anterior teeth, and brown discoloration on the lower anterior teeth. There was generalized marginal gingivitis and gingival recession related to the lower central incisors. Transversely, the upper arch was 2-mm deficient relative to the lower arch. The Angle molar classification was Class I, with a 7-mm overjet, a 9-mm open bite, increased compensating curve, and mild lower crowding (Figures 1 and 2). Bolton analysis showed 2 mm of excessive upper anterior tooth size. Radiographic examination revealed developing third molars, a Class II skeletal pattern, an increased lower face height, and a steep mandibular plane angle (Figures 3 and 4; Table 1).

### Treatment Objectives

After controlling periodontal health, treatment objectives were directed toward: (1) expanding the upper arch, (2) achieving ideal overbite and overjet, (3) improving the Class II skeletal pattern by counterclockwise rotation of the mandible, and (4) increasing upper incisor display. Extensive restorative dentistry would be necessary after orthodontic treatment.

### Treatment Plan

The initial treatment plan was a surgical approach preceded by archwire expansion. After performing a visual treatment objective (VTO), it was decided that

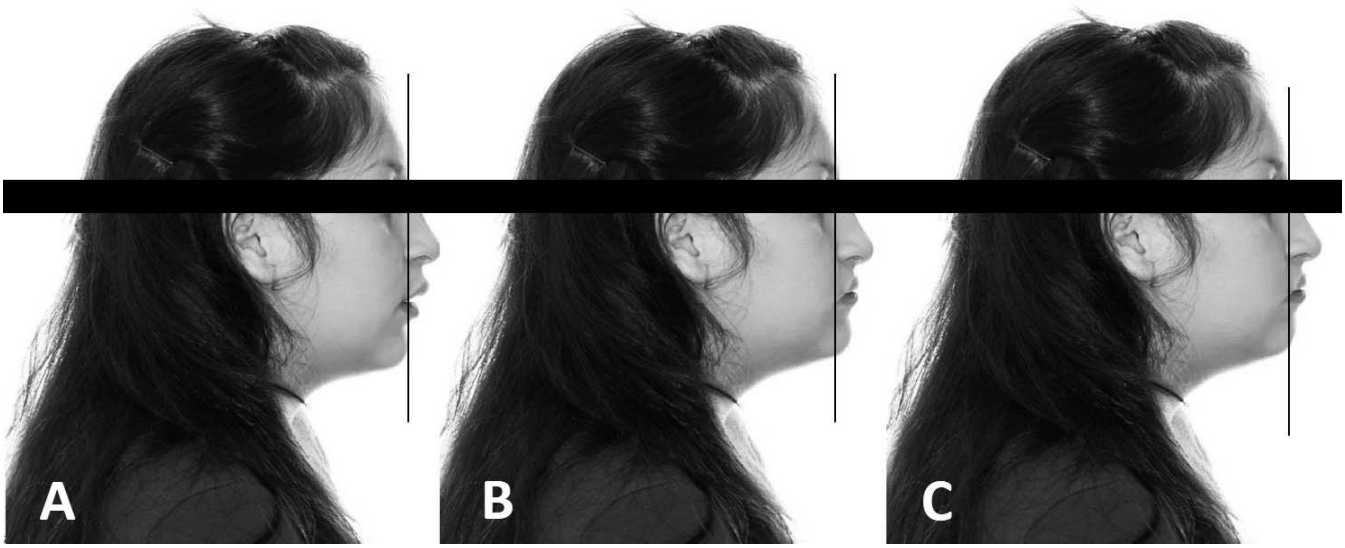


**Figure 5.** Visual treatment objective (VTO) images: (A) initial profile, (B) VTO with 2-mm upper incisor extrusion, 4 mm of posterior maxillary impaction, and 5.5° of counterclockwise forward mandibular rotation, and (C) same as the VTO in image B in addition to a 3-mm reduction genioplasty.

the surgical procedure would be posterior maxillary impaction allowing for forward counterclockwise rotation of the mandible along with reduction genioplasty (Figure 5). The alternative treatment plan, which was ultimately adopted, was nonsurgical treatment using the multiloop edgewise archwire (MEAW) technique to intrude the maxillary and mandibular posterior teeth with some anterior teeth extrusion. Alternatively, the use of miniscrews or miniplates to intrude the posterior teeth in both arches could have been done. With any of

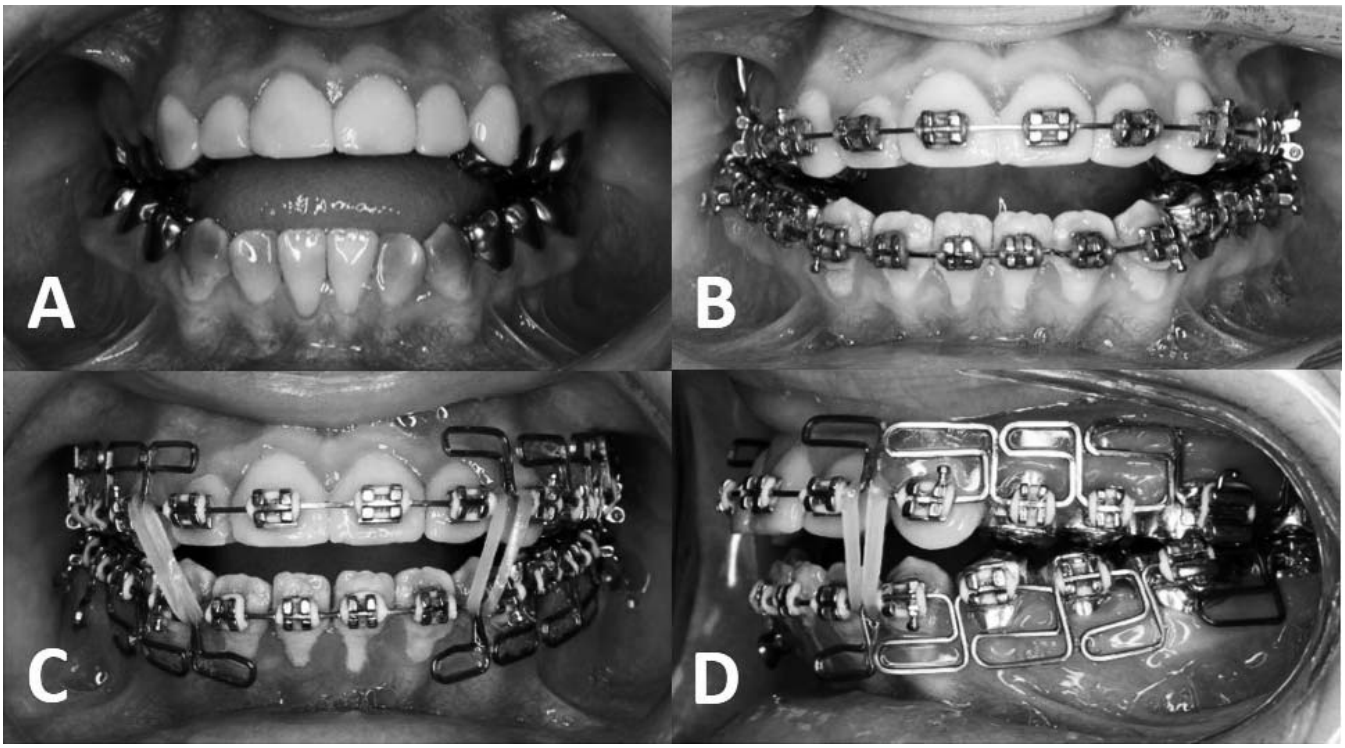


**Figure 6.** (A) Initial intraoral frontal image showing a 9-mm anterior open bite. (B) 10-month progress showing a 4-mm reduction in the anterior open bite due to upper arch leveling, upper arch expansion, and posterior torque correction. (C and D) Multiloop edgewise archwire mechanics initiated 19 months into the treatment with heavy elastics (3/16 to 6.5-ounce) worn from the loops mesial to the canines.

**Figure 7.** Facial and intraoral photographs taken at the debond visit (age 20 years, 4 months).

the aforementioned treatment options, extensive restorative dentistry would be necessary after orthodontic treatment.

### Treatment Progress

The stainless steel crowns on the posterior teeth increased the clinical crown lengths and allowed for easier banding. All molars and upper premolars were banded using stock bands, while the lower premolars were banded using pinched bands, which had brackets welded to them after proper fitting. The composite veneers on the upper anterior teeth were etched using 37% phosphoric acid, followed by a layer of monomer and a layer of bonding agent before applying bracket adhesives for bonding. The lower anterior teeth were bonded using the same technique without the monomer. The patient was told that bond strength might be substandard[15] and that bond failures could be expected. Slot size used was 0.022 × 0.028-inch with Roth prescription.

After initial leveling and alignment with nickel-titanium wires, 0.018 × 0.025-inch stainless steel wires were used for both arches. The upper archwire was expanded with added buccal root torque for the posterior teeth, and the lower archwire was constricted; in addition, all third molars were extracted. Ten months into treatment, the open bite was reduced from 9 mm to 5 mm due to upper arch leveling, upper arch expansion, and posterior torque correction (Figure 6A, B). The patient and a parent were brought in for a second consult and were presented with the option to continue the surgical treatment plan or to switch to the alternative nonsurgical alternative plan. The patient and the parent were made aware that the nonsurgical option would be more time-consuming, have less soft tissue changes, and would require a great deal of compliance wearing elastics. The patient and the

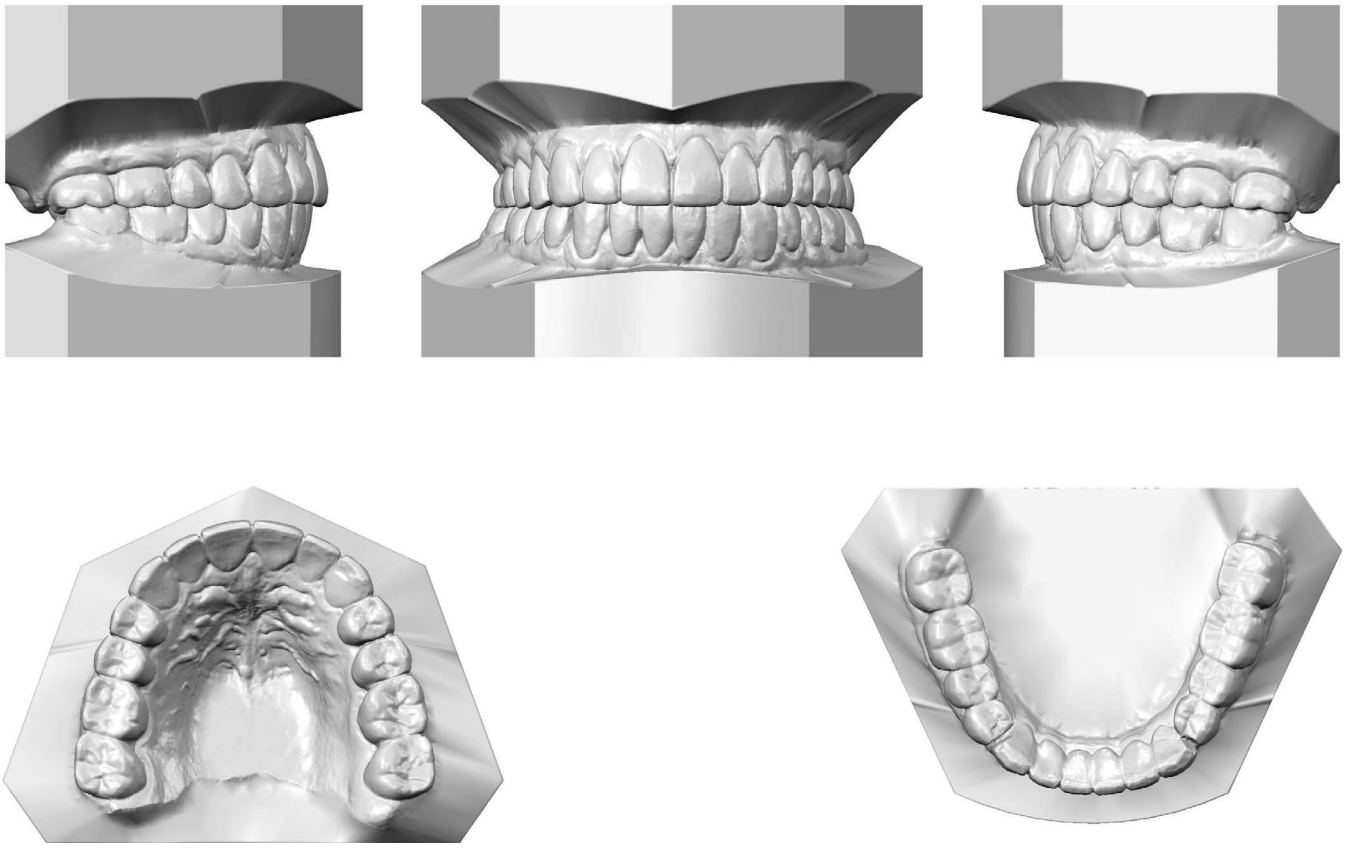

**Figure 8.** Posttreatment dental models.


**Figure 9.** Panoramic radiograph taken at the debond visit (age 20 years, 4 months).

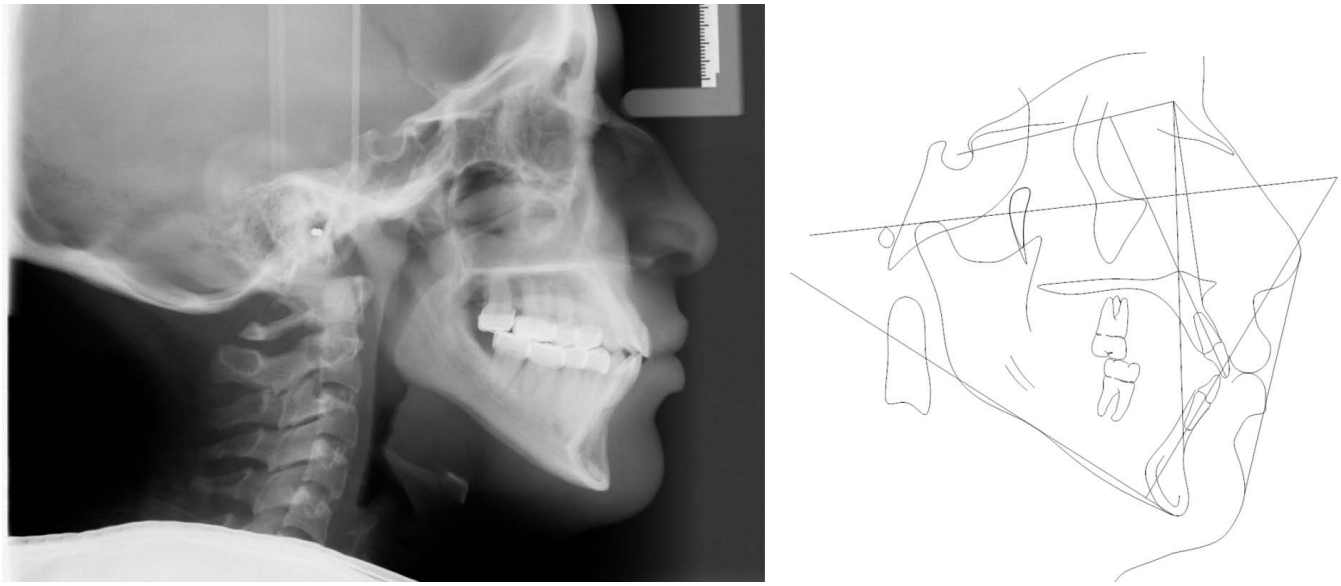

**Figure 10.** Lateral cephalogram taken at the debond visit, and tracing (age 20 years, 4 months).

parent elected to try the nonsurgical treatment plan. The patient and parent were also told that, if compliance was not maintained, then the nonsurgical treatment plan would be terminated and replaced with the surgical plan.

Upper and lower MEAWs were formed using 0.018 × 0.025-inch stainless steel straight wires with bite-opening curves. There was reverse curve of Spee in the lower archwire and increased compensating curve in the upper. MEAW mechanics were initiated 19 months into the treatment with heavy elastics (3/16 to 6.5-ounce) worn from the loops mesial to the canines (Figure 6C, D). Additionally, heavy elastics with a Class II vector between the loops, and medium short elastics (1/8 to 4.5-ounce) between Kobayashi hooks tied to the anterior teeth were used as needed. When the patient did not adhere to elastic wear, the bite started opening and the patient was reminded that, if the bite did not close, then surgery was still the treatment of choice.

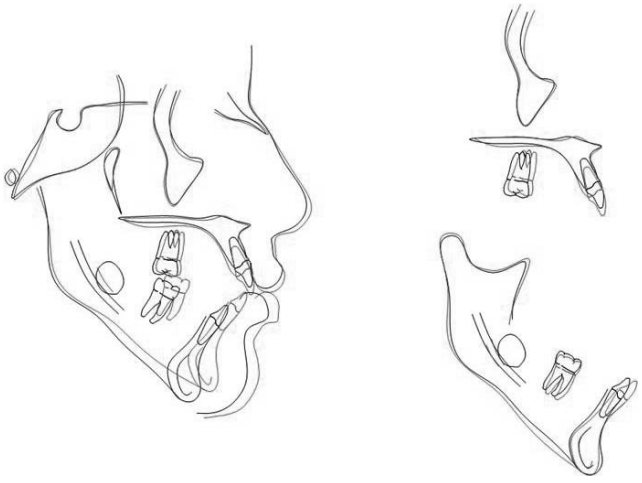

**Figure 11.** Superimposition of the cephalometric tracings before and after treatment.

After 10 months of MEAW mechanics, the open bite was overcorrected and the molars were intruded, with the second molars being intruded more than the first molars. The MEAWs were removed and 0.019 × 0.025-inch TMA wires were used for finishing. Although the transverse discrepancy was not fully corrected, it was discussed with the patient to accept it, to prevent the bite from reopening, and to get it corrected later when the prosthetic restorations were delivered. Bite-opening curves were incorporated in the TMA wires and anterior box elastics (5/16 to 4.5-ounce) were used. Four months before removal of the orthodontic appliances (debonding), the box elastics were switched to nights only, and were completely stopped 2 months before debonding to evaluate stability. Finishing involved interproximal reduction of the upper canines and lateral incisors to correct the Bolton discrepancy. When the treatment was completed, the premolars were debanded and a light elastomeric chain was used in the upper and lower arches from the right second molar to the left second molar to close premolar band spaces.

After full debanding and debonding, circumferential Hawley retainers were delivered for retention and to close any remaining band space by tightening the appliance at the loops. The patient was instructed to wear the retainers 24 hours per day for 6 months, except when eating or brushing, and then nighttime afterward. The patient showed compliance throughout

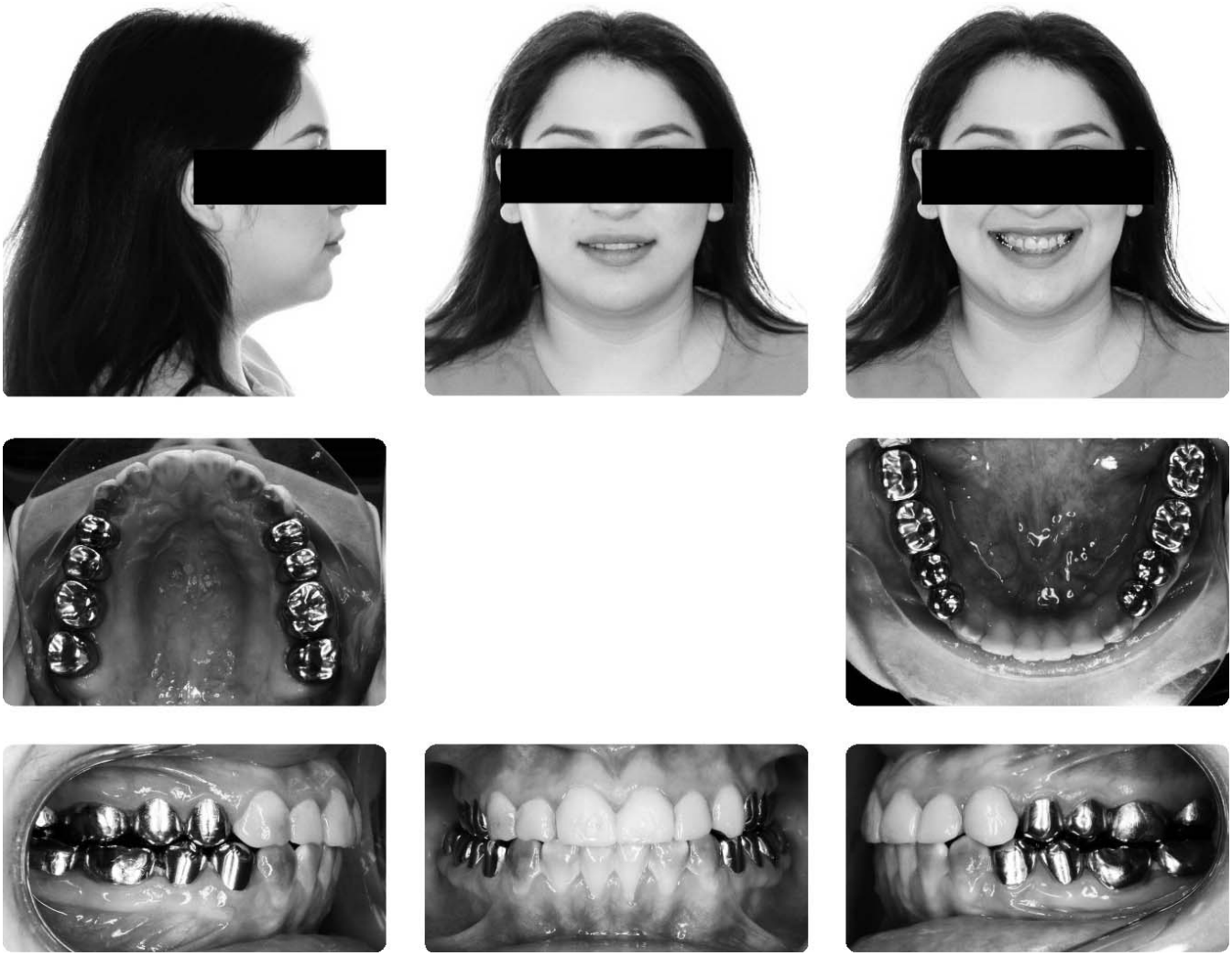

**Figure 12.** Facial and intraoral photographs taken 16 months after debond (age 21 years, 8 months).

treatment and, at the patient's request, no fixed retainers were used.

### Treatment Results

The patient showed great compliance with the elastics throughout treatment. The intraoral photographs and dental casts (Figures 7 and 8) showed satisfactory dental alignment, Class I canine and molar relationships, ideal overjet and overbite, and coincident midlines. The radiographic examination (Figure 9) showed satisfactory root parallelism.

The cephalometric evaluation and superimposition (Figures 10 and 11; Table 1) demonstrated that the skeletal Class II tendency had been reduced due to protrusion of the mandible (SNB increased from 76.3° to 78.2°; facial angle increased from 82.6° to 85.7°, and ANB decreased from 9.1° to 6.5°). The maxillary incisor inclination and position were not changed much, while the mandibular incisors proclined and protruded (L1 to mandibular plane increased from 84.2° to 89.8° and L 1-APo increased from 2.3 mm to 6 mm). Finally, the mandibular plane angle was decreased, reducing the lower facial height (Frankfort to mandibular plane angle decreased from 44.4 to 37.3, lower facial height decreased from 69.9 mm to 63.6 mm).

The total treatment time was 41 months (Figures 7 through 10; Table 1). Figure 12 shows the patient 16 months after debond with stable results and improved periodontal health. Although the patient was referred for restorations and periodontal evaluation after debond, no treatment was done 16 months after debond and the patient still had the stainless steel crowns and composite veneers she had at her initial orthodontic visit. Figure 13 shows pictures of the patient 78 months after debond. The results remained stable and the patient was able to get temporary crowns.

**Figure 13.** Facial and intraoral photographs taken 78 months after debond (age 26 years, 10 months).

## DISCUSSION

Treatment of anterior open bite malocclusion has historically been considered challenging in part because of its complex etiology and potential for relapse.[16] Ramos et al. published a well-treated case with an open bite malocclusion and amelogenesis imperfecta, and the treatment chosen involved maxillary and mandibular surgery. The argument against nonsurgical treatment was twofold. The first was the significant potential for relapse, and the second was that facial changes would not be sufficient.[3]

One of the best studies addressing the first argument, the potential for relapse, was a meta-analysis conducted by Greenlee et al. to study the stability of treatment for anterior open bite malocclusion.[16] They showed marginally higher stability in surgical treatment of anterior open bites (82%) compared to nonsurgical treatments (75%). However, this difference was not clinically significant especially when considering some surgical patients with an open bite at the presurgical stage might not have had an open bite initially, yet these patients were included in the surgical group and their stability was assessed. In addition, the nonsurgical group included growing subjects, and continuing vertical growth might have contributed to the open bite relapse. The present case was treated nonsurgically using MEAW mechanics, resulting in upper and lower molar intrusion with upper incisor extrusion. The case was followed and remained stable 78 months after debond.

To address the second argument against nonsurgical treatment, that facial changes would not be considered adequate, surgical correction of anterior open bites usually does not show a considerable facial change. This can be seen in the case presented by Ramos et al. where most of the facial improvement was achieved after pretreatment rhinoplasty.[3] Additionally, the VTO for surgical treatment in the present case did show some facial change, although it was not very

significant (Figure 5). A decrease in the mandibular plane angle, whether surgically or nonsurgically, can be accompanied by forward (counterclockwise) rotation of the mandible, and both can improve facial appearance in the vertical and sagittal dimensions. The MEAW technique is believed to result in incisor extrusion along with molar intrusion.[11] In the present case, significant molar intrusion, seen in the superimposition (Figure 11), decreased the Frankfort mandibular plane angle (FMA) by 7.1°, and the ANB angle by 2.6° (Table 1). Similarly, studies where molar intrusion was accomplished using miniscrews or posterior build-ups also showed a decrease in FMA and ANB.[12,13]

## CONCLUSIONS

- AI is a rare hereditary disorder that affects dental enamel and is often associated with an anterior open bite.
- In the present case with AI, MEAW mechanics allowed for successful correction of the anterior open bite, with significant reduction in the mandibular plane angle and improvement in the patient's profile.
- MEAW mechanics should be considered for selected patients with large anterior open bites, although this technique requires excellent patient compliance.

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