

Sequential MARA-Invisalign Treatment

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Although orthodontic treatment with clear aligner systems such as Invisalign* is usually contraindicated in teen-age patients with Class II malocclusions, it can be an option if the teeth are sufficiently erupted for the aligners to grasp them. When Class II elastics are used concurrently with aligners, however, the resulting changes may be primarily dentoalveolar. In contrast, approximately half the correction seen with the Mandibular Anterior Repositioning Appliance** (MARA) in adolescent Class II patients is skeletal.¹ In severe Class II cases, the MARA could prevent side effects that would be difficult to correct with Invisalign alone, such as first molar tipping or posterior intrusion, both of which have been observed during treatment with a combination of fixed appliances and the MARA.

I have occasionally attempted to treat Class II malocclusions involving significant crowding with concurrent MARA and Invisalign treatment. A disadvantage of this approach is that while pressure from the upper elbow of the MARA requires the use of a lingual arch to stabilize the mandibular molars, the arch must be held away from the lingual side of the mandibular anterior teeth to insert the lower aligner (Fig. 1). The lack of contact between the lingual arch and the lingual surfaces of the anterior teeth results in a mesial tipping of the molars that is difficult to correct with subsequent aligners.



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An alternative approach, as described in this article, is sequential treatment with the MARA followed by the Invisalign system.

Appliance Design

In an adolescent patient, the MARA can be used to accelerate mandibular growth by posturing the mandible forward as with a Herbst*** appliance. Unlike the Herbst, it has no connection between the jaws; like a fixed Twin Block,† it holds the mandible forward with two interfacing vertical surfaces. The MARA reportedly produces results similar to those of the Herbst, but with less headgear effect and less mandibular incisor proclination.¹

The design of the MARA has evolved over the last decade; in the most recent version, the robust lower arms incorporate buccal shields for cheek comfort and project enough from the mandibular molars to keep the upper elbows contained behind them (Fig. 2). When the patient tries to bite in a Class II position, the fixed lower arms interfere with closing, prompting the patient to hold the mandible forward in a Class I position. Opening and closing movements occur easily, and the patient generally adjusts to the appliance within a day or two. Because the MARA is cemented to the molars for the duration of treatment, its effectiveness does not depend on patient compliance.

The MARA works especially well in low-angle deep-bite cases, especially during the adolescent growth spurt that usually occurs after age 12.

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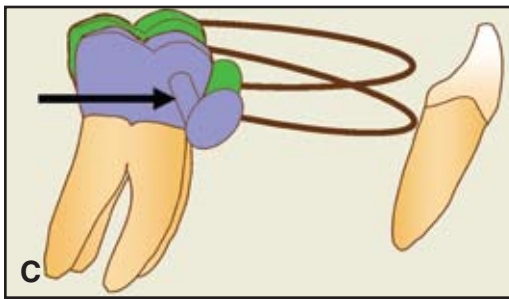
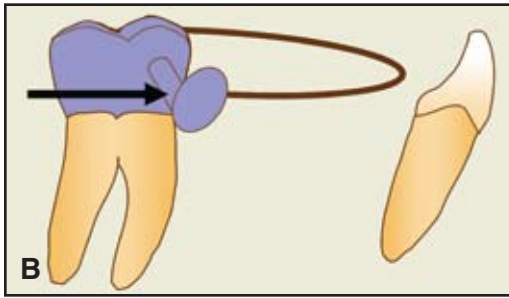
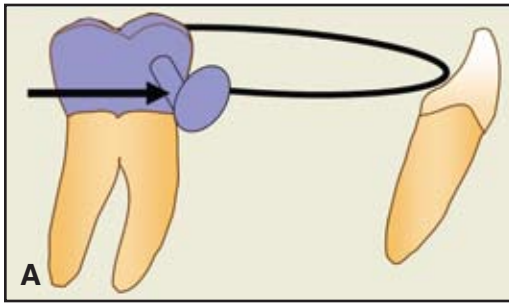


Fig. 1 Mandibular lingual arch used with Mandibular Anterior Repositioning Appliance (MARA). A. Lingual arch resting on incisor. B. Lingual arch positioned away from incisor. C. Mandibular molar tipped mesially. D. Mesial pressure exerted by upper elbow of MARA on lower arm. E. Mesio-gingival tipping of mandibular molar.

Case Report

A 13-year-old male presented for orthodontic treatment. Clinical examination revealed a severe Class II malocclusion with a deep bite and minor rotations, accompanied by a brachyfacial growth pattern and a prominent chin (Fig. 3). Inspection of the cervical vertebrae indicated that considerable growth remained.

We recommended sequential MARA and Invisalign treatment as described above. Appointments were scheduled every three months during both phases to monitor treatment progress and make any required adjustments.

The MARA was fabricated with stainless steel crowns and cemented in place using glass ionomer cement. After three months, the mandibular anterior teeth exhibited slight space opening and intrusion caused by pressure from the appliance's mandibular lingual arch, as well as a posterior open bite from the mandibular advancement (Fig. 4). After eight months of MARA treatment, the maxillary arch showed spacing due to molar distalization, but the posterior open bite had



Fig. 2 A. MARA in open position. B. MARA in engaged position.



Fig. 3 A. 13-year-old male patient with severe Class II malocclusion, deep bite, and minor rotations before treatment. **B.** Tomograms of left and right TMJs.

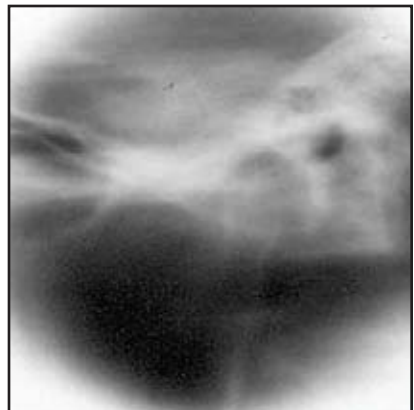
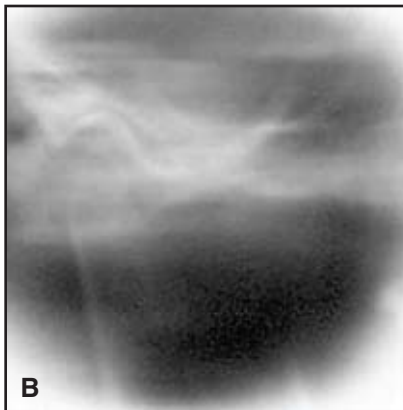


Fig. 4 After three months of MARA treatment.



Fig. 5 After eight months of MARA treatment.

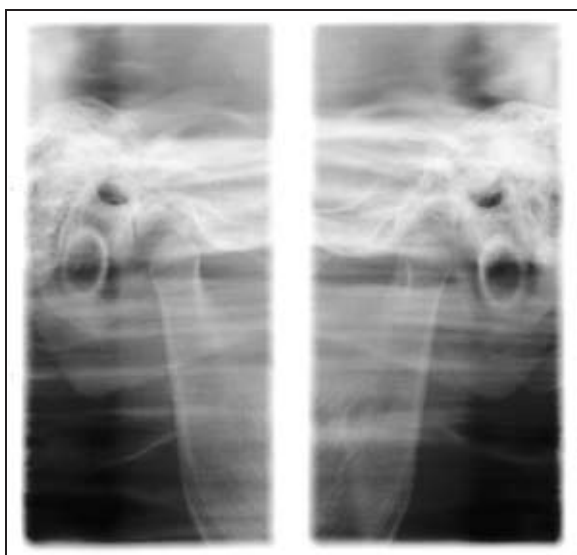


Fig. 6 Tomograms of left and right TMJs after 12 months of MARA treatment.

closed as the teeth had erupted into occlusion (Fig. 5). The maxillary incisors began to appear retroclined compared with their initial positions.

After 12 months of MARA treatment, progress TMJ tomograms showed the condyles still positioned down and forward compared with the initial tomograms (Fig. 6), so the MARA was left in place for an additional three months. The periodontal status of the molars supporting the appliance remained normal throughout the entire MARA phase.

After 15 months, the MARA was removed, leaving a slight posterior open bite (Fig. 7). The maxillary incisors and molars had tipped backward, the maxillary premolars had widened, and the maxillary molars had rotated mesiobuccally and moved distally (Fig. 8). No caries or periodontal problems were observed around the molars.

Before Invisalign impressions were taken,



Fig. 7 MARA removed after 15 months of treatment.

the molars were allowed to erupt and the posterior open bite to partially close. After three months of settling, the distal tipping of the maxillary molars

had improved (Fig. 9). The Invisalign prescription was then designed to close the remaining open bite, close the maxillary spaces, and align the

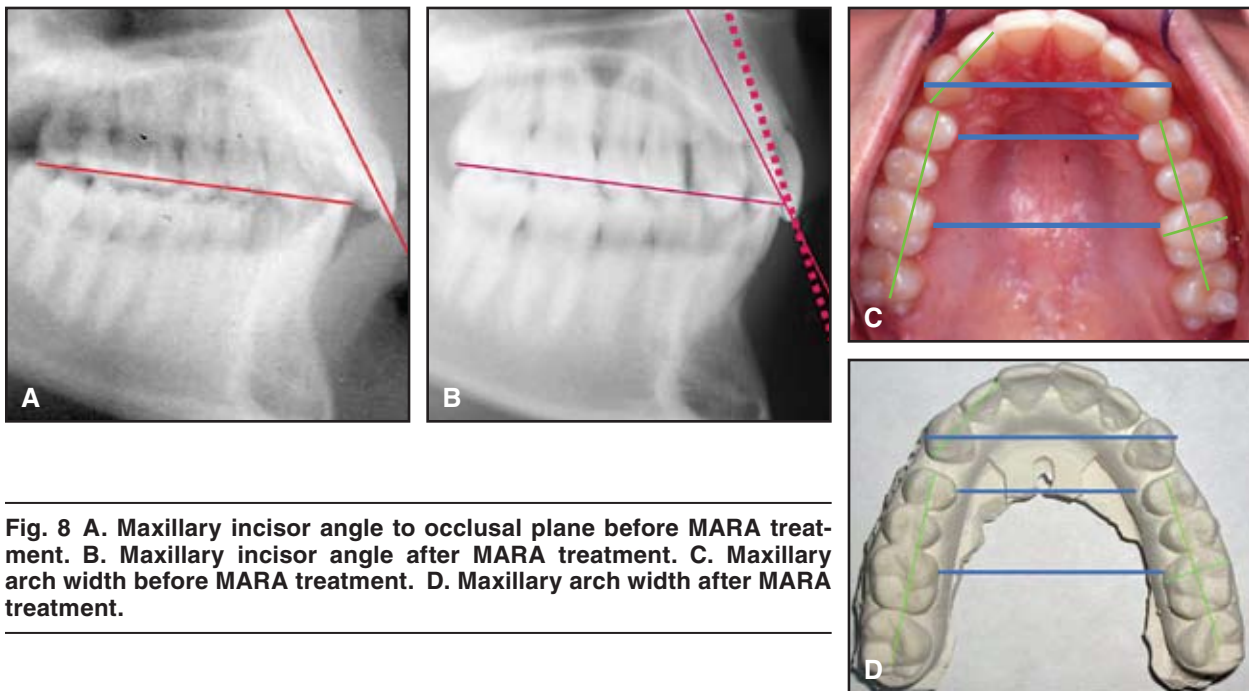


Fig. 8 A. Maxillary incisor angle to occlusal plane before MARA treatment. B. Maxillary incisor angle after MARA treatment. C. Maxillary arch width before MARA treatment. D. Maxillary arch width after MARA treatment.



Fig. 9 Patient after three months of settling following removal of MARA.

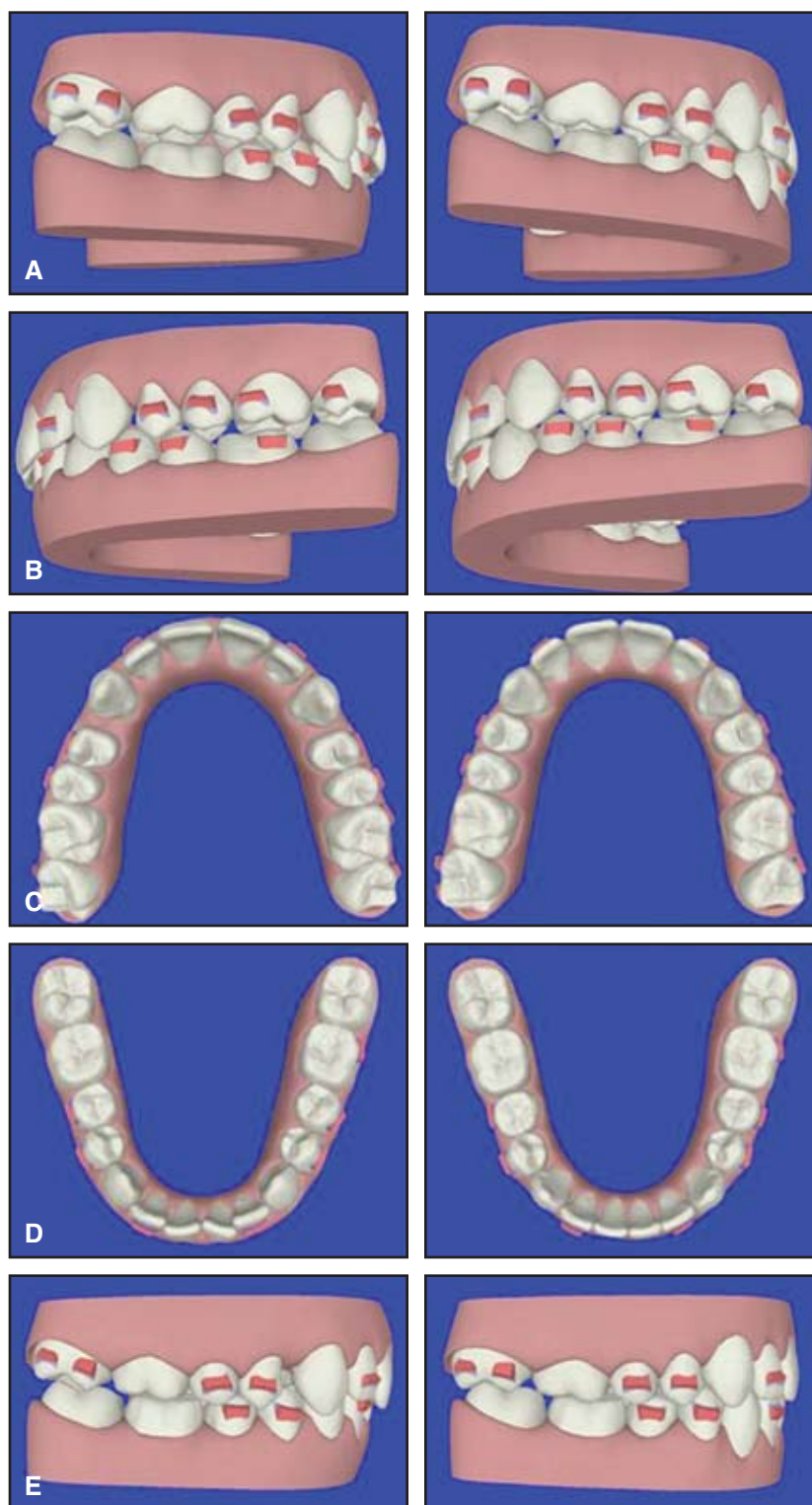


Fig. 10 ClinCheck* prescription showing initial tooth positions (left) and intended results (right). A. Right posterior bite closing. B. Left posterior bite closing and maxillary left canine intrusion, facilitated by use of attachments. C. Maxillary space closure. D. Mandibular incisor alignment. E. Maxillary incisor torque; in retrospect, more torque should have been planned, using attachments on central incisors.



Fig. 11 After three months of Invisalign treatment.



Fig. 12 After 12 months of Invisalign treatment.

mandibular incisors (Fig. 10). Because of the flexibility of the aligner material, the limited production tolerances, and the post-treatment effects of the transeptal fibers, it would have been unrealistic to expect a complete correction of the mandibular central incisor rotations from ideal ClinCheck* positions. In the Invisalign protocol,

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however, overcorrections are usually built into the Case Refinement phase.

At the Invisalign delivery appointment, a total of about 1mm of interproximal tooth structure was removed between the mandibular anterior teeth using a flexible rotary diamond disk. After three months of Invisalign treatment, some of the maxillary spaces had closed, and the posterior open bite had disappeared (Fig. 11). After 12

Sequential MARA-Invisalign Treatment

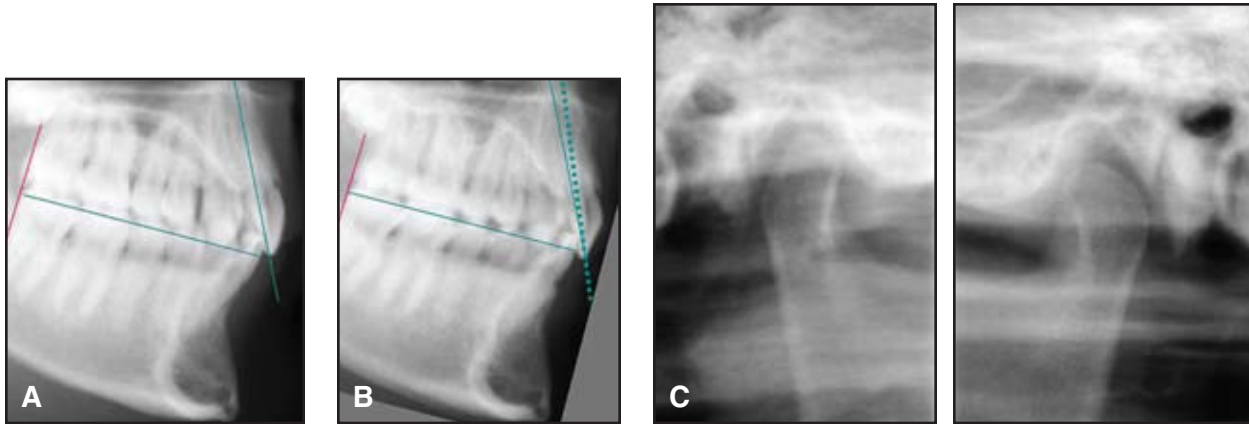


Fig. 13 A. At end of MARA treatment, with maxillary molar distal to mandibular molar. B. At end of Invisalign treatment, showing slight advancement of maxillary molar and uprighting of maxillary incisor. C. Left and right tomograms after 12 months of Invisalign treatment.

months of Invisalign treatment, the Invisalign attachments were removed, and Hawley-type retainers were delivered for the patient to wear indefinitely at night only.

The sequential MARA-Invisalign treatment was successful in opening the bite and fully correcting the Class II malocclusion (Fig. 12). Other than maxillary arch spacing, side effects were minimal. Although the mandibular incisor rotation was undercorrected, this was not of sufficient concern to the patient to warrant even a minor Case Refinement; therefore, the teeth are being aligned with the removable mandibular retainer.

Invisalign treatment resulted in additional uprighting of the maxillary incisors, indicating that more attention should have been paid to torquing these teeth in the ClinCheck prescription (Fig. 10E). (At the time the case was treated, the incisor torque ridges featured in the current Invisalign Teen aligners were not yet available.) In addition, the maxillary molars moved forward slightly during Invisalign treatment (Fig. 13). Both of these unwanted tooth movements were due to Invisalign's closure of the spaces created by the MARA. The use of upper aligners during the MARA phase could have prevented space opening in the maxillary arch and minimized maxillary incisor uprighting. This would have resulted in a more forward positioning of the maxillary incisors and thus a

greater horizontal Class II correction in the mandibular arch.

A comparison of measurements made on study casts immediately before and after Invisalign treatment showed no change in maxillary width and a 1mm increase in the mandibular intermolar, interpremolar, and intercanine dimensions (Fig. 14). Superimpositions of pre- and post-treatment cephalometric tracings showed a headgear-like effect, with no maxillary forward movement (Fig. 15). There was more maxillary vertical change during the MARA phase than during the Invisalign phase. The mandible grew considerably, but hinged downward because of the backward tipping of the maxillary incisors during both phases. The maxillary molars moved distally during MARA treatment and mesially during Invisalign treatment, with little net change. No significant distal tipping or intrusion of the maxillary molars was observed during the MARA phase.

The maxillary incisors were excessively retroclined; the mandibular incisors did not procline during MARA treatment, but did retrocline during Invisalign treatment because of the interproximal reduction and widening of the anterior arch. No mesial tipping or excessive intrusion of the mandibular molars occurred during the MARA phase. Overall, the mandibular molars erupted vertically in proportion to the increase in facial height.

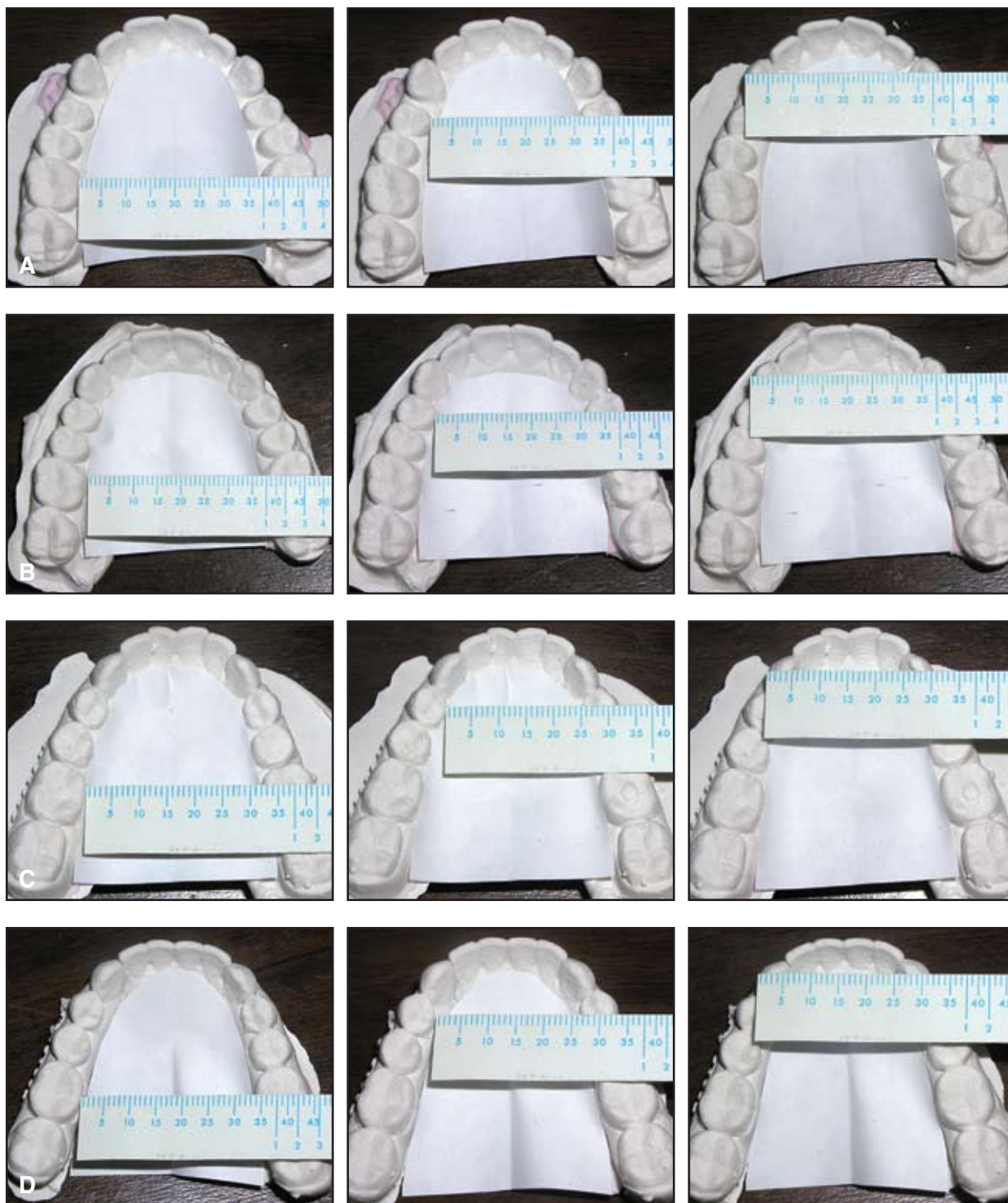


Fig. 14 A. Upper arch widths before Invisalign treatment. B. Upper arch widths after Invisalign treatment. C. Lower arch widths before Invisalign treatment. D. Lower arch widths after Invisalign treatment.

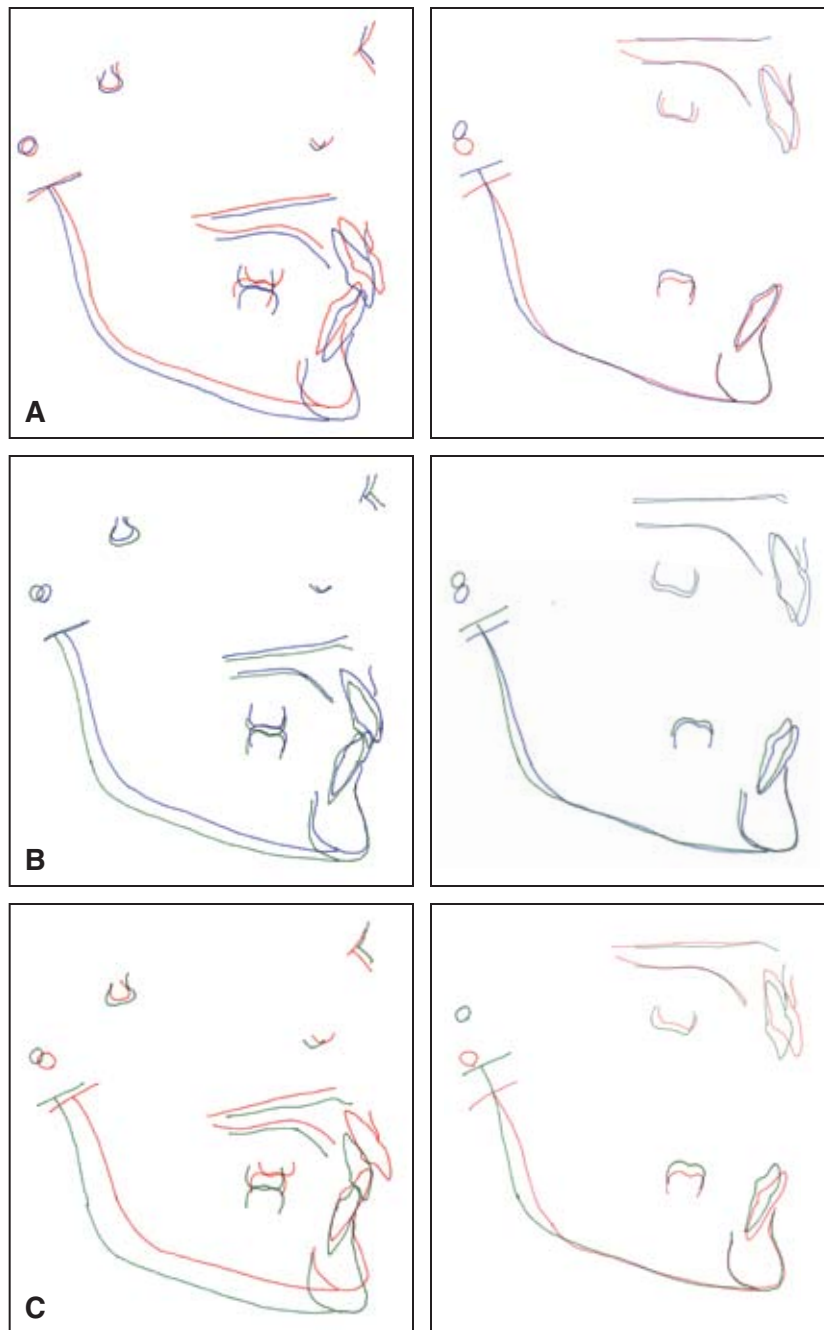


Fig. 15 Superimpositions of pre- and post-treatment cephalometric tracings (red = pretreatment; blue = after MARA treatment; green = after Invisalign treatment). A. MARA treatment alone. B. Invisalign treatment alone. C. MARA and Invisalign treatments combined.

Conclusion

In the sequential MARA-Invisalign case shown here, the outcome was satisfactory, although more maxillary incisor torque and horizontal change in the mandible would have been desirable. It remains to be seen how Invisalign treatment can be combined with the MARA in more complicated cases.

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