Treatment of Challenging Malocclusions with Invisalign and Miniscrew Anchorage

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Although many types of malocclusion can be successfully treated with clear aligners,[1-15] the most difficult cases are not typically handled using only these removable appliances.[16,17] By improving anchorage control and, therefore, treatment predictability, temporary anchorage devices (TADs) now make it possible to use aligners for effective orthodontic tooth movement in even more challenging situations.[18-26]

This article describes two adult patients with complex malocclusions who were treated with a combination of Invisalign* and miniscrew-supported anchorage.

Case 1

A 37-year-old female presented with the chief complaints of unesthetic tooth coloration and alignment, as well as insufficient upper-incisor display. Less than 20% of the upper incisors' clinical crown length was visible in her maximum posed smile (Fig. 1). Clinical examination revealed a mild midfacial retrusion and obtuse nasolabial angle. The patient displayed bilateral Class I molar and Class II canine relationships, an anterior crossbite and open bite, hypererupted mandibular incisors, a canted occlusal plane, multiple temporary resin crowns, and some tooth discoloration. Her narrow maxillary lateral incisors contributed to a tooth-size discrepancy. Cephalometric analysis indicated a mild skeletal Class III relationship, an obtuse mandibular plane angle, and normal dentoalveolar heights (Table 1).

The orthodontic treatment plan involved:

- Invisalign treatment to level and align both arches.
- Interproximal reduction (IPR) in the lower anterior region to permit some retraction for leveling of the curve of Spee and reduction of the crossbite.

*Registered trademark of Align Technology, Inc., San Jose, CA; www.invisalign.com.


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Fig. 1 Case 1. 37-year-old female patient with skeletal Class III relationship, midfacial retrusion, insufficient upper-incisor display, anterior crossbite, and open bite before treatment.

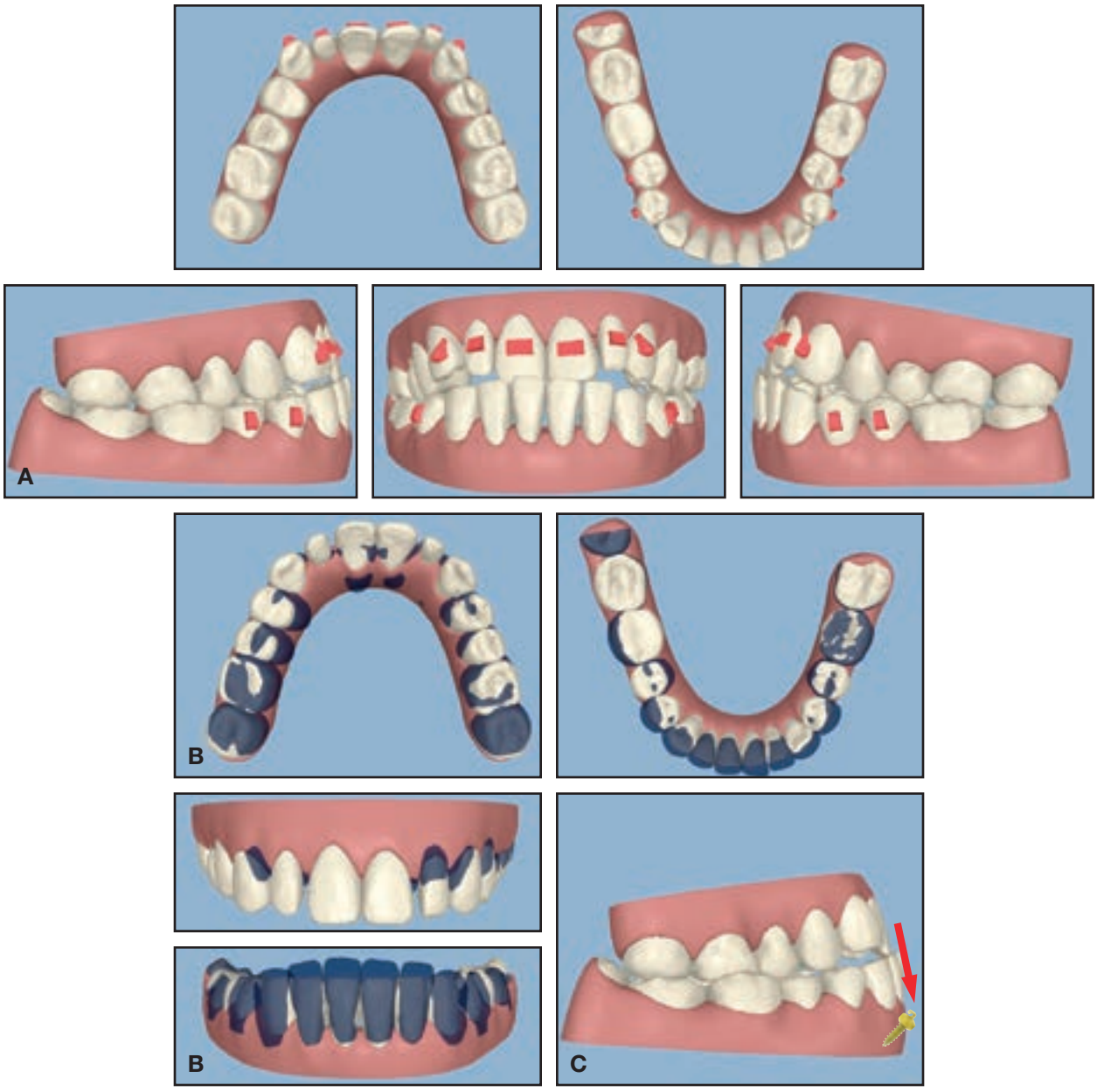

Fig. 2 Case 1. A. Initial ClinCheck* images. B. Superimposition of pretreatment ClinCheck analysis and post-treatment projections (final treatment goal in blue), showing desired upper anterior extrusion and lower anterior intrusion and retraction. C. Maxillary incisor extrusion supported by anchorage from single mandibular miniscrew.

- Aligner extrusion attachments on the upper anterior teeth to assist with closure of the open bite and improvement of the smile line and incisor display.
- Intrusion of the mandibular incisors, combined with absolute extrusion of the maxillary incisors.
- Insertion of a miniscrew in the mandibular midline symphysis to support intermaxillary elastics for extrusion of the maxillary anterior teeth.
- Space opening between the maxillary anterior teeth for final esthetic restorations after orthodontic treatment.

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Fig. 3 Case 1. After 22 weeks of treatment with 11 pairs of aligners.

Fig. 4 Case 1. Absolute upper-anterior extrusion from intermaxillary elastics between miniscrew in midline symphysis and composite buttons bonded at gingival margins of incisors, using aligners as eruption guides.

Fig. 5 Case 1. Absolute upper-incisor extrusion from combination of Invisalign* and miniscrew-supported elastic traction. A. Before treatment. B. After three months. C. After five months.

Fig. 6 Case 1. After 12 months of treatment and 24 pairs of aligners, showing improved occlusion and space opening for esthetic restoration of upper peg laterals.

The aligner treatment projection called for maxillary incisor extrusion, supported by anchorage from a single miniscrew in the mandibular anterior alveolus (Fig. 2).

IPR was performed from the lower left second premolar to right first premolar. The upper incisors were moving toward a positive overjet after the first 11 pairs of aligners (Fig. 3), but the patient was concerned about the stability of her improvement. Consequently, a LOMAS** hook screw (2mm × 9mm) was inserted into the midline symphysis,[27,28] and four composite buttons were built with a flowable resin on the labial cervical edges of the upper central and lateral incisors. Circumferential fiberotomies were performed around those same teeth. The patient was instructed to wear intermaxillary elastics between the hook screw and the composite buttons (Fig. 4). Aligners were worn continuously through the rest of treatment, serving as guides for extrusion of the upper anterior teeth (Fig. 5).

After an additional 13 pairs of aligners (supported with elastics), the lower IPR spaces were nearly closed, the anterior crossbite and open bite had been corrected, and adequate restorative spaces had been opened around the upper lateral incisors, closely matching the pretreatment projections (Fig. 6).

At this stage, new temporary crowns were fabricated for the maxillary lateral incisors and all first permanent molars, and further case refinements involving nine additional pairs of aligners were planned. At the conclusion of orthodontic treatment, the patient's dentist provided in-office bleaching, along with final full ceramic crowns for the anterior teeth and porcelain crowns for the posterior teeth.

*Registered trademark of Align Technology, Inc., San Jose, CA; www.invisalign.com.
**Mondeal Medical Systems GmbH, Mühlheim a.d. Donau, Germany; www.mondeal.de.

TABLE 1
CEPHALOMETRIC ANALYSIS

	Pretreatment	Post-Treatment
SNA	74.0°	75.0°
SNB	77.0°	75.0°
ANB	–3.0°	0.0°
MPA	34.0°	34.0°
U1-SN	109.0°	110.0°
IMPA	93.0°	84.0°
U6-PP	26.0mm	26.0mm
U1-PP	31.0mm	33.0mm
L6-MP	34.5mm	35.0mm
L1-MP	42.0mm	40.0mm

Fig. 7 Case 1. A. Patient after 18 months of treatment (continued on next page).

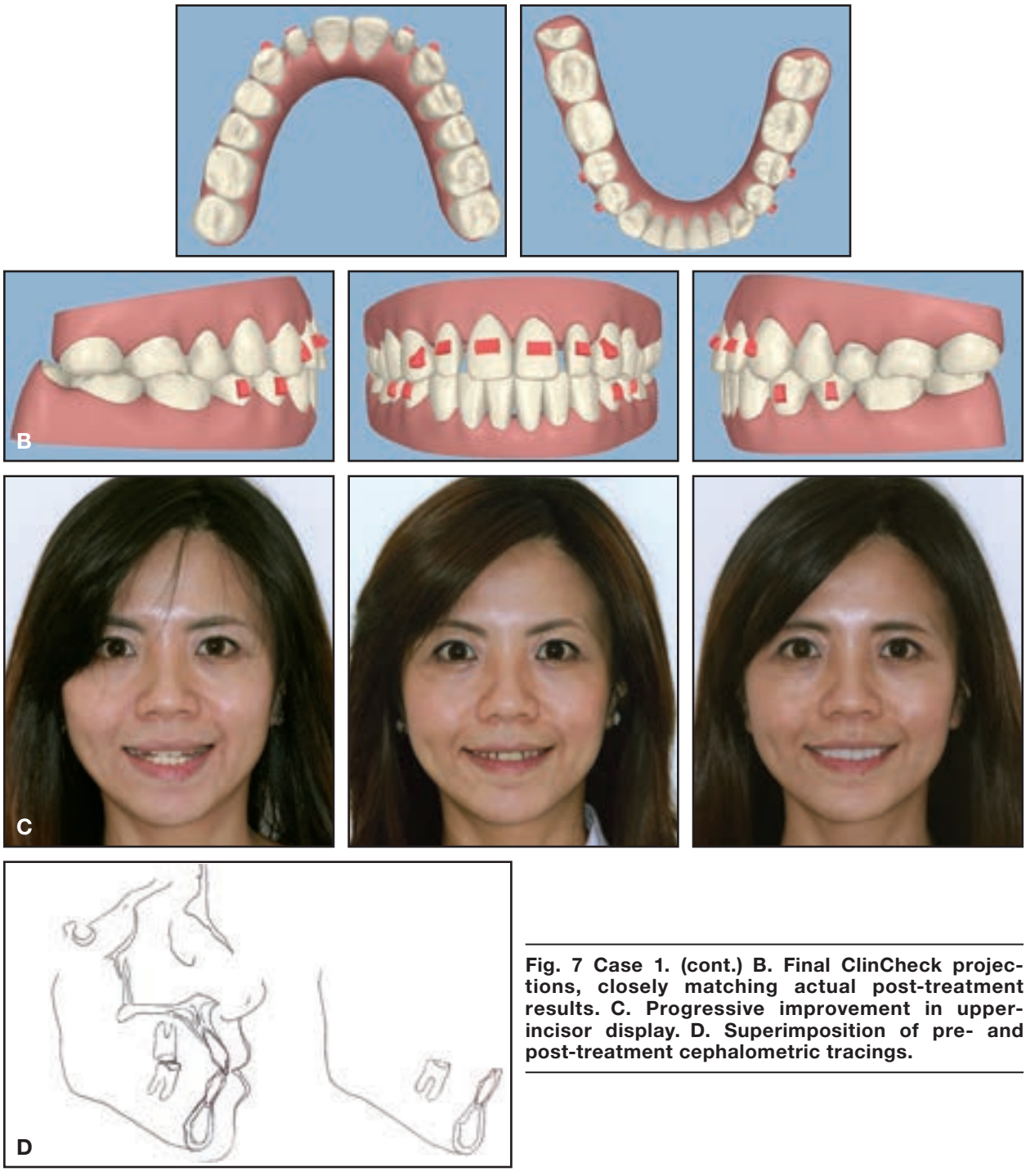

Fig. 7 Case 1. (cont.) B. Final ClinCheck projections, closely matching actual post-treatment results. C. Progressive improvement in upper-incisor display. D. Superimposition of pre- and post-treatment cephalometric tracings.

After 18 months of treatment, the patient's occlusion and smile exhibited a dramatic esthetic and occlusal improvement (Fig. 7A-C). Cephalometric superimpositions demonstrated absolute extrusion of the upper anterior teeth, retraction and intrusion of the lower anterior teeth, and slight retraction of the lips (Fig. 7D, Table 1). The vertical positions of both the upper and lower molars were unchanged.

Fig. 8 Case 2. 29-year-old male patient with Class III canine and molar relationships, moderate anterior crowding, and flared anterior teeth in both arches before treatment.

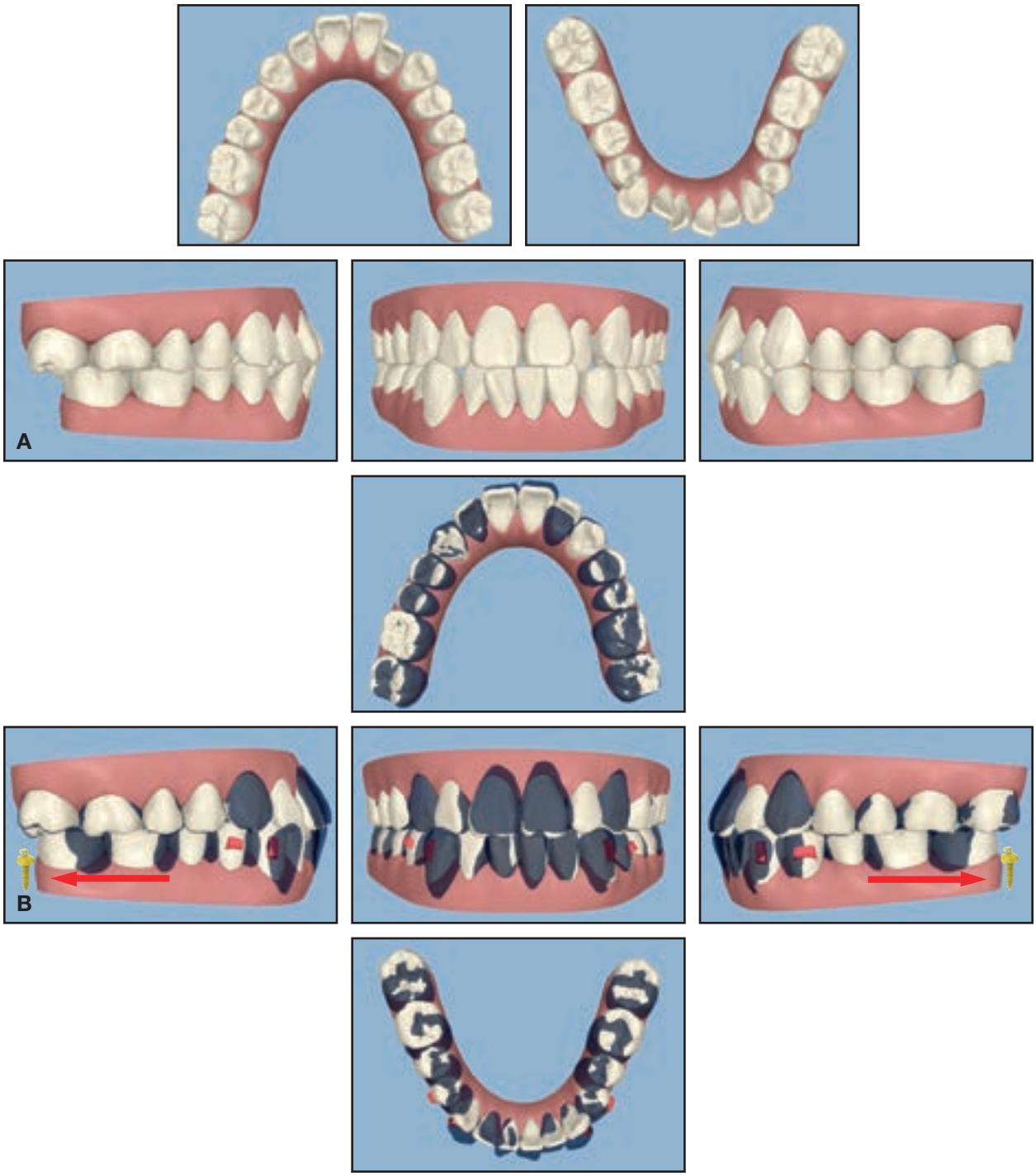

Fig. 9 Case 2. A. Initial ClinCheck images. B. Superimposition of pretreatment ClinCheck analysis and post-treatment projections (final treatment goal in blue), showing desired en masse retraction of lower dentition.

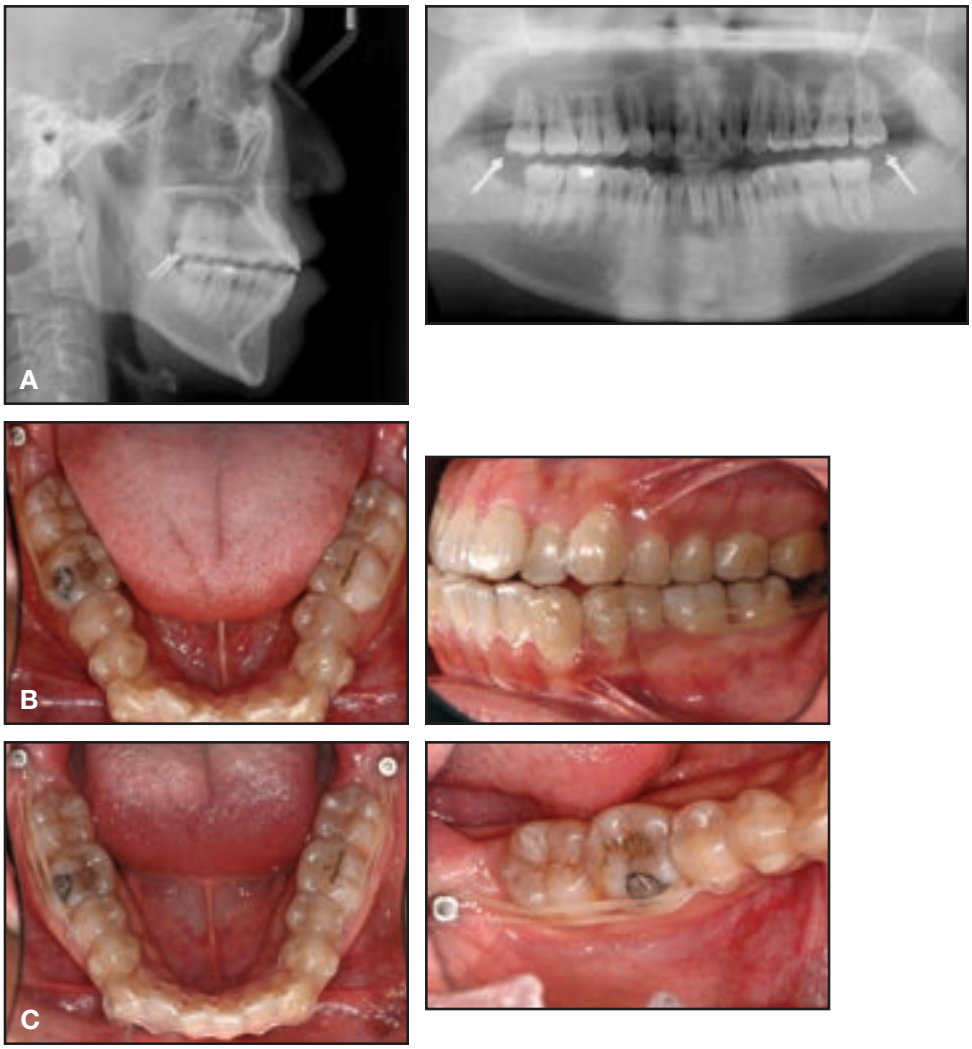

Fig. 10 Case 2. A. Miniscrews inserted into mandibular retromolar areas to support elastic traction. B. En masse retraction of lower dentition using intramandibular elastics from retromolar miniscrews to hooks cut into buccal first-molar areas of aligners. C. After four months, hooks cut into second-premolar areas for increased retraction force.

Case 2

A 29-year-old male presented with the chief complaints of dental crowding and an unesthetic smile, specifically requesting clear aligner treatment. Clinical examination showed an acute nasolabial angle, a short upper lip, a slightly deviated chin, and mild lip incompetence (Fig. 8). Both dental arches had bilateral Class III canine and molar relationships with moderate crowding. Cephalometric analysis indicated a skeletal Class I relationship, a moderate mandibular plane angle, and flared upper and lower incisors (Table 2).

The treatment objective was to improve the dental alignment and the Class III malocclusion by en masse retraction of the entire lower dentition,

Fig. 11 Case 2. After 15 months of treatment with combination of Invisalign and miniscrew anchorage.

using a combination of miniscrews and aligners. The mandibular third molars were extracted to facilitate the retraction.

Twenty-seven upper and 31 lower aligners, with rectangular attachments bonded to the mandibular canines and first premolars, were prescribed to correct the anterior crossbite, derotate the lower incisors, expand the arches, and retract the mandibular dentition with miniscrew support (Fig. 9).

After five pairs of aligners, LOMAS miniscrews (2mm × 13mm) were inserted into the right and left mandibular retromolar regions (Fig. 10A). En masse retraction of the lower dentition was initiated using Class I elastics hooked from the two miniscrews to notches cut into each aligner buccal to the lower first molars (Fig. 10B). In subsequent aligners, the notches were cut adjacent to the second premolars to gradually increase the retraction forces (Fig. 10C).

Notable improvement could be seen after 15 months of treatment (Fig. 11). A refinement phase with an additional 20 pairs of aligners was then planned for further detailing.

After a total 24 months of orthodontic treatment, the patient showed an improved smile and a Class I occlusion with normal overjet and overbite, closely matching the pretreatment projections (Fig. 12A,B). Cephalometric superimpositions confirmed a slight retraction of the upper anterior teeth, lingual tipping of the lower anterior teeth, and bodily retraction of the mandibular dentition, without any increase in the mandibular plane angle or lower anterior facial height (Fig. 12C, Table 2).

TABLE 2
CEPHALOMETRIC ANALYSIS

	Pretreatment	Post-Treatment
SNA	80.5°	80.0°
SNB	79.5°	79.0°
ANB	1.0°	1.0°
MPA	34.0°	34.0°
U1-SN	113.0°	107.5°
IMPA	107.5°	92.5°
U6-PP	35.0mm	35.0mm
U1-PP	41.0mm	42.0mm
L6-MP	47.5mm	46.5mm
L1-MP	57.5mm	57.5mm

Discussion

Although a few examples of significant malocclusions treated only with aligners have recently been published,[7-10,13] some cases are still con-

Fig. 12 Case 2. A. Patient after 24 months of treatment (continued on next page).

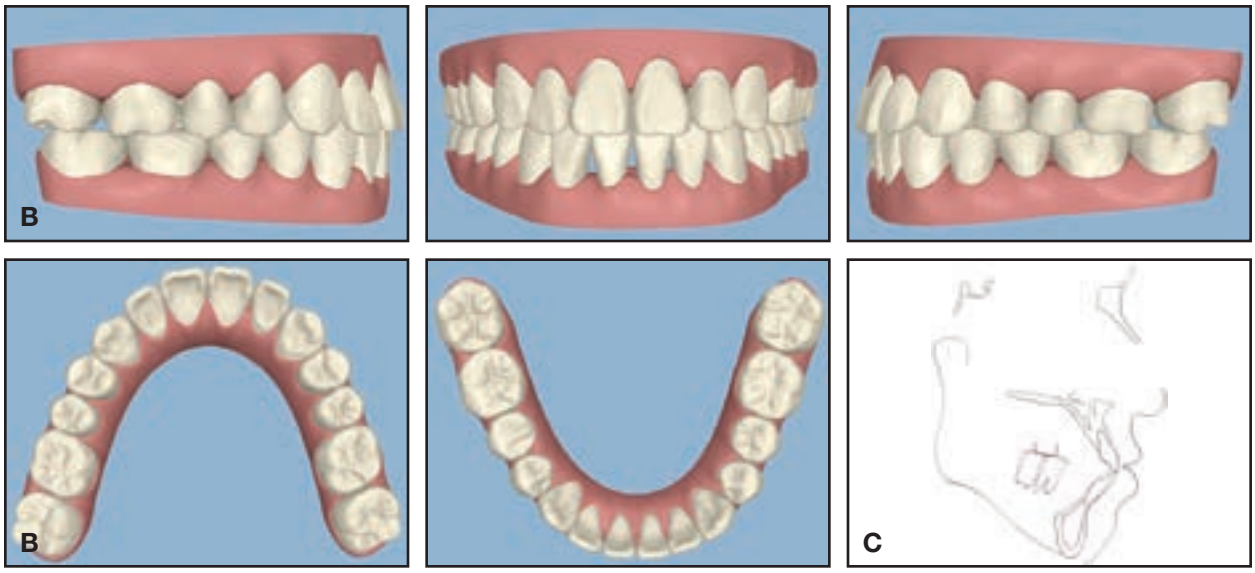

Fig. 12 Case 2. (cont.) B. Final ClinCheck projections, closely matching actual post-treatment results. C. Superimposition of pre-and post-treatment cephalometric tracings.

sidered beyond the scope of aligner capabilities. Boyd noted that absolute extrusion is extremely difficult to achieve with aligners, even when attachments are added.[8] Kravitz and colleagues found maxillary incisor extrusion to be the least feasible tooth movement in aligner therapy, probably because of the inability of the aligner plastic to "grip" around the blade-shaped incisors, combined with the resistance of the periodontal fibers.[17]

Although Schupp and colleagues reported successful treatment of two anterior open-bite cases using only aligners with attachments,[9] the anterior teeth were still relatively extruded at the end of treatment, as compared to the absolute extrusion shown here in Case 1.

In our Case 2, the use of miniscrew anchorage to support aligners during en masse retraction of the lower dentition contributed to correction of the anterior crossbite, lower crowding, and midline deviation during this two-year treatment. The third molars were extracted rather than the premolars to facilitate retraction of the entire mandibular dentition, since root parallelism is difficult to control in space closure with aligners.[29-32] In any case, the clinician must carefully evaluate the patient's facial pattern and dental relationships, the quality of soft tissue distal to the terminal molars, and the anatomical limits of the mandible before considering this approach.[33-36] Careful diagnosis and realistic treatment objectives are necessary to avoid undesirable side effects.[37]

Conclusion

Orthodontists who wish to use aligners to treat a complex malocclusion should fully understand their limitations and design proper biomechanics reflecting realistic expectations of tooth movement—including anchorage requirements—without violating anatomical boundaries. In some instances, other auxiliaries, sectional fixed appliances,[38] additional miniscrews,[39] or interdisciplinary treatment may be needed to achieve the best results.

Although the cases presented here clearly show the effectiveness of a combination of aligners and miniscrews in managing challenging malocclusions without conventional fixed appliances, we do not intend this as a call to discard traditional approaches. Rather, we would like the reader to consider miniscrews as an adjunct that can provide more reliable anchorage when aligners are chosen for orthodontic treatment.

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