

Creative Adjuncts for Clear Aligners

Part 3 Extraction and Interdisciplinary Treatment

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In Part 1 of this series (JCO, February 2015), we discussed the use of various adjuncts in Class II treatment with clear aligners. Part 2 (JCO, March 2015) showed how to use aligners for intrusion, rotation, and extrusion. This month, we conclude with demonstrations of the issues involved in extraction treatment, torque control, and interdisciplinary treatment with clear aligners.

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Extraction Treatment

Clear-aligner treatment of severe dental protrusion and/or crowding has been a challenge because of such problems as anchorage requirements, control of the occlusal plane and vertical dimension, anterior torque, and tipping of teeth into extraction sites—although favorable results have certainly been reported.⁵³⁻⁵⁶ Unless reciprocal space closure is desired, anchorage reinforcement is a necessity. This can take many forms, from the addition of elastics to the initial placement of partial fixed appliances⁵⁷ to the use of full fixed appliances for a portion of treatment before or after aligner therapy. Considering the complexity of extraction biomechanics with clear aligners, any treatment plan will require careful customized staging, as described by Samoto and Vlaskalic,⁵⁸ perhaps combined with the previously discussed adjuncts—especially miniscrew anchorage.^{59,60}

Miniscrews can provide indirect posterior anchorage by holding the molars in position while the retraction is directed by clear aligners (Fig. 18). Temporary implants may also be used as “posts” for the application of intramaxillary and/or intermaxillary elastics to support space closure, improve a Class II relationship, or correct a deep overbite (Figs. 3,19,20).

Although lingual appliances represent another esthetic alternative, a transition from preliminary treatment with full lingual brackets to

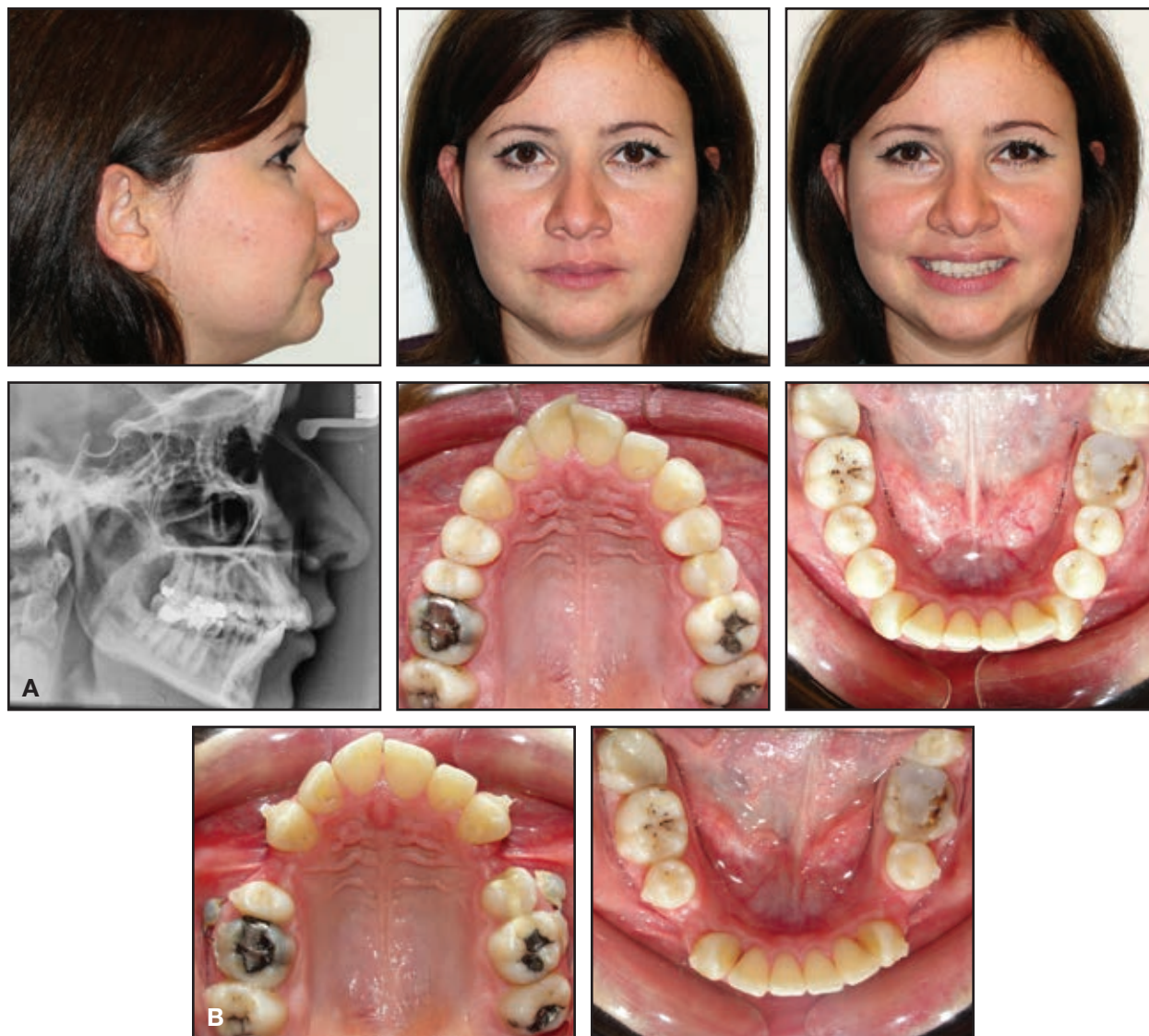


Fig. 18 Extraction treatment with indirect miniscrew anchorage. **A.** Adult female patient with crowded and protrusive dentition before treatment. **B.** After extraction of upper and lower first premolars and insertion of miniscrews between upper second premolars and first molars. Sectional wires bonded to buccal surfaces of first molars and heads of miniscrews provide indirect anchorage for retraction with aligners (continued on next page).

Invisalign* would be highly unlikely due to the costs and discomfort involved. Nevertheless, it seems reasonable in an extraction case to take advantage of miniscrew anchorage for a substantial amount of retraction and space closure with partial fixed lingual mechanics prior to the introduction

of clear aligners (Fig. 20). In addition, there are ongoing investigations of the effectiveness of devices such as AcceleDent**^{61,62} (Fig. 21), Propel*** and OrthoPulse† in accelerating the rate of tooth movement during clear-aligner therapy.

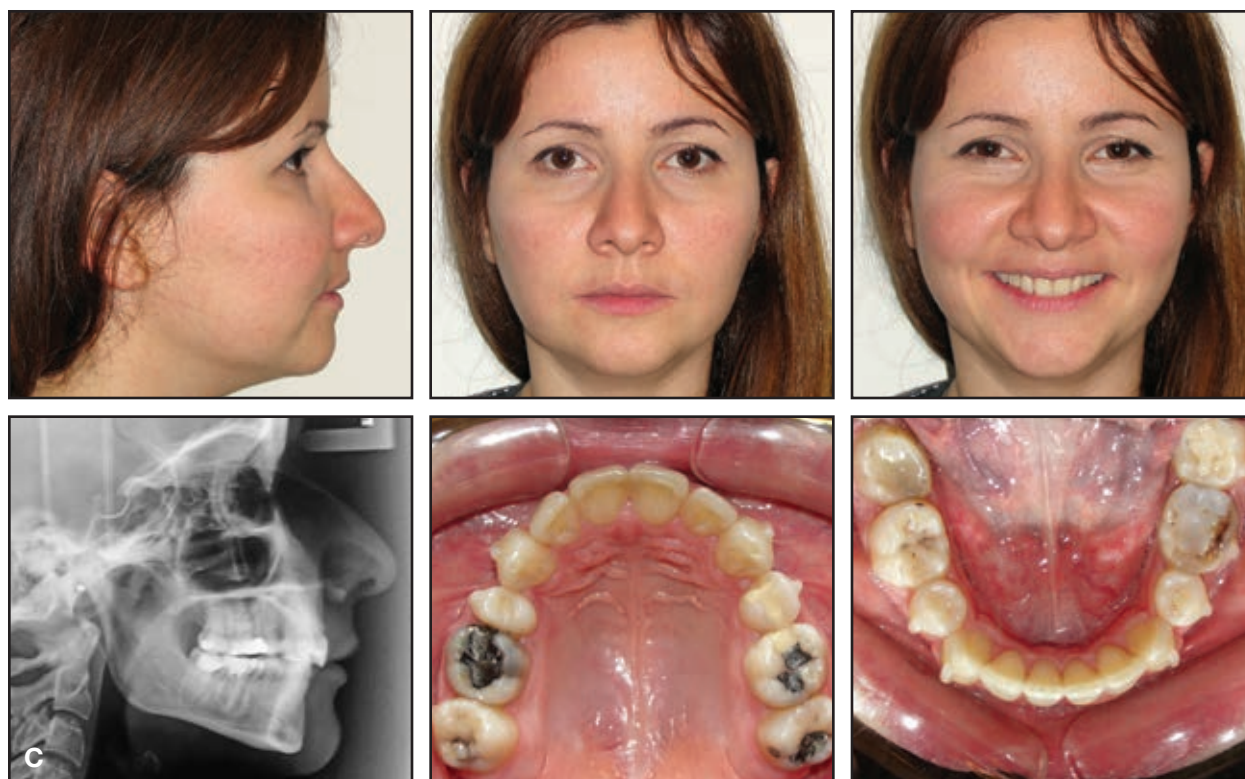


Fig. 18 (cont.) C. Patient after 25 months of clear-aligner treatment.

Anterior and Posterior Torque

The inability to apply anterior lingual root torque was originally considered to be a significant limitation of clear aligners.^{63,64} During the Invisalign TEEN* research project,¹³ however, the addition of “torque ridges” to enhance lingual crown torque on the upper incisors was found to be effective (although the positive results may have been influenced somewhat by the unprecedented attention given to this aspect of tooth movement).⁶⁴ During that preliminary investigation, an unin-

tended side effect of the anterior torque was a notable iatrogenic “rotation” (mesial tipping) and concomitant distal root rotation of the maxillary first molars (Figs. 3C,6D,22A).

Torquing moments of couple at the incisors create moments of force at the distal aspects of the anchoring first molars—a mesial force transmitted throughout the dental arch. Although the same biomechanical situation occurs with traditional brackets, it can be counterbalanced by using crown tipbacks or perfectly placed and tied-back omega stops in the archwire, or by other means of anchorage support. If the wire is not tied to the molars, the incisors will flare. Consequently, forces transmitted through the wire will produce a force at the distal aspect of the molar, perpendicular to the first-molar trifurcation, and a moment of force will rotate (tip) the molar forward.

If the force of occlusion is coupled through

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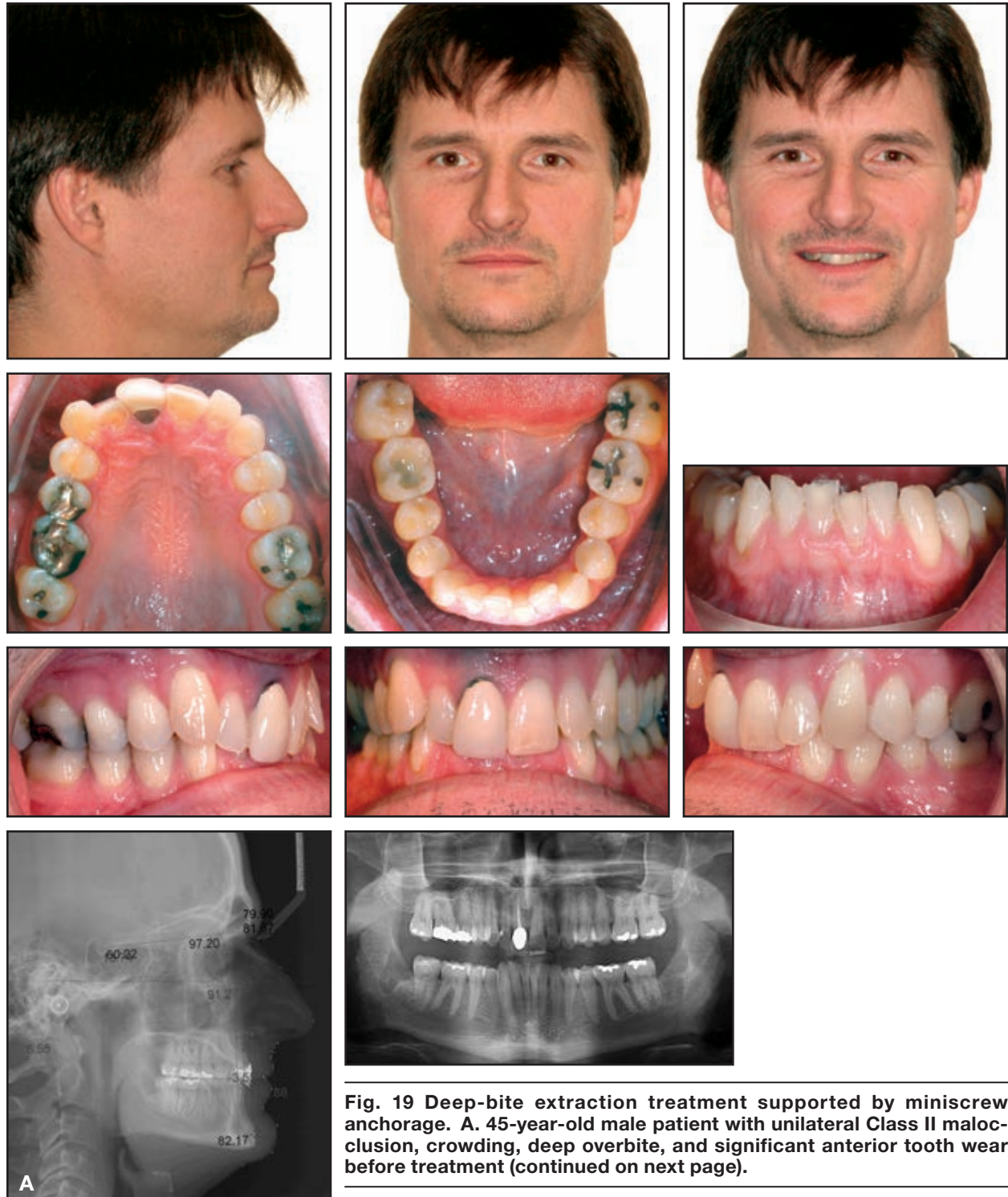


Fig. 19 Deep-bite extraction treatment supported by miniscrew anchorage. **A.** 45-year-old male patient with unilateral Class II malocclusion, crowding, deep overbite, and significant anterior tooth wear before treatment (continued on next page).



Fig. 19 (cont.) B. After extraction of upper right second premolar, two miniscrews inserted in anterior alveolus of each arch to support intrusion elastics worn to hooks formed in aligners (see Figure 9). C. After 29 months of treatment with 39 upper and 29 lower aligners, showing substantial improvement in overbite, crowding, midline, extraction-space closure, and clearance for restoration of lower anterior teeth.

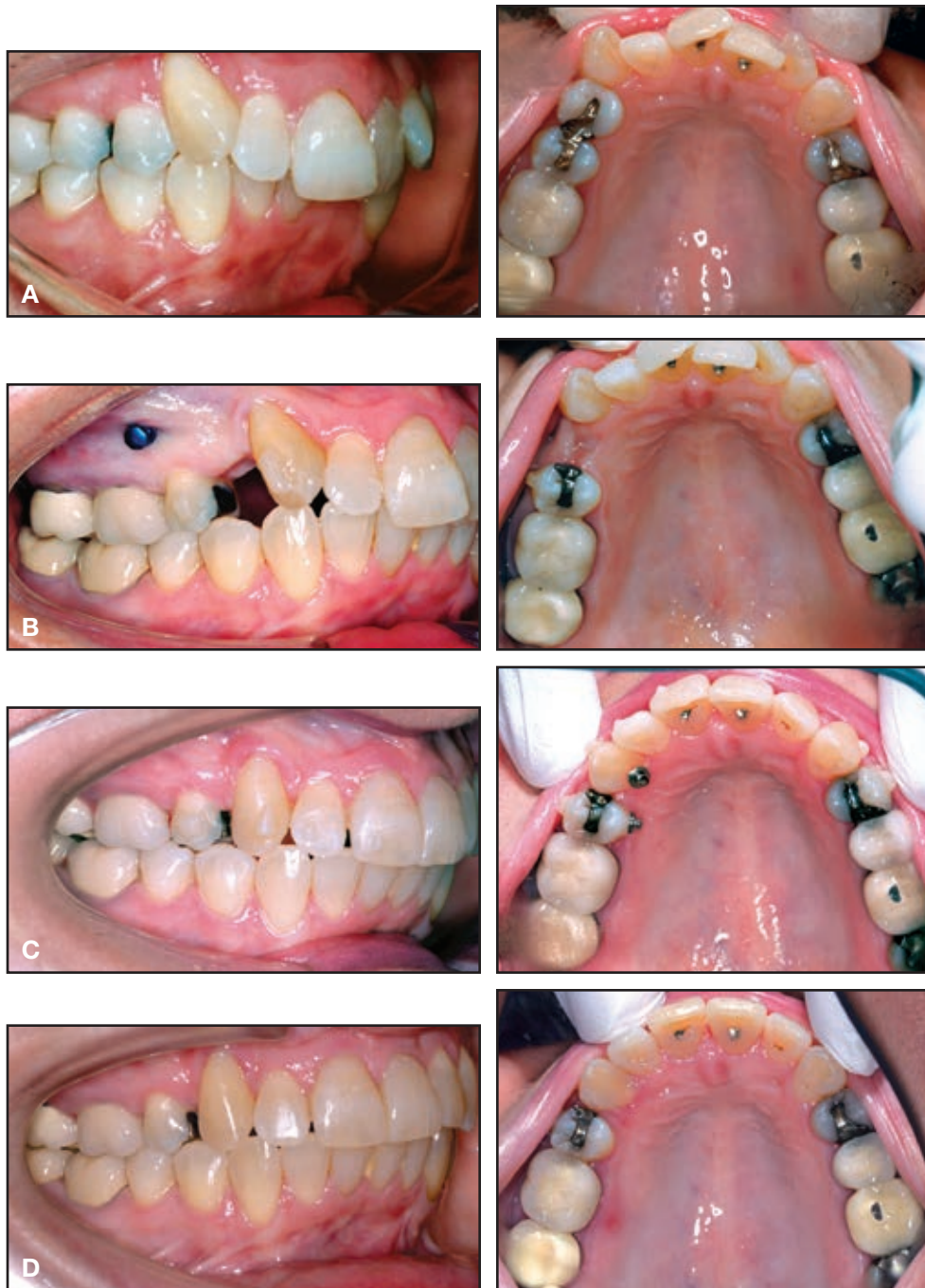


Fig. 20 Extraction treatment supported by miniscrew anchorage and elastics. **A.** 54-year-old female patient with significant maxillary crowding and overbite before treatment. **B.** Upper right first premolar extracted and buccal miniscrew inserted. **C.** After 24 months of treatment, including retraction supported by Class I intramaxillary elastic from miniscrew to notches in aligner trays mesial to canine. **D.** After 36 months of treatment, before esthetic restoration of upper right second premolar.

clear aligners, any extrusion is prevented by the plastic held between the posterior teeth. There is only limited control of intrusion, however, so that the mesial aspects of the molars tend to intrude as the crowns tip forward. When anterior lingual root torque is applied with clear aligners, this unintended lack of occlusion of the upper molars' interproximal marginal ridges must be counteracted with a balancing distal crown rotation (tip) of the molars (Fig. 22B). That may involve programming a mesial extrusion of the molars (mesial tip of the first molar roots), perhaps in conjunction with prominent horizontal rectangular attachments on the molars.

In 1996, as the basis for an Objective Grading System, the ABO determined the most common mistakes made by candidates who had failed the Phase III examination.⁶⁵ Improper buccolingual inclination in the posterior dentition was the most frequently noted error.⁶⁵⁻⁶⁷ According to Marshall and colleagues, "For proper occlusion, there should be no significant difference between the heights of the buccal and lingual cusps of molars and premolars."⁶⁸ Yang-Powers and colleagues reported that "orthodontists are deficient in placing adequate torque in the buccal segments",⁶⁹ and Sondhi added that "the degree of torque in the maxillary second molars is the most important factor in reducing interferences".⁷⁰

The combination of inadequate buccal root torque for the maxillary posterior teeth and excessive lingual crown tip for the mandibular posterior teeth appears to "roll out" the upper molars while "rolling in" the lower molars. Although this is a common concern with preadjusted appliances,^{66,67,71} the same problem may occur in clear-aligner treatment, since the applied biomechanical system is often expansive in "rounding out" the archforms. If the prescribing orthodontist and setup technicians do not address these concerns in the treatment plan, the results may be an accentuated curve of Wilson, prominent palatal cusps, improper and incomplete buccal cusp interdigitation, and inappropriate posterior overjet⁶ (Figs. 13,15). Compounding this situation is the so-called

"passive posterior intrusion" inherent in the long-term wear of two plastic trays, along with the previously noted intrusive effects on the first molars during the application of anterior torque. Add in the effects of en masse retraction, distalization, or extractions, and the development of posterior open bites becomes almost inevitable.

Align Technologies' new ClinCheck Pro Enhancements* software permits the orthodontist to adjust individual root torque in an aligner prescription.⁷² Specifically, the clinician can alter posterior buccolingual inclinations, improve buccolingual cusp heights, or change the curve of Wilson in the dental setup (Fig. 23). The occlusion can also be finished by cutting away posterior segments of the aligner trays to permit "passive settling" or by adding intermaxillary elastics, making occlusal adjustments, or even prescribing custom tooth positioners. Another option with the Pro Enhancements software is to increase posterior occlusal "collisions" by individual extrusion of selected teeth while moderating those contacts in the ClinCheck Pro "OCCLUS" translucent view. This system alone may reduce the incidence of passive intrusion and inadequate posterior occlusion in final results.

Interdisciplinary Treatment

Clear aligners have also entered the realm of multidisciplinary treatment involving orthodontic patients. For example, a 29-year-old female presented with a mutilated Class II occlusion, an anterior open bite, significant overjet, a canted occlusal plane, a short face, and a retrusive mandible (Fig. 24A). Clinical examination revealed numerous restorations; the upper first premolars, lower left canine, and lower right lateral incisor were missing. The interdisciplinary treatment plan included crown lengthening; extraction of the third molars; a preliminary phase of fixed appliances to level and align the dentition, including vertical control supported by miniscrews⁷³⁻⁷⁶; temporary replacement of existing crowns and bridges with resin crowns; Invisalign treatment after interproximal reduction; chin-augmentation surgery; dental bleaching; and final replacement of crowns and bridges.

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Fig. 21 Pre-aligner retraction supported by miniscrew anchorage. **A.** 22-year-old female patient with Class II malocclusion, significant maxillary protrusion, and associated lip incompetency before treatment. **B.** Midpalatal framework anchored by miniscrews for simple lingual sliding retraction. Archwire bonded to lingual surfaces of maxillary anterior teeth and extended through lingual molar tubes; elastic chain applied from palatal framework. Patient used AcceleDent** microvibrational device 20 minutes per day to speed treatment. **C.** After five months of retraction (continued on next page).

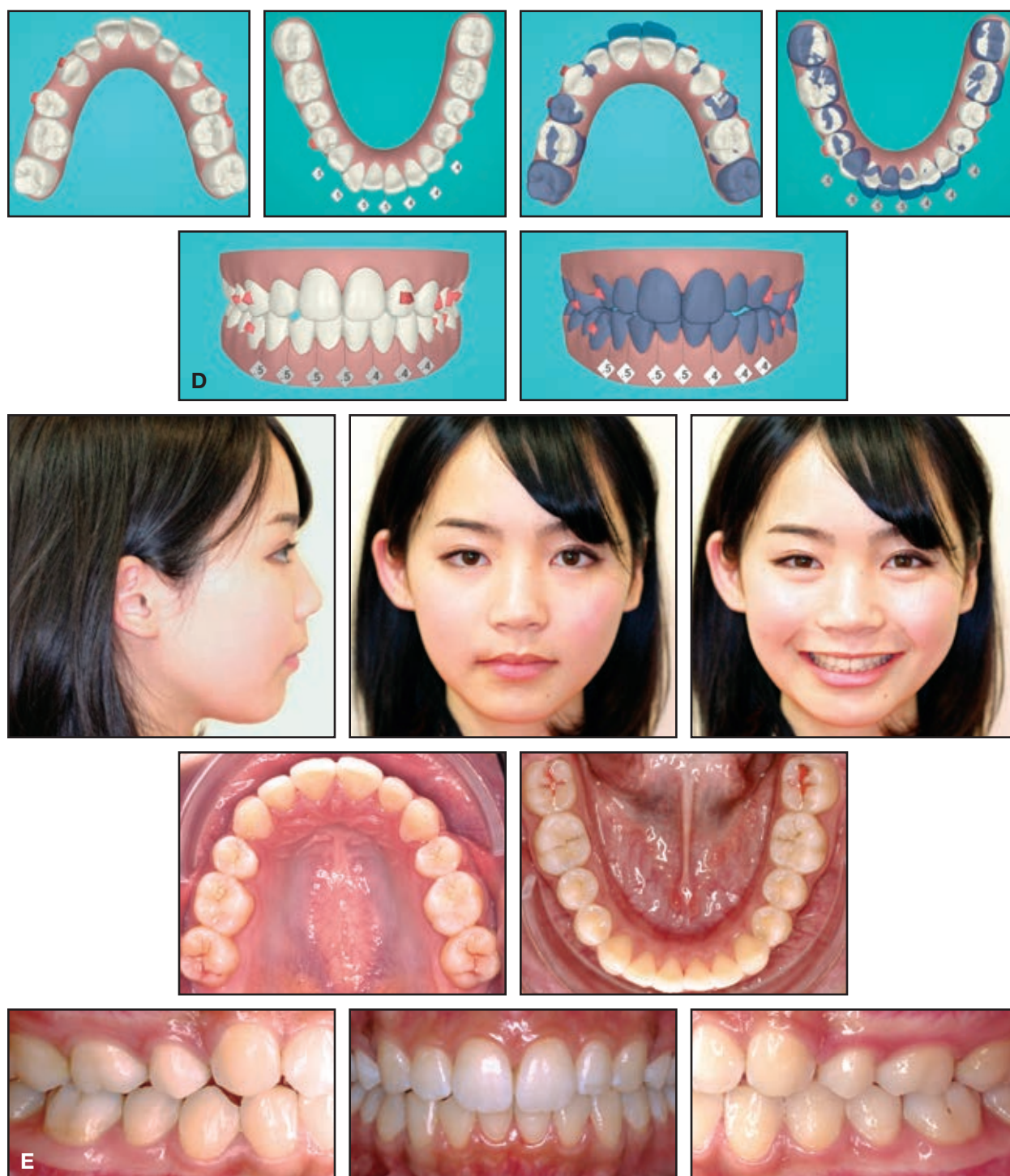


Fig. 21 (cont.) D. ClinChecks* show post-retraction situation (left) and superimposition of anticipated tooth movement (right) from treatment with aligners. Treatment plan included lower anterior interproximal reduction, weekly change of trays (rather than biweekly), and continuation of daily AcceleDent use. **E.** Patient after 16 months of treatment (preliminary retraction followed by 44 pairs of aligners).

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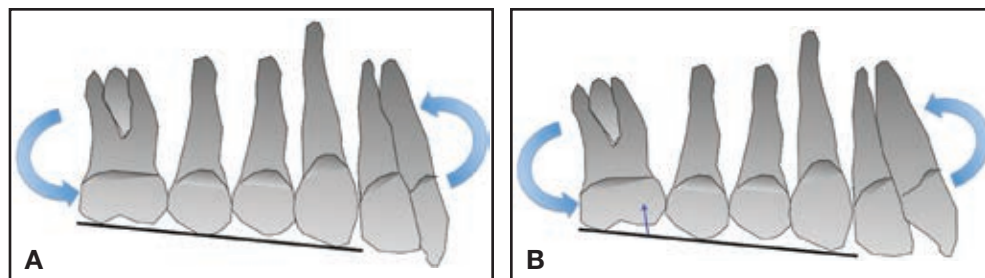


Fig. 22 Torquing effects of clear aligners. **A.** Reciprocal forces from moments of couples applied to increase anterior lingual root torque (including use of “torque ridges”^{13,64}) may result in undesirable mesial rotation (tipping) of first molar. **B.** With mesial marginal ridges and mesial cusps no longer in occlusion, compensation may require programmed forward mesial rotation and/or extrusion of mesiobuccal cusp within aligners, in effect producing crown-tipback rotation.

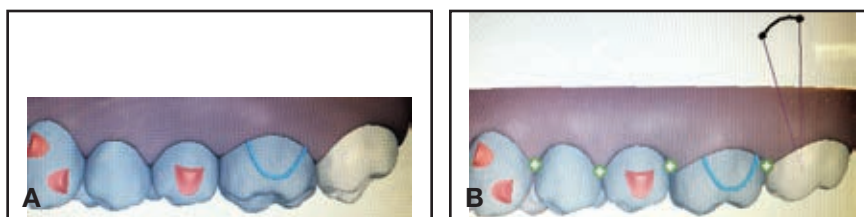


Fig. 23 **A.** Inappropriate posterior buccolingual inclination noted in ClinCheck ProEnhancements software. **B.** Unwanted movements may be counteracted by individually increasing arch width and buccal root torque to reduce curve of Wilson and potential for interferences, thereby improving posterior occlusion.

After the crown lengthening and three months of fixed-appliance treatment (Fig. 24B), a ClinCheck projection indicated the amount of en masse anterior retraction and midline correction planned for the aligner phase (Fig. 24C). Interproximal reduction was then carried out prior to the initiation of Invisalign therapy. Using 21 sets of trays, the anterior open bite and overjet were improved and the teeth were well aligned, closely matching the ClinCheck projections (Fig. 24D). Still, the overjet, upper gingival margins, and upper midline required further refinement. For the next three months, unilateral Class II elastics were hooked from notches in the aligners mesial to the upper canines to a bonded button on the lower left molar for midline correction.

After 25 months of orthodontic treatment, the patient’s occlusion and smile evidenced significant esthetic improvement (Fig. 24E). Superimpositions of cephalometric tracings demonstrated retraction and extrusion of the upper anterior

teeth, intrusion and retraction of the lower anterior teeth, intrusion of the upper molars, and mesial movement of the lower molars, along with a slight retraction of the lips and mandibular auto-rotation (Fig. 24F). The patient was then referred to a plastic surgeon for chin augmentation to increase her chin projection and lower anterior facial height. Four months later, cosmetic restorations were completed (Fig. 24G).

Conclusion

A variety of adjuncts to clear-aligner treatment offer many advantages to the orthodontist. As the scope of biomechanics and the range of treatable malocclusions have increased, clinicians have successfully addressed limitations of the aligner concept—much as adjuncts have improved the performance of traditional fixed appliances. Specifically, the incorporation of miniscrew anchorage has permitted the addition of direct and



Fig. 24 A. 29-year-old female patient with skeletal Class II relationship, short face, retrusive chin, and anterior open bite before treatment (continued on next page).



Fig. 24 (cont.) B. After three months of sectional fixed-appliance treatment to adjust length-width ratios and level gingival margins of upper incisors, as well as to align upper 6-6 and lower 5-5. (Bridge in lower left canine space removed and abutment teeth temporized prior to start of treatment.) **C.** ClinCheck images with superimposition of post-treatment projections (treatment goal in blue) show amount of anterior or retraction planned for both arches during aligner phase. **D.** Improvement in anterior open bite and overjet after 21 sets of aligners, before refinement (continued on next page).

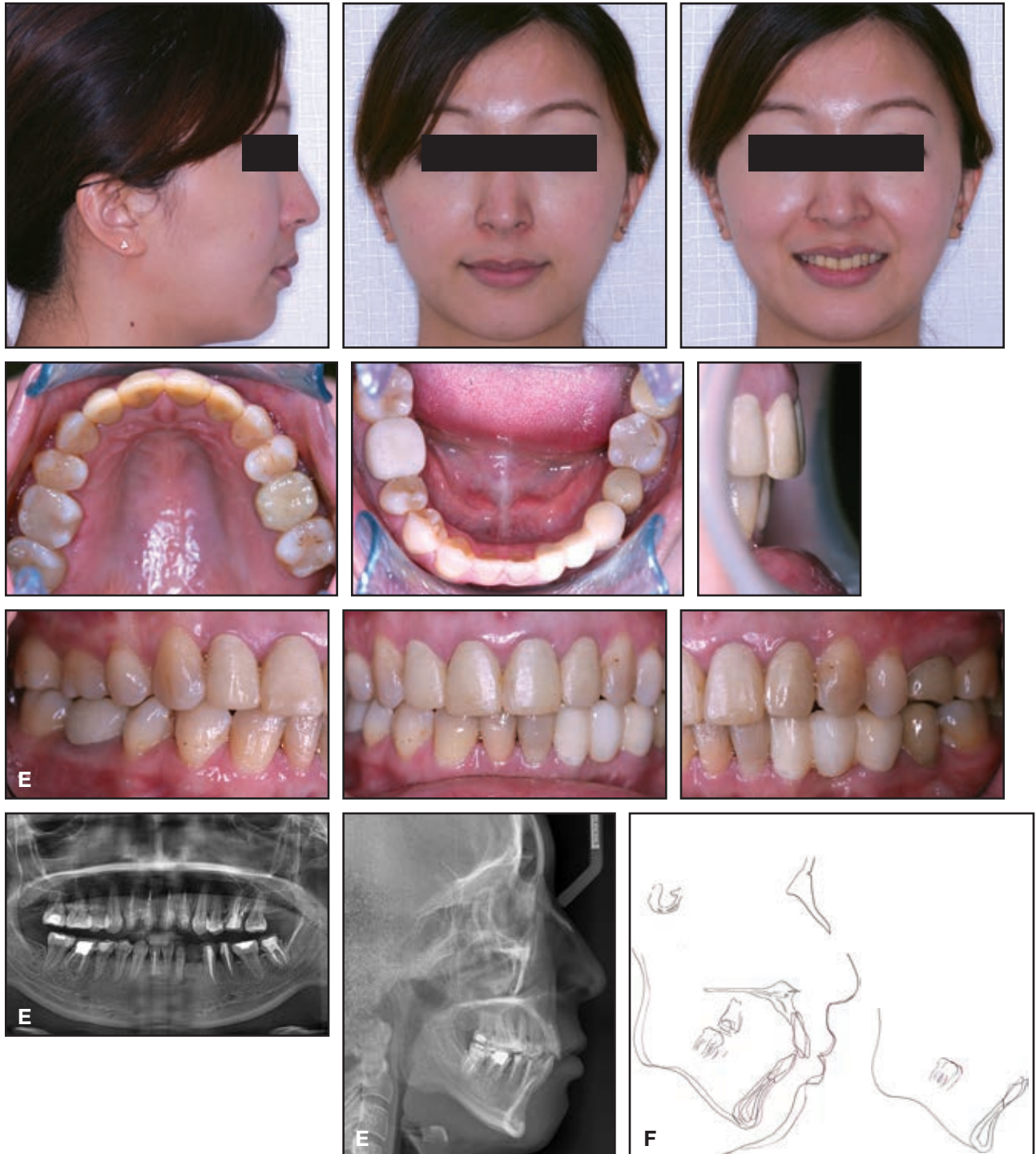


Fig. 24 (cont.) E. After 25 months of treatment with Invisalign, including case refinement. F. Superimposition of pre- and post-treatment cephalometric tracings (continued on next page).



Fig. 24 (cont.) G. Patient after completion of cosmetic restorations.

indirect support and control for more predictable programmed tooth movements.

While more complex treatments are being accomplished with clear aligners, the development of digital scanners presents a unique opportunity for outcomes research from massive databases. If scans of final treatment results were routinely submitted and collated, further improvements in techniques and treatments could be made more rapidly and reliably.

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