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A Miniscrew-Supported Intrusion Auxiliary for Open-Bite Treatment with Invisalign

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Various methods have been developed using skeletal anchorage for molar intrusion in patients with excessive maxillary posterior growth and anterior open bite. Although Erverdi and colleagues showed good results from attaching nickel titanium coil springs to molar brackets and to titanium plates fixed to the zygomatic bone,[1] this procedure requires an oral surgeon to insert and remove the plates. Miniscrews offer the advantages of lower cost, simpler placement, and a far less invasive means of achieving molar intrusion. They are usually inserted bilaterally into the infrazygomatic crest and loaded with nickel titanium coil springs attached to the molars.[2-8]

The palate has also been shown to be an effective site for miniscrew insertion due to its dense cortical bone.[9] Xun and colleagues described the use of a single palatal miniscrew for upper molar intrusion and two miniscrews in the mandibular cortical bone for lower molar intrusion, reducing the mandibular plane angle by an average 2.3° and anterior facial height by an average 1.8mm.[10] Razavi showed an efficient way to manage excessive posterior growth and anterior open bite with a single palatal miniscrew and a sequentially reactivated palatal bar.[11] More recently, Scheffler and Proffit illustrated a combination of temporary anchorage devices (TADs) and occlusal splints that could be used to intrude the buccal segments and induce counterclockwise mandibular rotation.[12] Unfortunately, all these methods require complex procedures and fixed appliances in both arches, as well as palatal bars or bite blocks that can be uncomfortable for patients.[13-17] Moreover, during maxillary posterior intrusion with any system, the mandibular teeth may extrude, negating the advantageous mandibular autorotation.

Molar extrusion seems to be prevented during treatment with aligners because of the constant presence of the material on the occlusal surfaces. Prolonged aligner wear can result in molar intrusion and development of a bilateral posterior open bite, simply due to the thickness of the aligner material. Intentional programming of significant molar intrusion into the aligners, however, can be slow and unpredictable.

We have developed a hybrid technique for treatment of open bite using partial fixed appliances with orthodontic miniscrews in combination with Invisalign* therapy. This method allows the mandible to rotate upward and forward, thereby closing the anterior open bite, reducing facial height, and improving pogonial projection with proper torque and inclination.

Intrusion Procedure

To achieve posterior intrusion for vertical correction, a buccal 3mm × 8mm Spider Pin** miniscrew is placed mesial to each maxillary first molar. An auxiliary is fabricated from .018" × .022" stainless steel sectional wire on each side of the working cast; the ends of the wire are coated with composite resin for easier placement in the mouth. A surgical hook is crimped at each first




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Fig. 1 Intrusion auxiliary on cast. Aligners arrive pretrimmed, following ClinCheck instructions.

molar for attachment to the TAD. Customized, precise cuts of the aligners are designed on the ClinCheck in order to accommodate the auxiliary wires, usually affecting two or three teeth on each side (Fig. 1).

After the auxiliaries are bonded in place, 150g nickel titanium coil springs are tied from the TADs to the crimped molar hooks. Torque control is crucial because the application of force on only the buccal side risks the development of undesirable labial torque. Although other techniques control torque with a palatal bar or a combination of labial and lingual miniscrews, we rely on the aligners to control molar torque. The digital treatment plan is designed for alignment with interproximal reduction and, if needed, with retrusion. Posterior intrusion and anterior extrusion are carefully avoided because the potentially different rates of intrusion induced by the TAD mechanics and by the aligners could result in imperfect aligner fit and inadequate torque control. The Class II correction is achieved solely by the counterclockwise mandibular rotation induced by molar intrusion with the miniscrew mechanics.

*Registered trademark of Align Technology, Inc., San Jose, CA; www.aligntech.com.
**Trademark of Ortho Technology, Inc., Tampa, FL; www.orthotechnology.com.

Case 1

A 17-year-old female presented with the chief complaint of an inability to bite properly. Clinical examination revealed a skeletal Class II, division 1 malocclusion with an anterior open bite, mild maxillary and mandibular tooth-size/arch-length discrepancies, and a vertical discrepancy (Fig. 2, Table 1). The patient's initial contact upon closure was between the upper and lower first molars, leading to a complex open bite that involved the premolars and all the anterior teeth. In addition, the maxillary transverse deficiency had resulted in a bilateral posterior crossbite and a severely rotated mandibular left second premolar. Profile analysis indicated excessive lower anterior facial height and a steep mandibular plane.

Two options were discussed with the patient and her parents. The first was comprehensive surgical-orthodontic treatment, including impaction of the posterior maxilla and expansion of the

Fig. 2 Case 1. 17-year-old female patient with Class II, division 1 malocclusion and anterior open bite before treatment.

TABLE 1
CASE 1 CEPHALOMETRIC ANALYSIS

	Norm	Pretreatment	Post-Treatment
SNA	82.0° ± 3.5°	75.0°	75.0°
SNPg	80.0° ± 3.5°	71.0°	74.0°
ANPg	2.0° ± 2.5°	4.0°	1.0°
Maxillary inclination	8.0° ± 3.0°	5.0°	5.0°
Mandibular inclination	33.0° ± 2.5°	40.0°	38.0°
ANS-PNS/GoGn	25.0° ± 6.0°	35.0°	33.0°
U1 inclination	110.0° ± 6.0°	103.0°	103.0°
L1 inclination	94.0° ± 7.0°	100.0°	98.0°
L1 compensation	2.0mm ± 2.0mm	6.0mm	4.0mm
Overjet	3.5mm ± 2.5mm	6.0mm	2.0mm
Overbite	2.0mm ± 2.5mm	–1.0mm	2.0mm
Interincisal angle	132.0° ± 6.0°	119.0°	121.0°

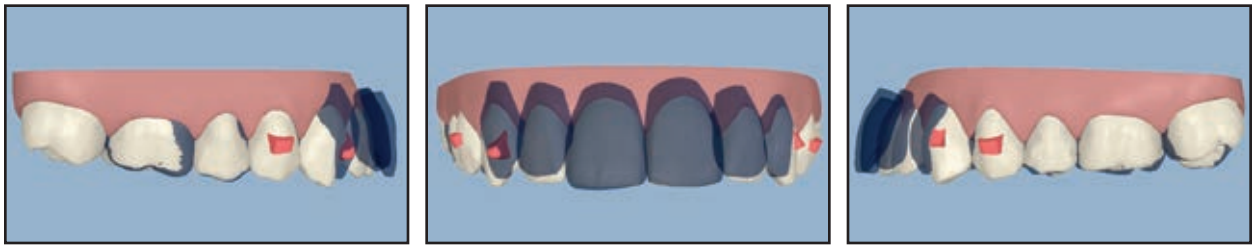

Fig. 3 Case 1. ClinCheck simulation, showing no posterior intrusion or anterior extrusion.

Fig. 4 Case 1. A. Intrusion auxiliaries and aligners in place. B. Patient after four months of intrusion; nickel titanium springs replaced with ligature wires for retention.

Fig. 5 Case 1. A. Patient after 10 months of treatment (continued on next page).

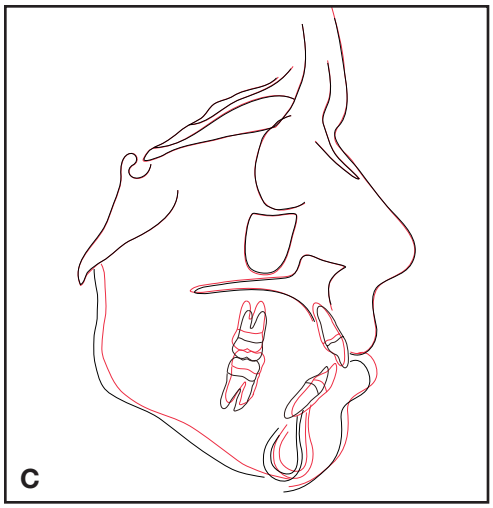

Fig. 5 (cont.) B. Projected ClinCheck results. C. Superimposition of pre- and post-treatment cephalometric tracings.

posterior segments with a three-piece Le Fort I procedure. The second option involved slow maxillary expansion and correction of the anterior open bite by intrusion of the maxillary posterior segments, using buccal miniscrew anchorage and aligners as described above. The second option was chosen.

Based on the ClinCheck* simulation, we prescribed 20 aligners in the upper arch and 18 in the lower arch, with no vertical movement of the posterior and upper anterior segments, slight retraction of the anterior teeth, and expansion of the maxillary arch (Fig. 3). The intrusion auxiliary was bonded bilaterally to the second premolars and second molars (Fig. 4A), and intrusion was completed in four months (Fig. 4B). The Class II correction was completed in 10 months, thanks to the counterclockwise rotation of the mandible resulting from molar intrusion (Fig. 5, Table 1).

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Case 2

A 21-year-old female presented with a mild skeletal Class II, division 1 malocclusion, moderate lower and mild upper crowding, a moderate anterior open bite, a severely hyperdivergent skeletal pattern, and an unbalanced transverse relationship (Fig. 6, Table 2). Clinical examination indicated excessive lower facial height with a gummy smile and a typical long-face appearance. The patient had a 3mm anterior open bite, with posterior occlusion only on the second molars. Radiographic examination confirmed the vertical excess in the lower face.

Two treatment options were presented: surgical correction or Invisalign therapy with TAD-

Fig. 6 Case 2. 21-year-old female patient with mild skeletal Class II, division 1 malocclusion, moderate anterior open bite, and severely hyperdivergent skeletal pattern before treatment.

TABLE 2
CASE 2 CEPHALOMETRIC ANALYSIS

	Norm	Pretreatment	Post-Treatment
SNA	82.0° ± 3.5°	72.0°	72.0°
SNPg	80.0° ± 3.5°	70.0°	70.5°
ANPg	2.0° ± 2.5°	2.0°	1.5°
Maxillary inclination	8.0° ± 3.0°	9.0°	9.0°
Mandibular inclination	33.0° ± 2.5°	41.0°	38.0°
ANS-PNS/GoGn	25.0° ± 6.0°	30.0°	29.0°
U1 inclination	110.0° ± 6.0°	109.0°	102.0°
L1 inclination	94.0° ± 7.0°	97.0°	96.0°
L1 compensation	2.0mm ± 2.0mm	4.0mm	4.0mm
Overjet	3.5mm ± 2.5mm	5.0mm	2.0mm
Overbite	2.0mm ± 2.5mm	–2.0mm	1.0mm
Interincisal angle	132.0° ± 6.0°	125.0°	132.0°

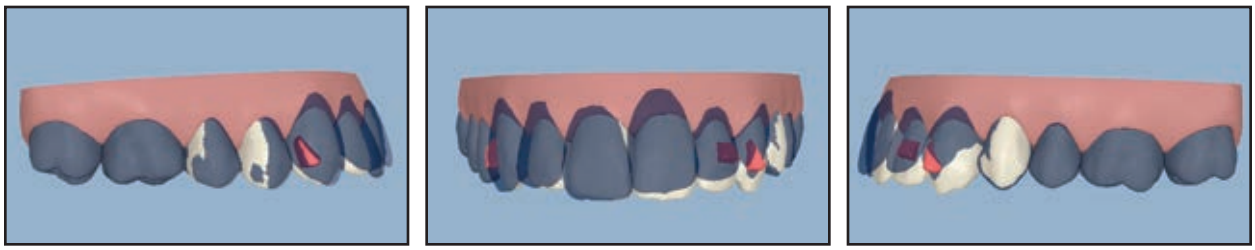

Fig. 7 Case 2. ClinCheck simulation, showing no posterior intrusion or anterior extrusion.

Fig. 8 Case 2. A. Intrusion auxiliaries and aligners in place. B. Patient after six months of intrusion.

Fig. 9 Case 2. A. Patient after 15 months of treatment (continued on next page).

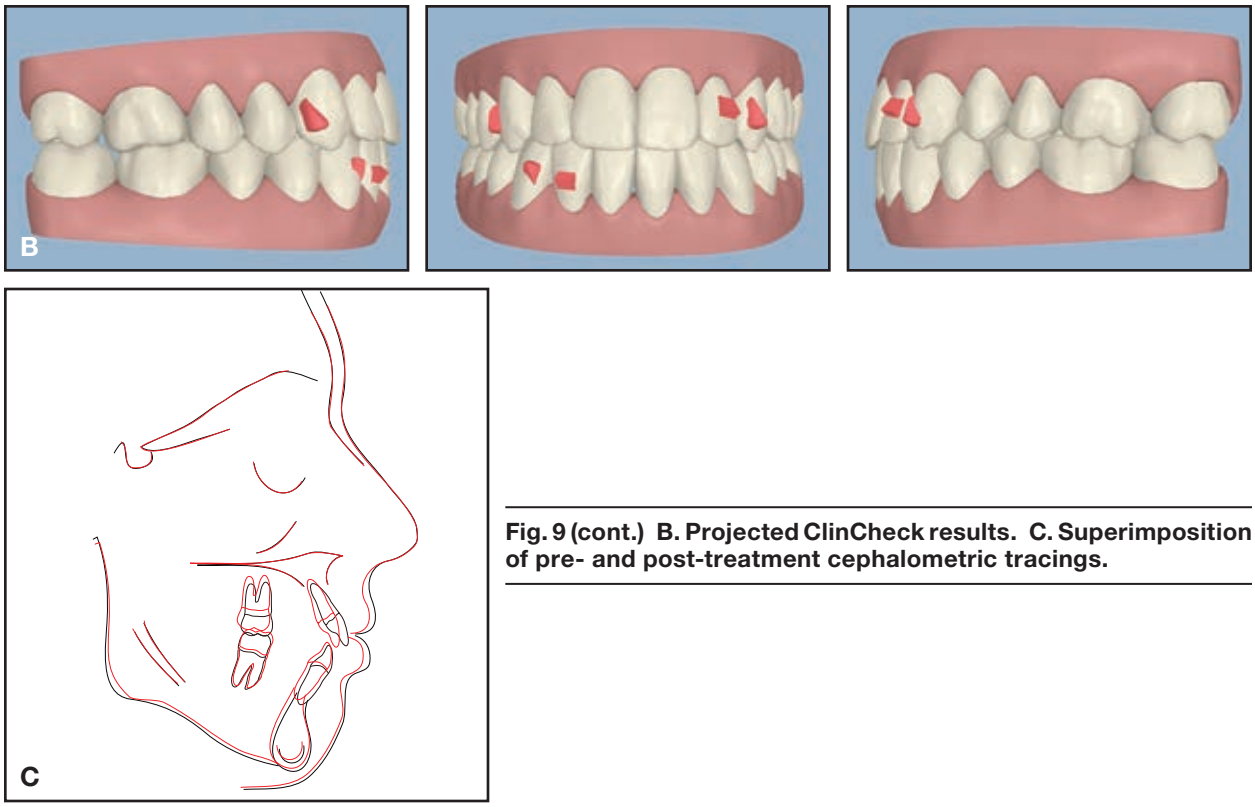

Fig. 9 (cont.) B. Projected ClinCheck results. C. Superimposition of pre- and post-treatment cephalometric tracings.

supported posterior intrusion. The patient chose the second option.

The digital treatment plan called for 13 upper and lower aligners, plus 10 upper and lower refinement aligners. As in Case 1, no vertical movements were programmed into the aligners (Fig. 7). After miniscrew-supported intrusion auxiliaries were bonded to the upper first and second molars (Fig. 8A), adequate intrusion was achieved in six months (Fig. 8B). Treatment was completed in 15 months (Fig. 9, Table 2).

Discussion

Vertical control of the posterior teeth is critical in the treatment of anterior open bite. Excessive lower facial height with a hyperdivergent pattern is commonly associated with a clockwise (downward) rotation of the maxilla, resulting in excessive gingival display in smiling. The challenge for the clinician is to avoid posterior extrusion during leveling and alignment, as well as any anterior extrusion that would worsen a gummy smile.[15] The biomechanical approach described here enables posterior intrusion with a consequent counterclockwise rotation of the mandible, reduction of divergency, and mandibular projection to resolve the Class II malocclusion.

As shown in these two cases, clear-aligner therapy in conjunction with skeletal anchorage provides a patient-friendly means of decrowding and coordinating the arches while controlling molar torque during posterior intrusion, eliminating the need for transpalatal arches or additional miniscrews to prevent transverse side effects. Above all, this combination of approaches avoids the need for orthognathic surgery.

In appropriate patients, we have found these

mechanics to be as reliable as procedures previously described in the literature. Vertical posterior intrusion and counterclockwise rotation of the mandible are produced with proven skeletal-anchorage mechanics. Leveling and alignment, arch coordination, and posterior torque control during intrusion are easily achieved with sequential aligners.

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