Biomechanical Considerations in Treatment with Miniscrew Anchorage

Part 1 The Sagittal Plane

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The use of miniscrews for reinforcement of orthodontic anchorage has become increasingly popular in recent years, especially in adult patients who do not want to wear extraoral appliances. Miniscrews are convenient, save time, and produce good treatment results with no need for patient cooperation. In some patients treated with miniscrews, however, mechanical factors can produce unusual changes or side effects. The present article explains these mechanical variations and provides tips for solving the problems they create in the sagittal plane. Subsequent articles will cover side effects in the horizontal and transverse planes and present relevant clinical cases.

Anchorage reinforcement is most commonly needed in patients with severe protrusion. In conventional retraction with sliding mechanics after first premolar extractions, the molars typically move forward 3.6-3.8mm.[1-3] Anchorage reinforcement can allow more retraction of the incisors while reducing forward movement of the molars.

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Anterior retraction with sliding mechanics is usually accomplished by placing elastomeric chain or nickel titanium springs between hooks on the anterior teeth and the second molars. The anterior and posterior segments rotate around the center of rotation, which causes bowing of the archwire. A precurved archwire can be used to prevent this side effect (Fig. 1).

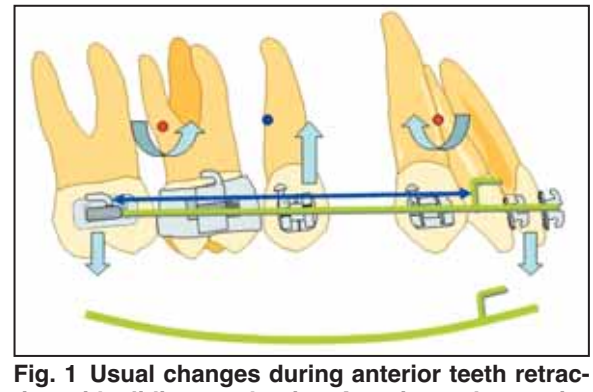


Fig. 1 Usual changes during anterior teeth retraction with sliding mechanics. Anterior and posterior segment rotates around center of rotation of each segment (red dots); archwire is forced to bend near center of rotation of entire arch (blue dot). These changes can easily be prevented with precurved archwires (bottom).

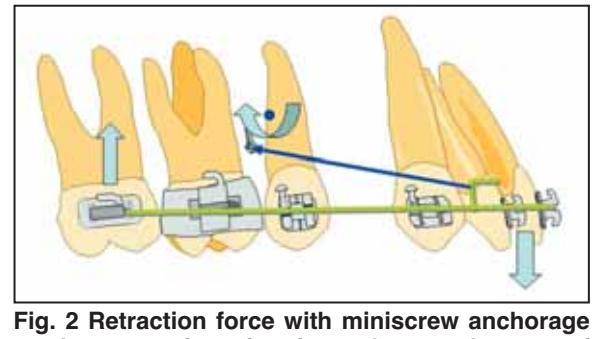


Fig. 2 Retraction force with miniscrew anchorage produces rotation of entire arch around center of rotation (blue dot).

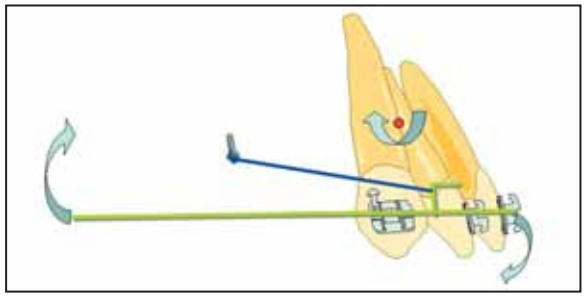
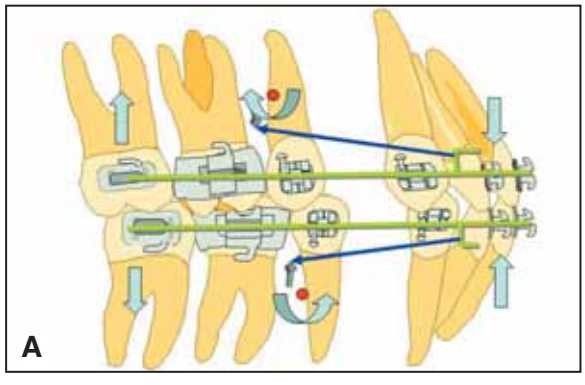
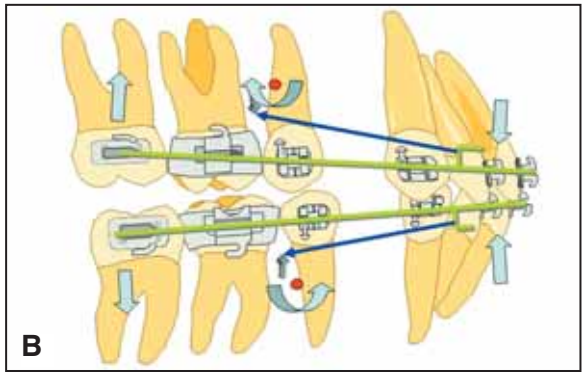


Fig. 3 Rotation of anterior segment around center of rotation (red dot) in absence of friction in posterior segment.





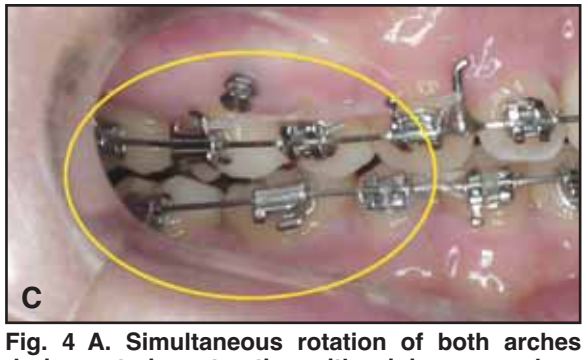


Fig. 4 A. Simultaneous rotation of both arches during anterior retraction with miniscrew anchorage. B. Resulting posterior open bite. C. Posterior open bite after space closure with miniscrew anchorage.

The use of miniscrews for anchorage reinforcement produces somewhat different mechanics. Because the force used during retraction is not reciprocal, either the entire arch[4,5] (Fig. 2) or the anterior segment (Fig. 3) will rotate around the center of rotation. In cases of severe protrusion, where absolute anchorage is required in both arches, these mechanics can produce posterior open bite and deep overbite (Fig. 4). The use of precurved archwires will result in an even stronger intrusive force on the posterior segment. Following are several possible solutions to these problems.

Redirecting the Retraction Force

One approach is to lengthen the archwire

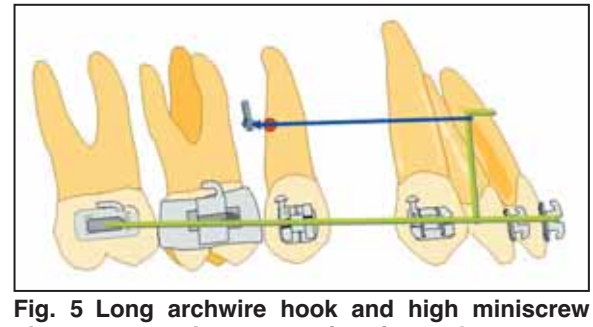


Fig. 5 Long archwire hook and high miniscrew placement produce retraction force that passes directly through center of rotation.

Fig. 6 Higher line of force promotes irritation of soft tissue by elastomeric chain or coil springs because of archwire curvature (red circle).

hook and raise the miniscrew insertion point to redirect the vector of retraction force, so that it passes through the center of rotation of the anterior segment. This is located between the lateral incisor and canine roots, 6.76mm above the cervical area,[6] or at the level of the root tip[7] (Fig. 5). Melsen and colleagues recommended that the archwire hook extend 10mm from the main archwire,[8] but anatomical limitations usually make this impractical.

Elastomeric chain or coil springs positioned above the bracket level may impinge on the soft tissue because of archwire curvature (Fig. 6). Furthermore, in many cases, it is difficult to place the miniscrew high enough (Fig. 7). Insertion in the mobile mucosa increases the risk of inflammation around the miniscrew and may lead to failure.[9] Therefore, it is almost impossible to use a retraction force that passes through the center of rotation, and other methods should be considered.

Posterior Intermaxillary Elastics

Placing intermaxillary elastics between the posterior teeth can be a solution. Light 3/16" intermaxillary elastics, worn only at night, can prevent posterior open bite (Fig. 8). Because such elastics can extrude the posterior teeth, however, they are not recommended for patients with vertical skeletal patterns.

Vertical Retraction Forces

In patients with gummy smiles or other factors favoring intrusion of an entire arch, more vertical retraction forces can be used to prevent occlusal plane rotation (Fig. 9). Occlusally directed archwire hooks should be placed posterior to the canines. This method can also be used to control overbite during retraction in cases of deep overbite.

Anterior Biteplanes

Occlusal plane rotation due to forces of occlusion can be prevented by bonding anterior biteplanes to the lingual surfaces of the anterior teeth at the beginning of retraction (Fig. 10). Biteplanes are also helpful in preventing attrition from ceram-

Fig. 7 Limited width of gingival tissue precludes high placement of miniscrew. White circle indicates optimal miniscrew location for translational movement.

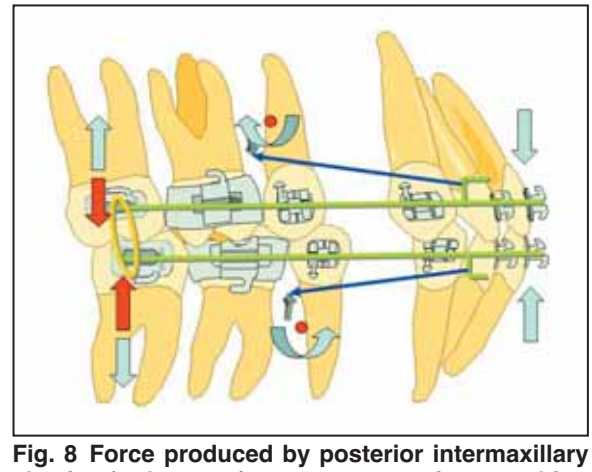


Fig. 8 Force produced by posterior intermaxillary elastics (red arrows) prevents posterior open bite.

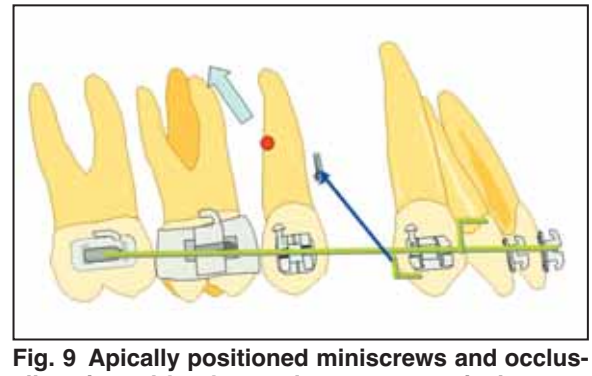


Fig. 9 Apically positioned miniscrews and occlusally oriented hooks produce more vertical retraction force (blue arrow) for intrusion of entire arch.

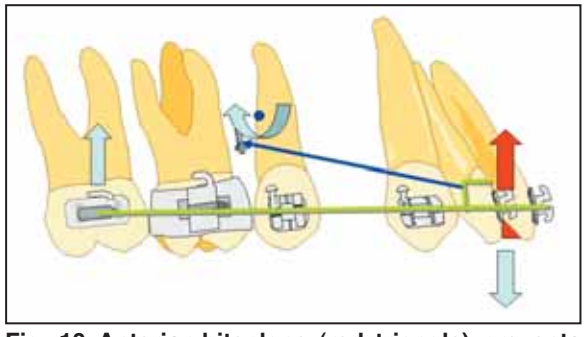


Fig. 10 Anterior biteplane (red triangle) prevents occlusal plane rotation due to forces of occlusion (red arrow).

Fig. 11 A. Biteplanes built up directly with composite resin.* B. Prefabricated acrylic biteplanes bonded to central incisors.

Fig. 12 Silicone putty trays used to make biteplanes for patients with different amounts of overjet.

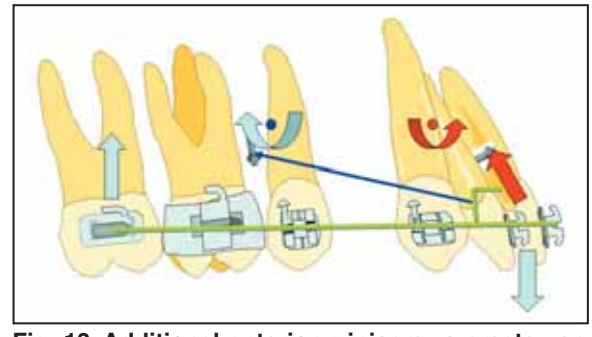


Fig. 13 Additional anterior miniscrews create vertical force to counteract occlusal plane rotation and maintain torque.

Fig. 14 Anterior miniscrews positioned between roots of lateral incisors and canines.

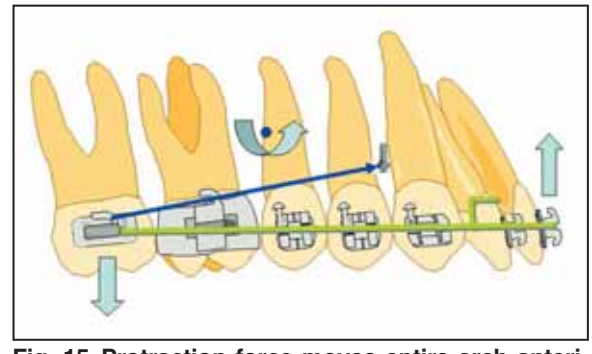


Fig. 15 Protraction force moves entire arch anteriorly, producing arch rotation around center of rotation (blue dot).

*Transbond Plus, trademark of 3M Unitek, 2724 S. Peck Road, Monrovia, CA 91016; www.3MUnitek.com.

ic bracket wear. They can be built up directly on the teeth with composite resin,* or prefabricated acrylic biteplanes can be used (Fig. 11). The prefabricated biteplanes can be easily fabricated from silicone putty trays, saving chairtime (Fig. 12).

To minimize extrusive effects and related patient discomfort, anterior biteplanes should be placed at the level of the pretreatment overbite. If they are used after the development of posterior open bite or placed at a level that can produce posterior open bite in a vertical skeletal pattern, clockwise mandibular rotation will occur. Longer biteplanes can be used in cases of significant overjet.

Additional Anterior Miniscrews

In a patient with a gummy smile or overerupted upper incisors, additional miniscrews can be placed in the upper anterior region to produce a vector of force that counteracts occlusal plane rotation and preserves anterior torque (Fig. 13). These miniscrews can be placed between either the central and lateral incisors or the lateral incisors and canines (Fig. 14). Some orthodontists prefer the area between the central incisors, but to avoid the frenum, the miniscrew must be placed submucosally with wire extensions.

If the molars are being protracted, the occlusal plane will rotate in the opposite direction, and anterior open bite can occur (Fig. 15).

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