Incisor Translation and Inclination Using Miniscrew Anchorage and the Edgewise Appliance

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This article describes the use of miniscrew anchorage to achieve the proper position and inclination of the upper incisors.

Mechanical Design

Torque is not a form of tooth movement. Rather, according to Blodgett and Andreasen, "torque is that force obtained from a twisted spring wire in its effort to untwist itself; the term 'torque' is used to describe the effect on a tooth when the twisted archwire delivers the resultant force".[1] Before the development of the Straight-Wire Appliance by Andrews, lingual root torque was achieved by bending the archwire.[2,3]

The deficiencies of preadjusted appliances in achieving lingual root torque[4-6] can be addressed by placing miniscrews in the infrazygomatic crest of the maxillary bone for skeletal anchorage, eliminating the need for cervical headgear and Class II elastics. Before insertion of the screws, a segmental arch that completely fills the slots is placed in the incisor brackets.

The following miniscrew placement technique is used:

1. Identify the infrazygomatic crest by palpating the area with the index finger.
2. Establish a purchase point with a hand drill, rather than a pneumatic drill.
3. Place the tip of the miniscrew at the purchase point.
4. Angulate the long axis of the screw to about 65° with respect to the occlusal plane.
5. Insert the miniscrew.

Although the images in this article depict the Mondeal TAD,* the senior author (Dr. Fisher) now uses a personally developed TAD** that is anatomically designed and FDA-approved for placement in the infrazygomatic crest.

One end of an Alpern-prescription Sentalloy*** retraction spring (Fig. 1) is attached to the miniscrew, and the other end to a hook bent into a power arm from the distal end of the anterior segmental archwire. The Alpern spring delivers 200g of constant force, resolving the problem of force diminution; because it is encased, it is also more hygienic than the traditional Sentalloy spring, which is often used for retraction mechanics.

Vanden Bulcke and colleagues found the center of resistance to be located 7mm apical to the level of the interproximal bone between the central incisors, measured perpendicular to the occlusal plane.[7] When the miniscrew is placed in the infrazygomatic crest, the power arm connected to the anterior segment can exert its force on the anterior teeth at the center of resistance. The arm length and angle can be adjusted depending on the amount of force desired and the clinician's accuracy in identifying the center of resistance (Fig. 2). The following formula is used to determine the amount of torque placed on the anterior teeth: force exerted by the spring (F) multiplied by arm length (A) equals the moment of force (M) in gram-millimeters ($F \times A = M$).

This mechanical setup includes both static and nonstatic variables. The static variables are the position of the anchor, the center of resistance of the anterior teeth, and the force exerted by the springs. The nonstatic variables are the length and

*Mondeal North America, Inc., P.O. Box 500521, San Diego, CA 92150; www.mondeal.de. Previously distributed by GAC International, Inc.

**Orthodontic TAADS (Temporary Anatomic Anchorage Device System), www.orthodontictaads.com.

***Registered trademark of GAC International, Inc., 355 Knickerbocker Ave., Bohemia, NY 11716; www.gacintl.com.

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Fig. 1 Encased, hygienic Alpern closed-coil retraction springs deliver constant forces of 200g.

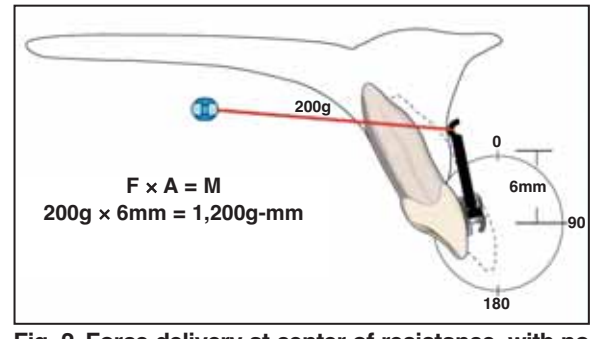

Fig. 2 Force delivery at center of resistance, with no extra space between archwire and bracket slot and thus no diminution of force. In this frictionless mechanical setup, arm can be positioned anywhere on azimuth from 0° to 180° to change vector of intrusive force. Force exerted by spring (F) multiplied by arm length (A) equals moment of force (M).

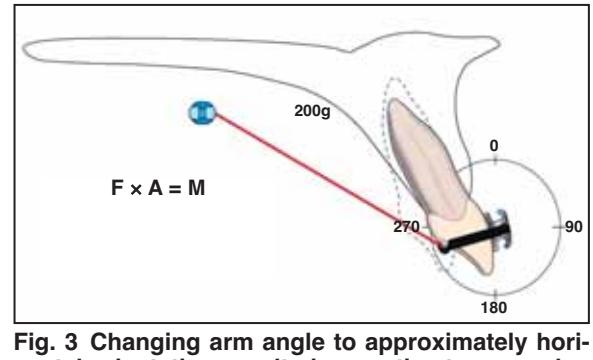

Fig. 3 Changing arm angle to approximately horizontal orientation results in negative torque value and tipping instead of translation.

angle of the arm. For example, if a 6mm arm is used with a 200g spring, the torquing force exerted on the anterior teeth will be 1,200g-mm; with bilateral springs, the total torquing force is 2,400g-mm. If the arm is lengthened, the tooth will be subjected to increased torque. If the arm is shortened, the crown will tend to tip lingually.[8] If the arm is adjusted to an approximately horizontal orientation, the force exerted on the teeth will decrease and become more intrusive (Fig. 3). When a tooth is being translated, the forces are distributed evenly over the root surface. Once a tooth begins to tip, the forces are reduced to zero at the center of resistance, increasing toward the end of the root and the facial crest of the bone.

Reactivation

At each follow-up visit, a three-prong plier is engaged on the power arm to reactivate the spring. Decreasing the arm angle will shorten the arm, thus reducing the torquing force on the wire and increasing the intrusive force (Fig. 4). This will open the bite, or at least keep the incisal edge in the occlusal plane. To maintain the same force magnitude and

Fig. 4 A. Power arm before reactivation of Alpern spring. B. Reactivation with three-prong plier. C. Decreased arm angle shortens power arm, thus reducing torquing force and increasing intrusive force.

vector, a new segmental wire with an arm of the same length would have to be inserted.

Figure 5 shows a patient treated in 12 weeks using the described mechanics, with 2,800g-mm of torque applied to the anterior segment by a 7mm power arm and the Alpern springs. The initial cephalogram shows retroclined upper incisors, but the torque placed on the wire inclined these teeth forward, relocating the GALL line (a line parallel to the head's frontal plane, passing through the forehead's facial axis point) near and parallel to a line tangent to the central incisors' facial axis point.[9]

After the anterior sectional wire is removed, a continuous rectangular archwire is inserted, with the TADs remaining in place for anchorage (Fig. 6). An .022" × .018" wire could be used in an .022" slot to fill the slot vertically, producing a passive slide with no ligation force in a self-ligating bracket.[10] An .018" × .018" wire could be used in an .018" slot. This eliminates the need for cervical anchorage or Class II elastics, and it avoids either having to bend the upper archwire up distal to the molars or placing a tieback from the anterior teeth to the molars, as might be required in traditional mechanics.

Discussion

A miniscrew location in the infrazygomatic crest has several advantages over placement between the maxillary first molar and second premolar, which the senior author has attempted repeatedly (with many different systems) without success. Most patients lack sufficient bone density in this area to withstand the required forces. The thickness of the bone at the infrazygomatic crest has been well documented.[11] As much as 350g of force can be applied to a properly placed TAD in the infrazygomatic crest, compared with 100-150g in the area between the maxillary first molar and second premolar. Even in patients with sufficient bone density mesial to the maxillary first molar, the space between the roots may be inadequate, and interradicular placement will increase the likelihood of root damage. In many patients, the maxillary sinuses are penetrated, further reducing the stability of the screw. Finally, the infrazygomatic crest offers a vector of force that is better suited to translation or intrusion of incisors without tipping, addressing one of the reported deficiencies of preadjusted appliances.

If the miniscrew is placed too superiorly, the tissue may overgrow it, requiring a diode laser to expose the screw for removal. The problem of tissue overgrowth can be avoided if the insertion procedure described above is followed, using a TAD anatomically designed for this area. Better training in miniscrew placement is needed for orthodontists to provide high-quality treatment with skeletal anchorage.

Since around 2000, it has become increasingly difficult to obtain third-party approval for orthognathic surgery when needed to properly align the lower incisors and mandible. As a result, the cost of ideal treatment has become prohibitive for many patients, and the orthodontist is often forced to perform "camouflage" treatment. One problem with such treatment is achieving sufficient

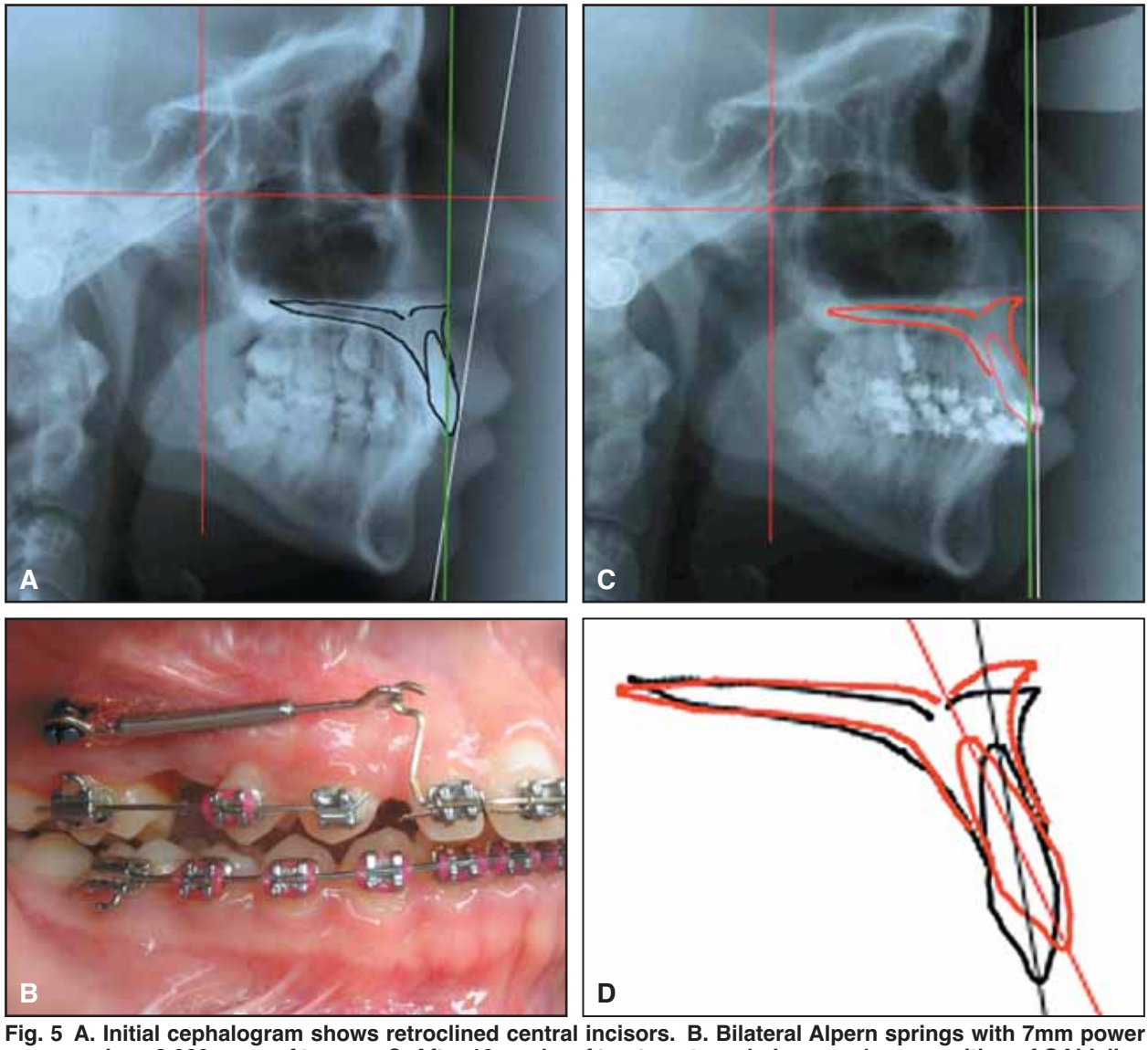

Fig. 5 A. Initial cephalogram shows retroclined central incisors. B. Bilateral Alpern springs with 7mm power arms produce 2,800g-mm of torque. C. After 12 weeks of treatment, cephalogram shows position of GALL line with respect to facial axis point of upper central incisors. D. Superimposition of initial and 12-week cephalometric tracings.

anchorage for proper lingual root inclination and translation, the result being excessive lingual tipping of the upper anterior crowns. Translational tooth movement is traditionally achieved using headgear and Class II elastics. Even with these devices, however, the optimal force vector is not available, so that a pulling force is exerted directly against the bracket, which often results in tipping.

Since the initial development of the fully programmable bracket system, many prescriptions have been developed to overcome the anchorage challenges associated with these appliances. The time is fast approaching when orthodontists will be able to order indirect setups with particular edge-

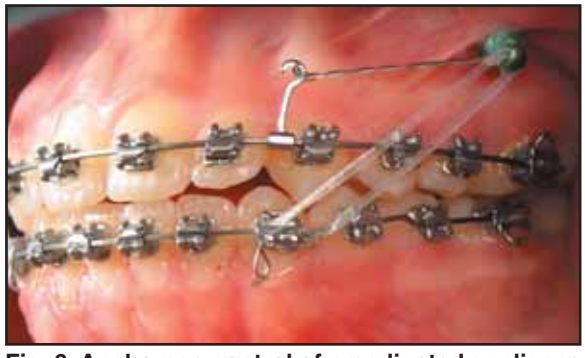

Fig. 6 Anchorage control of preadjusted appliance with rectangular continuous archwire after removal of anterior segmental wire.

wise bracket prescriptions to match whatever Visualized Treatment Objective software they prefer to use.

In the meantime, the use of miniscrews placed in the infrazygomatic crest of the maxillary bone, in conjunction with an anterior archwire segment with power arms, offers a predictable and consistent mechanism for translating the upper incisors with virtually no friction, eliminating the need for supplementary anchorage and patient cooperation.

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