JCO-Online Copyright 2003 - VOLUME 35 : NUMBER 1 : PAGES (55-57) 1998

LETTERS

R. SCOTT CONLEY, DMD
THANH DE NGUYEN, DMD
ROBERT EDWARDS, DDS
GARY L DANZER, DMD
KONG-GEUN LEE, DDS, PHD
STANLEY BRAUN, DDS
ROBERT C. SJURSEN, DDS
HARRY L. LEGAN, DDS

Molar Uprighting

This letter is written in regard to the article "A Simple Technique for Molar Uprighting" by Drs. Capelluto and Lauweryns (JCO, February 1997). One of the first problems with the authors' "MUST" system is that the .016" X .022" NiTi archwire does not provide an efficient moment to cause root movement within a reasonable time period. Previous research has suggested a moment of approximately 29.4-35.5 N/mm to achieve root movement within a reasonable length of time without tissue destruction.1,2 Due to the wire's properties (specifically, the low modulus of elasticity), the amount of moment per degree of deflection is considerably lower than that of stainless steel. Consequently, the NiTi archwire, even deflected as much as 180°, is insufficient to achieve the moment for efficient root movement. Additionally, the amount of angular deflection, and therefore the reactive moment magnitude, is determined by the initial bracket-archwire orientation and not by selective activation of the appliance. If the brackets are aligned as depicted in Figures 3A, 3B, 5B, and 5C, the posterior moment (or beta moment) cannot be equal to the anterior moment (or alpha moment). The beta moment will always be greater. To satisfy the laws of equilibrium, a vertically oriented couple is created that produces an extrusive force on the molar, not an intrusive force as depicted in Figures 3A and 3B.

In some cases, uprighting is desired with mesial root movement instead of distal crown tipping. When a moment is placed upon a constrained body (the molar), rotation will occur about its center of resistance. To obtain mesial root movement, a mesial force must be directed at the crown to move the center of rotation coronally. The authors advocate the use of an elastomeric chain to provide this constraining force. However, the force needed would be 2.5-2.9 Newtons, according to the following formula:3

$$\frac{M}{F} = \frac{29.4 \text{ to } 35.3 \text{ N/mm}}{F} = \frac{12}{1}$$

Assuming that the magnitude of the moment produced were sufficient, an elastomeric chain might provide this force level at initial placement, but would quickly decay to a level insufficient to maintain a coronal center of rotation. A stainless steel rope tie (or the equivalent) would be needed to provide the constraining force.

Since the NiTi wire can only be of straight form, the relative orientation of the molar and premolar brackets, in the occlusal view, is vitally important. If they are malaligned, as they are likely to be in a malocclusion, then uncontrollable and complex buccolingual force systems can occur.

On pages 121-122, the authors describe an "additional moment" to the molar created by rigidly fixing the premolar to the remainder of the lower arch. What actually occurs is that by rigidly fixing the premolar, the alpha moment is not readily expressed. As a result, the only movement perceived would be molar uprighting. There is, in fact, no "additional moment".

A clinical example of the MUST appliance is shown in Figures 10 and 11. In the post-treatment radiograph, the first and second premolars have rotated counterclockwise (showing the effect of the alpha moment). Only a wire with a high modulus of elasticity and sufficient cross-sectional area, joining all the teeth with stainless steel ligatures, would have created a rigid enough anchor unit. It appears that in this case, a wire of inadequate stiffness was used to anchor the premolars to the remainder of the arch, and that consequently the alpha moment was expressed.

In Figures 7, 8, and 9, the "counterbalancing" force at the center of resistance that the authors describe does not exist. When the wire is activated, a couple is created at the bracket, not at the center of resistance. The resulting moment of the couple causes a rotation about the center of resistance. The arrows in the figures do not accurately depict the force system. Additionally, because an extrusive vertical force exists on the molar (not an intrusive force, as explained earlier), buccal to the center of resistance, the moment is counterclockwise, leading to further lingual inclination of the molar.

In short, the main weakness of the "MUST" system is the choice of a NiTi wire. This wire is preformed at the factory into either a straight length or a manufacturer's archform. The clinician cannot alter the shape; thus, the appliance establishes the force system (and its side effects), rather than the clinician.

The authors reply:

ELIE CAPELLUTO, LSD
ISABELLE LAUWERYNS, LTH, PHD

We thank the writers for their interest in our article on molar uprighting. We agree with them that the NiTi wire has a low modulus of elasticity, but clinically speaking, it does produce molar uprighting. The deflection needed to introduce the wire into the distal side of an inclined molar tube from the mesial side of the premolar tube is much more than 180°. Furthermore, the opinion that a moment of 29.4-35.3 N/mm is needed for root movement is not shared by all authors. Drescher and colleagues state that a bending moment of only 7.5 N/mm, caused by an .016" X .022" Sentalloy wire in the pseudoelastic plateau during unloading, is enough to upright a molar.4,5 We realize the importance of the initial bracket-archwire orientation, but we activate the MUST to shorten the wire and elevate it, thus reducing mucosal interference, and to reduce its bending radius and allow it to work within the pseudoelastic plateau during molar uprighting. 5,6

Figures 5A and 5B illustrate the activation force system, and Figure 5C the deactivation force system. Figure 5B agrees with the writers: the posterior moment needed to introduce the wire into the molar attachment is greater than the anterior moment needed to introduce the wire into the premolar attachment (beta moment is greater than alpha moment). This would inevitably result in a vertical component that would extrude the molar during deactivation. However, if the molar is not allowed to move, equilibrium requires a counterclockwise rotation of the entire system, depicted as R4 in Figure 5C. This rotation accelerates the uprighting movement and simultaneously delivers an intrusive force to the molar, counteracting the extrusive force mentioned above. We did not advocate a complete mesialization of the molar; in some cases, we are merely looking for less distal crown movement and more mesial root movement by passively supporting the crown with an elastomeric chain. We do not object to the use of a stainless steel rope tie.

On pages 121-122, we used the word "additional" to differentiate Figure 5A from Figure 5B. When bent and activated, the wire undergoes and stores the internal tensions and stresses needed to express all the moments and forces of the deactivation force system. These moments and forces are expressed as soon as one or both ends of the wire are released. If the alpha moment cannot be expressed by moving the premolar end of the wire, nothing prevents it from producing an effect on the other end of the wire. Equilibrium is not obtained until the sum of all forces is zero. The "additional moment" is simply the moment needed to obtain equilibrium when the alpha moment is expressed without premolar movement.

It is true that stainless steel ligatures were not used to anchor the premolar in our clinical example. Our premolar anchorage may not have been optimal, but it was sufficient. The molar was uprighted, the patient experienced no discomfort, and there was no molar jiggling. This tends to demonstrate that the "extrusive force on the molar" (the result of beta moment expression) was effectively counteracted by the MUST system.

We are convinced of the existence of an intrusive component of force delivered by the MUST on the molar. Our biomechanical approach may be incomplete, but our clinical results do show an uprighting movement, without extrusion and with correction of the lingual inclination of the molar.

We agree that the clinician should establish the force system. Nevertheless, thousands of orthodontists around the world use "straight wires" daily to level dental arches. The MUST does establish a force system, but we influence it by anchoring the premolar and activating the wire. The MUST becomes uncontrollable only if the orthodontist allows it to work beyond the limits of molar uprighting. We use it as a sectional wire to move one tooth while keeping control of the rest of the arch.

We like the NiTi wire because it has pseudoelastic properties and is capable of delivering low, constant forces during the entire uprighting procedure, without any deformation from chewing. In one case, we have found the use of a larger NiTi cross-section helpful. To us, however, the main weakness of the MUST system is not the wire, but rather the need to solder a tube to a premolar or canine bracket. This difficulty is about to be resolved as manufacturers develop new brackets. □

REFERENCES

1 Roberts, W.; Chacker, F.; and Burstone, C.: A segmented approach to mandibular molar uprighting, Am. J. Orthod. 81:177-184, 1982.

2 Braun, S.; Sjursen, R.; and Legan, H.L.: Variable modulus orthodontics advanced through a new auxiliary archwire attachment, Angle Orthod. 67:219-222, 1997.

3 Smith, R.J. and Burstone, C.J.: Mechanics of tooth movement, Am. J. Orthod. 85:294-307, 1984.

4 Drescher, D.; Bourauel, C.; and Thier, M.: Application of the orthodontic measurement and simulation system (OMSS) in orthodontics, Eur. J. Orthod. 13:169-178, 1991.

5 Drescher, D.; Bourauel, C.; and Thier, M.: Eine pseudoelastische NiTi-Aufrichtefeder für Molaren-

-Entwurf, biomechanische Prufung und klinische Anwendung, Fortschr. Kieferorthop. 53:286-296, 199

6 Shellhart, W.C.: Equilibrium clarified, Am. J. Orthod. 108:394-401, 1995.