Lever-Arm Mechanics in Lingual Orthodontics

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Bodily translation for anterior retraction is achieved either by directly applying a moment and force to an edgewise bracket or by using lever-arm mechanics to change the point of force application so that it passes closer to the center of resistance[1,2] (Fig. 1). Although labial placement of a lever-arm system may be prevented by the oral anatomy, lingual placement is always possible due to the width of the palate.[3]

One of the most difficult problems to overcome in lingual orthodontics has been torque control of the anterior teeth. However, lingual lever-arm mechanics can be effective in producing anterior root movement[4] (Fig. 2), as this article will demonstrate.

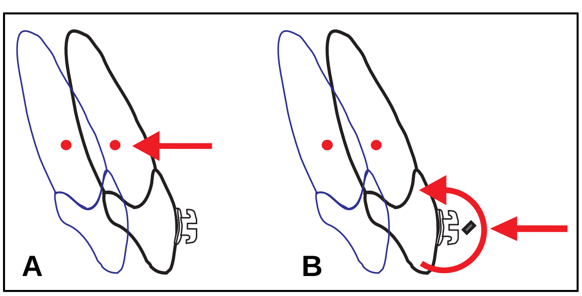

Fig. 1 Anteroposterior translation by: A. Application of force through center of resistance. B. Application of force and moment through edgewise bracket.

Principles of Lever-Arm Mechanics

In a lever-arm system, the desired tooth movement is attained by adjusting the length of the lever arm and the point of force application.[1] A transpalatal arch, made of brass or .016" × .022" rectangular stainless steel wire, is needed to control the point of force application in the posterior area. The position and stiffness of the brass hook soldered to the TPA will depend on

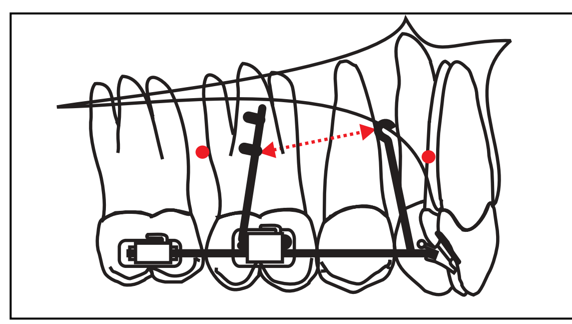

Fig. 2 Lingual lever-arm mechanics can be effective in producing root movement of anterior teeth for space closure.

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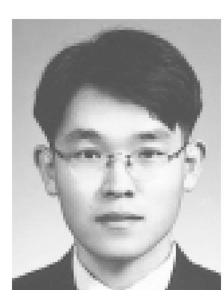

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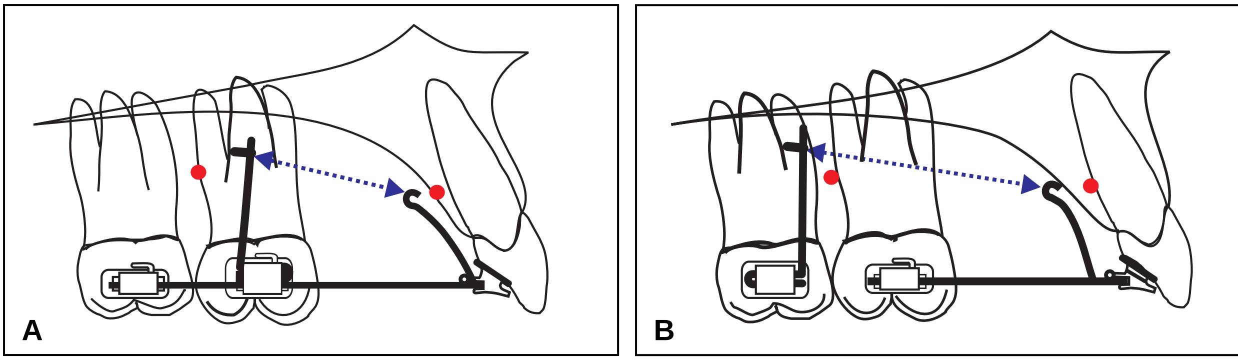

Fig. 3 Transpalatal arch inserted in lingual sheath on: A. Maxillary first molar. B. Maxillary second molar.

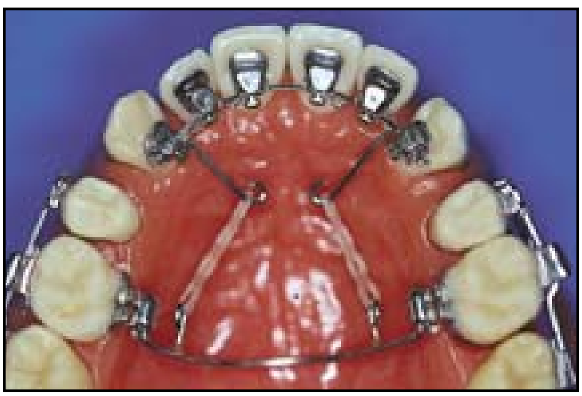

Fig. 4 Segmented lingual lever-arm mechanics, with anterior and posterior teeth stabilized as separate units using stiff wires.

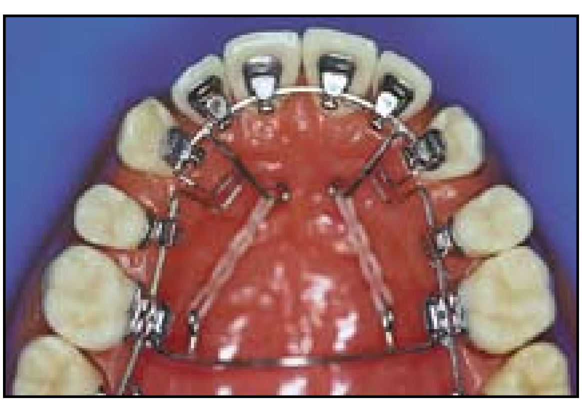

Fig. 5 Lingual lever-arm mechanics using continuous archwire with conventional loops.

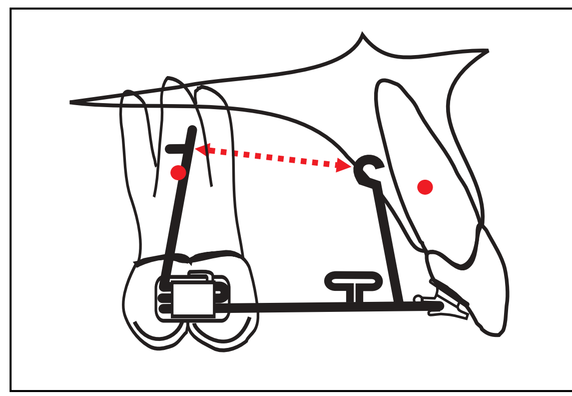

Fig. 6 Anterior torque control with continuous looped archwire.

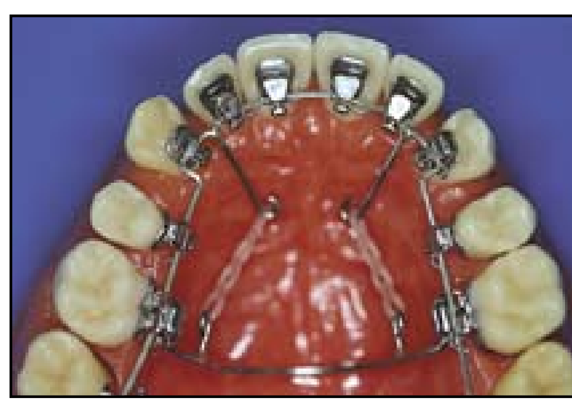

Fig. 7 Lingual sliding mechanics, using lever arm to adjust moment-to-force ratio through point of force application and line of action.

the anchorage requirements and desired direction of force.[2]

Lingual brackets with sheaths for the TPA can be placed on either the maxillary first molars or second molars (Fig. 3). Considering the amount of retraction force, the TPA should normally be inserted from the distal. If the lingual sheaths are on the second molars, however, it may be difficult to insert the TPA from the distal, and mesial insertion with steel ligation is recommended. Care should be taken that the TPA does not cause discomfort or gingival irritation and does not compromise oral hygiene.

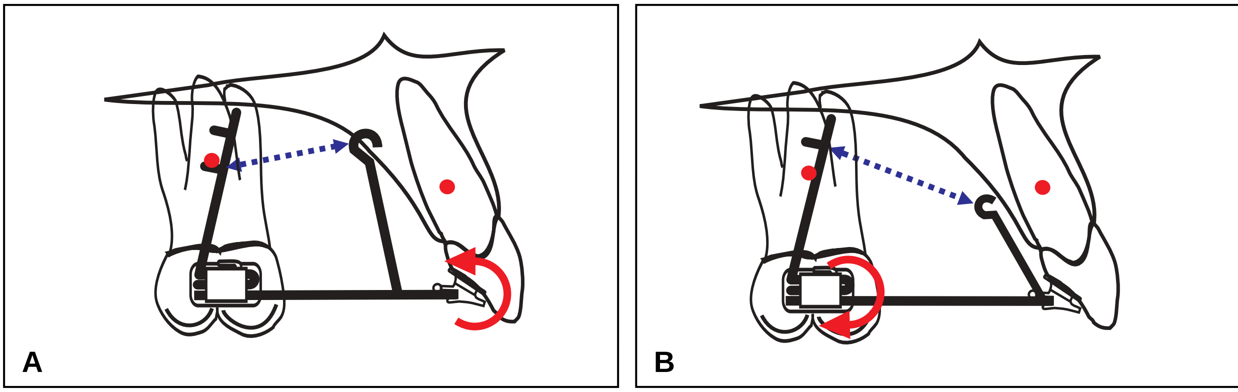

Fig. 8 With sliding mechanics, lever-arm application can be adjusted as necessary during space closure to add moments to: A. Anterior unit. B. Posterior unit.

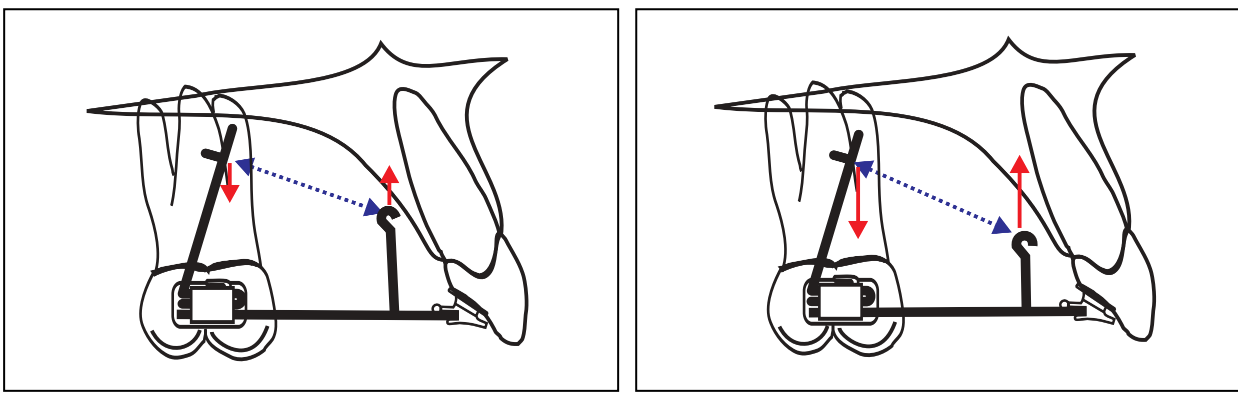

Fig. 9 Increasing vertical forces in anterior and posterior areas enhances anchorage, but increasing anterior intrusive force makes torque control more difficult and flattens occlusal plane.

Lever-arm mechanics can be applied by one of three methods:

1. *Segmented archwires.* This technique uses only the lever arms for tooth movement, with the anterior and posterior teeth consolidated into separate units with stiff wires (Fig. 4). Because no friction is introduced, precise calibration and accurate tooth movements are possible.[5]

2. *Looped archwire.* This method uses both the lever arms and a continuous archwire with conventional loops (Fig. 5). There is no friction between the wire and the brackets; while exact calibration is impossible because of the limitations of loop design, a moment can be added with the lever arm for effective control of anterior torque (Fig. 6).

3. *Sliding mechanics.* Calibration is imprecise, but friction and the moment-to-force ratio can be controlled (Fig. 7). Moments can be added to the anterior or posterior units if necessary during space closure (Fig. 8).

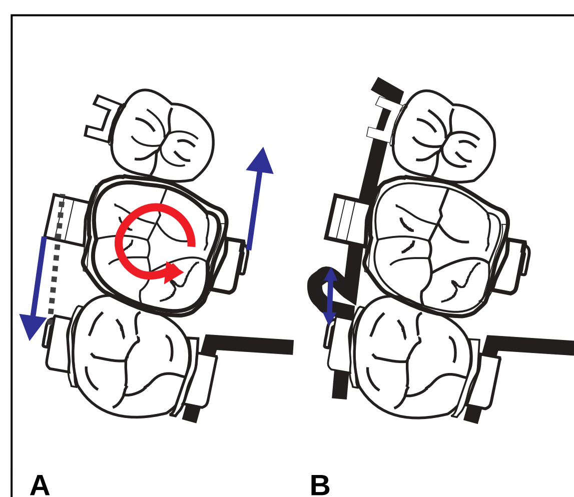

Fig. 10 A. When first molar is tied to second molar for anchorage reinforcement, undesirable rotation couple may be generated on first molar. B. When retraction force is applied to second molar, posterior teeth should be engaged with rigid wire, and second molar should be tied to omega loop.

Fig. 11 A. 38-year-old female Class II patient before treatment. B. Maxillary lever arms and continuous archwire with conventional loops combined for anterior torque control (continued on next page).

Clinical Application

The point of force application and line of action of the force are planned using the lateral cephalograms.[2] Increasing the vertical forces in the anterior and posterior areas will reinforce anchorage, but increasing the intrusive force in the anterior segment makes torque control more difficult and flattens the occlusal plane[6] (Fig. 9).

When the force of retraction is applied to the first molar, the first and second molars can be tied together for anchorage reinforcement. Care must be taken, however, to avoid a rotation couple on the first molar resulting from opposite forces applied on the labial and lingual sides

Fig. 11 (cont.) C. After 25 months of treatment.

(Fig. 10A).

When the retraction force is applied to the second molar so that the point of force application is apical to the center of resistance, a tipback or root movement of the second molar will tend to separate the first and second molars. This can be avoided by engaging the posterior teeth with a rigid wire and tying the second molar to an omega loop (Fig. 10B).

If vertical bowing of the lingual archwire occurs during space closure, the anterior and posterior vertical forces should be checked to see that the difference between them is not excessive. Other factors that should be closely monitored include torque control and improvement in the intermaxillary sagittal relationship. If necessary, moments can be added anteriorly or posteriorly by changing the point of force application and the line of action of the force (Fig. 8).

Conclusion

The use of lever-arm mechanics makes it possible to achieve bodily translation during anterior retraction with lingual orthodontics (Fig. 11).

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