Biomechanics in Orthodontics

PRINCIPLES AND PRACTICE

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Once comprehensive diagnosis and treatment planning have set the stage for initiating treatment procedures, appliance design and systems have to be developed to achieve treatment goals. Correct application of the principles of biomechanics assists in the selection of efficient and expedient appliance systems.

Over the last three decades, there has been an explosion in the development of technology related to orthodontics. New materials and designs for brackets, bonding, and wires have combined to create a nearly infinite number of possibilities in orthodontic appliance design. As these new materials are brought together in the configuration of orthodontic appliances, it is necessary to understand and apply the principles of biomechanics for a successful and efficient treatment outcome. Lack of proper understanding may not only set up inefficient force systems but also cause collateral damage to the tissues. The path to successful treatment is through good knowledge of biomechanics.

This book is written with the purpose of introducing a student of orthodontics to the evolving technology, material properties, and mechanical principles involved in designing orthodontic appliances.
When the wire is engaged in the incisor brackets, three possible effects can be observed. First is the rowboat effect, which is caused by a counterclockwise moment on the canine that strains the anchorage.\textsuperscript{10–12} This moment tends to push the crown forward, resulting in incisor protrusion, which can be prevented only by means of a laceback.

In Class II, division 1 extraction cases, the rowboat effect is an undesirable side effect because of the round tripping or jiggling effect,\textsuperscript{13–15} which may occur during retraction of anterior teeth and result in root resorption. Laceback can prevent the canine crown from tipping forward. In Class II, division 2 nonextraction cases, incisor protrusion may be desirable; therefore, use of a straight wire will help induce anterior protrusion as well as quick alignment.
The second effect is deepening of the bite (bowing effect; Fig 3-23a). Deepening of the bite during treatment is usually not a desired effect unless it is indicated in an anterior open bite that needs to be corrected by maxillary incisor extrusion. To diagnose or predetermine this effect, place the archwire in the canine bracket slot before ligating it. If the anterior part of the wire runs below the incisor brackets, it should not be tied to the brackets to avoid incisor extrusion. If a bendable wire is used, a step-up can be bent to bypass the incisors gingivally. Another method is to place a continuous intrusion arch along with the straight wire. The extrusive effect of the straight wire would therefore be compensated for by the intrusion arch.

If the stepped, bypass archwire is not left passive and is engaged in the incisors to intrude them or prevent them from extruding, it will cause the canine crown to tip more distally owing to the clockwise moment occurring on its bracket (Fig 3-23b).

In the explanations above, the main reasons for the adverse effects are the positions or axial inclinations of the teeth or the brackets. If the problem is caused by the axial inclinations of the canines, it is important to upright them with a laceback before inserting a continuous wire.

### Conclusion

In the analysis of the relationship between two teeth, the slot sizes and bracket widths are assumed to be equal in all the examples given here. Naturally, as the slot sizes and widths change, the magnitudes of the balancing forces and the moments also change. In clinical
Control their eruption before they reach the occlusal plane. For this purpose, a 0.016 × 0.022–inch SS segmented arch can be used as an occlusal stop\(^\text{36}\) (Fig 6-36).

**Arches with reverse curve of Spee**

Anterior open bite can be closed with a combination of a reverse-curved archwire and anterior box elastics\(^\text{31,32}\) (Fig 6-37). The archwire tends to extrude the maxillary and mandibular premolars, opening the bite, while strong anterior box elastics prevent eruption of the premolars and extrude the anteriors. Because the premolars cannot erupt, the molars intrude and tip back with reciprocal forces. These mechanics effectively close the bite in 1 or 2 months, but they are heavily dependent on patient cooperation. If the patient fails to wear the elastics, the premolars will extrude and cause the bite to open more. Even though this approach is very effective in closing the bite, the elastics should not be worn longer than 2 months because of the possibility of gingival recession and a gummy smile from overeruption of the incisors.

**Molar intrusion with microimplant anchorage**

Molar intrusion may be required to control the vertical discrepancy in skeletal open bite. However, using conventional techniques, this movement is one of the most challenging procedures in orthodontics—depending on strong anchorage—but intraoral anchorage is usually not

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**Fig 6-35** In open bite cases, control of vertical movement of the molars can be achieved effectively with a high-pull headgear–transpalatal arch combination. If the transpalatal arch crosses the palate 2 to 3 mm away from the mucosa, the molars will be intruded by vertical tongue forces during swallowing.

**Fig 6-36** (a and b) In open bite cases, erupting second molars can be controlled using a 0.016 × 0.022–inch SS segmented arch that passes through the auxiliary tube of the first molar.\(^\text{36}\)

**Fig 6-37** Using reverse-curved archwires to close an anterior open bite. The strong anterior box elastics prevent the premolars from erupting, while the molars intrude and tip back and the incisors extrude. These mechanics work quite effectively in a very short time, but they are heavily dependent on patient cooperation. Elastics must be worn all day, otherwise the bite may open with quick extrusion of the premolars.
Treatment of High-Angle Cases and Correction of Open Bite

enough without extrusion of adjacent teeth. High-pull headgear with long arms in conjunction with a transpalatal arch is usually needed to achieve effective intrusion of posterior teeth (see Figs 5-7 and 6-35). Microimplant anchorage also is a very effective way to intrude molars.

There are two basic methods to intrude molars with microimplant anchorage:

- Two TADs can be inserted, both buccally and palatally, and elastic traction applied to the hooks (Fig 6-38). If two or more posterior teeth need intrusion, the force can be applied to the archwire.

- One TAD can be inserted buccally, while a transpalatal arch controls buccolingual tipping of the molar (Fig 6-39). Tongue forces during swallowing will assist this intrusion (see Fig 6-35).

In either method, TADs can be placed between the maxillary first molar and second premolar roots or between the first and second molar roots. Molar intrusion in the mandibular arch is usually more difficult than in the maxilla. Because microimplant insertion is not recommended on the lingual of the mandibular dental arch, a lingual bar can be used to control buccolingual molar inclination. Molar protraction in conjunction with intrusion causes the mandible to rotate counterclockwise and helps close the bite28 (Fig 6-40).

A microimplant on the zygomatic cortical bone butress is also recommended for intruding molars more effectively.33 Even though it is stronger, zygomatic microimplant insertion requires flap surgery, which may cause soft tissue irritation.