

Biomechanics of orthodontic correction of dental asymmetries

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Correction of dental asymmetries requires special attention in orthodontic treatment. Several types of asymmetries are described, along with the biomechanics needed for correction. Treatment with different appliance designs that correct these asymmetries with the lowest level of negative contribution from side effects will be compared with conventional treatment. (AM J ORTHOD DENTOFAC ORTHOP 1995;107:618-24.)

Asymmetries are commonly observed in various combinations in orthodontic patients. The origin of these asymmetries can be skeletal,¹⁻⁵ dental,⁶ soft tissue,⁷ or a combination of these.^{1,2,8,9} Many possible causes for asymmetries have been reported in the literature, including hemifacial microsomia,¹ hemifacial hypertrophy,⁵ juvenile rheu-

matoid arthritis,⁹ condylar hyperplasia,² cleft lip and cleft palate,⁹ holoprosencephaly,⁹ neurofibromatosis,¹⁰ mandibular fractures, and drifting and tipping of teeth.⁶

Refined diagnostic tools, such as computerized tomographic images^{3,11,12} and stereo photogrammetry,¹³ allow three-dimensional analyses of the craniofacial complex. These methods can generate, with the aid of a computer, a three-dimensional image of the patient's face. With a coordinate system, the asymmetries can be quantified. The most important diagnostic tool, however, remains the clinical examination of the patient. Roentgenograms, such as

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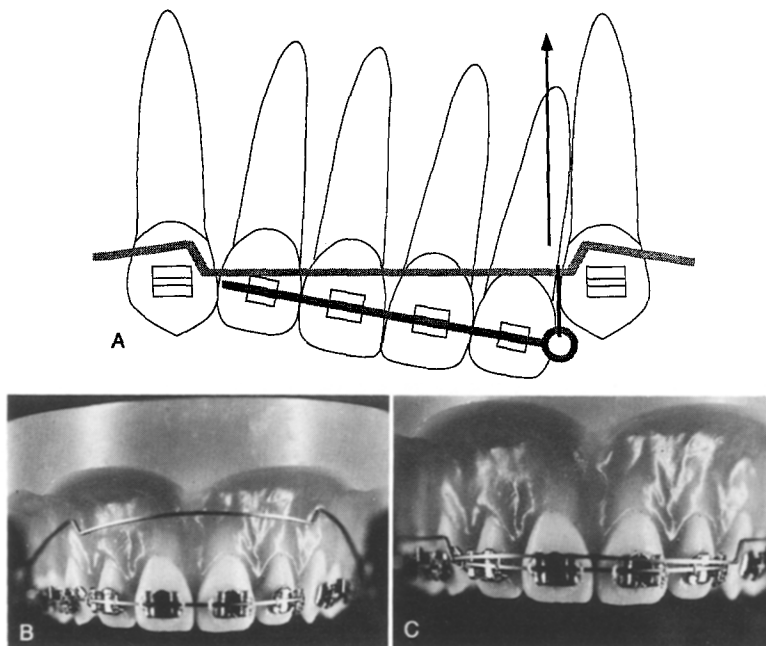


Fig. 1. A, 0.017 × 0.025-inch TMA intrusion arch comes from molar auxiliary tube and is tied to one side of anterior segment (0.018 × 0.025-inch stainless steel) delivering intrusive force on that side. B, Activated intrusion arch, before ligation on anterior segment. C, Intrusion arch tied in on one side only.

the posteroanterior view and the submental vertex, also remain important for diagnosis and quantification of asymmetries.

Skeletal asymmetries are preferably treated with a combination of orthodontics and orthognathic surgery.^{6,8} Dental and/or small skeletal symmetries are most often treated by orthodontic therapy.⁶ However, minor asymmetries are often neglected until they become apparent in the finishing stages of treatment. In other instances, an attempt to correct them with poorly designed appliances often causes more adverse effects than the asymmetry itself. This has been demonstrated in several publications by Burstone.¹⁴⁻²¹

The purpose of this article is to discuss orthodontic treatment possibilities and their biomechanical rationale for various types of dental asymmetries that are encountered in the orthodontic practice. Other commonly used orthodontic mechanics and their side effects are also discussed. The emphasis is on treatment to correct an asymmetry efficiently with minimal or no side effects.

CLASSIFICATION

Dental asymmetries in orthodontics can be divided into four groups:

1. Diverging occlusal planes
2. Asymmetric left to right buccal occlusion, with or without midline deviation
3. Unilateral crossbite
4. Asymmetric arch form

Treatment of diverging occlusal planes

Canted anterior occlusal plane (in transverse direction). The conventional treatment for this problem is the use of vertical interarch elastics to extrude the side of the occlusal plane that is farthest from the treatment occlusal plane. The vertical elastic exerts an extrusive force on both the maxillary and mandibular arches. If both upper and lower occlusal planes are equally diverging and the treatment plan calls for extrusion, this is a viable option. However, in the majority of the patients, the problem is limited to either the upper or lower arch, or isolated to anterior or posterior segments.

In patients with a canted maxillary anterior occlusal plane and a deep bite, the cant can be corrected in combination with overbite correction.¹⁴ This can be performed with a one-piece intrusion arch of 0.017 × 0.025-inch titanium molybdenum alloy (TMA) (Ormco Corp., Glendora, Calif.), which is tied to that side of the anterior segment requiring intrusion. The intrusive force level should be approximately 60 gm for four maxillary incisors and approximately 50 gm or less for four mandibular incisors. A diagram of the appliance is presented in Fig. 1, A. If the canine also requires

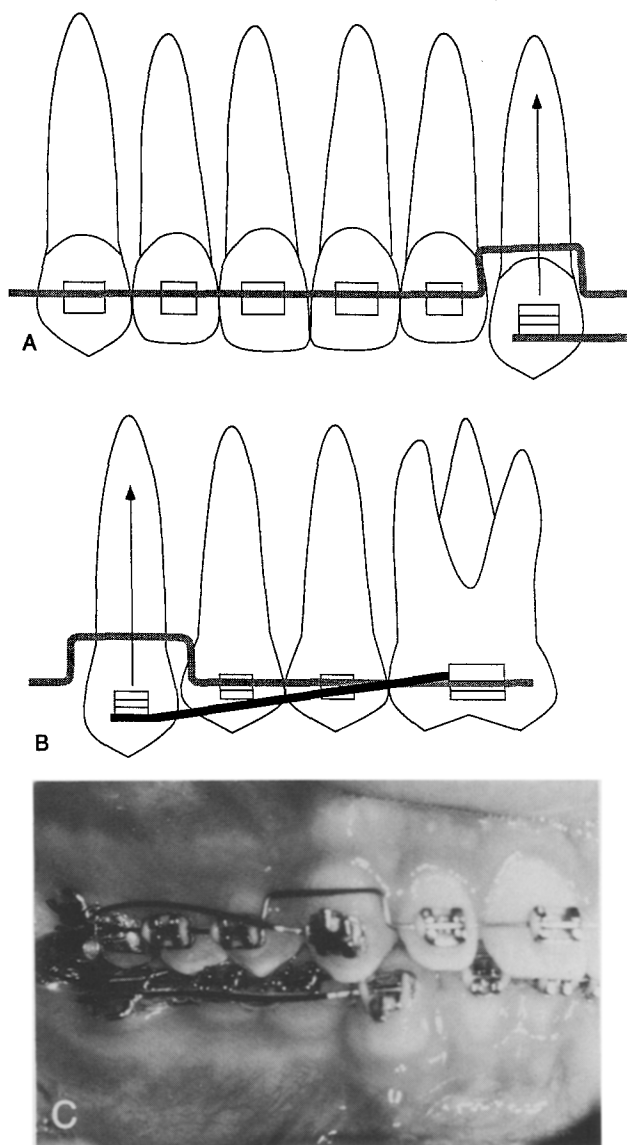


Fig. 2. A, Anterior view of separate canine intrusion. 0.018 × 0.025-inch stainless steel arch wire bypasses canine. 0.017 × 0.025-inch TMA cantilever comes from molar auxiliary tube and is tied underneath canine bracket (point force contact) delivering intrusive force. B, Buccal view of separate canine intrusion. Ideally wire should not be tied into bracket slot to deliver force without moments. C, Buccal view of separate canine intrusion.

intrusion, this is better performed in a separate stage after the incisor intrusion. A simple cantilever (0.017 × 0.025-inch TMA) exerting a force of 20 to 25 gm (Fig. 2) can be used. A high-pull headgear, with a force anterior to the center of resistance of the maxillary molars, is desirable to counteract the side effects of the intrusion arch.¹⁵

When there is no deep overbite problem and only one side requires extrusion, a unilateral cantilever can be

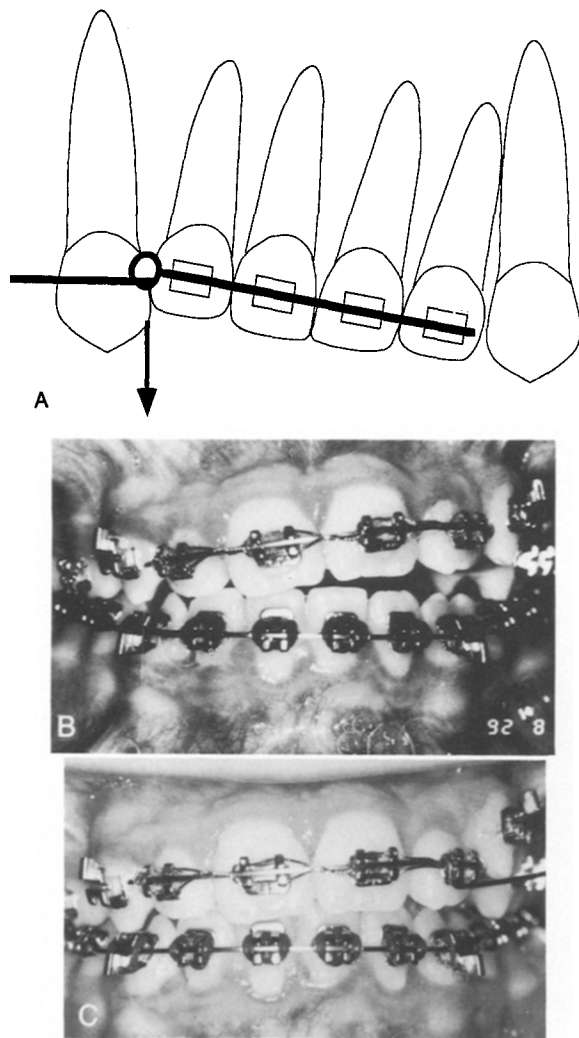


Fig. 3. A, Diagrammatic representation of unilateral extrusion of canted anterior segment. 0.017 × 0.025-inch TMA cantilever coming from auxiliary tube of molar is tied to one side of anterior segment. B, Patient with canted maxillary occlusal plane. C, Correction of canted occlusal plane with cantilever hook tied on affected side.

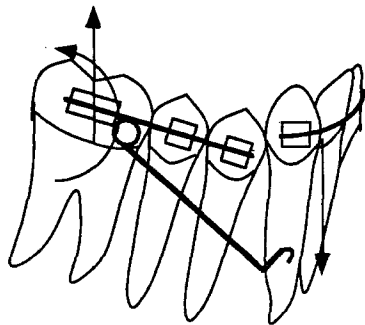


Fig. 4. To upright buccal segment, cantilever with hook can be used. Side effects are extrusion of buccal segment and unilateral intrusion of anterior segment.

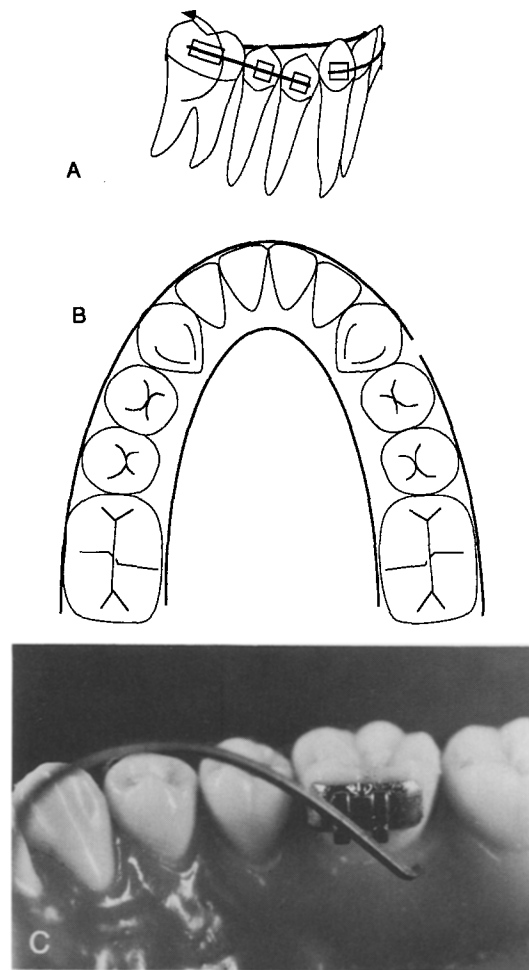


Fig. 5. A, 0.032 × 0.032-inch TMA lingual arch can be used to upright buccal segment without vertical side effects. Side effect of tip-back moment on right side is tip-forward moment on the left side that will be distributed over large stainless steel wire segment. B, Occlusal view of buccal wires for mechanics shown in A. C, Lingual view of tip back activation in lingual arch.

used to correct the occlusal cant. The cantilever, 0.017 × 0.025-inch TMA, comes out of the auxiliary tube of the first molar on the side where the extrusion is to take place and is hooked around the anterior segment. A force of approximately 30 gm is sufficient (Fig. 3).

Canted posterior occlusal plane (in anteroposterior direction). A variation of the intrusion arch¹⁴ can also be used to correct a cant of the posterior occlusal plane in patients who have a deep overbite. To correct this problem the magnitude of force is increased to 150 gm that causes a large tip-back moment on the buccal segment, thereby, flattening the occlusal plane. This appliance (Fig. 4) delivers appropriate force to the area of the arch in need of correction. The side effects are minimal in contrast to the undesirable side effects when using interarch elastics for this problem.

Another frequently observed problem is a unilateral

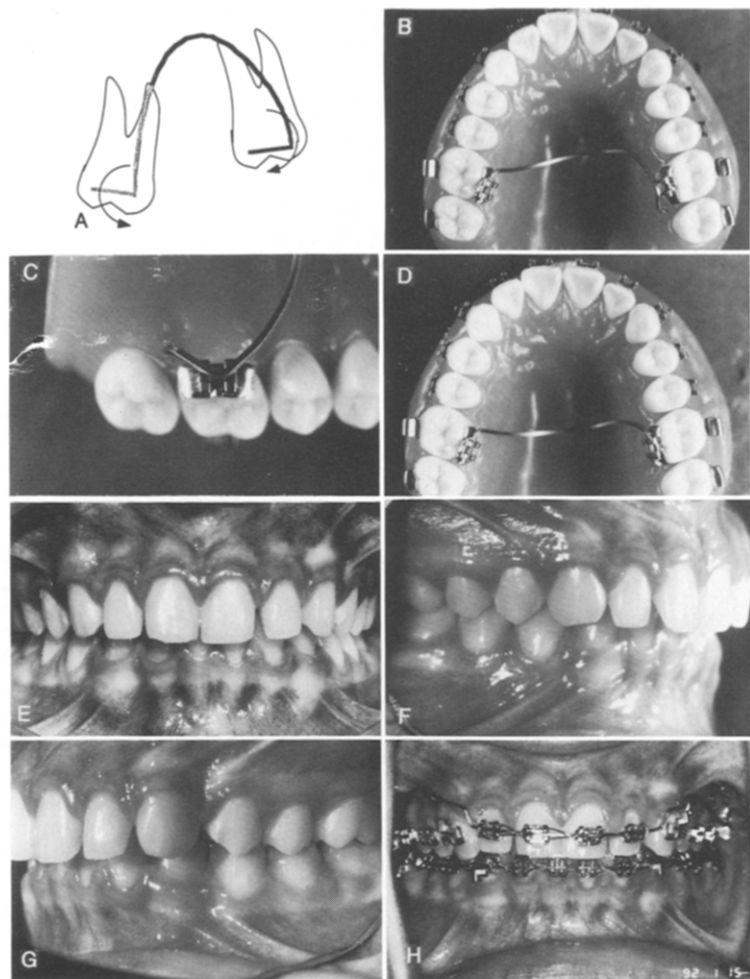


Fig. 6. A, Diagram of force system delivered by 0.032 × 0.032-inch TMA transpalatal arch. B, C, and D, Transpalatal arch should be activated by making gradual bends instead of sharp bends to deliver desired force system. E through G, Patient with asymmetric buccal occlusion and deep bite. First stage of treatment was correction of deep overbite by intrusion of maxillary incisors and simultaneous correction of asymmetric buccal occlusion by tipping maxillary left molar and mandibular right molar back. H, Anterior view of three-piece intrusion arch. Tip-back moment on the right side will counteract the tip forward moment from transpalatal arch. Tip-back moment on left side adds to tip-back moment from transpalatal arch.

cant of the occlusal plane, in which the posterior occlusal plane on one side is steeper (in anteroposterior direction) than the occlusal plane on the contralateral side. This can be corrected with the use of a precision palatal arch in the maxilla and/or a precision lingual arch in the mandible,^{16,19,20} depending on the location of the problem. A lingual arch with a tip-back activation on the steep side and a tip forward activation on the contralateral side will deliver the desirable moment to correct a cant of the mandibular occlusal plane.¹⁶ The side effect of this activation is the mesial tipping of the molar or buccal segment on the contralateral side. To minimize this, the unaffected side and the anterior segment are ligated together as a segment incorporating more teeth for increased anchorage (Fig. 5).

Treatment of asymmetric left and/or right buccal occlusion

Clinical example A: differences in left and right molar axial inclinations. Often left and right molar relationship is asymmetric, for example, Class I on one side and Class II on the other. This can be due to differences in axial inclination of the molars between the left and right sides and/or upper and lower arch. To correct uniarch molar asymmetries, a lingual or palatal arch (0.032-inch TMA or 0.032 × 0.032-inch TMA)^{16,19,20} activation is made to deliver a tip forward moment on the Class I side and a tip-back moment on the Class II side.^{16,17} This is a good example where side effects are useful in the correction of the problem (Fig. 6).

Clinical example B: differences in left and right molar

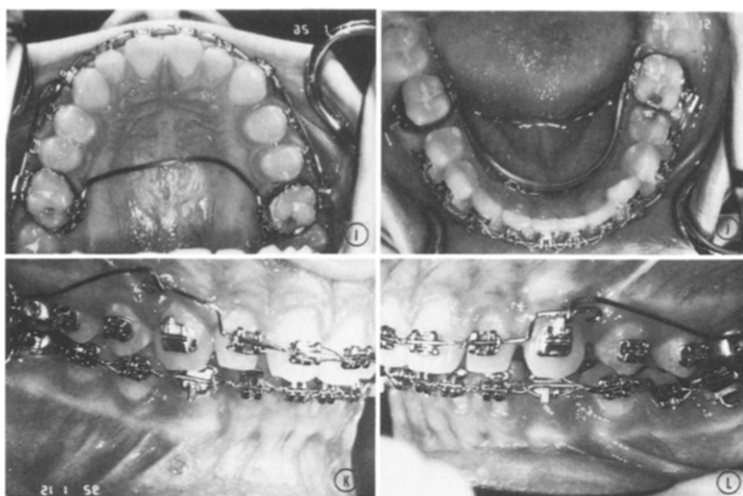


Fig. 6. Continued. **I**, Spaces have opened on maxillary left premolar and molar area. **J**, Space has opened up between mandibular right first molar and second premolar because of tip-back activation of lingual arch. To prevent mesial tipping on left side, heavy stainless steel arch wire extends from left molar to the right second premolar. **K** and **L**, Right and left buccal view of the three-piece intrusion arch. Note symmetric molar occlusion.

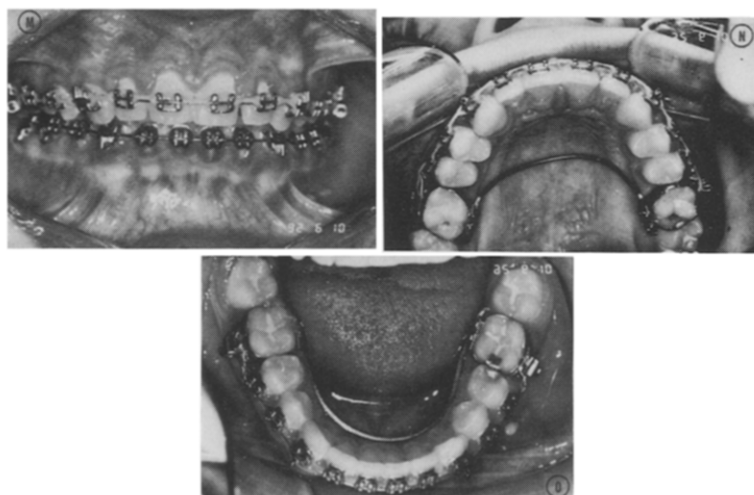


Fig. 6. Continued. **M** through **O**, After correction of molar asymmetry, teeth are individually tipped with powerchain. Teeth in buccal segments were rebracketed parallel to occlusal plane. On maxillary left side, continuation of space closure is required followed by rebracketing of canine. Note symmetric buccal occlusion and coincident dental midlines. Remainder of Class II malocclusion was then corrected with headgear mechanics.

rotation. Rotated molars are frequently seen in the maxillary arch. A mesial-in rotation of one molar often results in an asymmetric molar occlusion. To correct this problem, a transpalatal arch is used with equal amounts of antirotation activation. An 0.018 × 0.025-inch stainless steel wire is tied into all teeth except the rotated molar¹⁶ (Fig. 7).

Clinical example C: no difference in molar rotation and/or axial inclination. The right and left molar rela-

tionship can be asymmetric without perverted axial inclinations or rotations. A conventional approach to correct this problem is to use an asymmetric headgear.²² This headgear has the potential to move one molar further distally than the other molar. However, the transverse components of the forces exerted by this appliance²³ can cause undesirable side effects. Good patient cooperation (wearing the headgear) is necessary for this approach to succeed.

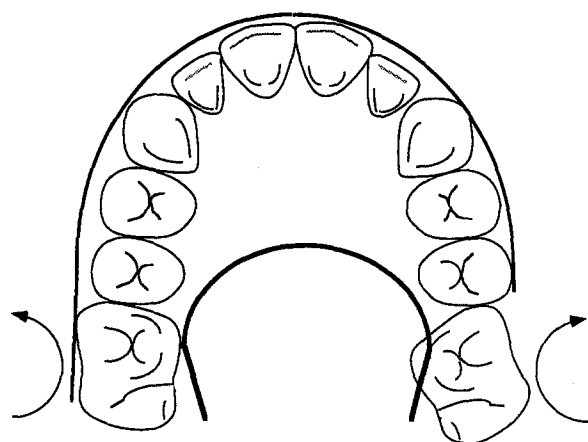


Fig. 7. 0.032-inch round transpalatal arch can be used for correction of asymmetric rotations. Heavy stainless steel arch wire is used to prevent side effects on contralateral side.

When the asymmetry is relatively small (up to about 3.0 mm), it can be corrected by a slight change in the axial inclinations of the posterior teeth. This can be accomplished by a transpalatal or lingual arch to tip the molars, as depicted in Fig. 6, A.

Unilateral dental crossbite

The treatment of a unilateral dental crossbite can be performed with a lingual arch (0.032 × 0.032-inch TMA) in the mandible and transpalatal arch (TPA) in the maxilla.^{16,19,20} In the case of a lingually tipped upper molar, a rigid arch wire is tied to all of the teeth except the molar in crossbite. Buccal root torque is placed in the TPA on the side that is not in crossbite. When the TPA is inserted into the bracket, the horizontal part of the TPA will be occlusal to the bracket on the crossbite side. In addition, expansion activation should be built into the transpalatal arch. When this TPA is engaged, the force system created causes the desired buccal tipping of the molar in crossbite. This tipping movement occurs before translation of the molar on the contralateral side. The vertical forces, which act to cause intrusive and extrusive side effects on the two molars, are small and usually are not expressed because occlusal forces are far larger in magnitude, albeit, transient duration. After the crossbite has been corrected, the wire should be removed, made passive, and reinserted. A diagram of the appliance is shown in Fig. 8.

Asymmetric arch form

Orthodontists often use an asymmetrically shaped arch wire or asymmetric interarch elastics to correct an asymmetric arch form. A more efficient way is to use a cantilever (0.017 × 0.025-inch TMA) from the first molar, with a hook that is attached in the area where the arch needs to be expanded or narrowed. The cantilever

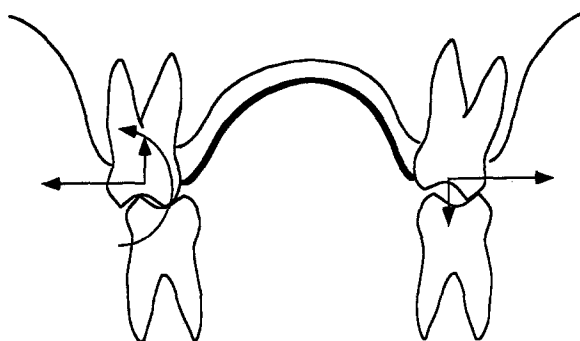


Fig. 8. Diagram representing force system needed to correct unilateral dental crossbite. Force system can be delivered by 0.032 × 0.032-inch TMA transpalatal arch that exerts expansive force on both molars and buccal root torque on untipped molar. Moment to force ratio on correct side should be 10 or larger to prevent this side from tipping buccally.

can be inserted on top of a light arch wire, for example 0.016-inch TMA. A transpalatal or lingual arch connecting the molars should be in place to prevent rotation of the molar to which the cantilever is attached. A cantilever with a buccal force on the arch wire tends to rotate the molar mesial in. Conversely, a cantilever with a lingual force on the arch wire tends to rotate the molar mesial out.

SUMMARY

The mechanics described herein are not all inclusive for all dental asymmetries encountered in practice. However, a small variation in activation, ligation, size of the anchor units, force and moment magnitudes can significantly help in correcting most dental asymmetries. The use of asymmetric interarch elastics for dental asymmetries is often not discriminatory and creates undesirable side effects. A judicious use of biomechanics with simple appliances, such as cantilevers and lingual and palatal arches, can deliver optimal forces to obtain predictable tooth response with minimal side effects.

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