Loss of Anterior Torque Control Due to Variations in Bracket Slot and Archwire Dimensions

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Colleagues around the world have recently begun to report intermittent failures of protraction mechanics that use incisor lingual root torque from rectangular archwires to provide anterior anchorage. Once-reliable intra-arch protraction mechanics have become unreliable, with incisors tipping lingually instead of maintaining their anteroposterior positions, under force systems designed to protract the posterior teeth.

This undependability coincides with the introduction of an increasing number and variety of preadjusted bracket systems. A recent study by Kusy and Whitley indicates that variations in bracket slot and archwire dimensions may account for the failure of protraction mechanics, as well as for the loss of incisor axial inclination control during other forms of tooth movement.[1]

Kusy and Whitley measured 24 brackets from eight manufacturers microscopically, to the nearest .0001", and found that while three bracket slots were smaller than the stated sizes, 20 others exceeded the stated sizes. The largest .018" slot actually measured .0209"—nearly .003" oversized. The largest .022" slot measured .0237", or almost .002" oversized.

In addition, because European vendors use metric tooling, their target values are .5mm (.0197") for .018" slots and .6mm (.0236") for .022" slots. In other words, brackets from European vendors are oversized even without errors.

Although 30% of the 26 archwires mea-

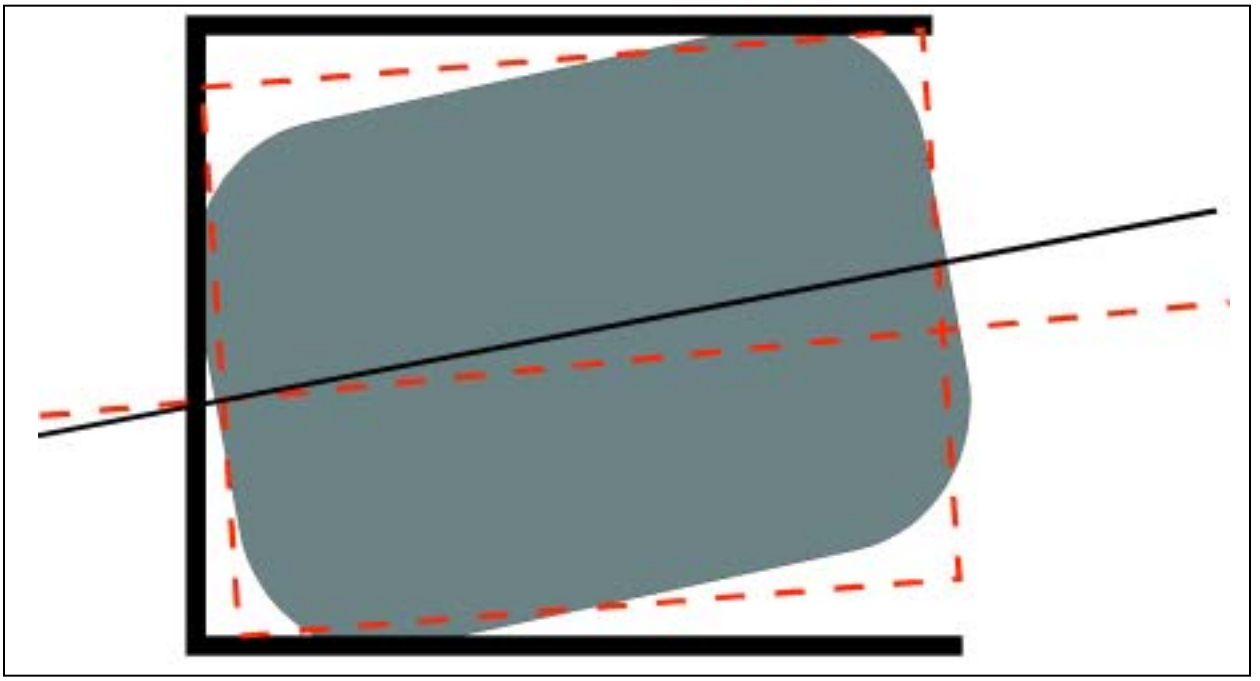

Fig. 1 Effect of rounded corners ("edge bevel") on play between rectangular wire and bracket slot. Rectangular wires have rounded corners because they are formed from round stock.

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TABLE 1
TIPPING DUE TO LOSS OF TORQUE CONTROL*

	Torque Loss		
	5°	8°	10°
Maxillary	1.3mm	2.1mm	2.7mm
Mandibular	1.2mm	1.9mm	2.3mm

*Lingual change in incisal edge position (incisors of average dimensions).

sured by Kusy and Whitley were larger than the stated sizes, the rest were smaller than advertised.

Impact of Variation in Bracket Slot and Archwire Sizes

If undersized rectangular wires are placed into oversized bracket slots bonded to the incisors, the impact can be severe, as these two examples show:

1. If an .018" bracket slot is actually .0195" (less than the maximum error measured by Kusy and Whitley), an .017" × .025" archwire will have 5° of additional wire-bracket play, using typical edge-bevel values for archwires with rounded corners[2] (Fig. 1). An .018" × .025" wire, which should fill an .018" slot, will still have 2-4° of wire-bracket play. If the .017" × .025" archwire is *actually* .0165" × .024", an additional 5° of wire-bracket play results, for a total of 10°.
2. If an .022" slot bracket is actually .0235" (again, less than the maximum error measured), an .018" × .025" archwire will have 5° of wire-bracket play beyond that usually anticipated for an .022" slot. An .0215" × .028" archwire, which should fill an .022" slot, will have 5° or more of wire-bracket play in an .0235" slot.

When protracting posterior teeth, if the mechanics depend upon moments generated at the incisor brackets with rectangular archwires, the above slot-size errors can induce lingual tipping of the incisors (Table 1, Fig. 2). Such results are undesirable, to say the least. If the archwires are smaller than their stated sizes, the impact is even worse.

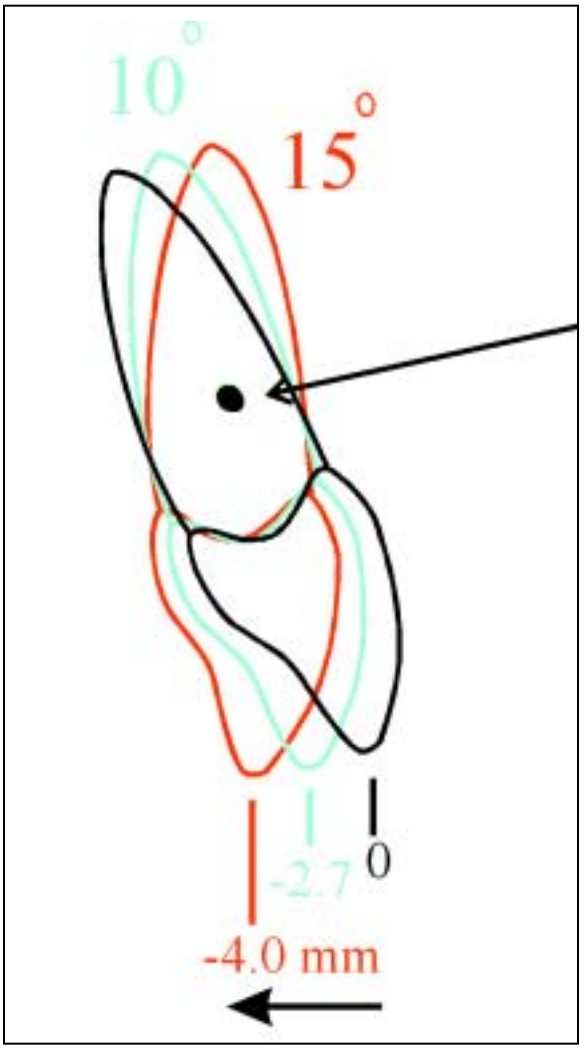

Fig. 2 Progressive loss of maxillary incisor anteroposterior position when incisors are free to tip lingually due to increasing wire-bracket play (not to scale). Center of rotation for pure lingual tipping (arrow) is a mean 1.6mm apical to center of resistance of maxillary central incisor.

Discussion

Given the variations in bracket slot and wire sizes that are possible today, it would behoove clinicians to do their own measurements. A micrometer or digital calipers (e.g., Fowler*) can be used to measure the dimensions of archwires upon arrival in the office. Undersized wires can then be returned to the vendor.

Sparkplug feeler gauges—inexpensive leaf gauges sold in automobile supply stores for setting sparkplug gaps**—have leafs in .001" increments, plus one that is .0015" thick (Fig. 3). The .0015" leaf can be cut off and spot-welded to either the .017" leaf or .021" leaf, yielding a thickness of .0185" or .0225", depending on the slot size used in the practice. If the .0185" leaf will not fit into an .018" bracket slot, or the .0225" leaf will not fit into an .022" slot, this means the bracket is less than .0005" oversized and, therefore, that the torquing error will be 1° or less, a clinically insignificant amount. Incisor brackets with grossly oversized slots can be returned.

Tooth-by-tooth V-bend protraction sliding mechanics[3] could be used in patients already bonded with oversized incisor slots. Bracket slot-size errors will not affect the crown-labial/root-lingual moments delivered to the incisors by this system of mechanics, which uses round wires. Alternatively, for en masse protraction mechanics, lingual root-torquing auxiliaries (TP 256 series***) could be added as overlays to ensure adequate anteroposterior incisor control.

Brackets and wires that have been used in sliding mechanics show evidence of considerable wear and tear.[4,5] They should not be reused, no matter how well recycled, if 3rd-order control is a clinical goal.

*Max-Cal, Newton, MA.

**Kastar Hand Tools, Racine, WI.

***TP Orthodontics, Inc., 100 Center Plaza, LaPorte, IN 46350.

†Ortho Specialties, 7707 W. 99th St., Hickory Hills, IL 60457.

Fig. 3 Common sparkplug-gap leaf gauge (#36A).**

Conclusion

Recent tolerance inaccuracies in bracket slot and archwire dimensions have caused unpredictable failures of formerly reliable mechanics, especially those that depend on protracting posterior teeth. This has resulted in lingual tipping of incisors and in general loss of incisor axial inclination control.

I am aware of only one vendor, Ortho Specialties,† that currently specifies the measured central incisor bracket/wire torque for each of its archwires in each bracket slot size. All vendors should provide clinicians with the exact wire and bracket slot dimensions to the nearest .0005".

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