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Frictional Resistance of the Damon SL Bracket

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Orthodontic brackets have been modified in several ways to decrease frictional resistance and improve the efficiency of sliding mechanics. These changes initially focused on bracket width,1-5 interbracket distance,5,6 and ligation technique.5,7-10 In recent years, self-ligating brackets have been developed to further minimize frictional forces.11-13

This study was designed to compare the kinetic frictional force of a new self-ligating bracket with that of a conventional twin bracket.

Materials and Methods

Twenty Damon SL self-ligating brackets and 20 Mini-Twin brackets were tested. All samples were .0225" X .030" maxillary first premolar brackets with standard Andrews prescriptions. The wires used were 55mm lengths of .018" X .025" nickel titanium and .019" X .025" stainless steel.

Each bracket was bonded perpendicularly to a cylindrical Plexiglas jig, which was then fixed in a specially designed apparatus (Fig. 1). The apparatus was secured to the base of an Instron Universal Testing Machine. The wire was attached through a Jacobs chuck to a tension load cell on the crosshead of the testing machine. This allowed it to slide through a single bracket slot without any influence from bracket tip or torque. To maintain uniformity of ligation forces on the Mini-Twin brackets, .110" elastomeric power modules were applied with a Straight Shooter.

Each test was carried out for two minutes at a crosshead speed of .02"/minute. Frictional forces were measured and analyzed using the SAS program. T-tests were conducted to evaluate the significance of differences between mean values.

Results

The Damon SL bracket showed significantly lower kinetic frictional forces ($p < .0001$) than the Mini-Twin bracket with both wires (Fig. 2, Table 1). With the nickel titanium wires, the Damon SL brackets had a mean friction of 15.0g, compared to 41.2g for the Mini-Twin brackets. With the stainless steel wires, the Damon SL brackets produced a mean friction of only 3.6g, compared to 61.2g for the Mini-Twin brackets.

Discussion

These results corroborate the findings of previous studies of self-ligating brackets.11-13 Several design and manufacturing features may account for the difference in bracket friction. First, the Damon SL bracket has a locking spring-clip slide over the slot that holds the archwire securely in place (Fig. 3). Unlike the conventional elastomeric ligature, this slide allows the wire to lie passively in the slot, reducing the normal component of force (Fig. 4).

Another contributing factor may be the difference in surface conditions within the bracket slots. Under a scanning electron microscope, the Damon SL bracket (Fig. 5) shows smoother surface detail

than the Mini-Twin (Fig. 6). Although both brackets are manufactured from 17-4 PH stainless steel, the Damon SL bracket is made by metal injection molding, while the Mini-Twin is investment cast.

The lower friction measured between the self-ligating bracket and the stainless steel wire, compared to the nickel titanium wire, confirms previous reports.11 The lower frictional resistance of the Mini-Twin bracket with nickel titanium wire is more difficult to explain in light of other studies.5,15 Our results could be explained by the bracket manufacturing process; the presence of microbonds between wire and bracket; the sharper mesial and distal edges of the Mini-Twin bracket slot, causing point contact between wire and bracket and allowing the wire to be held more tightly in the slot by the elastomeric ligature; or the greater cross-section of the stainless steel wire (.019" X .025" vs. .018" X .025").

Conclusion

The results of this study indicate that self-ligating brackets not only make archwire placement more convenient and secure, but also have lower kinetic frictional forces than conventional brackets. These features can be substantial advantages for orthodontists who use sliding mechanics. □

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15.

FIGURES

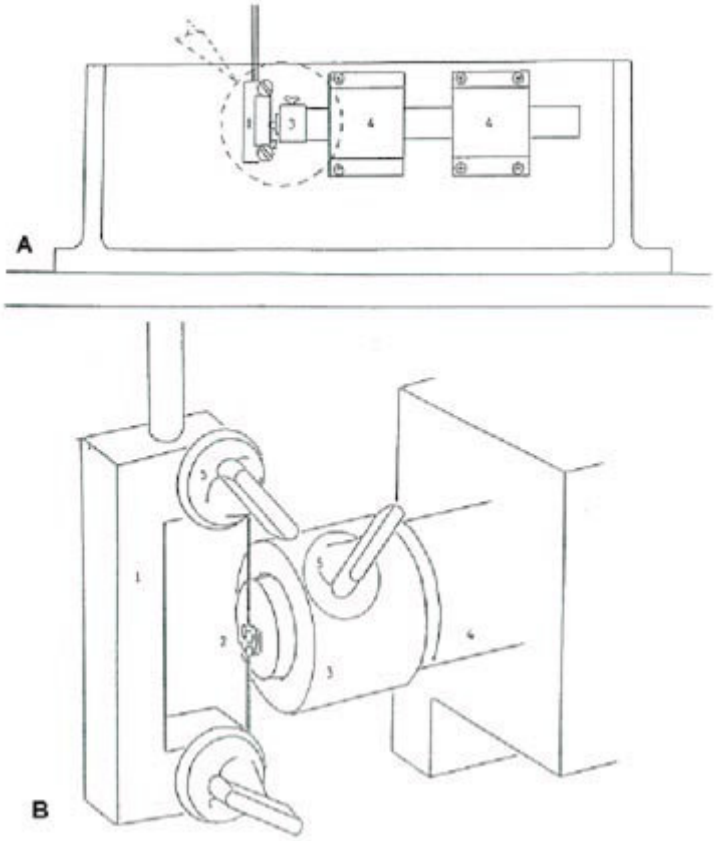

Fig. 1 A. Testing apparatus. B. Bracket-wire setup in testing apparatus (1 = C-shape rod connected to chuck and load cell; 2 = bracket-wire assembly mounted on plastic pedestal; 3 = stainless steel rod with plastic pedestal attached; 4 = roller bearings for linear and rotational displacements; 5 = wing nuts to hold wire and plastic pedestal).

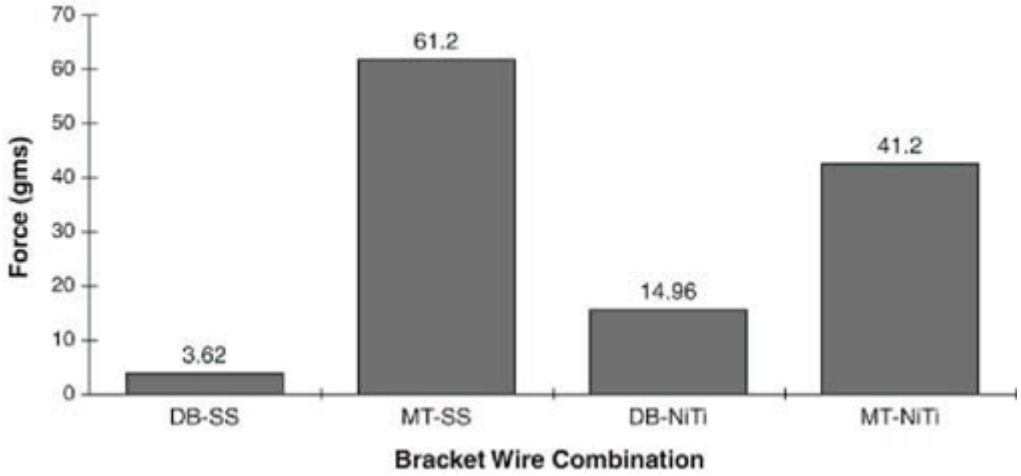

Fig. 2 Mean kinetic frictional forces (DB = Damon SL bracket; MT = Mini-Twin bracket; SS = stainless steel wire; NiTi = nickel titanium wire).

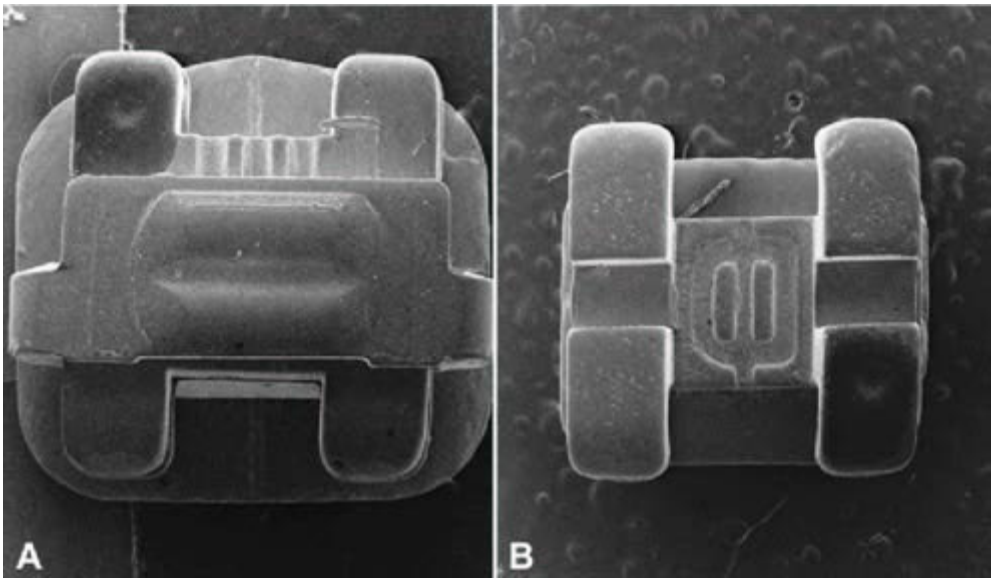

Fig. 3 Scanning electron microscopic views of Damon SL bracket with closed spring clip (A) and conventional Mini-Twin bracket (B).

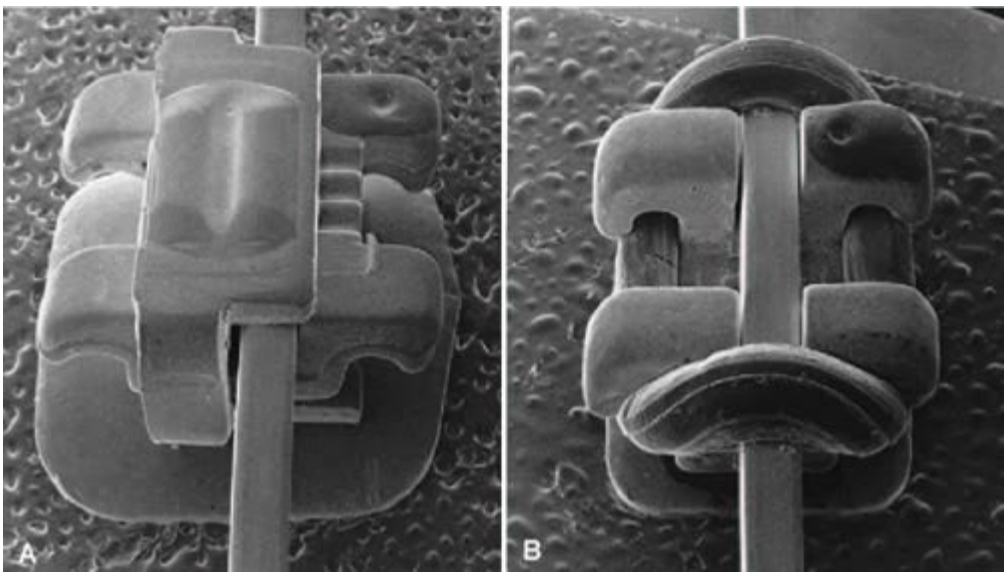

Fig. 4 Scanning electron microscopic views of .019" × .025" stainless steel archwires held in Damon SL bracket slot by spring clip (A) and in Mini-Twin bracket slot by elastomeric ligature (B).

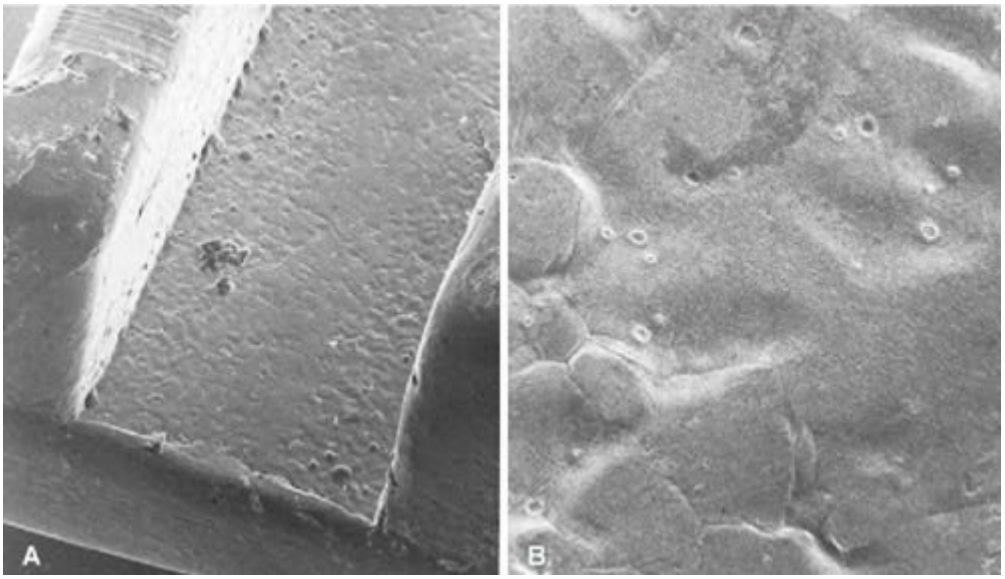

Fig. 5 Scanning electron microscopic views of Damon SL bracket slot surface. A. 100× magnification. B. 300× magnification.

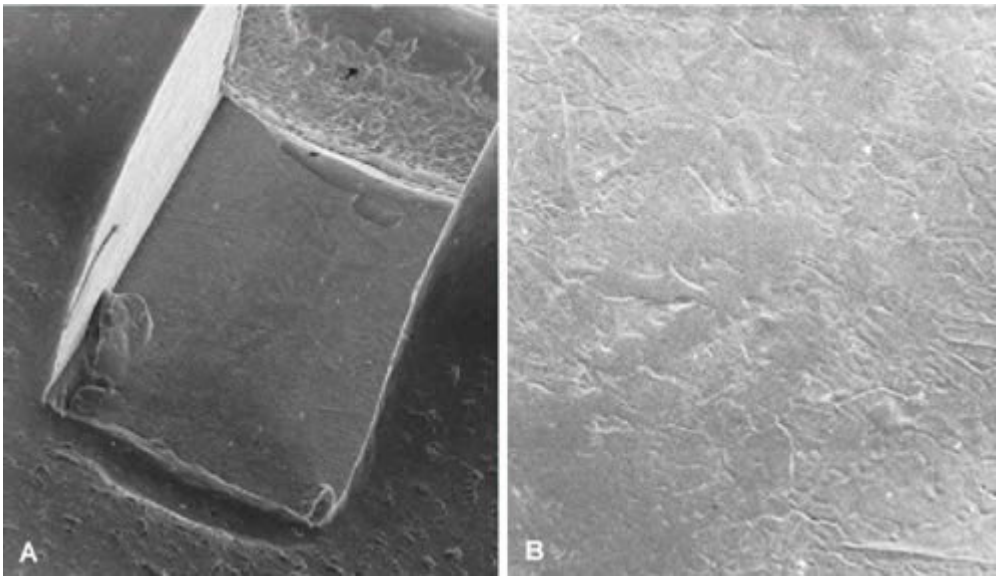

Fig. 6 Scanning electron microscopic views of Mini-Twin bracket slot surface. A. 100× magnification. B. 300× magnification.

TABLES

TABLE 1
KINETIC FRICTIONAL FORCES (G)

	Mean	S.D.	Range
.018" × .025" Nickel Titanium Wire			
Damon SL bracket	15.0	3.1	0-23.1
Mini-Twin bracket	41.2	45.3	0-134.2
.019" × .025" Stainless Steel Wire			
Damon SL bracket	3.6	1.4	0-8.2
Mini-Twin bracket	61.2	55.7	0-185.9

Table. 1

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FOOTNOTES

1 Damon SL, Mini-Twin, stainless steel wires, Ormco/"A" Company Orthodontics, 1717 W. Collins Ave., Orange, CA 92667. Damon SL is a trademark.

2 Instron Testing Machine, Model No. 4468, Instron Corporation, Canton, MA.

3 Straight Shooter, trademark of TP Orthodontics, Inc., 100 Center Plaza, LaPorte, IN 46350.

4 SAS program, SAS Institute, Cary, NC.