# Resistance of a 4-META–Containing, Methacrylate-based Sealer to Dislocation in Root Canals

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## Abstract

The dislocation resistance of root fillings created with MetaSEAL, a self-adhesive 4-META–containing methacrylate resin-based sealer, was evaluated. Forty-six incisors were cleaned and shaped using NaOCl and EDTA as irrigants. They were filled with gutta-percha/MetaSEAL or gutta-percha/AH Plus sealer using either a single-cone technique or warm vertical compaction ($n = 10$). The roots were sectioned at the coronal and middle thirds to obtain thin slices, which were subjected to compressive loading to displace the set sealer/filling toward the coronal side of the slice. The remaining six teeth were filled with gutta-percha/MetaSEAL and cryofractured for scanning electron microscopic examination. The push-out strength of AH Plus was significantly higher than MetaSEAL irrespective of filling techniques ($p < 0.05$). A minimal hybrid layer was seen in radicular dentin, and resin tags were inconsistently identified from canal walls in the MetaSEAL-filled canals. The lower dislocation resistance in MetaSEAL-filled canals challenges the use of a self-adhesive bonding mechanism to create continuous bonds inside root canals. *(J Endod 2008;34:833–837)*

## Key Words

4-META, AH Plus, dislocation resistance, root canal sealer, thin-slice push-out test

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The use of a sealer and a thermoplastic core material for filling root canals is the accepted norm in contemporary endodontics. Although predictable clinical results have been reported with the use of nonbonding root canal sealers (1, 2), there is a continuous quest for alternative sealers or techniques that bond to dentin and the filling material (3–6). Because leakage from the apical or coronal direction is a possible cause of root treatment failure (7, 8), a root canal sealer should show good sealing (9) and adhesive properties (10–19). Although the correlation between the sealing property of an endodontic sealer and its adhesive characteristics has not been definitively proven, the ability to resist disruption of the established seal via micromechanical retention or friction is highly desirable during the preparation of cores or post spaces along the coronal and middle thirds of canal walls (20, 21).

A 4-methacryloyloxyethyl trimellitate anhydride (4-META) containing polymethyl methacrylate-based (PMMA) endodontic sealer (MetaSEAL; Parkell Inc, Farmington, NY) has recently been introduced. Similar to the relatively new class of self-adhesive resin cements (eg, Maxcem; Sybron-Kerr, Orange, CA) (22), MetaSEAL is dual cured and self-adhesive in nature and therefore eliminates the use of a separate self-etching primer to create an initial bond in radicular dentin. The manufacturer claims that MetaSEAL bonds to radicular dentin and gutta-percha via the formation of hybrid layers. Thus, MetaSEAL should provide superior dislocation resistance of gutta-percha root fillings when compared with the use of nonbonding sealers. Mechanical disruption to root fillings during the preparation of amalgam cores or post spaces was simulated in this study by cutting thin sections of filled canals derived from the coronal and middle thirds of single-rooted teeth for a "thin-slice push-out test" (23–27). The null hypothesis tested was that there is no difference in the dislocation resistance between MetaSEAL-filled canals and those filled with a commercially available nonbonding sealer. The ability of the self-adhesive MetaSEAL sealer to form hybrid layers in smear layer–free radicular dentin was also investigated using scanning electron microscopy of cryofractured-filled canals.

## Materials and Methods

### Experimental Design

Forty-six extracted human mandibular incisors with single root canals were cleaned, shaped, and obturated under an operating microscope. Instrumentation was performed to 0.5 mm short of the radiographic apex with a crown-down technique using EndoSequence 0.06 taper nickel-titanium rotary instruments (Brasseler USA, Savannah, GA) to ISO standard file size 40. The canals were irrigated with 6.15% NaOCl between instrumentation. Five milliliters of 17% EDTA was used as the final rinse to remove canal wall smear layers. Each canal was dried with paper points and trial fitted with a 0.06 taper EndoSequence gutta-percha master cone with tugback.

Forty teeth were randomly divided into four groups ($n = 10$) for evaluating the dislocation resistance of two root canal sealers, MetaSEAL and AH Plus Jet (Dentsply Caulk, Milford DE), using a thin-slice push-out test. For each sealer, a single-cone technique and a warm vertical compaction technique were used to achieve a balanced experimental design. MetaSEAL was mixed with a plastic spatula in the ratio of 3 drops of liquid to one level scoop of powder. AH Plus Jet was mixed using the auto-dispenser. For the single-cone technique, the respective sealer was applied to the prepared canal using the gutta-percha master cone followed by inserting the latter to the working length. The gutta-percha in both sealer subgroups was removed at the cementoenamel junction with a System B heat source (SybronEndo, Orange, CA). Access cavities were restored with Cavit (3M ESPE, St Paul, MN). For the warm vertical compaction technique, the respective sealer was applied to the canal walls with the master cone as described earlier. The latter was down-packed with the System B heat source to 5 mm coronal to the working length. The remaining canal space was backfilled with warm gutta-percha using an Obtura II unit (Spartan, Fenton, MO). Access cavities in both subgroups were restored with Cavit. The teeth were stored at 100% relative humidity for 48 hours before laboratory preparation.

### Thin-slice Push-Out Test

Each tooth was sectioned along the coronal and middle thirds of the root into four 1.5-mm thick slices with a slow-speed Isomet saw (Buehler, Lake Bluff, IL) under water cooling. This resulted in 40 root slices for each of the four subgroups. The thickness of each root slice was measured with a pair of calipers. A 0.8-mm diameter carbon steel cylindrical plunger was used for the push-out test. The plunger had enough clearance and did not contact any part of the radicular dentin during the push-out procedure.

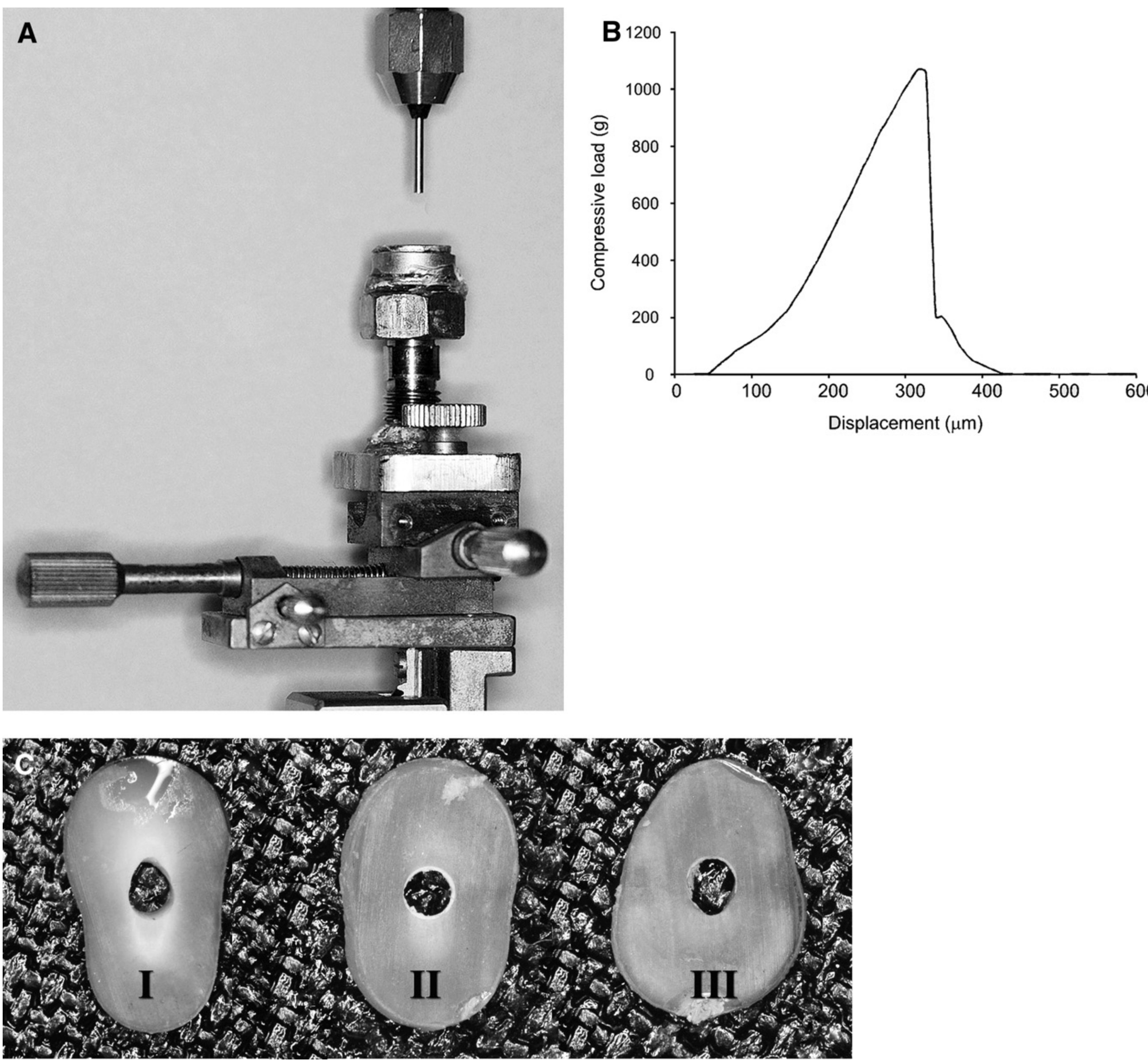


**Figure 1.** (*A*) Experimental setup for the thin-slice push-out test. (*B*) An example of a load-displacement curve generated by the thin-slice push-out test (MetaSEAL coronal group) when the plunger was correctly aligned so that it is not contacting the dentin walls during the push-out procedure. The sharp drop after attaining the maximum load represented an abrupt dislocation of the sealer from the dentin wall. The "lag" behind the sharp drop represented frictional resistance because the dislodged material core was being pushed out of the canal space. (*C*) Representative examples of the three different failure modes identified after dislodgement of the root fillings: (I) adhesive failure between the sealer and radicular dentin; (II) adhesive failure between the sealer and gutta-percha; and (III) mixed failure, partial adhesive failure and partial cohesive failure within the sealer and/or gutta-percha.