1834 Effects of Amalgam Thickness and Bonding on Failure Mode under Hertzian Indentation

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Objectives: Determination of the effects of thickness and bonding on the failure mode of amalgam under Hertzian indentation, which test mode is intended to represent cuspal loading of occlusal restorations. Methods: Amalgam discs (Lojic+, SDI, Australia), 10 mm diameter, were prepared 0.8 to 5.0 mm thick. Surfaces were finished flat to 600 grit under running water. Specimens were tested (10 replicates) either freely resting or bonded (Panavia F, Kuraray, Japan) on 5 mm x 10 mm diameter substrate discs (as a dentine mimic, E = 10 GPa) by centre-point loading with a 3 mm diameter steel ball at 0.2 mm/min cross-head speed. The loads at the first sound of cracking (if any) and at final fracture were recorded; fracture surfaces were observed with SEM to identify crack initiation sites. Results: Up to 2.4 mm thick, fracture was clearly into 2 - 5 nearly-symmetrical and equal pieces, the radial cracks being initiated at the lower surface; 5 mm discs fractured into many irregular fragments of varied size, with cracking being initiated subsurface, quasi-plastically, with occasional signs of Hertzian cone-cracking as well. Between these limits there was a mode transition. Failure load increased with thickness in a power-law relationship (power ~3/2). Bonding improved failure resistance (700 ± 65 N vs. 378 ± 27 N, $P<0.01$, at 1.6 mm), radial crack initation again occurred at the lower surface giving 2 - 4 pieces. Conclusions: Failure mode is thickness-dependent, and for clinically-relevant thicknesses cracking is initiated at the lower surface. Bonding is beneficial in improving failure resistance.

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