Evaluation of a Novel Laser-induced Reversible Orthodontic Resin Cement

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Objective: The objective of this study was to evaluate the dislodging force of orthodontic bands cemented with traditional cements and a novel cement, with and without laser activation.

Methods: Sixty intact human molars (n=15 for each group) were selected randomly for evaluation. GAC molar bands (Dentsply GAC International, Islandia, NY) were used for the study. Each tooth had an orthodontic band fitted to its crown portion and this pairing was maintained throughout the investigation. An extra attachment was spot-welded onto the lingual surfaces of the bands so that a force could be applied from both the buccal and lingual attachments to dislodge the bands in an occlusal direction. The bands were cemented using the four cement types listed in Table 1, as directed by the manufacture's cementation protocol. After cementation, each specimen was mounted by embedding the root portion in Orthodontic Clear Resin (Dentsply Sirona) to form a base with dimensions 25 mm × 15 mm × 15 mm for dislodging force testing. The mounted specimens were stored in a 37°C water bath for 24 hours before testing. Prior to tensile testing of the reversible cement, it was activated by laser (wave-length 450nm) for ~ 60 sec to trigger a rapid chemical cascading reaction (Figure 1). The specimens were tested using Universal Testing Machine (Model 5500; Instron Engineering Corp., Canton, MA) in tensile mode with a customized jig at a cross-head speed of 5 mm/min (Figure 2). Each specimen was subjected to a pulling force until the cemented band was visibly dislodged in an occlusal direction from the crown. The maximum dislodging force was recorded. One-way ANOVA and Tukey HSD tests were applied for statistical analysis of the dislodging force data, with statistical significance at α=0.05.

Figure 1. Laser equipment used to trigger the rapid cascading chemical reaction.

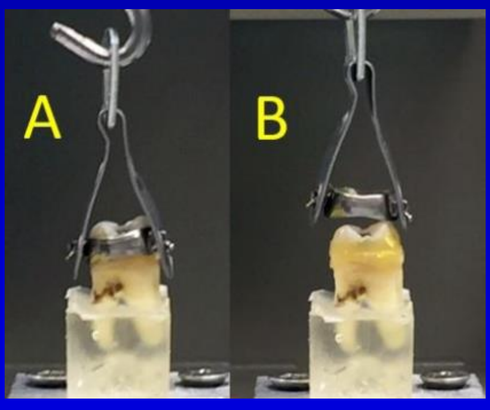

Figure 2. Dislodging test setup. A. Before testing; B. After testing.

Result: The results are summarized in Table 1.
The cement groups without laser activation are not different statistically ($P > 0.05$).
The laser activated group is weaker than all other groups. ($P < 0.01$).

Table 1: Materials used and results of the dislodging forces of tested cements

Material	Mean (N)	Standard Deviation
3M Glass Ionomer (3M)	169.62^{A}	79.96
Band-lok (Reliance)	237.61^{A}	90.99
Reversible composite cement without laser treatment (Cao Group)	184.56^{A}	54.84
Reversible composite cement with laser treatment (Cao Group)	37.93	10.37

Groups with same superscript letters were not statistically different ($P \geq 0.05$).

Conclusions: A novel reversible cement has been developed and introduced for minimizing iatrogenic damage of tooth enamel during debonding of bands and brackets. The reversible cement activated by a laser allows bands and brackets to be removed easily with minimal or no damage to enamel surfaces.

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The laser-induced reversible cement is their product.