



Received: November 18, 2025
Revised: January 19, 2026
Accepted: February 6, 2026

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Effect of Cavity Configuration on the Fracture Strength of Composite-Restored Root-Filled Maxillary Premolars: An *In Vitro* Study

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Abstract

Objectives: To evaluate the fracture strength and fracture patterns of root-filled maxillary premolars restored with direct resin composite using three cavity configurations: occlusal, mesio-occlusal (MO), and mesio-occluso-distal (MOD).

Methods: Forty extracted maxillary premolars were randomly assigned to four groups (n=10): intact controls, occlusal, MO, and MOD restorations. Root canal treatment was performed for restored groups, followed by standardised cavity preparation and incremental restoration with nano-filled resin composite. Specimens were mounted with periodontal ligament simulation and loaded axially to fracture using a universal testing machine at 1 mm/min. Maximum fracture strength was recorded in Newtons. Fracture patterns were examined under 3× magnification and classified as favourable (Types 1-2) or unfavourable (Types 3-4). Differences among groups were analysed using one-way ANOVA with Games-Howell post-hoc tests at the significant level of 0.05.

Results: The control group showed the highest mean fracture strength (1265.7 N), followed by occlusal (846.1 N), MO (685.8 N), and MOD restorations (474.1 N). ANOVA revealed significant differences among all groups ($p < 0.001$). Favourable fracture types predominated in intact and occlusal groups, whereas MO and MOD restorations showed substantially higher proportions of unfavourable Type 3 and Type 4 fractures. The MOD group exhibited the most catastrophic failures, with nearly half classified as a Type 4 failure.

Conclusions: Cavity configuration significantly influenced both fracture strength and fracture pattern of restored root-filled maxillary premolars. Preserving marginal ridges produced higher strength and more favourable fracture patterns. Further laboratory and clinical studies are warranted to optimise the management of structurally compromised premolars.

Keywords: composite resin, dental cavity preparation, dental restoration, endodontics, tooth fractures