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# Interfacial fracture toughness between resin-modified glass ionomer and dentin using three different surface treatments

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**Summary** *Objectives*. To identify the long-term dentin–resin modified glass ionomer cement (RMGIC) interfacial fracture toughness (FT) using three different dentin surface treatments prior to RMGIC placement. Fuji II LC (GC America) was bonded to dentin using cavity conditioner (CC), Scotchbond Multipurpose (3M ESPE) complete system (SS), or Scotchbond etching and priming without adhesive (SP). Twenty-four teeth were used for each of the three groups.

*Methods*. Two samples were obtained from each tooth and they were stored in artificial saliva (AS) or oil for 1- or 24-weeks before determining interfacial FT. The results were fit to Weibull distributions with log-rank and Wilcoxon tests for comparison of failure curves over time for each experimental condition. Statistical analysis was performed at a 0.05 level of significance.

*Results*. FT values in artificial saliva were as follows: 1 week SS = SP > CC, 6 months SS > SP = CC; in oil SS = SP = CC for both storage times. A significant decline in FT occurred between 1- and 24-week storage for SS and SP. Storage in oil, on the other hand tended to increase FT values for all groups.

*Significance*. These observations support findings of hydrolytic degradation in adhesive resin-based surface treatments.


## Introduction

Resin-modified glass ionomer cements (RMGIC) were introduced at the begining of the 1990s as a restorative material with superior physical properties and ease of clinical usage relative to conventional glass ionomer cements (GIC). Research continues on characterization and optimization of adhesion between RMGIC/GIC and tooth structure. The mixture of hydrophilic methacrylate resin with GIC improved not only the mechanical properties

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and esthetics [1] but also permitted the possibility of bonding to dental structures with traditional dental adhesives systems intended for resin-based composite [2]. Tam et al. [3] concluded that an intermediary dentin bonding agent increased the interfacial fracture resistance of RMGIC to dentin.

As the acid–base reaction proceeds in GIC and RMGIC the material matures and peak physical properties are obtained between 8 days and 6 months [4–7]. Storage of RMGIC in neutral aqueous-based media has demonstrated swelling and decrease in mechanical properties [8]. The effect of storage media and time on a RMGIC varies depending on the commercial brand [9].

Resin-based adhesives have also demonstrated a decrease in bond strength when stored in an aqueous-based media, probably due to hydrolitic degradation of the polymer matrix [10]. In both cases, RMGIC and resin-based adhesives, the presence of water seems to be closely related to the deterioration of bond strength.

Mechanical testing of resin adhesive–dental tissue interface is most commonly performed with strength-based approaches, e.g. shear bond strength, tensile bond strength, and microtensile bond strength. In such tests a nonuniform interfacial stress distribution exists [11,12]. GIC and RMGIC most commonly fail cohesively when tested using these traditional bond strength test methods [13–15] and the results obtained may not truly describe the nature of the interface. Versluis [16] suggested that a more valid method would be one that represents the true localized effort of debonding and that such a method requires the use of fracture mechanics. A method that studies the failure of an interface by the initiation and growth of a single, large, dominant crack, such as the fracture toughness (FT) test [17], would be more appropriate for testing the relatively brittle RMGIC–dentin interface.

The objectives of this research were to determine the 1-week and 6-month FT between a RMGIC and dentin preconditioned with three different surface treatments and to investigate the effect of storing the samples in either artificial saliva or inert oil (non water-based media). The three dentin surface treatments used were: (1) polyacrylic acid conditioning, (2) phosphoric acid etch and dentin primer, and (3) phosphoric acid etch, prime and adhesive.

## Materials and methods

Seventy-two human teeth extracted within 1 month of the experiment were cleaned of debris and mounted in stone blocks (Fig. 1A). A flat, superficial, occlusal dentin surface was exposed using 400- and 600-grit SiC papers under water irrigation (Fig. 1B) and the teeth were randomly divided into three groups. A different surface treatment was applied to each group as follows:

1. 20% polyacrylic acid/3% aluminum chloride (Cavity Conditioner, GC America) for 10 s, rinsed for 20 s, gently dried to leave a moist surface (CC)
2. 35% phosphoric acid for 15 s, rinsed for 20 s, lightly dried to leave a moist surface, apply primer (Scotchbond-Multipurpose system, 3M-ESPE) for 5 s and dry to leave a shiny surface,

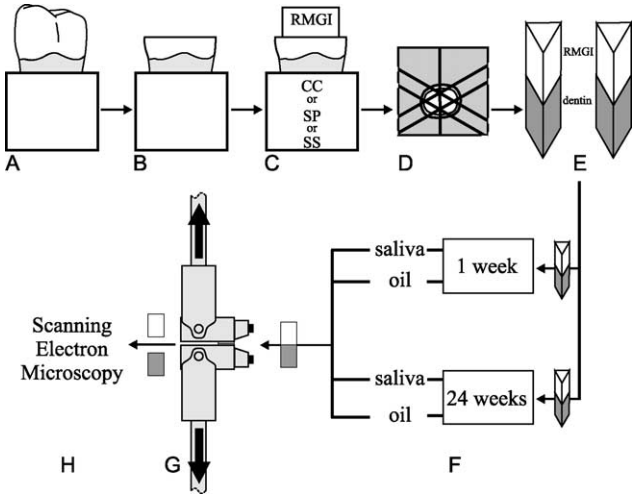


**Figure 1** Schematic representation of the preparation of the resin-modified glass ionomer–dentin notchless triangular specimens for measuring interfacial fracture toughness testing in the modified Ruse fixtures.