Influence of Resin Cements and Aging on the Fracture Resistance of IPS e.max Press Posterior Crowns

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The purpose of this study was to evaluate the effect of different adhesive cements and thermocycling on the fracture resistance of IPS e.max Press posterior single crowns. Thirty-two sound maxillary molars were subjected to standardized preparation and received IPS e.max Press crowns. Another 16 molars were left unprepared to serve as controls (group 1). Panavia F 2.0 and Rely X Unicem luting cements were used to bond the fabricated crowns (n = 16 each) to their respective prepared teeth. Eight specimens from each of the three groups were selected randomly for further thermocycling (5,000 cycles). All specimens were then subjected to fracture resistance testing using anatomical metal attachments fixed to the upper portion of the universal testing machine (1 mm/min). Data were analyzed statistically using two-way analysis of variance and the Student *t* test ($\alpha = .05$). Natural teeth presented significantly higher (1,043 and 1,279 N) fracture resistance than that of adhesively cemented ceramic crowns (907 to 986 N) before and after thermocyling, respectively ($P < .05$). Cement type did not significantly affect fracture resistance results (986 N and 974 N for Panavia F 2.0 and Rely X Unicem, respectively; $P > .05$). Thermocycled specimens showed lower fracture resistance than that of nonthermocycled ones ($P < .05$). Neither conventional adhesive cement nor self-etching adhesive cement affected the fracture resistance of IPS e.max crowns. Thermocycling decreased the fracture strength of the crowns in both cement groups. Natural teeth fractured at significantly higher loads than the ceramic crowns. *Int J Prosthodont 2012;25:33–35.*

Adhesive cementation increases the clinical success of glass matrix ceramics.[1] Self-etching cements do not require conditioning of the dentin or ceramic surfaces. Such cements have multifunctional phosphoric acid dimethacrylate–modified monomers.[2] However, their diffusion level into dentin and their hydrolytic stability are not optimal.[2] Thus, lower fracture strength of the ceramic crowns could be anticipated with such cements compared to those that involve dentin conditioning. The objectives of this study were to evaluate the effects of two resin cements before and after aging conditions on the fracture resistance of glass-ceramic posterior crowns. The tested hypotheses were that use of self-etching cements would result in lower fracture resistance for glass-ceramic crowns and that thermocycling would decrease the results.

Materials and Methods

Caries-free human maxillary first molars (N = 48) of similar size were randomly divided into three groups (n = 16) (Table 1). Descriptions of the materials used are presented in Table 2.

Before being embedded in resin, the roots of the teeth were coated with a 0.25-mm-thick layer of low-viscosity silicone rubber (Imprint II, 3M ESPE) to represent the periodontal ligament. Molars in groups 2 and 3 were subjected to standardized preparations using a water-cooled cross-slide carbide insert running at 400 rpm on a lathe cutting machine (AB Wood Machine Tools, SGia M/C). The prepared teeth were

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Table 1 Distribution of Experimental Groups

Group 1 (control, n = 16)	Unprepared molars
Subgroup 1 (n = 8)	Thermocycling
Subgroup 2 (n = 8)	No thermocycling
Group 2 (n = 16)	Molars prepared for IPS e.max crowns cemented with Panavia F 2.0
Subgroup 1 (n = 8)	Thermocycling
Subgroup 2 (n = 8)	No thermocycling
Group 3 (n = 16)	Molars prepared for IPS e.max crowns cemented with Rely X Unicem
Subgroup 1 (n = 8)	Thermocycling
Subgroup 2 (n = 8)	No thermocycling

Table 2 Brands, Compositions, and Manufacturers of the Materials Used

Material	Composition	Manufacturer
IPS e.max Press	Lithium disilicate–reinforced pressable glass-ceramic	Ivoclar Vivadent
IPS e.max Ceram	Fluoroapatite veneering ceramic	Ivoclar Vivadent
Panavia F 2.0	Primer A: HEMA, 10-MDP, 5-NMSA Primer B: 5-NMSA, water, sodium benzene MDP Paste A: BPEDMA/MDP/DMA Paste B: Al-Ba-B-Si glass/silica-containing composite	Kuraray Medical
Rely X Unicem	Powder: glass powder, silica, calcium hydroxide Liquid: methacrylated phosphoric ester, DMA	3M ESPE

HEMA = hydroxyethyl methacrylate; MDP = methacryloxydecyl dihydrogen phosphate; NMSA = salicylic acid monomer; BDEDMA = bisphenol-A-polyethyl dimethacrylate; DMA = dimethacrylate; Al = aluminum; Ba = barium; B = boron; Sl = silicon.

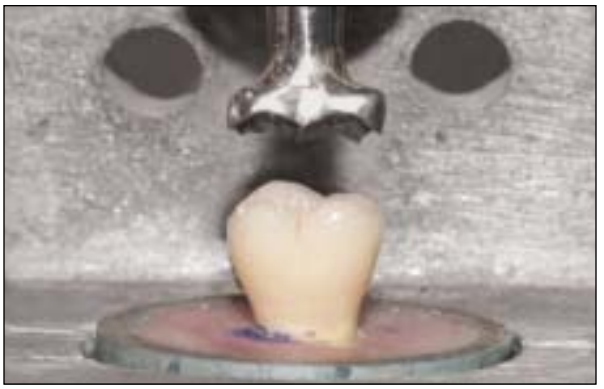

Fig 1 Anatomical metal attachment used to apply compressive loads to the cemented IPS e.max crowns.

4 mm in height and had a 10-degree occlusal taper and 1.2-mm circular shoulder finish line. Impressions were made from prepared teeth using a medium-viscosity polyvinyl siloxane impression material (Imprint II) and poured in type IV gypsum (Zeta Muffle, Acrostone). The prepared teeth were stored in distilled water (37°C ± 1°C) for 24 hours before cementation.

Full anatomical wax-ups were made for the crowns. Round wax sprues of 3-mm diameter were attached to each wax-up at approximately 45 degrees to the long axis before investing in Empress 2 speed investment material (Ivoclar Vivadent). The preheating cycle was carried out at 850°C for 60 minutes. The molds were then transferred to the furnace and press-filled with IPS e.max Press ingot material at 915°C for 20 minutes. After divesting and separation of the restoration, the tooth-colored copings were veneered with IPS e.max Ceram using the layering technique. Anatomy and thickness were controlled using a silicone key.

The axial surfaces of the teeth were coated with die-spacer (Tru-Fit) 0.5 mm above the finish line. The intaglio surfaces of the restorations were sandblasted (50-μm aluminum oxide particles, 1 bar; Reco Dental). In group 2, the tooth surfaces were cleaned using fluoride-free pumice, rinsed with water, and dried using a syringe filled with air. ED primers A and B were applied to the dentin surfaces. The crowns of group 3 were cemented to their respective teeth using Rely X Unicem.

Table 3 Mean Fracture Loads (N) of Experimental Groups With and Without Thermocycling

	Group 1		Group 2		Group 3			
	Mean	SD	Mean	SD	Mean	SD	F	*P*
Thermocycled	1,043	261	921	19	907	21	8.1	< .05
Not thermocycled	1,279	193	986	23	974	11	13.6	< .05

SD = standard deviation.

The crowns were seated under a 5-kg constant load for 10 minutes.[3] After removal of the excess cement, half of the specimens were thermocycled (5,000 cycles, 5ºC to 55ºC; dwell time: 60 seconds, transfer time: 12 seconds) and the other half were stored in distilled water (37°C ± 1ºC).

Specimens were loaded under compression in a universal testing machine (Type 500, Lloyd Instruments) until fracture using an anatomical metal structure representing the opposing contact (1 mm/min) (Fig 1). Since the occlusal anatomy of each crown varied slightly, the device used for applying the load in the universal testing machine was custom made for each specimen.

Results

A significant difference was found between the test groups ($P < .05$). Interaction terms were also significant ($P < .05$, two-way analysis of variance and Student *t* test). No significant difference was found between the mean fracture loads of groups 2 and 3 ($P > .05$) (Table 3). Thermocycling significantly decreased the fracture resistance independent of the resin cement used ($P < .05$). Specimens of groups 2 and 3 presented significantly lower fracture loads compared to unprepared teeth (group 1) before and after thermocycling ($P < .05$).

Discussion

Since cement type did not affect the fracture resistance of the ceramic crowns significantly, the first hypothesis was not accepted. It can therefore be stated that the adhesion was dominated by the macromechanical retention. In this study, the axial surfaces of the teeth were coated with only one coat of die-spacer 0.5 mm above the finish line. An increase in the amount of spacer used, however, could increase the cement thickness and cement volume accordingly. In this case, especially when cements with a lower modulus of elasticity are used, the strength within the adhesive joint could be lower.[3]

Thermocycling simulating aging of the adhesive joints in the crown-cement-dentin complex decreased the fracture resistance of the cemented crowns leading to acceptance of the second hypothesis.

The mean load at fracture was higher than the clinically anticipated maximum occlusal force (597 to 847 N).[4] Future studies should verify the results after cyclic loading.

Conclusions

- The cements tested did not affect the mean fracture resistance of IPS e.max Press posterior crowns.
- Thermocycling decreased the fracture resistance of IPS e.max Press crowns.
- Nonprepared teeth exhibited higher fracture resistance compared to that of the cemented crowns.

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