

Effect of Eugenol and Non-eugenol Containing Temporary Cement on Permanent Cement Retention and Microhardness of Cured Composite Resin

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This present study had three aims: 1) to evaluate the bond strengths of carboxylate and resin cements in cementing cast Co-Cr crowns to pretreatment of composite resin cores with eugenol and non-eugenol containing temporary cements, 2) to determine the microhardness of composite resin treated with temporary cement, 3) to view the surface differences of composite resin with SEM.

The composite cores were divided into three experimental groups for the following pretreatments: Group 1, No treatment was provided, Group 2, The external walls of the composite cores were covered with eugenol-containing temporary cement, Group 3, The external walls of the composite cores were covered with non-eugenol containing temporary cement.

Analysis of variance results showed that there was a significant difference between all three groups. Temporary cement with eugenol was significantly reduced the bond strength of full crown casting with resin cement compared with non-eugenol.

The resin specimens treated with the eugenol-containing temporary cement showed the lowest microhardness values, the non-eugenol-containing temporary cement was not significantly different from those of the control groups.

Key words : Temporary cements, Composite resin, Bond strength

INTRODUCTION

Composite resins are commonly used for cores for both vital and nonvital teeth. Their properties allow the completion of a core in one visit. Compared with other restorative methods, this means a reduction in chair time and hence a substantial saving to the dentist and patient¹⁾.

Provisional and permanent crowns and fixed partial dentures are commonly cemented with eugenol-containing temporary cements²⁾. Eugenol is known to be incompatible with resin polymers. It has been shown that eugenol-containing bases and liners partially inhibit the polymerization of freshly mixed composite resin restorations and that there is a softening of the resin surface adjacent to the eugenol liners^{3–5)}. This phenomena raises the question of whether cured composite resins are immune to effects of eugenol such a question is relevant since an adverse effect by eugenol may require different handling of temporary crowns over composites resin cores⁶⁾. Application of eugenol-containing cement to cured composite resin cores before final cementation with resin cement significantly reduced retention of the

crowns⁷⁾. The compatibility of different dental materials root canal sealer and composite core build-up restorative is an important factor for a successful restoration⁸⁾.

This study had three aims; 1) to evaluate the bond strengths of carboxylate and resin cements in cementing cast Co-Cr crowns to pretreatment of composite resin cores with eugenol and non-eugenol containing temporary cements, 2) to determine the microhardness of composite resin treated with eugenol and a non-eugenol containing temporary cement, 3) to examine the surface differences of composite resin with SEM.

MATERIALS AND METHODS

Bond strength

Maxillary first premolar teeth prepared as a core form and this sample used as a master model. Using this master model a mould prepared with elastomeric impression material (Speedex putty and light body, Coltene, Altsötten, Sweden). The mould filled with Dynamic universal composite resin (President, Dynamic Universal Hybrit Composite, Munich, Germany) to produce the cores and total 60 core forms were made. Co-Cr (Wironit, Bego, Bremen, Germany, Co: 64.0, Cr: 28.65, Mo: 5.0, C: max. 0.35, Si, Mn: 0.5) full crown casting made to fit a standard maxillary first premolar crown preparation were prepared. A simple wax pattern with a loop attached to the occlusal surface of crowns. The cast samples produces by the lost-wax technique in a centrifugal, induction-heated casting machine (Rotaks Dent. Diş Tic. AŞ. Beyoğlu/Istanbul) according to the manufacturer's instructions.

Before cementation the composite cores were divided into three experimental groups for the following pretreatments,

Group 1, No treatment was provided (control group)

Group 2, The external walls of the composite resin cores were covered with eugenol-containing temporary cement (Temp-Bond, Kerr Co., Salerno, Italia)

Group 3, The external walls of the composite cores were covered with non-eugenol containing temporary cement (Provilat (eugenol-free), Promedica, Neumunster, Germany).

Temporary cement prepared at an ambient temperature of 18°C to 23°C and relative humidity of 45 to 55%. Two equal lengths of paste and catalyst were mixed using a metal spatula to thoroughly mix the paste for 30 sec until a homogenous consistency was achieved. After application of the temporary cement the composite cores were stored in distilled water at 37°C and 100% humidity for 10 days. After the 10 days, the specimens removed this environment. The temporary cements were mechanically removed using a hand instrument. Then 30 specimens were cemented with carboxylate cement (Durelon Espe, 3M ESPE AG, Seefeld, Germany); another 30 specimens were cemented with resin cement (Duo-cement kit, Coltene, Altsötten, Sweden). Equal amounts of base and catalyst paste were mixed following the manufacturer's instructions and applied to the core and the samples were held together with firm finger pressure for 5 min until setting was complete. This procedure was

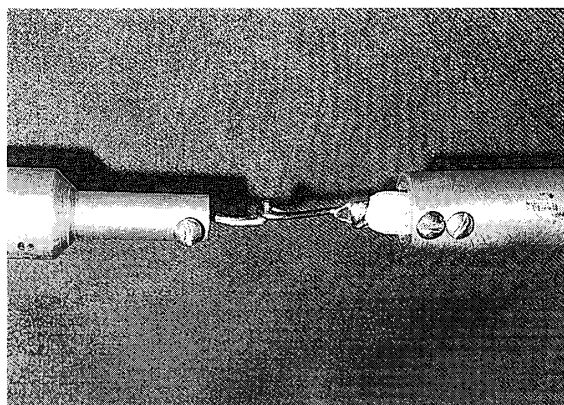


Fig.1 Separation force applied for test specimens.

repeated for carboxylate cement.

These samples were stored in distilled water at 37°C and 100% humidity for 10 days. After storage the bond strength was measured using a press and pull machine (Haunsfield Test equipment company, Croydon, England) in tensile mode at a cross-head speed of 5 mm/min (Fig.1).

Evaluation of microhardness

Thirty fiberglass moulds (internal diameter 5 mm, height 2 mm) were made and placed on a flat glass plate. Moulds were filled with resin composite light cure, according to the manufacturer's directions for use. Each specimen was polymerized for 60 sec. (Translux EC, Kulzer, Wehrheim, Germany). After setting, the specimens were removed from the mould and randomly divided into three experimental groups (n=10).

After application of the cements the resin composite specimens and control group were stored at 37°C and 100% humidity for 10 days. The specimens were removed from this environment. The temporary cements were removed mechanically using a hand instrument.

The Vickers surface hardness was measured with a microhardness tester (Micromet 1600-4980T, Buehler GmbH, Dusseldorf, Germany). A diamond pyramid surface indenter was used with a load of 25 kg for 15-sec. The Vickers hardness was obtained using the following formula.

$$VH = 1.854P/d^2$$

(P=applied load in kg, d=average length of the measured diagonals in mm). Three measurements were made on each specimen and the mean was recorded for the three readings.

Following data collection, the SPSS (10:0) statistical software program was used for statistical evaluation. The mean values, standard deviations of the bond strength and microhardness were calculated. The results were compared statistically

using the one-way analysis of variance test. Duncan's post hoc test was used to determine the group mean differences, when significant differences were noted.

Evaluation of SEM

After the microhardness evaluation, all surfaces were coated with palladium-gold and viewed using a scanning electron microscope (SEM)(JSM 6400, JEOL, Tokyo, Japan).

RESULTS

Mean bond strengths were calculated (Table 1). The results were compared statistically using an analysis of variance to compare the two luting cements and three pretreatment groups. Significant differences ($p < 0.001$) were found among the groups. This was followed by Duncan's post hoc test, when a significant difference was noted in the analysis of variance (Table 2). The resin cores pretreated with eugenol-containing temporary cement and cemented with resin cement clearly had lower bond strength values than the other groups (16.0 N). In the control group, the resin cements produced the highest bond strength value (200.0 N). Between the carboxylate cements in the control group (46.0 N) and pretreatment non-eugenol groups (58.0 N) no significant difference was found.

Table 3 presents the Vickers microhardness values for the three groups. The

Table 1 The means and standard deviations of bond strength values

Group	Mean (N)	Std. Dev.	min.	max.
Resin cement & eugenol containing temporary cements	16.0	5.16	10.0	20.0
Resin cement & non-eugenol containing temporary cements	67.0	10.59	50.0	80.0
Resin cement; Control	200.0	66.50	130.0	310.0
Polycarboxylate cement & eugenol containing temporary cements	28.0	12.29	20.0	50.0
Polycarboxylate cement & non-eugenol containing temporary cements	58.0	10.32	50.0	70.0
Polycarboxylate cement; Control	46.0	17.12	30.0	90.0

Table 2 Duncan's test results for the resin cement and carboxylate cement bond strengths

Resin cement	N	1	2	3	Carboxylate cements	N	1	2
Temp-Bond (eugenol)	10	16.0				10	28.0	
Provilat (non-eugenol)	10		67.0			10		58.0
Control	10			200.0		10		46.0
Sig.		1.000	1.000	1.000			1.000	0.058

$\alpha : 0.05$

Table 3 Vickers surface microhardness values for the test groups

Group	N	min.	max.	Mean	Std. Dev.
Temp-Bond (eugenol)	10	13.24	23.76	17.58	3.28
Provilat (non-eugenol)	10	20.26	30.15	27.43	3.30
Control	10	18.54	44.80	32.49	8.66

Table 4 Duncan's test results for the microhardness value

Group	N	1	2
Temp-Bond (eugenol)	10	17.58	
Provilat (non-eugenol)	10		27.43
Control	10		32.49
Sig.		1.000	0.056

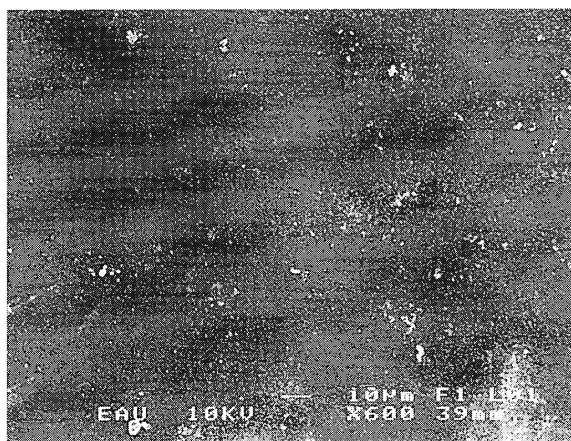


Fig. 2 Scanning electron micrograph of the control group.



Fig. 3 Scanning electron micrograph of composite resin sample pretreated with eugenol containing cement.

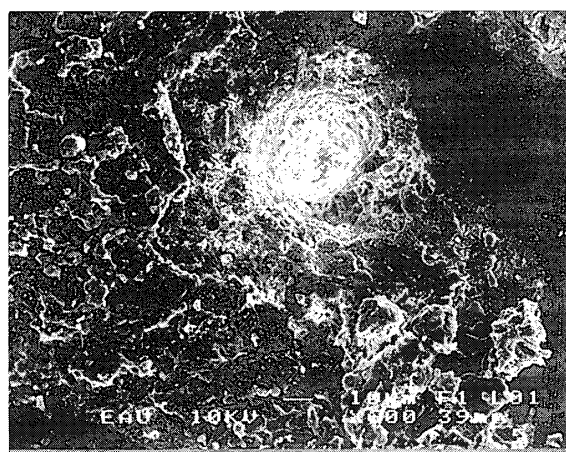


Fig. 4 Scanning electron micrograph of composite resin sample pretreated with non-eugenol containing cement.

highest microhardness values were observed for the control group. According to the analysis of variance results, there was a significant difference among the three groups ($p < 0.001$). Resin specimens treated with the eugenol-containing temporary cement showed the lowest microhardness value than the other groups. Table 4 showed Duncan's post hoc test.

Figs. 2 to 4 show SEM photomicrographs of the composite resin samples. The

control group showed a smooth surface compared with the other sample micrographs (Fig. 2). The eugenol treated sample is shown in Fig. 3. The surface displays an abraded appearance noticeably different from the control group surface. In the non-eugenol group, the filler particles were less visible and the porosities in the resin were filled with temporary cement (Fig. 4).

DISCUSSION

Eugenol is a phenol derivative used in combination with zinc oxide as pulp capping agents, temporary cement and root canal filling cement. Eugenol reacts with free radicals, thereby inhibiting the polymerization of methacrylate monomers. Thus, it is incompatible with the resin restorative system³⁾.

Benzoyl peroxide (BPO) is widely used as an indicator of the resin system in dentistry. BPO induces decomposition in the initiation of polymerization of methacrylate and its free radicals kinetics first and second order processes⁹⁾. BPO decomposes very rapidly in the presence of phenol derivatives, when they were investigated as solvents for BPO decomposition at 60-80°C¹⁰⁾. Phenol derivatives such as eugenol are chain-breaking and radical destroyers¹¹⁾.

Fujisawa and Kadoma¹²⁾ suggested that eugenol acts as a retarder against the polymerization of the resin system, when excess eugenol interacts with BPO and its related compounds.

Composite resins were studied both as material for the post-core itself and for the cementing agents^{7,13,14)}. Many studies reported on the bonding properties of eugenol cements with resin composite^{7,13,15-20)}. Yap *et al.*²¹⁾ demonstrated that eugenol-containing temporary cements had significantly lower bond strengths of composite to dentine. The present research showed that resin cement exhibits stronger bond strengths to composite resin cores than does carboxylate cement in the control group. The resin cores pretreated with eugenol-containing temporary cement and cemented with resin cement showed the lower bond strength values than the non-eugenol-containing temporary cement group.

Millstein and Nathanson⁶⁾ reported that eugenol and eugenol-containing cements can alter the surface of cured composite resin. They also stated that this might be due to the combined effects of eugenol, the adhesive properties of temporary cements, and the rubbing action required to remove the cement. The incomplete removal of temporary cement from a cured composite resin core may affect the quality of cementation of the final restoration.

Millstein and Nathanson⁷⁾ also compared the effects on retention of base metal cylindrical retainers placed on composite resin cores when pretreated with eugenol and non-eugenol temporary cements. They showed that the application of eugenol-containing cement to cured composite resin cores before final cementation with resin cement significantly reduced retention of the crowns. Cohen *et al.*⁸⁾ stated that if the eugenol directly contacts before curing the composite resin, they do not achieve a full cure or hardness. In the present study evaluated the effect of contact with eugenol

containing cement on cured composite resin was evaluated.

The combinations of resin core and resin cement produced bond strength values two to three fold greater than bond strength produced by polycarboxylate cement. It is possible that a chemical bond occurred between the resins cement and the resin core, enhancing bond strength⁷⁾.

Various studies investigated changes in the bond strengths and surface hardness of resin composites in different storage media^{15,16,22,23)}. Gregory and Campbell²⁴⁾ stated that the surface hardness of current conventional and hybrid composite resin was adversely affected by exposure to temporary luting agents compared with controls. The temporary cements invariably failed at the interim acrylic crown interface while the zinc phosphate cement failed at the core interface. The use of $\text{Ca}(\text{OH})_2$, as an temporary luting agent for acrylic crowns over hybrid cores compared with eugenol or non-eugenol containing temporary cements, should afford significantly greater bond strength with no adverse effect on the bond strength of the final casting.

SEM micrograph showed that eugenol containing temporary cement can alter the surface of cured composite resin. Mechanical abrasion and softened rough surfaces were observed. Control group exhibited smoother surface. The treated surface was significantly rougher than the control group. The findings of present study showed that eugenol containing temporary cement affected the surface hardness of a resin composite. The surface hardness of resin composite was significantly reduced by eugenol-containing cement. A softening was observed in the eugenol containing cement and this result was significantly different compared with the non-eugenol containing cement groups.

CONCLUSIONS

One limitation of this study was that bond strength was greatly reduced when composite core samples were pretreated with eugenol-containing temporary cement. In control groups the resin cements produced the highest bond strength value. In this study, it was suggested that eugenol-containing cements can alter the surface of cured composite resin, and this alteration affects the success of the final restoration.

The results of the present study showed that the eugenol containing temporary cements affected the surface hardness of composite resin. The resin surface was softened by eugenol containing temporary cement. The resin specimens pretreated with the eugenol containing temporary cement showed the lowest microhardness values. Although the porous surface of treated surfaces varied from sample to sample, all control surfaces appeared to be smooth and unaffected in SEMs.

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