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The Effects of Different Metal Surface Treatments on Marginal Microleakage in Resin-Bonded Restorations

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Abstract: Margins are one of the most important aspects in the success of restorations. Therefore, we evaluated the effects of different metal surface treatments on the marginal microleakage of a resin-bonded non-precious alloy (Remanium CS).

After alloy surfaces were roughened by chemical etching or sandblasting the tooth and metal specimens were bonded together in pairs with a chemically curing resin cement

(Panavia 21 EX) and placed in methylene blue dye. Spectrophotometry was used to assess marginal leakage. Statistical analysis was completed using the ANOVA test. No statistically significant difference in leakage was found between the groups ($F=0.4387$, $p>0.05$).

Key Words: Marginal microleakage, resin-bonded restorations, resin cements.

Introduction

Recent advances in adhesive restorative dentistry, particularly adhesion to both tooth and metal, have prompted interest in luting agents for resin-bonded prostheses. Restorations using cast metal resin-bonded retainers have become increasingly popular and are recommended for a variety of clinical conditions (1).

Since the introduction of resin-bonded bridge constructions into clinical dentistry, this concept has gained widespread use due to the greater simplicity of the clinical and laboratory work procedures compared with conventional bridge work, and due to its economical advantages, especially when non-precious alloys based on Ni, Cr, Co, and Be are used (2, 3).

To simplify the technique for making resin-bonded restorations, a number of less complicated methods have been introduced. Etching cast metal by means of chemical etchants is one method. This technique is simple and gives uniform results (4).

The aim of the present study was to investigate three methods for the creation of surface irregularities in a base-metal alloy for resin-bonded bridge work, namely, sandblasting, sandblasting and chemical surface etching (acid etching) alone, and chemical etching alone, in order to test their ability for marginal microleakage after being bonded with resin composite cement.

Materials and Methods

Sixty human permanent mandibular molars which had been extracted because of periodontal problems were used. Teeth with gross caries or fractures were excluded from the study. Following extraction, the teeth were stored in 10% Formalin solution. The coronal portion of each tooth was prepared and a flat surface perpendicular to the long axis of the tooth was obtained. Sixty non-precious alloy metal discs (Remanium CS, Pforzheim-Germany) were casted (Figure 1).

Casting was done at a commercial technical laboratory according to the instructions of the alloy manufacturing company. The thickness of the metal discs was 1 mm and the shapes were suitable for teeth. All metal samples were subjected to a simulated sham porcelain firing four times by heating to a temperature of 940°C in a porcelain vacuum furnace. The casted discs were divided into three groups of twenty each.

In Group A, casted metal discs were sandblasted with 50 micron alumina particles on 60-100 psi and cleaned with distilled water in an ultrasonic bath for 10 minutes.

In group B, casted metal discs were sandblasted with 50 micron alumina particles and then cleaned with distilled water in an ultrasonic bath for 10 minutes. Cleaned discs were air-dried and then etched by immersion in a mixture of a 50% conc. of HNO_3 and a



Figure 1. Casted metal discs.

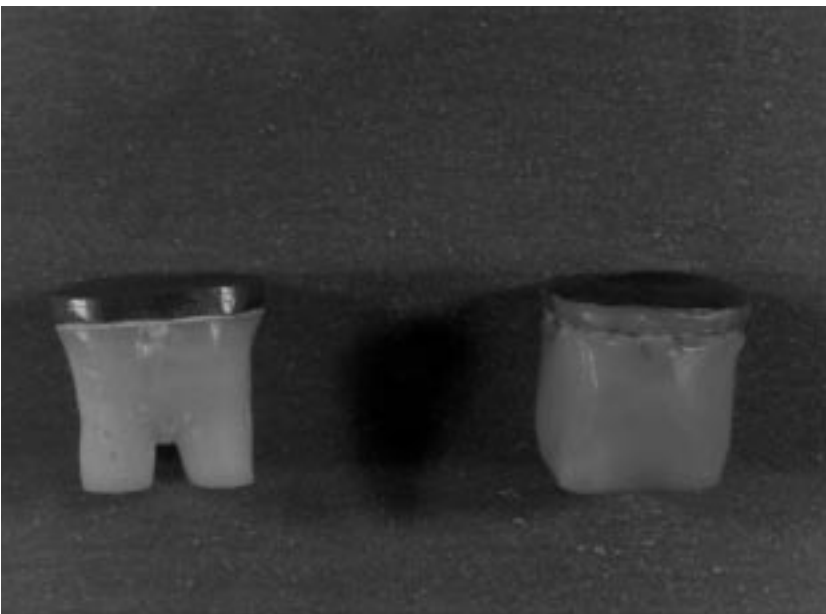


Figure 2. Metal disc and tooth sample bonded with Panavia 21 EX (left) and sample covered with wax (right).

50% conc. of HCl for two minutes and then cleaned with distilled water in an ultrasonic bath for 10 minutes.

In Group C, metal discs were etched by immersion in a mixture of a 50% conc. of HNO_3 and a 50% conc. of HCl for two minutes without sandblasting, and cleaned in an ultrasonic bath in a similar manner.

In all groups, the metal discs and teeth were bonded together in pairs by means of an adhesive resin cement (Panavia 21 EX, Kuraray Co., Ltd., Osaka-Japan) (Figure 2). During bonding, a force of 2 kg/cm^2 was applied so

that the samples would stay together. Excess Panavia 21 EX paste was removed with a brush tip and oxyguard II was applied to all restoration margins. After cementation, and 10 min. after the start of the resin being mixed, the specimens were stored in a moist state at a temperature of 37°C . Prior to the testing of microleakage, all specimens were subjected to 1000 thermal cycles between 5°C and 60°C (5). The dwell time at each temperature was 60 seconds (6).

The entire root surfaces of the teeth and metal discs were covered with a layer of wax so that only the



Figure 3. Spectrophotometer instrument.

restorations with a one millimeter peripheral margin of tooth remained exposed (Figure 2).

Then the teeth were submerged in 2% methylene blue dye solution for 15 days in individual glass vials. After removal from the dye, all the teeth were air-dried. The specimens were lightly polished with a bur to remove superficial staining. Then the teeth were dissolved in 50% nitric acid in individual glass vials. The test solutions were then spectrophotometrically (Shimadzu, UV-160 A Recording Spectrophotometer, Tokyo-Japan) analyzed for marginal leakage (Figure 3). Statistical analysis was completed by the one way analysis of variance test (ANOVA).

Table 1. Mean, standard error and standard deviation values of the groups.

GROUPS	A	B	C
	Sandblasted	Sandblasted and Acid Etched	Acid Etched
Mean	2.29	2.07	2.51
Standard Error	0.37	0.27	0.36
Standard Deviation	1.64	1.22	1.62

Results

The results of the marginal microleakage (Absorbance) are shown in the Table 1.

The significances between the groups are shown in Table 2.

Table 2. The significance between the groups.

GROUPS COMPARED	SIGNIFICANCE
Between A and B	not significant
Between A and C	not significant
Between B and C	not significant

ANOVA (F=0.4387, p>0.05)

According to the statistical test, the differences between the groups are not significant (p>0.05).

Discussion

The importance of gap formation and microleakage has been clearly established but the exact amount that becomes clinically significant remains undefined. Other factors in the selection of a dental luting agent include biocompatibility, acidity, antimicrobial activity, solubility,

film thickness, viscosity, hardness, tensile, shear and compressive strengths, elastic modulus, strength of bond to tooth and restoration, ease of manipulation, setting time, thermal and electrical conductivity, and dimensional stability. The choice of luting agent should be based on appropriate criteria for a specific clinical situation (4).

Tjan et al. (8) have evaluated and compared the marginal leakage of cast gold complete crowns group cemented with Panavia EX cement with the other group cemented with a standard zinc phosphate cement. Crowns cemented with Panavia EX cement exhibited substantially less marginal leakage than the other group and no dye penetration was observed at the microblasted metal-cement interfaces of crowns.

In this study, Panavia 21 EX was used as a luting material because of its superior mechanical properties and high bonding affinity to tooth structure (enamel and dentin), metals, silanated porcelain and cured composite resin (9-14).

The SEM observations revealed that for both Ni-Cr and Co-Cr alloys, surface properties with a presumably high bonding potential to composite luting materials can be obtained by sandblasting and/or chemical etching of the metal surface for a few minutes. Prolongation of the etching period did not affect these patterns qualitatively and may, on the other hand, compromise the physical properties of the alloy (2). Furthermore, the SEM observations of the sand-blasted specimens revealed a surface structure that presumably also gives rise to a mechanically induced retention, with the assumption that adhesion is the most important part of the retention mechanism (2, 12).

In our study, chemical etching treatment was applied for a short time and it was observed that chemical etching treatment was as effective as sandblasting. At the same time, the metal surfaces were found to have a structure which provides bonding to the luting material and minimal marginal microleakage.

In group B, both sandblasting and chemical etching treatments were used. The results obtained were not statistically significant ($p>0.05$), and using both treatments is not advantageous for marginal microleakage.

Conclusions

In our study, no statistically significant difference in leakage was found between the groups ($F=0.4387$, $p>0.05$). Therefore,

I) The findings of this study seemed to suggest that sandblasting and/or acid etching (chemical etching) are adequate to prevent microleakage and have the same effect.

II) It was observed that the sandblasting method is simpler and easier than the acid etching method.

III) The chemical etching period should not be long in the treatment of the metal surfaces with acids.

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