THE EFFECT OF SURFACE TREATMENTS ON THE REBONDED RESIN-BONDED RETAINERS

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The resin : metal interface is at the basis of most bonding failures in resin-bonded prosthesis. Although debonding has been a problem with adhesive fixed partial dentures, various dentists classify them as long-term restorations. The advantages of resin-bonded fixed partial dentures include minimal tooth reduction and the possibility of rebonding . if resin-bonded protheses can be easily rebounded, it is of clinical importance to know if the lutingagents rebond as well the second time as they did originally.
Several retentive systems for resin-to-metal bonding have recommended. Treatments such as electrolytic etching and silicone coating, despite the good result of bond strength, have proved to be time-consuming and technique-sensitive. Therefore a simple and more reliable method is desirable. This study evaluated the effect of metal surface treatments on the rebond strength of panavia 21cement to a nickel-chromium(Ni-Cr) alloy. The samples were received the following surface treatments : Group No.1(control or served as the control) treatment with sandblasting with 50um aluminum oxide and ultrasonically cleaned for 10minutes in double-deionized water, Group No.2 were no surface treatments. Group No.3 were treated with metal primer. Group No.4 were treated with sandblasting as previously described, and then metal priming. From the analysis of the results, the following conclusions were drawn:

1. Sandblasting and metal priming appears to be an effective method for treatment of metal after accidental debonding.
2. Group without surface treatment had significantly lower bond strengths compared with other groups
3. The combination of sandblasting and metal priming may not develop superior bonding strengths compared with other techniques that used the Ni-Cr alloys.
4. Combination of cohesive and adhesive failures were the most common type observed.

The results support the use of sandblasting as a viable procedure when rebonding accidentally lost adhesive partial denture. We concluded that sandblsting and metal priming of metal surface before bonding could provide the adequate bond strength during rebonding of resin-bonded fixed partial denture.

Key word
Resin-bonded prothesis, Surface treatment, Sandblasting, Metal primer

Since etched cast resin-bonded metal restorations were introduced at the Dental School of the University of Maryland at Baltimore in 1980, they increasingly are being used as alternatives to conventional fixed partial denture.

The advantages of resin-bonded fixed partial dentures include minimal tooth reduction and the possibility of rebonding.[1] Also Kerschbaum et al.[2] showed no signs of greater caries incidence after multiple recementation procedures.

Although debonding has been a problem with adhesive fixed partial dentures, many dentists classify them as long-term restorations.[3,4] However, The resin/metal interface is at the basis of most bonding failures in resin-bonded prosthesis.[5]

If resin-bonded prosthesis can be easily rebonded, it is of clinical importance to know how to increase the strength of metal to resin bonding.

Resin luting agents have contributed to their acceptance as fixed restorations.[6,7] Several retentive systems for resin-to-metal bonding have recommended.[8-14] Treatments such as electrolytic etching and silicone coating, despite the good result of bond strength, have proved to be time-consuming and technique-sensitive.[15-18] Therefore, a simple and more reliable method is desirable.

Various chemical adhesive systems are being reported for bonding base metal alloys.[19-24] They are composed of a variety of base monomers, fillers, initiator systems and adhesive functional monomers. Adhesive monomers are thought to play an important role for chemical bonding between resin-based luting agents and base metal alloys.[25] Metal primer(MEPS. methacryloyloxyalkyl thiophosphate derivative) is commercially available.

Surface treatment of the metal by sandblasting with Al_2O_3 particles(37~250㎛) has improved the effectiveness of the surface area of the metal and increased the composite resin-metal bond strengths. O'Connor et al.[26] have demonstrated that microblasting with 50㎛ alumina enhances the retention of luting agents to gold and base metal alloys.

This study evaluated the effect of metal surface treatments on the rebond strength of panavia 21 cement to a nickel-chromium(Ni-Cr) alloy.

MATERIALS AND METHODS

Preparation of metal specimens

To produce a standard circular test face(7mm diameter), fresh base metal alloy(verabond, Aalba Dent Inc., Concord, CA., USA., Ni-principal constituent, Cr-12~14%, Be-1.6~1.9%) was used.

The samples were machined on a lathe to assure a flat surface perpendicular to the long axis for tensile testing.

For initial bond study, all four groups were air abraded with 50㎛ aluminum oxide and ultrasonically cleaned for 10 minutes in double-deionized water.

The adhesive resin selected for this study was Panavia 21dental adhesive(Ku-raray Co., Ltd., Japan).

The four groups were luted with the panavia 21 resin, which was mixed according to the manufacturer's recommendations. The adhesive paste was placed on the metal. The metal was secured with finger pressure for 4 minutes to simulate clinical conditions and the excess paste was removed from the margins with a sharp-tipped brush. An anaerobic environment was provided by placing the Oxiguard gel over the margins of the metal-paste-metal unit while maintaining finger pressure for 4minutes. After the paste had set for 10 minutes from start of the mix, the Oxyguard gel was rinsed for 30seconds with deionized water.

The bonded samples were placed in deionized water at 37℃ for 7 days and thermocycled in

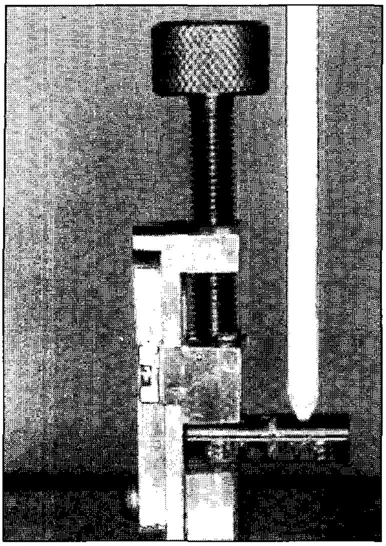

Fig. 1. Measurement of the shear bond strength of specimen.

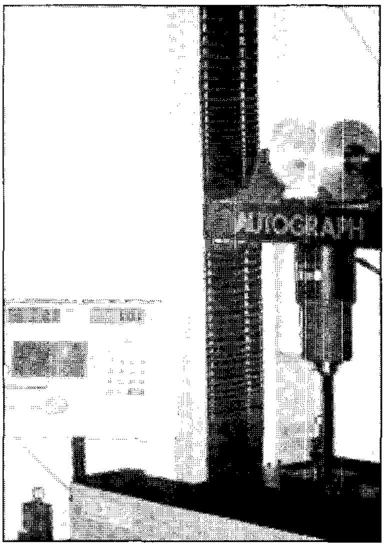

Fig. 2. Universal testing machine (AGS-1000D, Shimadzu, Japan).

Table Ⅰ. Group classification according to surface treatment.

	No. of Sample	Surface treatment
Group 1(control)	20	No treatment
Group 2	20	Sandblasting
Group 3	20	Metal primer
Group 4	20	Sandblasting + Metal primer

15℃ to 40℃ water baths for 500 cycles.

The samples were then debonded for tensile failure(Fig. 2). An universal testing machine (AGS-1000D Shimadzu, Japan, Fig. 1) at a crosshead speed of 2mm/min and 500kg load cell was used.

Surface treatment

All metals were cleaned of composite resin with green stone.

Metal primer(MEPS. methacryloyloxyalkylthiophosphate derivative) designed for conditioning group 3 and 4 base metal alloys were used. Metal primer was applied as a single liquid directly to the dental alloys with a brush for 15 seconds and then air-dried for 5 seconds.

For the rebond portion of the study, the samples were then arbitrarily dived into fore test groups of 20each and received the following surface treatments:

Group 1 (control or served as the control) were no surface treatment.

Group 2 were treated with sandblasting with 50㎛ aluminum oxide and ultrasonically cleaned for 10minutes in double-deionized water.

Group 3 were treated with metal primer.

Group 4 were treated with sandblasting as previously described, and then metal priming.

Shear bond strength testing

To prepare the samples for shear bond strength testing, two metal specimens with the treated surface were luted with the panavia 21resin, as directed in manufacture's recommendations.

The bonded samples were placed in deionized water at 37℃ for 7 days and thermocycled in 15℃ to 40℃ water baths for 500 cycles.

Shear bond strength was measured as previously described. Debonded surfaces were observed by means of a stereomicroscope(SZ-ST Olympus, Japan, Fig. 3) and the location of each failure was recorded as a cohesive failure within the luting agent, an adhesive failure at the resin-metal interface, or a combination of cohesive and adhesive failures.

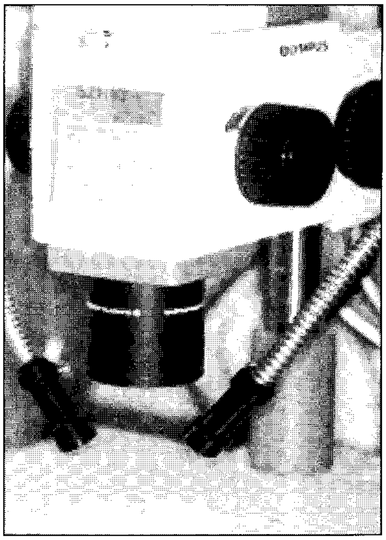

Fig. 3. Stereomicroscope (SZ-ST Olympus, Japan).

Statistical analysis

An one-way analysis of variance(ANOVA) was performed on the shear bond strengths of the four test groups to determine intergroup differences. If significant intergroup differences were detected, Duncan multiple comparisons analysis with $p<0.05$ was used to indicate significance among the four groups.

RESULTS

The means and standard deviations for all four groups are listed in Table Ⅱ.

The ANOVA results indicated that the bond

Table Ⅱ. The bond strengths according to the various surface treatments of metal alloys(unit; KgF).

	mean	standard deviation	No. of samples
group 1(control)	81.535	3.860	20
group 2	91.790	3.639	20
group 3	93.715	6.758	20
group 4	94.175	6.312	20

Table Ⅲ. One way analysis of variance among groups(ANOVA).

Source	Sum of Squares	df	Mean Squares	F	Sig.
Between Groups	2114.462	3	704.821	24.804*	.000
Within Groups	2159.607	76	28.416		
Total	4274.069	79			

*: Significant, $p<0.05$

Table Ⅳ. Results of Duncan's multiple range analysis

GROUP		No.	Mean	Duncan grouping
1(control)	No Treatment	20	81.535	A
2	Sandblasting	20	91.790	B
3	Primer	20	93.715	B
4	Sandblasting + Primer	20	94.175	B

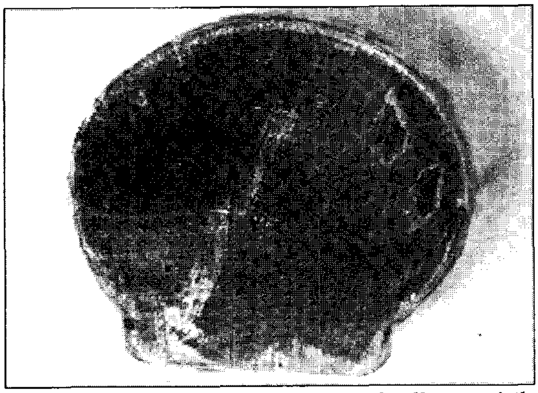

Fig. 4. Combination of cohesive and adhesive failures(× 2.5).

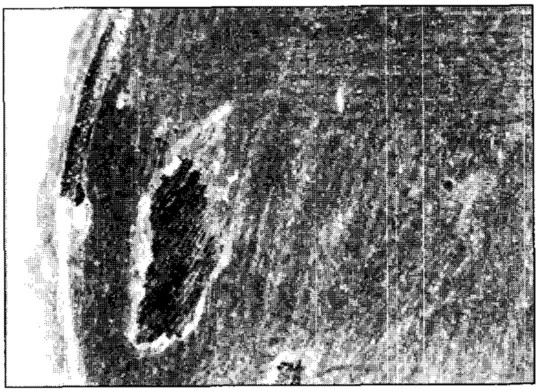

Fig. 5. Fragments of composite resin(× 7).

strengths were influenced by the primer, sandblasting, and their combinations(Table Ⅲ).

Groups 2, 3 and 4 were not statistically different among three groups after rebonding. But group 1 showed lower bond strength compared with other groups. The difference between group 1 and other groups indicates that the sandblasting and metal primer application was effective in elevating the bond strengths(Table Ⅳ).

Means with different letters are different at the 0.05 level of significance.

Evaluation and analysis of the tested specimens with the stereomicroscope showed that all groups exhibited a combination of cohesive and adhesive failures at the rebonding surface(Fig. 4). The views of the debonded metal base showed fragments of composite resin(Fig. 5).

DISCUSSION

This study used shear bond strength determination in combination with surface treatment. Shear testing is useful for evaluation of bond strength of prosthodontic adhesive systems because shearing load is frequently applied to fixed partial dentures in the oral environment.

This study showed clinical relevance in resin-bonded fixed partial denture. Other study have shown that five years after insertion 66.1%(± 3.7%) of originally inserted prostheses remained in place. If additional rebonding was computed, the probability of survival was 82.0%(±3.0%).[2]

Naifeh et al.[16], using a bovine tooth-resin-etched-metal system, determined that rebond strengths were significantly lower than initial bond strengths at the 0.05 level for all experimental groups tested. However, Jassem et al.[27], using extracted human central incisors and orthodontic bands, showed no significant difference in bond versus rebond tensile or shear strengths. These two studies, incomparison with this study, introduced a second interface(namely the tooth), so that more variables need to be controlled. Also the current study used matal-to-metal bonded specimens for evaluating the single effect of the metal-resin interface on the bond strength. This system is capable of eliminating other factors such as resin-to-dentin bond strength, which may affact the recorded metal-to-resin bond strength.[1] Williams et al.[28] reported that specimens rebonded with panavia resin showed a degradation of the bond strength. With increased failure rates after rebondings, the reason "unknown" predominated.[29]

Creugers et al.[30] reported that debond rate of rebonded fixed partial denture were only slightly higher than the original failure rates, and they were retained for many years.

Rebonding of resin-bonded fixed partial denture is only indicated if processing errors such as field control, surface conditioning, and so forth, are suspected.

However, if elastic deformation, misfit of the framework, or lack of retention is discovered after debonding, rebonding attempts will be unsuccessful. Therefore rebonding of resin-bonded fixed partial denture will be successful with appropriate patient selection.[2]

The sandblasting procedure was used, since this mode of attachment has been popular. Sandblasting is a simple, cheap and predictable method for the creation of a micromechanically retentive surface on the metal for the resin cement.[12,31]

In this study, also metal primer was in effective in improving the shear bond strength of composite resin bonded base metal alloy. The results support the use of sandblasting and metal priming as a viable procedure when rebonding accidentally lost adhesive partial denture. A combination of sandblasting and primer demonstrated the highest metal composite strength, but there was no statistically significant difference between the three groups with surface treatment.

Resin rebond specimens had mostly a combination of cohesive and adhesive failures(Fig. 4). Failure mode findings of this study are comparable to those of previous studies.[6,5,28] Watanabe et al.[5] reported no destruction of the panavia resin bond(cohesive failure). Atta et al.[6] reported cohesive failure through the adhesive layer for the panavia resin specimens. The difference of failure mode could be caused by the rebonding procedure.

CONCLUSION

From the analysis of the results, the following conclusions were drawn:

1. Sandblasting and metal priming appears to be an effective method for treatment of metal after accidental debonding.
2. Group without surface treatment had significantly lower bond strengths compared with other groups
3. The combination of sandblasting and metal priming may not develop superior bonding strengths compared with other techniques that used the Ni-Cr alloys.
4. Combination of cohesive and adhesive failures were the most common type observed.

It was concluded that sandblsting and metal priming of metal surface before bonding can provide the adequate bond strength during rebonding of resin-bonded fixed partial denture.

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