

## EFFECT OF ALKALINE VS ACID SURFACE TREATMENT ON BOND STRENGTH OF ADHESIVES USED FOR AMALGAM REPAIR

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### ABSTRACT

**Objective:** To assess the effect of alkaline versus acid surface treatment on bond strength of adhesives used for amalgam repair.

**Materials and Method:** Sixty cylindrical samples were prepared by condensing amalgam into plastic tubes of 4mm diameter and 10mm length. Tubes were filled up to 5.0mm with admixed amalgam. They were allowed to set hard for three months. The samples were divided into A1, A2 and A3. A1 and A2 had 25 samples each and A3 had 10 samples. Flat exposed surfaces of the samples in A1 were treated with 35% Phosphoric acid for 3 minutes. The samples in A2 were treated with 10% solution of Ca (OH)<sub>2</sub>. A dentine adhesive containing 4 – META, Amalgabond was applied on the treated surfaces. The adhesive-coated surfaces, with the help of a probe were pushed inside the tubes such that uncoated surfaces came in level with the margins of the tubes on the other end. Samples in A3 were not treated with acid or alkali and were kept as control group. Freshly mixed amalgam was packed against the coated surfaces to completely fill the transparent tubes. The samples were subjected to electromechanical testing machine at the crosshead speed of 10mm/minute to collect the data.

**Result:** Mean bond strength of the control samples was 3.0 MPa. It decreased with 35% phosphoric acid and increased with 10% Calcium Hydroxide in the range of 4.5 MPa.

**Conclusion:** The results of the present study revealed that alkaline treatment brings more hardness to the sample surface, whereas acid softens the surface.

**Key Words:** Amalgam repair, Bond strength, Calcium Hydroxide.

### INTRODUCTION

Most dental restorations either break or undergo wear after few years of service in a patient's mouth<sup>1</sup>. Such failed amalgam restorations need total replacement or repair<sup>2</sup>. Though repair of amalgam restoration is a clinically viable procedure but many dental clinicians do not consider repair as an adequate solution for fractured amalgam restorations. It has been observed that repaired amalgam restorations give fairly long enough service to the patients. Studies shows that repair of amalgam has definite indication in dental practice<sup>3</sup> and should be used more often because the newer amalgam bonding adhesives provide a stron-

ger bond between the old and new amalgam<sup>4</sup>. Repair is a conservative and simple procedure that increases the longevity of amalgam restorations with minimal loss of tooth structure<sup>5</sup>. Repair is preferable over replacement as durability of repaired amalgam is as good as replaced amalgam. The difference between the longevity of replaced amalgam versus repaired amalgam, has shown similar results<sup>6</sup>. Various techniques have been utilized to repair a broken amalgam restoration with varying degree of success<sup>7-8</sup>. Use of dentine adhesives to effectively repair a broken amalgam restoration has also been reported in literature<sup>9</sup>.

Ozer<sup>10</sup> used various adhesives including Phosphonated anaerobic resin to repair broken amalgams and evaluated the tensile bond strength of the repaired amalgams. While Chang<sup>11</sup> used 4-META adhesive resins for more than 20 years in Dentistry. For ease of use and consistency of the results, 4 META adhesives have an edge over others. The bond strengths

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of these adhesives have been found to be varying in various studies. Some adhesives showed satisfactory bond strength while others have very low bond strength<sup>12-13</sup>. The variation in bond strength of adhesive materials may be due to the ever changing environment in an oral cavity. Presences of saliva, repeatedly changing temperature, varying pH and masticatory loads make it very hostile<sup>14</sup>.

Effects of pH on bond strength of resin to metal have been studied and it was found that pH change in oral environment affects bond strength of the resin<sup>15</sup>. The purpose of this study was to assess the effects of alkaline versus acid surface treatment on bond strength of adhesives used for amalgam.

**Hypothesis**

It was hypothesized that direct application of acid and alkali on the existing restoration will change the pH and have positive or negative effect on the bond strength of the 4-META adhesive.

**MATERIAL AND METHODS**

Sixty cylindrical samples were prepared using an admixed alloy, ARISTALLOY (Engelhard-CLAL UK, Ltd. David Road, Chessington KT9, UK). The amalgam was mixed according to manufacturer’s instructions and was condensed with persistent force, into transparent hard plastic tubes of 4.0mm diameter and 10.0mm length to prepare the samples. Sixty tubes were filled up to 5.0mm (half lengths) with admixed amalgam. They were allowed to set hard for 7 days and kept for three months as the most solid state changes occur within this period<sup>16</sup>.

The samples were divided into A<sub>1</sub>, A<sub>2</sub> and A<sub>3</sub>. The group A<sub>1</sub> and A<sub>2</sub> had 25 samples each and A<sub>3</sub> had 10 samples. Flat exposed surfaces of the samples in A<sub>1</sub> were treated with 35% Phosphoric acid for 3 minutes with the help of a cotton bud. The phosphoric acid was used as it is available at each dental operatory to be used as an etchant. The samples in A<sub>2</sub> were similarly treated with 10% solution of Ca (OH)<sub>2</sub>. A dentine adhesive containing 4 – META, Amalgabond (Parkell, Farmingdale, NY 11735, USA) was then applied on the treated surfaces with the help of a brush. The adhesive- coated surfaces, with the help of a probe were pushed inside the tubes such that uncoated surfaces came in level with the margins of the tubes on the other end.

Samples in A<sub>3</sub> were not treated with acid or alkali and were kept as control group. They were prepared by directly applying Amalgabond. Freshly mixed high copper spherical amalgam, Cinalux (Dental Corp. P.O. Box # 16315-477 Tehran) was packed against the coated surfaces to completely fill the transparent tubes. Spherical amalgam was used as it gives better results than other amalgams when used for repair work<sup>17</sup>. The samples were subjected to electromechanical universal testing machine (SATEC USA) at the crosshead speed of 10mm per minute to collect the data. The data was collected in form of a table and was statistically analyzed using SPSS-13.

**RESULTS**

The results of the study reveal that mean bond strength of the control samples was almost 2.96 MPa. The mean bond strength slightly decreased (2.90 MPa) when the surfaces of the samples were treated with 35% phosphoric acid before application of the adhesive. The samples treated with 10% solution of Calcium Hydroxide show increased Mean bond strength of 4.54 MPa. (Table: 1).

**Table 1: Tensile Bond Strength - Mean values**

Surface treatment	Mean Tensile Bond Strength
No treatment	2.96 MPa
35% phosphoric acid	2.90 MPa
10% Ca (OH) <sub>2</sub>	4.54 MPa

To test the difference between the three groups, the Mann-Whitney statistical test was applied. The pair wise results are listed Table-2. The treatment of 35% Phosphoric acid showed highly significant difference from control as well as from the treatment of 10% Ca (OH)<sub>2</sub> (p =0.000). Further, the difference between control and 35% phosphoric acid was found to be not statistically significant (p =0.090).

**Table 2: Difference between the groups**

Group	p- value
Control Vs 35% Phosphoric acid	0.090
Control Vs 10% Ca (OH) <sub>2</sub>	0.000
35% Phosphoric acid Vs 10% Ca (OH) <sub>2</sub>	0.000

**DISCUSSION**

Oral environment is very hostile for any substance or material used in the mouth. Persistent flow

of saliva, repeated change of temperature due to the nature of consumed diet, varying occlusal loads depending upon crushing hardness of the food are various factors which make the environment hostile. Another important factor that has an effect on restorative materials used in an oral cavity is the pH. In a study, Kurashige et al<sup>15</sup> reported that the bond strengths of resin bonding systems to metal alloy is adversely affected by pH change. He used an adhesive, metabond to bond Co-Cr and Ni-Cr plates. The samples were put the samples in various acidic and alkaline solutions and tested their shear bond strengths. The bond strengths to alloys exhibited the lowest value when pH was 2.3 and the highest values at alkaline pH of 8. The results of the present study also showed the same findings. Using 10% Ca (OH)<sub>2</sub> made the environment of the samples alkaline and thus the bond strength produced was higher than control group. On the contrary, samples produced by phosphoric acid pretreatment showed low bond strength as compared to control group.

Jylan et al<sup>19</sup> conducted a study to investigate the bond strength of various luting cements at different pH. Their conclusion was that bond strength at acidic pH was significantly lower than neutral pH<sup>19</sup>. Elkhatib et al<sup>20</sup> reported that when pH of dentin was raised by applying bleaching agent, the bond strength of the adhesive decreased. The reason behind may be the structure of dentin which contains amino acids. Probably interaction between the bleaching agent and dental amino acids did not make a good bond. Our study, in this respect contradicts the results of Elkhatib's study.

The difference in bond strength seems to be due to surface hardness of the samples. Assad<sup>21</sup> found that control group was prepared without any alkaline or acidic surface treatment. The adhesives panavia, amalgabond HPA and amalgabond showed hardness values of 70, 67 and 74 Vicker's pyramid number (VPN). The specimens treated with 35% phosphoric acid showed reduced hardness than their control specimen. The specimen treated with alkaline solution showed increased hardness.

It reveals the fact that alkaline treatment brings hardness to the sample surface whereas acid softens the surface. Various shortcomings may be noted in this study. Only one concentration of phosphoric acid and Ca (OH)<sub>2</sub> were used. If various concentrations

of acidic and alkaline solutions are used, varying degree of hardness will be produced. Bond strength in such condition should be evaluated. Time of application of treating solutions may also play a part in ultimate bond strength of the samples. Moreover, only 4-META adhesive has been included in this study. Effect of pH on bond strength of Panavia and other 4-META products should also be assessed.

## CONCLUSION

Specimens treated with 35% Phosphoric acid showed reduced hardness than their control specimen. The specimen treated with alkaline solution showed increased hardness. Moreover the results of the present study revealed that alkaline treatment brings more hardness to the sample surface, whereas acid treatment softens the surface.

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