

EFFECT OF DISINFECTION OF ACRYLIC RESIN CUSTOM TRAYS ON ADHESIVE PROPERTY OF POLYVINYL SILOXANE IMPRESSION MATERIAL ADHESIVE SYSTEMS

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ABSTRACT

The bond strength for elastomeric materials to prevent detachment of the impression from the custom tray is important. The effect of disinfection procedure of custom trays with freshly prepared 1:213 iodophor and 10% sodium hypochlorite disinfectants on the tensile bond strength of polyvinyl siloxane impression adhesive/systems were evaluated. Thirty autopolymerizing resin plates were made in silicone mold. Before, the resin became rubbery, a metal nut with retentive threads was embedded so that an eye bolt could be thread into it for attachment during tensile testing. The specimens were stored in ambient air for 24 hours before testing. Ten specimens were exposed to freshly prepared 1:213 iodophor and additional 10 resin specimens were exposed to freshly made 10% sodium hypochlorite disinfectant solution. The specimens were stored in sealed plastic bags for 24 hours. The remaining 10 specimens served as control. After application of adhesive, addition reaction silicone impression material was injected over the tray specimens. The force necessary to separate the impression from the tray material was recorded using Instron Universal Load Testing Machine. The results indicated that the use of iodophor and sodium hypochlorite disinfectant solutions reduced the bond strength of impression adhesive system to autopolymerizing resin tray compared to control (iodophor = .38 MPa, sodium hypochlorite = .49MPa, control .52MPa). It is therefore suggested to perforate the tray at the construction stage and disinfected in the laboratory to overcome the reduced bond strength of polyvinyl silicone impression adhesive/system to tray material.

Key words: *Impression adhesive / tray system, bond strength of impression materials to acrylic tray, disinfection of acrylic resin custom tray, polyvinyl siloxane adhesive systems*

INTRODUCTION

An accurate registration of oral structures requires a uniform thickness of elastomeric impression material, a rigid and accurate custom tray to support the material and a mechanism for bonding or attaching the set elastomeric impression material to the custom tray.¹ Custom trays can be made of auto-polymerizing acrylic resin, thermoplastic material and visible-light curing resin.

Retention of elastomeric impression material to the impression tray is important to prevent the material from being pulled away from the tray on removal from the mouth, and to ensure that the direction of

polymerization shrinkage is towards the tray. Attachment of the impression material to the custom tray is accomplished by; (1) bonding with adhesive materials, (2) use of perforation and (3) and/or combination of the above. The liquid paint-on adhesive method is most commonly used.²

Studies have evaluated the bond strength of selected impression material adhesive systems to different tray materials^{1,3}, the bond strengths of impression materials to tray as a function of adhesive drying time^{4,5}, fabrication techniques and various surface treatments i.e. surface roughening, cleaning with alcohol, and washing with soap and water.⁶ For an impression adhesive/tray system to be effective, the surface of the

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tray should not be contaminated.^{7,8} Phillips⁹ noted that tray adhesives for polysulfide, polyether and condensation silicones were satisfactory, whereas those used with addition silicones were less effective. Therefore, a tray free from contamination is important when polyvinyl siloxane impression material is used. However custom trays made in the laboratory should be disinfected before placement in the patient's mouth¹⁰ Thompson, et al.¹¹ studied the bond strength of impression material adhesive systems to resin tray materials as a function of tray material and disinfection procedures. They indicated that disinfection of resin tray materials by immersion for 10 minutes reduced the retention of elastomeric impression material to the tray. In a laboratory where multiple trays are entering the disinfecting bath throughout the day, trays may be left inadvertently in the bath beyond the manufacturer's prescribed soaking period. Therefore, investigating the effects of immersion for up to 24 hours is necessary. The objective of the present study was to investigate effects of immersion for 24 hours in two disinfectants on the tensile bond strength of polyvinyl siloxane impression adhesive/systems to auto-polymerizing acrylic resin tray material.

MATERIALS AND METHODS

The type and manufacturer of materials used in this study are listed in Table 1. Thirty auto-polymerizing resin plates, 2 cm x 2 cm testing surface and 1.5 mm thickness were made in a silicone mould. The liquid and powder of auto-polymerizing acrylic resin were proportioned according to manufacturer's instructions. The test surfaces were polymerized against tin foil to simulate the practice of burnishing tin foil over the model surface to act as separator when making a custom tray. Before the resin became rubbery, a metal nut with retentive threads was embedded in the acrylic material so that an eye-bolt could be threaded into it for attachment in the universal testing machine (Fig 1). The specimens were stored at room temperature for at least 24 hours before testing as studies have shown that polymerized acrylic resin trays exhibit shrinkage during that period.¹³ Another set of 30 machined perforated metal plates of the same dimensions with stops at four corners in height were made (metal impression holder). The stops at the four corners of the metal impression holders provided space for the impression material between the metal impression holder and the

acrylic resin test specimen when approximated. An eye-bolt was screwed to the opposite side of each metal impression holder for attachment during tensile testing (Fig 1). The purpose of using a metal perforated plate was to hold and retain the impression material while being subjected to a tensile force.

Ten auto-polymerizing acrylic resin specimens were exposed to freshly prepared 1:213 iodophor disinfectant solution (Biocide, Biotrol, Intl., Louisville, Colo.), and an additional 10 resin specimens were exposed to freshly prepared 10% sodium hypochlorite (Bleach, James Austin Co., Mass. Pa.) disinfectant solution. Each specimen was placed in sealed plastic bags containing the disinfectant solutions for 24 hours. The remaining 10 acrylic resin specimens were not exposed to disinfectant solutions and served as controls. The specimens were subsequently removed from the plastic bags and rinsed with running tap water for 1 minute and allowed to dry for at least 24 hours before use. This procedure was used to make sure that specimen had no trace of water on its surface.

The auto-polymerizing acrylic resin trays and the metal impression holder were painted with the adhesive and allowed to dry for 15 minutes. Studies have shown this to be the minimal time needed for adhesive to be effective.⁵ Impression material was injected over the tray specimens using automatic mixing device with double spiral cylindrical tip (Fig 2). The metal impression holders were also loaded with impression material. The tray specimens and the metal impression holders were approximated correctly and hand pressure was used to maintain the relationship of the assembly as the material set (Fig 3). This is closely approximated to clinical practice.^{1,8} Excess impression material, which had been expressed beyond the sides of the assembly was removed with a sharp scalpel blade before testing.

Each specimen was placed in the Instron Universal Load Testing Machine (INSTRON Corp. Canton Massachusetts) using a 10 KN load cells with a crosshead speed of 0.5 mm/min (Fig 4). The force necessary to separate the impression material from the tray material specimen was recorded. Ten replications for each combination (30 specimens total) were tested. The data was statistically analyzed using analysis of variance of repeated measure design at 0.05 level of significance.



Fig 1: Metal nut with retentive threads embedded in the acrylic resin plate opposite to the test surface to which eye-bolt is screwed, (left); machined perforated metal impression holder with stops at four corners to which eye-bolt is screwed, (right).



Fig 2: Impression material injected over the tray specimen using mixing device.

Fig 3: The acrylic resin tray specimen and the metal impression holder were approximated and pressure was used to maintain the relationship of the assembly as the material set.



Fig 4: Specimen mounted on Instron Machine for testing.

Type	Trade Name	Manufacturers/Distributor
Addition reaction silicone	Express 3M	3M Dental Products, St. Paul, MN.
Auto-polymerizing resin tray material	Special Tray	Dentsply Ltd. Weybridge, Surrey. KT, England.
Disinfectant	Biocide	Biotrol Intl, Louisville Colo.
Disinfectant	Bleach	James Austin Co. Mass, Pa.

TABLE 1. TYPE, TRADE, NAME AND MANUFACTURERS OF MATERIALS

TABLE 2. MEAN ADHESIVE BOND STRENGTH VALUES.

Treatment	N	Mean	Standard Deviation	Coefficient of Variation
Group 1 (polyvinyl siloxane iodophor/resin)	10	.38 ^a	± .06	[14.56%]
Group 2 (polyvinyl siloxane/NaOCl/resin)	10	.49 ^b	± .04	[7.28%]
Group 3 (polyvinyl siloxane/untreated resin)	10	.52 ^c	± .04	[7.16%]

The different alphabets as superscript show the statistical significance.

RESULTS

The mean values for adhesive bond strength of combinations of polyvinyl siloxane impression material (PVS), auto-polymerizing resin material (resin) disinfected with either iodophor or sodium hypochlorite solution (NaOCl), and control group of PVS/untreated resin are summarized in Table 2. The control Combination of PVS/untreated resin showed the highest mean adhesive bond strength (0.52 MPa), as compared to PVS/NaOCl/resin combination mean bond strength (0.49 MPa) and PVS/Iodophor/resin mean bond strength (0.38 MPa). The adhesive bond strength overall ranged from lowest of 0.32 MPa for PVS/Iodophor/resin combination to highest of 0.58 MPa for PVS/untreated resin combination.

The mean adhesive bond strength for PVS/iodophor/resin was significantly lower when compared with the PVS/NaOCl/resin and PVS/untreated resin combinations ($p < .005$ and $p < .001$ respectively). The PVS/NaOCl/resin combination exhibited significantly lower bond strength ($p < .030$) compared with the control PVS/untreated resin combination. The PVS/untreated resin combination had the highest bond strength than the two experimental groups. The coefficient of variation ranged from 7.1% for the PVS/untreated resin combination to 14.5% for PVS/Iodophor/resin system. The PVS/NaOCl/resin combination showed a higher tensile bond strength and smaller coefficient of variation, whereas the PVS/Iodophor/resin combination exhibited lower tensile bond strength and higher coefficient of variation (Table 2).

The mean bond strength value for PVS/Iodophor/resin was 26.5% less than that of PVS/untreated resin combination. The PVS/NaOCl/resin combination also exhibited mean bond strength which was 5.6% lower than that of control PVS/untreated combination. The use of NaOCl as a disinfecting medium did not reduce the bond strength value as much as the iodophor disinfectant.

DISCUSSION

The present study compared the adhesive tensile bond strength of polyvinyl siloxane impression adhesive system (PVS) to the auto-polymerized acrylic resin tray material disinfected with iodophor and sodium hypochlorite disinfection solutions for 24 hours with a control group of PVS/untreated combination. The control group showed the highest mean tensile bond strength of 0.52 MPa, the value which lies within the range of 0.48 to 0.58 MPa as reported by other studies^{1,2,6}. The results indicate that the studied disinfectants altered the ability of the adhesive to provide effective bond to the tray material.

Thompson et al.¹¹ investigated adhesive bond strength of polyvinylsiloxane to auto-polymerizing resin tray materials disinfected with iodophor and NaOCl disinfectant solutions for a period of 10 minutes. Although their findings were broadly comparable to the results of this study, the reported values were higher as 1.0 MPa for PVS/untreated resin combination, 0.94 MPa for PVS/NaOCl/resin and 0.73 MPa for PVS/Iodophor/resin combination. The reasons for low bond

strength values recorded in this study could be related to the longer period of immersion (24 hours) of resin tray material in disinfectant solutions and to contamination of the testing surface of the tray material with residues from disinfectant solutions, although the test surface of the tray material was washed thoroughly with running tap water before application of the adhesive. Furthermore, it is likely that long duration of immersion may have altered the surface free energy affecting the adhesive phenomenon of acrylic resin tray material.

The coefficient of variation may reflect variation in mixing, application of material to the resin plates, and the nature of bond strength. In this study the coefficient of variation ranged from 7.1% for PVS/untreated combination to 14.5% for PVS/iodophor/resin. The PVS/untreated combination showed the highest bond strength and the smallest coefficient of variation. The result of this study compared favorably with those of Thompson et al.¹¹

The amount of bond strength necessary for elastomeric impression material to prevent detachment of the impression from the custom tray has not been quantified. However, an approximation of forces involved is in the range of 0.224 to 0.50 MPa.⁸ The force necessary to remove stiff impression materials such as polyvinyl siloxane from the mouth may be increased in the presence of severe undercuts, the shape of the clinical crown and the spacing and angulation of teeth. Phillips⁹ noted that the tray adhesives for polysulfide, polyether and condensation silicones were satisfactory, whereas those with addition silicones were less effective. This study has shown that the mean bond strength values for PVS/iodophor/resin and PVS/NaOCl/resin combinations were lower by 26.5% and 5.6% respectively compared with the control PVS/untreated resin combination bond strength.

The study showed that the use of polyvinyl siloxane impression material with auto-polymerizing acrylic resin and iodophor disinfection should be avoided if maximum bond strength of the adhesive to the tray material is desired. The bond strength between the material and the tray is even more critical if the impressions are poured repeatedly.⁹ Therefore, an adhesive agent with perforated tray is suggested for additional security with impression. It is desirable as a routine procedure that the custom tray should be

perforated at the fabrication stage and disinfected in the laboratory.

CONCLUSIONS

1. The use of iodophor and NaOCl disinfectant solutions reduced the bond strength of impression-adhesive system to auto-polymerizing resin tray.
2. The use of addition silicone with auto-polymerizing resin tray disinfected with iodophor produced the lowest adhesive bond strength.

Disclaimer: The author does not have commercial interest in any of the products use in this research.

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