An Evaluation of Compatibility of Three Different Impression Materials to Three Different Tray Acrylic Materials Using Tray Adhesives: An In vitro Study

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Abstract

Background: Impressions are an integral part of prosthodontics. Elastomeric impression materials are the impressions materials of choice in fixed prosthodontics for its better surface detail reproduction. Out of the elastomers available, vinyl polysiloxane represents the state of art impression material in prosthodontics, but even these materials cannot give an accurate reproduction of the tissues if there is separation of impression materials from the tray which may results in a distorted impression leading to poor final restorations made from such impressions. Hence, tray adhesives need to be applied to the tray to obtain an accurate and consistent impression. The purpose of the study was to evaluate the compatibility of three different impression materials to three different tray acrylic materials using tray adhesive, by determining the tensile bond strength.

Materials and Methods: Two acrylic discs were utilized to make one impression sample of 3 mm thickness. The dimension of each acrylic disc was 2 mm in thickness and 2 cm in diameter. Specimens were made using a standard stainless steel die of the above-mentioned dimensions. A total of 135 specimens were prepared which included 15 samples in each category of nine groups. The samples were subjected to tensile bond strength testing using the universal testing machine and the values were recorded. All the values were subjected for statistical analysis.

Results: Impregum (3M) specimens had demonstrated the highest tensile bond strength value (51.60N). Statistical analysis was done using Tukey’s post hoc test and one-way ANOVA. Highly Statistical significant results were evident in Impregum (3M) and Indentium, as the P = 0.00. Conclusion: In this study Impregum (3M), specimens had highest tensile bond strength values compared to the other Groups followed by Indentium.

Keywords: Autopolymerizing resin, hydrophilic, vinyl siloxanether

INTRODUCTION

Elastomeric impression materials have simplified restorative procedures in today’s dentistry. Surface detail reproduction has improved with evolution from reversible hydrocolloid (agar) to polysulfide, then to condensation silicone and finally to polyether and vinyl polysiloxane materials. Recent advances have focused on making these materials more hydrophilic, thereby allowing the materials to be in more intimate contact with the teeth and tissues with the aim of capturing better surface detail and having fewer defects.

Craig and Sun in 1994 studied relatively new impression material vinylsiloxanether (VSXE) which was made commercially available by the manufacturer. The newly formulated VSXE impression material yielded more accurate impressions and casts than those of addition silicone and polyether impression materials.[1]

The use of a custom tray may have a significant effect as well and offers an advantage by providing a uniform thickness of impression material to improve the accuracy of the working cast.[3] Any material used to make custom trays must be dimensionally stable over time and must not permanently deform during the impression making procedure or as the impression is being retrieved from the oral cavity (materials should have good tear resistance).[2,6]
Tensile strength is the maximum tensile stress applied in stretching a specimen to rupture. It has been reported to indicate the ability of an impression material to withstand tearing in thin interproximal and cervical areas.\([3]\)

Another important factor that can lead to inaccurate impressions is that the impression materials, especially VPS impression materials, used with custom impression trays often do not possess any chemical adhesion with the tray materials. On removal of the impression from the mouth, the impression may be distorted if the impression material pulls away from the tray.\([7]\)

Hence, adhesives were recommended to be used in all trays, even those with perforations. Rapid removal of impression from the mouth increased the retention between the tray and the impression materials, as did removal in a vertical rather than oblique direction. Also, in general, between the tray and impression material decreased with increase in flexibility of the impression materials.\([8]\)

The bond between the impression material and the tray is essential and is achieved by means of mechanical retention or chemical adhesion or both. Mechanical retention is by means of undercuts or perforations on the tray and chemical adhesion is by means of using a tray adhesive.\([9,10]\) The adhesives used are usually polydimethylsiloxane, and ethyl silicate and these adhesives react with the surface of the tray and to the impression material. Impression tray adhesives are applied as a spray or manually applied using a brush.\([11]\) These adhesives are designed to react with the molecular networks in polyvinylsiloxane and to chemically bond with both the elastomeric impression and the tray materials.\([12]\)

Before placing the elastomeric rubber impression material on the custom resin tray, tray adhesives have usually been recommended to be applied not only for the inside of the custom tray but also to the surface of border molding materials of the tray border.\([9,13]\)

The purpose of this study was to evaluate the tensile bond strength of three different elastomeric impression materials to three different tray acrylic materials with a tray adhesive and thus observe their compatibility with each other by testing for tensile bond strength.

**Materials and Methods**

This *in vitro* study was conducted in the Department of prosthodontics, Sri Rajiv Gandhi College of Dental Sciences and Hospital, Bangalore, Karnataka, India. The study was done to evaluate the compatibility of different impression materials to different acrylic tray materials using a tray adhesive. The acrylic tray materials that were subjected to test in this study were autopolymerizing resin, light polymerizing acrylic resin, and tray material. The impression materials that were subjected to test in this study were vinyl polysiloxane impression material (medium body consistency), newly formulated VSXE impression material (medium body consistency) and polyether (medium body consistency).

**Fabrication of master die**

A stainless steel metal plate having dimensions of 30 mm × 5 mm in dimensions was milled in such a way so as to obtain a disc of dimensions 20 mm × 2 mm. The rest of the metal plate extensions had been utilized to facilitate the grip of the sample while they were subjected for testing.

**Preparation of tray specimens**

The stainless steel die was used to prepare a putty mold to make tray specimens [Figure 1].

The obtained molds were used to prepare samples. The materials used as tray samples were as follows - 1) Chemical cure resin a - Dental products of India (DPI), b - Tray material resin MP Sai enterprises (MPS) 2. Light cure resin (Voco). Chemical cure resin tray samples were prepared by dough method following manufacturer’s recommendation for powder and liquid ratio. They were cured in a pressure pot at 37 ° C subjected to 30 psi pressure for 30 min.

Light cure resin tray sheets were cut and placed in the mold. They were light cured uniformly in light curing unit.

In this manner, 270 discs were divided into 9 groups of 30 each. In each group, 2 discs were used to make one test sample thus resulting in 15 test samples in each group. Therefore, there were 135 samples totally [Figure 2].

**Preparation of test samples**

The two discs were and finished. Two strokes of tray adhesive were applied with a brush on each disc and were allowed to dry for their respective recommended time [Figure 3].

Once the two trays were ready, they were loaded with impression material to be tested and carefully placed in metal box to maintain the even thickness of impression material [Figure 4].

![Figure 1: Stainless steel die was used to prepare a putty mold](image-url)
Results showed highly significant bond strength of polyether with chemically cure (DPI) discs followed by VSXE impression material with chemical cured (DPI) discs.

Discussion

The purpose of this study was to determine the compatibility of the three different impression materials to three different tray materials using tray adhesives. The adhesives used in the study are usually polydimethylsiloxane and ethyl silicate. The adhesive reacts with the surface of the tray material and forms a chemical bond to the tray and to the impression material. It is generally recommended to wait 10 to 15 min after application of the adhesive before making the impression this allows time for the solvent to react with the tray material.[14]

Retention of the impression material to custom tray resin ultimately depends on the ability of the adhesive solvent to resolve tray resin. The high specificity of the tray material and the impression material combination obtained in this study is an important clinical consideration. The degree of
bonding achieved with these chemical cure tray materials appears to be clinical adequate. However, in vivo, variables, namely, direction and force of removal, flexure of the resin tray material, and contamination of resin surface before an adhesive application may lead to an overall deterioration of the bond strength.

A clinically adequate bonding strength is required between two interfaces i.e. between tray and tray adhesive and tray adhesive and impression material. The results of the present study revealed $F = 10.576$ and $P = 0.00$ which was highly significant.

The result of the present study showed an increased in tensile bond strength of Group C that polyether bonding on the chemical cure resin tray.

Each test group from Group A to Group I was evaluated for its difference in bonding strength with various tray materials using ANOVA and Turkey’s post hoc tests. Group C with chemical cure showed statistically significant increase in tensile bonding strength that was mean bond adhesive strength 14 psi, values varying (44.1473–59.0527) followed by Group A mean bond adhesive strength 13 psi, values varying (38.0769–51.9231) followed by Group E mean bond adhesive strength 11 psi, values varying (34.6596–46.6738) followed by Group I mean bond adhesive strength 10 psi, values varying (32.6219–43.1114) followed by Group D mean bond adhesive strength 9 psi, values varying (31.2641–40.8692) followed by Group B mean bond adhesive strength 8 psi, values varying (30.4143–39.5857) followed by Group F mean bond adhesive strength 7psi, values varying (27.2235–37.9765) Group H mean bond adhesive strength 6 psi, values varying (27.2235–37.9765) Group H mean bond adhesive strength 7 psi, values varying (25.1959–33.0707) followed by Group G mean bond adhesive strength 7 psi, values varying (19.8373–27.6293) showing the least strength.

The same rationale may be used to explain the significant difference in bond strength polyether and other two materials to the three tray materials. However, the exact nature of this variation has yet to be investigated.

The polyether tested in the study showed a result similar to most of those reported.

Group G shows adhesive failure thereby the weakest bond strength and least compatibility. Payne and Dixon,[15] in their respective studies stated that visible light cure material shows a poor bond with siloxane if the air-inhibited, nonpolymerized layer is not removed with isopropyl alcohol or a carbide bur.[14,16]

Sulong and Setchell[17] demonstrated that roughening the surface of the impression tray will significantly improve the effectiveness of polyvinyl siloxane adhesives.

Polyether and Indentium demonstrated better adhesive bond strength to autopolymerizing resin than Monopren transfer impression material, although they did differ satisfactorily.

The highest mean adhesive bond strength achieved by polyether impression material was approximately was 14 psi. In this study, Group C showing the polyether system Group G showed cohesive failure in this study, as the adhesive bond strength is greater than the tensile strength of the elastomer itself.[11] The polyether systems have the greatest bond strengths while the polyvinyl siloxanes show great variability between manufacturers with some being very poor, and others rivaling the polyether systems.[11]

Since the study has been restricted to laboratory investigation, further observation in clinical application is required.

**Clinical implication**

When the entire study was analyzed, it became evident that the degree of bonding achieved with these chemical cure tray materials appeared to be clinically adequate. However, the action of in vivo variables, namely, direction and force of removal, flexure of the resin tray material, and contamination of resin surface before adhesive application may lead to an overall deterioration of the bond strength.

**Conclusion**

Within the limitation of the current study, it can be concluded that:

- Polyether (Impregum) impression material showed highest bond strength with DPI tray acrylic resin followed by the new VSXE (Indentium medium), when compared to Group D, Group E, and Group F.
- Light-activated resin tray produced weakest bond strength compared to all the three impression material. Indentiummedium (VSXE) showed higher bond strength than polyvinyl siloxane.

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**Conflicts of interest**

There are no conflicts of interest.

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