

Manufacturer supplied tray adhesive vs. Universal tray adhesive: An *in vitro* study

Original Article

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ABSTRACT

Objective: The purpose of this study is to evaluate and compare the tensile bond strength of GC Universal paint-on adhesive and the adhesive supplied by the manufacturer using vinyl polysiloxane impression materials (medium body and heavy body) with autopolymerizing acrylic (PMMA) custom tray material. **Material and Methods:** A total of 120 custom tray resin and poly vinyl chloride specimens were fabricated. Effectiveness of universal tray adhesive was compared with the manufactured tray adhesive using the two viscosities of two brands of vinyl polysiloxane impression materials and tested. For tensile strength testing, different viscosities of the brands were dispensed in the cylinders attached to the custom tray specimen coated by the universal and manufacturer supplied tray adhesive. Each of these specimens was then subjected to tensile load in Lloyd's Universal Testing Machine. Data obtained was statistically analyzed. **Results:** Analysis of tensile bond strength revealed that the universal tray adhesive showed better strength and was statistically significant when compared to the manufacturer supplied tray adhesive. The tensile bond strength test revealed statistically significant difference between the two brands of vinyl polysiloxane. **Conclusion:** Within the limitations of this *in vitro* study, the universal tray adhesive is more effective than the manufacturer supplied tray adhesives.

KEY WORDS: Custom tray, dentistry caulk tray adhesive, GC America Universal tray adhesive, heavy body, medium body, tensile bond strength, universal testing machine, 3M VPS Tray adhesive

INTRODUCTION

Contemporary restorative dentists have a host of excellent impression material to make impressions.^[1,2] Accurate registration of oral structures requires an accurate impression material and accurate impression tray to support the material.^[3] Auto polymerizing (PMMA) custom trays have been used as an integral part of impression making^[4] for elastomeric impression material.^[5] These impression materials are widely used because of their proven accuracy, reliability and elastic recovery. In routine clinical procedures the material may separate from the custom tray leading to distortion of the cast and the die. Hence a strong bond is desired to prevent inaccuracies in impressions that contribute to non-fitting restorations.^[6]

As there is no established chemical bond between custom tray and impression material manufacturers

recommend the use of a tray adhesive to provide retention and improve the bond strength between acrylic resin trays with elastomer. Both manufacturer recommended tray adhesives and universal tray adhesives are available these days. A universal paint-on adhesive offers the advantage of equal or superior bond strength when compared to the manufacturer recommended adhesive.^[6,7] Medium body vinyl polysiloxane impression material is used for complete denture and fixed partial denture cases, whereas heavy body vinyl polysiloxane impression material has been used with custom made tray for making of implant impressions.^[1,8]

Studies have been done using medium body vinyl siloxane impression material but there is no relevant data on heavy body vinyl siloxane impression material with the universal tray material; hence no evaluation and comparison has been made between the two

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consistencies. With this background the present study aims at evaluating and comparing the two consistencies with their adhesives and the universal tray adhesive.

MATERIALS AND METHODS

This *in vitro* study aims to evaluate and compare the bond strength of the tray adhesive supplied by the manufacturer with universal tray adhesive using custom fabricated tray.

Material Used:

The study was carried in the following manner:

- Preparation of auto polymerizing custom tray specimens
- Preparation of Poly vinyl chloride samples
- Preparation of assembly

1. Auto polymerizing custom tray specimens-120 samples

Standardized (ADA specification no.33) auto polymerizing custom tray specimens were obtained from a metal mold [15 x 15 x 20 mm] made of stainless steel; 120 cubical specimens were made 24 hours prior to testing of the samples. The custom tray resin was mixed according to the manufacturers recommended polymer monomer ratio (3:1) and poured into the prepared mold. Once the resin had polymerized, the samples were retrieved and finished. The test surface was left untouched to be polished with the silicone carbide paper (320-grit) before the tray adhesive

Table 1: Statistics of group with its four different sub groups of medium body and heavy body

S.no.	Material used	Lot no.	Manufacturer
1.	Imprint II Garant (Medium body vinyl polysiloxane)	6KWW1Y1	3M ESPE (USA)
2.	Imprint II Garant (Heavy body vinyl polysiloxane)	7AXTIE3	3M ESPE (USA)
3.	3M ESPE VPS tray adhesive	287627	3M ESPE (USA)
4.	Aquasil ultra monophase (Medium body vinyl polysiloxane)	070301	Dentsply Int. (USA)
5.	Aquasil ultra heavy (Heavy body vinyl polysiloxane)	070219	Dentsply Int. (USA)
6.	Caulk tray adhesive	050413	Dentsply Int. (USA)
7.	Universal tray adhesive	0604061	GC America Inc. (USA)
8.	Auto polymerizing custom tray resin	271	DPI India

application. Preparation was done for the specimen to attach the hook on the opposite side of the test surface. The specimen served for the alignment of the hook for rest of the tray specimens on the stone index prepared for orientation of the other samples. All the specimens were marked for easy identification for each group.

2. Poly vinyl chloride open cylinders-120 samples (to house impression material)

Uniform size specimens in the form of open cylinders (15mm diameter and 20 mm height) were obtained from polyvinyl chloride pipe to serve for the housing of impression material. Multiple vents were drilled with the straight fissure carbide bur at different locations. For other specimens a standardized index was made to locate vents at the same position for all the open cylinders.

To attach its chain, a metal rod was passed through the open cylinder from one side to the other at its upper end. The same end of the cylinder was closed with the auto polymerizing resin to confine the impression material. Two windows were created on the covered surface to act as inlet for the impression material and the other as outlet for excess material [Figure 1].

3. Assembly

PVC cylinder was aligned on the tray specimen in such a way that it contacted the greatest surface area of the custom tray specimen. The assembly was fixed and stabilized with cyanoacrylate adhesive. This assembly was used for the fabrication of stone index thus serving for orientation of rest of the samples.

All test samples were grouped as below and tested in their subgroups as follows:

In all the above mentioned groups the tray adhesive was applied on the intact custom tray specimens and allowed to dry for a prescribed time of 15 minutes. The poly vinyl chloride open cylinder was then placed on acrylic specimen in the prepared stone index. After 15 minutes of tray adhesive drying time, the impression material was auto mixed and dispensed into the cylinder from one of the windows.

The impression material was then allowed to polymerize for five minutes. After polymerization, the stone index was separated and the specimen retrieved. The assembly was then attached to the universal testing machine. The same procedure was carried out for all the subgroups. The specimens were then tested in tensile mode for its debonding force at a crosshead speed of 5 mm per minute until separation

Table

Group	Subgroup	Adhesive used	Consistency used
GROUP 1 (3M ESPE)	MMM(1-15)	3M *	Medium body +
	MMU(1-15)	GC**	Medium body +
	MHM(1-15)	3M *	Heavy body +
	MHU(1-15)	GC**	Heavy body +
GROUP 2 (Dentsply)	DMM(1-15)	Dentsply***	Medium body ++
	DMU(1-15)	GC **	Medium body ++
	DHM(1-15)	Dentsply ***	Heavy body ++
	DHU(1-15)	GC **	Heavy body ++

*3M ESPE VPS tray adhesive, **GC Universal tray adhesive,

***Dentsply caulk tray adhesive, +IMPRINT II (3M ESPE),

++AQUASIL (DENTSPLY)

failure occurred.

The force was measured in Newton (N) which was calculated for its tensile bond strength using the formula:

Tensile bond strength = F/A

Where,

F=maximum force at which the separation failure occurred in Newtons (N)

A= Area of adhesion i.e. area of the circle ($3.14 \times r^2$) in mm^2

{r= radius of the circle i.e. r =diameter of circle/2}

[R=15/2=7.5 mm]

All the values were measured in Mega Pascal's (MPa) and data was analyzed and tested for its significance using one way ANOVA and T-Test.

RESULTS

Table 1 shows the statistics of group 1 i.e. 3M ESPE with its four different sub groups of medium body and heavy body treated with its own tray adhesive and with the universal tray adhesive. Scheffe's mean revealed that the heavy body with the universal tray adhesive gave the better strength at 0.183 MPa and the heavy body with its own tray adhesive gave the least at 0.127MPa. ANOVA showed the F value with in the groups to be 18.95 and hence was highly significant. (P=0.000)

Comparison between both the groups i.e. group 1 (3M ESPE) and group 2 (Dentsply) revealed that group 2 (Dentsply) gave better tensile bond strength with both their own adhesives and the GC universal tray adhesive except for the medium body consistency of group 1 (3M ESPE) when treated with its own tray adhesive [Figure 2]. The universal tray adhesive for both the groups gave the good bond strength when compared to their own adhesives except for the heavy body

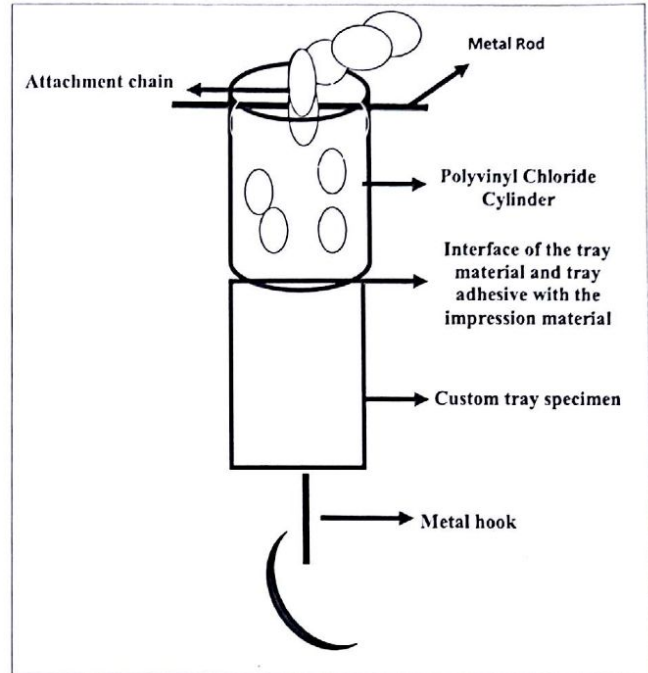


Figure 1

consistency of group 2 (Dentsply) which gave the better strength with its own tray adhesive (caulk).

DISCUSSION

Accuracy and consistency of impression are best maintained with the bond between custom tray and adhesive.^[9] Metal and plastic trays are used routinely for dental impressions with the putty material as custom tray but chances of air entrapment are more. Therefore it is not as accurate as custom trays. Hence for the clinical accuracy of the impression the custom trays are commonly made of auto polymerizing acrylic resin.

It is suggested that custom trays should be fabricated at least 24 hours before the impressions are made allowing the material to become dimensionally stable. It is the most common material employed for tray fabrication because of ease in fabricating the tray and is cost effective as compared to visible light cured resin. Hence the samples in this study were made with the auto polymerizing custom tray material.^[10-12]

The optimum technique for use of vinyl polysiloxane impression is to construct a custom tray and make the impression by using low viscosity material in the syringe on the medium- or heavy- body viscosity in the tray.^[13] These materials can be dispensed with an auto mixing dispenser and hence there are less chances of air entrapment.^[13] The use of impression

Table 1: Comparison of Sub Groups within Groups 1(3M ESPE)
Descriptive Analysis in Group 1: MPA

	N	Mean	Std. Deviation
MMM	15	0.13	2.06
MMU	15	0.17	3.79
MHM	15	0.12	1.34
MHU	15	0.18	1.54

ANOVA MPA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.242E-02	3	1.08	18.94	0.000
Within Groups	3.195E-02	56	5.70		

MPA Scheffe

Subgroups	N	Subset for alpha=.05		
		1	2	3
DMM	15	0.11		
DMU	15		0.21	
DHU	15			0.29
DHM	15			0.32
Sig.		1.000	1.000	0.36

tray adhesive in retaining the elastomeric impression material has definite benefits. The bonding between the impression material and tray is not adequate and as the material goes into the undercut, a considerable amount of force is required to pull away the material. Hence the surface preparation of the custom tray, especially with the silicone carbide paper, significantly affected the retention of the impression material with the adhesive.^[4]

It is a routine procedure to apply a tray adhesive as it controls the direction of polymerization shrinkage of the material towards the custom tray side. The basic composition of the tray adhesive contains the pressure sensitive silicone adhesive (dimethylpolysiloxane), the volatile solvent in the form of ethyl acetate and the various colorants which differ in their composition in different manufacture supplied tray adhesive. Dimethylpolysiloxane is meant to be the reactive component of the tray adhesive which reacts with the fillers of the impression material especially the vinyl component. The solvent reacts with the auto polymerizing tray material to create microporosites on the tray material so that the adhesive physically and mechanically bonds with it. The more the reactive

Table 2: Comparison of Sub Groups within Group 2 (Dentsply)
Descriptive Analysis in Group 2: MPA

	N	Mean	Std. Deviation
DMM	15	.115680	3.72
DMU	15	.21	5.49
DHM	15	.32	3.21
DHU	15	.29	3.95

ANOVA MPA

	Sum of squares	df	Mean square	F	Sig.
Between Groups	0.396	3	0.132	75.41	0.000
Within Groups	9.7E-02	56	1.75		

MPA Scheffe

Subgroups	N	Subset for alpha=.05		
		1	2	3
DMM	15	0.11		
DMU	15		0.21	
DHU	15			0.29
DHM	15			0.32
Sig.		1.000	1.000	0.36

silicone in the adhesive; the more is the film thickness.

Previous literature reported that the material adhesive combination supplied by the manufacturer might not necessarily be the best.^[6] Universal adhesives have now started to replace the manufacturer's adhesives. Paint-on adhesive on medium body vinyl polysiloxane is found to be effective^[6] whereas studies regarding heavy body vinyl polysiloxane are scanty.

Medium body consistency of 3M ESPE and Dentsply gave the lowest mean tensile bond strength when compared to their own heavy body consistency. This is attributed to the amount of filler content in the composition and correlates with the study done by Peregrina et al.^[6] According to Philip's, the base used for adhesive may contain a residue silicone i.e. polydimethyl siloxane and ethyl acetate. The latter creates a physical bond with the impression tray resin.^[6] Lower bond strength of 3M ESPE can be attributed to the film thickness of their own adhesive as it gave a thin film thickness when it was painted on as compared to Dentsply which gives a thicker film and is tacky; 3 M ESPE heavy body gave the lowest mean strength in its group when used with its own adhesive.

Among the individual groups of 3M, medium body consistency when treated with their manufacturer recommended tray adhesive and compared with the GC universal tray adhesive showed that the universal adhesive has better mean bond strength. These value

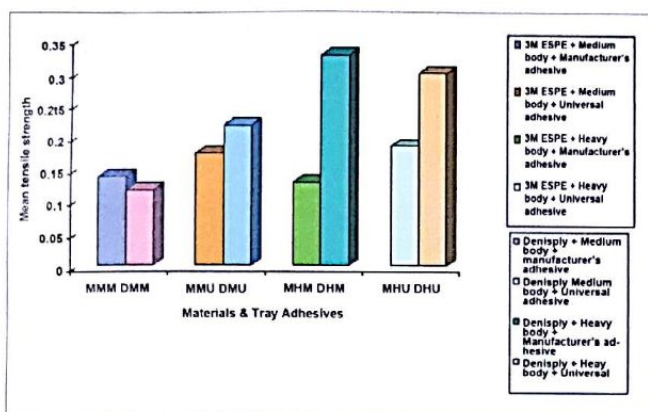


Figure 2: Comparison Between Group 1 (3m espe) and Group 2 (Dentsply)

correlates with the study done by Peregrina *et al.* in 2005.^[6] Among the Dentsply group, the medium body gave better bond strength when compared to the manufacturer recommended tray adhesive. The addition of modifiers which are the solvents in the form of petroleum spirits, toluene and benzene in very less concentration (according to the literature of GC Universal tray adhesive) could possibly impact the resulting strength with their ability to dissolve the surface of auto polymerizing acrylic resin.^[3,14]

In both the groups 3M and Dentsply, the heavy body gave the higher mean tensile bond strength with GC universal tray adhesive except with the Dentsply heavy body consistency which gave a higher value with their own adhesive as compared to universal tray adhesive

Dentsply gave the better mean tensile bond strength as compared to 3M except for medium body consistency with the manufacturer recommended adhesive. This difference lies in the composition of impression material of the individual manufacturer. The variation is seen in the percentage of filler content and polymethyl hydrogen siloxane in their composition which binds with the similar reactive siloxane of the adhesive.^[8,14]

CONCLUSION

The following conclusions were made keeping in mind limitations of this study:

In group 1 i.e. 3M ESPE group, Universal tray adhesive showed better strength as compared to the 3M ESPE recommended adhesive. The heavy body gave the higher bond strength when compared to the medium body.

In group 2 i.e. Dentsply Group, Universal tray adhesive showed better strength with medium body but manufacturer supplied tray adhesive showed better strength with the heavy body.

Among both the groups, group 2(Dentsply) gave better bond strength with universal tray adhesive.

It is recommended that further studies be conducted on the effect of filler particles in the manufacturers base and catalyst composition to be evaluated for its role in the bonding of the tray adhesive with impression material

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