



Original Research Article

Tensile bond strength of polyvinyl siloxane impression material to auto-polymerizing custom tray using different tray adhesives: A comparative study

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ARTICLE INFO

Article history:

Received 11-07-2020

Accepted 30-07-2020

Available online 24-09-2020

Keywords:

Adhesives

Dental Bonding

Dental Impression Materials

Silicone Elastomers

Stress

Mechanical

ABSTRACT

Aim: In clinical practice, a material called adhesive is frequently applied over the impression tray to adhere impression materials to it. This prevents dislodgement of material which causes distortion of the impression made. This study aimed to compare the tensile bond strengths of polyvinyl siloxane impression material to auto-polymerizing custom tray using different tray adhesives.

Materials and Methods: A total of sixty uniform blocks of auto-polymerizing custom tray specimens were built using a mould made of stainless steel. They were coated with one of the four adhesives (manufactured by 3M ESPE, Coltene-Whaledent, Ivoclar Vivadent, GC) and the force at which separation failure occurred was measured using Universal testing machine.

Result: The results found that any of the commonly used adhesives (manufactured by 3M ESPE, Coltene-Whaledent, Ivoclar Vivadent, GC) can be used for application on auto-polymerizing custom trays before polyvinyl siloxane is added to the tray, however, tray adhesive by Coltene-Whaledent (Adhesive) was found to have the best bond strength followed by tray adhesive from GC (Vps Universal Tray Adhesive).

Conclusion: Tray adhesive by Coltene-Whaledent (Adhesive) has the best bond strength followed by tray adhesive from GC (Vps Universal Tray Adhesive).

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1. Introduction

An accurate reproduction of prepared tooth is a crucial step in delivering a prosthesis with good fit and longevity for the purpose of restoring patient long-term chewing function. This requires careful consideration of many factors such as impression material, impression technique, operator's experience in impression making, and type and material of tray.^{1,2} In clinical practice, a material called adhesive is frequently applied over the impression tray to adhere

impression materials to it. This prevents dislodgement of material which causes distortion of the impression made. Therefore, it is an important step in impression making, often ignored, because the application of adhesives on trays allows final prosthesis to be made without any problem caused by distortion. Addition silicones are the material of choice for impression making. It is used widely in clinical practice as their properties are better than other siloxane materials. In other words, they are dimensionally more stable, better surface details, and ease of use.³⁻⁵ Several adhesive materials from different brands are available in market today. This study aims to conduct a comparative

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evaluation of tensile bond strength of polyvinyl siloxane impression material to auto-polymerizing custom tray using different tray adhesives. The primary objective of our study was to compare the tensile bond strength between different tray adhesives. Furthermore, the secondary objective of our study was to measure the bond strength of each tray adhesive and to evaluate their adhesiveness to the auto-polymerizing custom tray.

2. Materials and Methods

This was an experimental, in-vitro study conducted in the department of Prosthodontics after obtaining approval from institutional ethics committee. In this study, auto-polymerizing custom tray specimens were used. Custom trays made of auto-polymerizing material/acrylic gives more accurate impression when compared to plastic stock trays.^{6,7} Custom trays allow uniform thickness of material loaded and hence, less distortion during polymerisation and more accuracy.^{8,9} Hence, in our study, four commonly used adhesive materials were compared for their bond strength with auto-polymerizing custom tray specimens. We conducted this study on a total of 60 auto-polymerizing custom tray specimens with the help of a stainless steel mould for uniformity of the sample. All the blocks which were hard, smooth and of uniform thickness were included in the study. However, blocks with porosity or non-uniform were excluded from the study. Based on these criteria, a total of 74 blocks were fabricated, out of which 14 blocks were discarded.

2.1. Fabrication of auto-polymerizing custom tray specimens

A uniform block of size 20mm x20 mm x30 mm was built using a mould made of stainless steel. Later, using the same mould, 59 additional samples were built. Perforations on the block were made. First of all, separating medium was applied on the steel mould for easy separation. Autopolymerizing material manufactured by Dentsply was mixed and poured into the mould. As per the manufacturer instructions, a ratio of 3:1 polymer:monomer was mixed together and poured in dough-like consistency before the mix had reached rubbery stage. These moulds were kept in water for 24 hours to prevent any distortion. Once set, the samples were gently separated from the mould after an hour. Now, to attach these samples to the Universal testing machine for strength testing, a provision was made in the prepared blocks. This machine has a hook so to have an attachment, therefore, blocks were cut using bur, the hook is embedded and space was filled with acrylic resin. This step helped in preparation of secured attachment of block to the Universal testing machine.

2.2. Impression making

A total of 15 auto-polymerizing custom tray specimens were coated with one of the four adhesives chosen for the study as per recommendation by manufacturer of the respective impression materials. Table 1 lists the names of the adhesive materials along with the respective manufacturers and method of application. The adhesives were allowed to dry for the prescribed time by the manufacturers.

The polyvinyl silicon impression material (Aquasil Monophase (Dentsply/caulk) was then mixed according to the manufacturer's instructions and loaded on to the auto-polymerizing custom tray specimens. The impression material was then allowed to polymerize in accordance with the respective manufacturer recommendation time. After polymerization was complete, the stone index was separated and the excess was removed from the specimen with the help of scalpel and blade. These specimens were then attached to the Universal testing machine with metal hook at one end of the tray specimen.

The force was then measured at a crosshead speed of 5 mm/minute using 450 kg load all set at full scale load till the time separation occur due to debunking. The values for noted for each auto-polymerizing custom tray specimens. The tensile bond strength was calculated using the formula:

Tensile bond strength = F/A where F is the maximum force at which separation failure, and A is the area of adhesion.

2.3. Statistical evaluation

The tensile bond strengths were calculated for each specimen using the formula, the maximum force at failure divided by the surface area. The data were analyzed statistically using SPSS software version 21 with one-way analysis of variance (ANOVA) and post hoc Tukey's test.

3. Results

The mean and standard deviations of tensile bond strengths for 3M ESPE, Ivoclar Vivadent, GC and Coltene-Whaledent adhesives were 1.47 ± 0.12 , 1.51 ± 0.12 , and 1.80 ± 0.04 MPa, and 1.87 ± 0.14 respectively. Table 2 summarises the results of the study. According to post hoc Tukey's test, the bond strength of Coltene-Whaledent adhesive was not significantly greater than that of GC (Vps Universal Tray Adhesive) ($p=0.09$).

4. Discussion

The technique used in making an impression and the type of impression material are determinants of the quality of an impression.^{10,11} The bonding of an impression material to tray is important by means of mechanical and/or chemical retention. The adhesives used for rubber base materials mainly contains polydimethyl-siloxane and ethyl

Table 1: Tray adhesives used in the study

Material name	Method of application	Manufacturer
Vps Tray Adhesive	Paint-on	3M ESPE
Adhesive	Paint-on	Coltene-Whaledent
Virtual Tray Adhesive	Paint-on	Ivoclar Vivadent
Vps Universal Tray Adhesive	Paint-on	GC

Table 2: Comparison of mean tensile strength among different adhesives

Adhesive	No. of Samples	Mean + SD	P value
3M ESPE	15	1.47±0.12	0.06
Coltene-Whaledent	15	1.87±0.14	0.05
Ivoclar Vivadent	15	1.51±0.12	0.06
GC	15	1.80±0.04	0.09

Test used- one-way ANOVA and post hoc Tukey's test P<0.05

silicate. Polymethylsiloxane forms bonds to the silicone impression material, whereas ethylsilicate forms hydrated silica for physical bonding. The volatile solvent, ethyl acetate reacts with the polymethylmethacrylate of tray to create microporosites forming physical and mechanical bonds with it.¹²

The strengths of our study were the use of single impression material to compare the bond strengths of different adhesives and reduce bias with different impression materials. We used commonly available adhesive materials in the market. The study was carried out with utmost attention to manufacturer's instructions. Auto-polymerizing tray material is the most commonly used in clinical dental practices today.⁶ In a study by Ashwini et al,¹³ the authors used two dental tray materials to evaluate bond strengths of universal and manufacturers adhesives to elastomeric materials from three different manufacturers. These were auto polymerising resin material manufactured by dental product of India (DPI) and visible light cured resin from DP dental. In another study by Vijayaraghavan et al,¹⁴ adhesive systems compared were 3M™ universal tray system (commonly used) and Medicept universal tray adhesive system (less commonly used) to evaluate the bond between tray resin material and medium body addition silicone impression material.

The drawback/limitation of study was that it was conducted under controlled conditions in the laboratory. Due to this, the results could vary if the bonds strengths were tested inside the oral cavity, in other words, under natural conditions where presence of saliva and temperature change could have given different readings on the testing equipment. The acceptable bond strength between adhesive and tray material was found to be in the range of 0.13–2.1 MPa in few studies in the past.^{15,16} In our study, the tensile bond strength of all the adhesives were well in this range suggesting these adhesives are clinical acceptable material for adhering impression material to the impression tray. Kumar et al¹⁷ found the highest tensile bond strength of adhesive by GC Asia Dental Pvt. Ltd. of 2.05 MPa among

other adhesives by 3M, Zhermack, Dentsply, Coltene with both autopolymerizing poly(methyl methacrylate) (PMMA) by Dental product of India and Dentsply. We found similar results, but the maximum measured bond strength was 1.87 of Coltene-Whaledent adhesive material and 1.80 of GC (Vps Universal Tray Adhesive) adhesive material.

5. Conclusion

The use of adhesives on custom trays is an essential step to retain polyvinyl siloxane to the tray material during the process of impression making. Although any of the commonly used adhesives (manufactured by 3M ESPE,Coltene-Whaledent, Ivoclar Vivadent, GC) can be used for application on auto-polymerizing custom trays before polyvinyl siloxane is added to the tray, tray adhesive by Coltene-Whaledent has the best bond strength followed by tray adhesive from GC (Vps Universal Tray Adhesive).

6. Source of Funding

None.

7. Conflict of Interest

None.

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Cite this article: Kumar K, Vaibhav V, Raj R, Singh AK, Kedia G, Kumar S. **Tensile bond strength of polyvinyl siloxane impression material to auto-polymerizing custom tray using different tray adhesives: A comparative study.** *IP Ann Prosthodont Restor Dent* 2020;6(3):145-148.