

Comparative Evaluation of Marginal Discrepancy in Tooth Colored Self Cure Acrylic Provisional Restorations With and Without Reinforcement of Glass Beads: An In-Vitro Study

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ABSTRACT

Context: This invitro study was conducted to compare and evaluate marginal discrepancy in two types of tooth colored self cure provisional restorative materials {DPI&UNIFAST TRAD} before and after reinforcement of glass beads.

Aim: The aim of the present study was to evaluate and compare marginal discrepancy in two types of provisional restorative materials (DPI and UNI FAST TRAD) before and after reinforcement with Glass beads.

Materials and Methods: Tooth shaped resin copings were fabricated on custom made brass metal die. A total of 60 resin copings were fabricated in which 30 samples were prepared with DPI and 30 samples with UNIFAST material. Each group of 30 samples were divided in to two sub groups in which 15 samples were prepared with glass bead reinforcement and 15 samples without reinforcement. The marginal discrepancy was evaluated

with photomicroscope {Reichert Polyvar 2 met} by placing the resin copings on custom made brass resin coping holder.

Results: Measurements obtained were statistically analysed by unpaired t-test to know any significance between two variables. Unreinforced DPI specimens had shown lower marginal discrepancy (442.82) than reinforced specimens (585.77). Unreinforced UNIFAST specimens have shown high values of marginal discrepancy (592.83) than reinforced specimens (436.35). p-value between reinforced and unreinforced specimens of DPI ($p=0.0013$) and UNIFAST ($p=0.0038$) has shown statistical significance.

Conclusion: This in-vitro study revealed that unreinforced DPI specimens have shown lower marginal discrepancy than reinforced specimens and unreinforced UNIFAST specimens have shown higher values of marginal discrepancy than reinforced specimens.

Keywords: Fixed partial dentures, Marginal fit, Plaque retention, Prosthesis

INTRODUCTION

Provisional restorations are an essential part of fixed prosthodontic treatment. Patients must be provided with an interim restoration from initial tooth preparation until the definitive prosthesis is placed. In addition to their biologic and biochemical requirements interim restorations provide the clinician with valuable diagnostic information [1]. They act as a functional and aesthetic try-in and serve as a blueprint for the design of the definitive prosthesis. Materials available for fabrication of provisional fixed partial dentures include auto polymerizing methyl methacrylate, poly vinyl methacrylate, urethane methacrylate, Bis-acrylic and micro filled resins. These materials can be polymerized by chemical, light or both by chemical and light activation [2].

Provisional material selection should be based on how their mechanical, physical, and handling properties fulfill specific requirements for any clinical case [3,4]. The ideal provisional restoration material has not yet been developed. These materials shrink during polymerization, which causes marginal discrepancy, especially when direct techniques are used. In addition, the resins currently used are exothermic and not entirely biocompatible. Considerations of all biological, mechanical and aesthetic factors should be given importance because provisional resin restorations are worn over a long period to assess the results of periodontal and endodontic therapeutics and also during the restorative phase of implant reconstructive procedures [5].

Accurate marginal fit of temporary crowns protects prepared

teeth from physical, thermal, bacterial and chemical injury. Marginal discrepancy leads to plaque retention resulting in gingival inflammation, marginal leakage which can lead to cement dissolution secondary caries, sensitivity, gingival recession and deboning of restoration [6-8].

The aim of the present study was to evaluate and compare the marginal fit of two commercially available tooth colored provisional restorative materials before and after reinforcement of glass beads.

MATERIALS AND METHODS

An invitro study was conducted in a dental institute in Southern India to evaluate and compare marginal discrepancy in two types of provisional restorative materials (DPI and UNI FAST TRAD) before and after reinforcement with Glass beads. This study was conducted for about one year period and the raw material required for the study was procured from the dental material distributor through online services.

In this study, the samples were prepared with specific dimensions using a master die that is precision milled of specific dimensions, based on the model employed by Francis. B. Robinson and Suthera Hovijitra [9] for their studies. This assembly essentially consists of 3 parts namely, the brass top, brass die and brass base.

1. The brass top is 30 mm in height, 20 mm in diameter and it can be placed and removed from the brass base and die which aids in easy removal of resin copings. The internal surface of the brass top is uniformly 1mm larger than the die circumference,

and occlusally 2.5 mm larger than the actual die [Table/Fig-1]. This fabrication maintains a uniform space of 1 mm throughout the master die, except occlusally where it is 2.5 mm.

- The brass die simulated crown preparation with a 5° total axial wall taper [Table/Fig-2]. The height of the brass die is 4.5 mm, with a diameter of 7.5 mm cervically and 7 mm occlusally. The shoulder margin was designed at cervical area with 1mm width at 90° angulation to long axis. Four markings were made on the base of the die on four sides to serve as standard reference points for measurement of marginal discrepancy of resin copings.
- The brass base is 20 mm in height and 20 mm in width into which the brass die can be accurately inserted and removed, and die can be stabilized with the help of screw retained pin lock [Table/Fig-1]. A total of 3 vents were created in the brass base with a diameter of 2 mm and 6 mm length to allow extrusion of excess material. The brass base is indexed with metal flanges to ensure consistent repositioning of brass top.

A total of 60 resin coping samples were fabricated in which 30 samples were prepared with DPI and 30 samples with UNIFAST TRAD tooth coloured self cure acrylic resin. Each group of 30 samples were divided in to two sub groups in which 15 samples were prepared with glass bead reinforcement and 15 samples prepared without reinforcement.

Each sub group (30 numbers) was equally divided in to 15 each for evaluation of marginal discrepancy between different variables as depicted in [Table/Fig-3].

All the resin copings were categorized as follows:

- Group-I: DPI tooth coloured self cure acrylic resin material without reinforcement of glass beads. (DPI-C)
- Group-II: UNIFAST TRAD tooth coloured self cure acrylic resin without reinforcement of glass beads. (UNIFAST-C)
- Group-III: DPI tooth coloured self cure acrylic resin material with glass beads reinforcement. (DPI-R)
- Group-IV: UNIFAST TRAD tooth coloured self cure acrylic resin material with glass beads reinforcement. (UNIFAST-R)

Resin coping fabrication with DPI and UNIFAST TRAD material for evaluation of marginal discrepancy:

The custom made brass master die with base and brass top assembly as described previously was used to fabricate acrylic resin

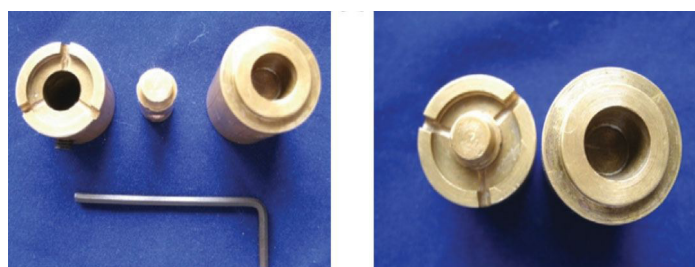
copings. A fine coating of die lubricant (LUBE WAX SEP, Dentecon, Los Angeles, USA) was applied on to the die and the internal fitting surface of brass top. Acrylic resin (DPI/UNIFAST TRAD) powder and liquid was mixed according to manufacturer’s instructions (1 gram of powder to 0.45 cc of liquid) in a mixing jar for 15 sec, once the material turns into doughy stage, it was packed into the brass top, which is seated on to the brass base containing the die till both the halves are in absolute contact and constant load was applied using hydraulic press (SILFRADENT). Vents present in the brass base allow the extrusion of excess material.

The brass die and top were separated 1min prior to rigid set of material. The resin coping was immediately removed from the die and reseated once. Excess material is trimmed from the cavo surface margin with a scalpel blade with in 30sec and each coping was placed on the die under a constant vertical load for 1min. The pattern was checked with wax calliper to verify uniform (axial and occlusal) thickness of material [Table/Fig-4]. A total of 60 resin copings were fabricated from the above mentioned [Table/Fig-5] method with DPI and UNIFAST TRAD resin material.

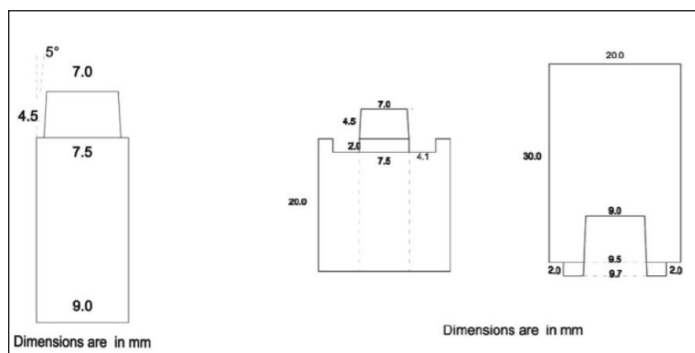
The remaining 60 samples were fabricated by reinforcing with glass beads in to the resin material. The type of product used in this study is GF-325 manufactured at Tainrong glass bead CO. Ltd, Lang Fang City, China. The particles of GF-325 are < 53µm for 88% of mass and remaining 12% of >53µm in thickness. The glass beads are added to DPI and UNIFAST TRAD resin by 10%W/W. i.e. (90 gm of acrylic resin polymer with 10 gm of glass beads) based on recommendations given by the studies performed by SB Sehajpal [10], Paul Franklin [11], San Yue Chen [12]. Reinforced powder & liquid was mixed according to manufacturer’s instructions and the resin coping samples were fabricated by above mentioned method for evaluation of marginal discrepancy. Evaluation of marginal discrepancy is a separate heading ,should be titled below glass bead composition.

Component	Percentages
Silicon dioxide (SiO ₂)	65-72%
Aluminium oxide (Al ₂ O ₃)	1-7%
Calcium oxide (CaO)	4-11%
Magnesium Oxide (Mgo)	0-5%
Boron oxide (B ₂ O ₃)	0-8%
Sodium + potassium oxide (Na ₂ + K ₂ O)	9-13%
Zinc oxide (ZnO)	0-6%

Each coping was seated on brass die with a finger pressure until resistance was met. Microscopic measurements were recorded at 80X magnification perpendicular to axial wall with a photomicroscope (Reichert Polyvar 2 met photo microscope, Reichert AUSTRIA) [Table/Fig-6] at the Department of Nuclear Physics, Madras University, Chennai, India. Measurements were recorded between coping



[Table/Fig-1]: Occlusal view of custom made brass former assembly and brass master die



[Table/Fig-2]: Line diagram of custom made brass master die & former

S. No	Parameter	DPI		UNIFAST TRAD	
		Unreinforced samples	Reinforced samples	Unreinforced samples	Reinforced samples
1	Marginal Discrepancy	15	15	15	15

[Table/Fig-3]: Specimens Prepared for Marginal Discrepancy Evaluation



[Table/Fig-4]: Custom made resin coping holder
[Table/Fig-5]: Prepared specimens on master die



[Table/Fig-6]: Photo Microscope (Reichert AUSTRIA)

margin and the brass die margin for marginal discrepancy. Marginal discrepancies were measured to the nearest micron on each coping at the four predetermined markings on base of the brass die. The same procedure is employed to record the marginal discrepancy for all the 15 test samples belonging to four test groups. The measurements obtained were tabulated and statistically analysed.

RESULTS

The measured values were recorded and subjected to statistical analysis by unpaired t-test to know any significant difference between the two variables. The 'mean', 'standard deviation' and p-values were calculated for the variables. In this present study p < 0.05 is considered as the level of significance. The results of this invitro study were tabulated in [Table/Fig-7].

It shows the mean and standard deviation values of marginal discrepancy between reinforced and unreinforced specimens of two provisional restorative materials. Unreinforced DPI specimens had shown lower marginal discrepancy (442.82) than reinforced specimens (585.77). P-value between reinforced and unreinforced DPI specimens (0.0013) has shown statistical significance.

Unreinforced UNIFAST specimens have shown high values of marginal discrepancy (592.83) than reinforced specimens (436.35). p-value between reinforced and unreinforced UNIFAST specimens (0.0038) has shown statistical significance.

The mean values of marginal discrepancy between unreinforced (442.82 – DPI, 592.83 – UNIFAST) and glass bead reinforced (585.77 – DPI, 436.35 – UNIFAST) specimens of two provisional restorative materials (DPI and UNIFAST) [Table/Fig-8].

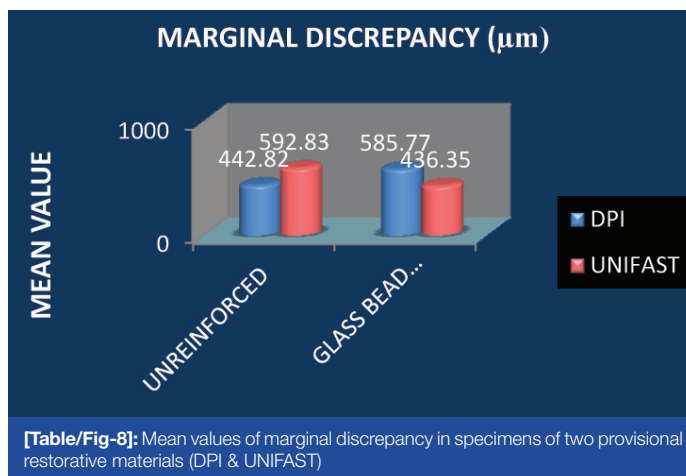
DISCUSSION

Provisional restoration protects and stabilizes the prepared teeth until the definitive form of treatment is accomplished [5]. Interim restoration must maintain the health of the pulpal and periodontal tissues. Marginal integrity is the most important predictor for clinical performance of provisional restorations. Poor marginal fit allows passage of fluids and bacteria between prepared tooth and restoration and may predispose the restoration to failure [1]. In addition poorly adapted interim restorations will cause mechanical irritation to surrounding tissues and enhance plaque accumulation which in turn cause periodontal problems ranging from gingival inflammation and gingival recession, especially when the margins of restorations are placed subgingivally [8].

One of the inherent properties of polymer based interim restorative materials is shrinkage during polymerization. Shrinkage can cause distortion that may jeopardize the accuracy of fit of the interim restoration and may also cause development of internal stresses within the restorations [8]. Marginal adaptation measure the amount of polymerization shrinkage that occurs in the interim restorations within the interim period.

	Unreinforced (μm)		Glass Bead Reinforced (μm)		p-value (<0.05)
	Mean	SD	Mean	SD	
DPI	442.82	118.20	585.77	99.55	0.0013
UNIFAST	592.83	165.27	436.35	97.54	0.0038

[Table/Fig-7]: Comparison of Mean and Standard Deviation Values of Marginal Discrepancy between Unreinforced and Glass Bead Reinforced Specimens of Two Provisional Restorative Materials



[Table/Fig-8]: Mean values of marginal discrepancy in specimens of two provisional restorative materials (DPI & UNIFAST)

The commercially available materials for provisional coverage include methyl methacrylate, ethyl methacrylate and bis-acrylic composite resins among which the methyl methacrylate and bis-acrylic resin composites are routinely used and only few studies have investigated their mechanical properties [13].

Glass fibres have been used as resin strengtheners since 1960's. Carbon fibres, Kevlar fibres, poly ethylene fibres have been used as resin strengtheners and they have shown favourable results in improving mechanical properties. The colour of carbon and kevlar fibres generates aesthetic problem. Colorless fibres can be reinforced either with a unidirectional or bidirectional fibers to the polymers for enhancement of mechanical properties [14].

In this present study unreinforced DPI specimens has shown lower marginal discrepancy (442.82 μm) than reinforced specimens (585.77 μm). Whereas, the unreinforced UNIFAST specimens has shown higher marginal discrepancy (592.83 μm) than reinforced specimens (436.35 μm).

The results in this study are coinciding with the work done by Vallittu [15] and demonstrated that an excess of monomer may be better for impregnation of fillers with poly methyl methacrylate but may cause more polymerization shrinkage, dimensional changes and more of marginal discrepancies and plastic deformation that was resulted due to deterioration of intermolecular linkage [16]. The magnitude of polymerization shrinkage depends on a number of factors such as the type of monomer, the volume and size of the filler, degree of conversion, the nature of the resin, flow of the resin, rate of polymerization, difference in the monomer to polymer conversion ratio, powder to liquid ratio can also account for the observed discrepancy [17].

Among the variables (DPI and UNIFAST) DPI has shown better mechanical properties than the UNIFAST. One of the limitations of the study is that measurements obtained in vitro may not reflect the conditions found in the oral environment which may affect the results of this study and furthermore specimens were not thermocycled (or) experimentally aged. Further studies have to be focused towards the clinical implications, long span interim bridges, evaluation and improvement of interface between reinforced material & resin matrix like silanization, chemical interaction and specific percentage of filler reinforcement. Other techniques can be studied and developed to improve the marginal fit of provisional restorations.

CONCLUSION

According to the results obtained in this study and with the specific materials used, Unreinforced DPI specimens have shown lower marginal discrepancy than reinforced specimens and Unreinforced UNIFAST specimens have shown higher values of marginal discrepancy than reinforced specimens.

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