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"Comparative Evaluation of the Shear Bond Strength and Tensile bond strength of Hard and Soft tissue Denture Relining Materials Bonded to Microwave Cured Denture Base Resin and Conventional Heat Cured Denture Base Resin"

[1]Dr. Lakshmi Priyadarshini P, [2]Dr. Puja Malhotra, [3]Dr. Sumit Singh Phukela, [4]Dr. Bhupender Yadav, [5]Dr. Kunal Nischal, [6]Dr. Pankaj Ritwal,

[1]lecturer, Dept. of Prosthodontics, Santosh Dental College, Santosh Deemed to be University, Ghaziabad

[2]Professor, Dept. of Prosthodontics, Faculty of Dental Sciences, SGT University, Gurgaon

[3]Professor, Department of 1. Prosthodontics, Faculty of Dental Sciences, SGT University, Gurgaon

[4]Professor, Department of Prosthodontics, Faculty of Dental Sciences, SGT University, Gurgaon.

[5]Lecturer, Department of Prosthodontics, Faculty of Dental Sciences, SGT University, Gurgaon.

[6]Reader, Department of Prosthodontics, Faculty of Dental Sciences, SGT University, Gurgaon.

Correspondence address- Dr. Puja Malhotra, MDS (Prosthodontics) Professor, Dept. of Prosthodontics, Faculty of Dental Sciences, SGT University, Gurgaon.,

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KEYWORDS

Shear Bond Strength, Tensile bond strength, Hard and Soft tissue, Conventional Heat, Base Resin

ABSTRACT:

Background: Denture bearing tissues are subjected to different types and different magnitude of forces, they also undergo remodeling over a period of time. Hence, many a times the intaglio surface of the overlying prosthesis has to be relined to fit onto the modelled tissues. Denture Liners have been widely used in Prosthodontics to refit the tissue contacting surface of prostheses. Chairside Denture (Hard and Soft) reliners are commonly used for this purpose they also act as shock absorbers i.e, help to distribute forces applied to soft tissues during function. It is very important that these lines bond to the denture surface to serve the purpose they are meant to. Various studies have been conducted to evaluate the bond strength of reline materials with conventional heat cure denture base resins however not much is known about the bonding of commercial denture reliners with other acrylics like microwave cured, light cured denture base resins. The present study was conducted to evaluate and compare the Tensile and Shear Bond Strength of Hard and Soft Denture Relining Materials Bonded to Conventional Heat Cured Denture Base Resin versus Microwave Cured Denture Base Resin.

Materials & Methods: A total of 160 Cylindrical Specimens were made from Cylindrical Metal Mould of dimension 20mm length and 8mm diameter. 80 specimens each using Conventional Heat Cured Acrylic Denture Base Material and Microwave Cured Denture Base Material. The study was divided in to 8 groups. Each group contained 20 samples. The centre of cylinder was marked using a marker and 4mm was cut off from the midsection using water cooling Disc. The test samples (Heat cured & Microwave cured denture base resin) were placed back in the respective portion of the cylindrical mould. Repacking was done with reline resins .Tensile and shear bond strength test was done with Instron Universal Testing Machine .Kruskal-wallis test was used for comparison of multiple groups followed by Mann-whitney U test that used for comparison the assessment of any significant differences between the groups.

Results: The highest mean Tensile bond strength value was obtained for Microwave cured denture base resin relined with G C Reline Hard (Kooliner) (27.08 MPa) and lowest for Heat cured denture base resin with G C soft denture reliner (1.04MPa). The highest mean Shear bond strength value was obtained for Microwave cured denture base resin relined with G C Reline Hard (Kooliner) (27.24 MPa) and lowest for Heat cured denture base resin with G C soft denture

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reliner (1.43MPa).

Conclusion: The microwave resin samples relined with hard liners exhibited maximum adhesion and showed highest tensile and shear bond strength value followed by heat cure resin samples relined with hard liners, microwave resin samples relined with soft liners and lastly heat cure resin samples relined with soft liners.

INTRODUCTION

Tooth loss is one of the most common oral health problems among elderly population[1]. Such chronic condition may be a result of oral health disease occurrence in life-course, like dental caries and periodontal disease [2, 3]. Despite advances in preventive dentistry, edentulism is still prevalent worldwide. It is a major and irreversible condition and is delineatied as the "final marker of illness burden for oral health" [4]. Studies have shown that edentulism is intimately related to socioeconomic factors and is common in poor populations. In these cases, conventional dentures play a vital primary course of treatment [5]. Hard and soft liners are two types of chairside denture liners used to Reline Removable Prosthesis directly in the mouth. Hard Relining Materials are divided on the basis of activation mechanism as Heat Cured, Self Cured and Light Cured. Most commonly Soft and resilient Liners are used for thin and sensitive mucosal tissues. On the basis of chemical structure Soft Relining Materials are divided into 4 subgroups: Plasticized Acrylic Resins (chemical or heat-cured), Rubbers (polyurethane and polyphosphate) Vinyl Resins, and Silicone Rubbers [6]. These relining materials eliminate the need for making new dentures when an existing denture is in good condition. The favourable result for relining depends on the Bond strength between reline resin and denture base resin and composition of both resin. A frail Bond will result in staining of the Relining Material [7]. There are very few studies on the Bond Strength of the Reline Resins to Microwave Cured Denture Base Resins . Therefore, the aim of the present study was to evaluate and compare the Tensile and Shear Bond Strength of Hard and Soft Denture Relining Materials Bonded to Conventional Heat Cured Resin and Microwave Cured Resin.

MATERIALS

1. Heat Cured Resin (DPI Heat Cure)
2. Microwave Cured Resin (ACRON MC)
3. Hard Liner(GC KOOLINER)
4. Soft Liner (GC Soft Denture Reliner)
5. Dental Stone (Kalabhai)
6. Dental Plaster (Type II gypsum).
7. Alginate separating media
8. Modelling Wax (Dento Kem, India)

METHODOLOGY

A total of 160 Cylindrical Specimens were made from Cylindrical Metal Mould of dimension 20mm length and 8mm diameter. 80 specimens were prepared using Conventional Heat Cured Acrylic Denture Base Material and 80 specimens were prepared using Microwave Cured Denture Base Material respectively. The methodology in present study is narrated in the following order:

1. Fabrication of Cylindrical Metal Die
2. Preparation of wax models
3. Fabrication of Test Specimen
4. Sectioning of Denture Base Resin Specimen
5. Repacking with Reline Resin
6. Shear Bond Strength Test
7. Tensile Bond Strength Test
8. Statistical Analysis

FABRICATION OF CYLINDRICAL METAL DIE

The Cylindrical Metal Mould (Figure 1) with dimensions 20mm length and 8mm diameter was designed and prepared for the present study.

Figure 1 : Cylindrical Metal Mould

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PREPARATION OF WAX MODELS

The obtained Mould was used to prepare wax blocks of desired dimensions for ease of fabrication of acrylic samples.

FABRICATION OF TEST SPECIMENS

A total of 80 specimens were prepared by conventional cured denture base resin and 80 specimens of microwavable cured resin respectively .The study was divided in to 8 groups. Each group contained 20 samples.

GROUPING OF SAMPLES

Group I: Heat Cured Resin bonded with Hard Liner

Group II: Microwave Cured Resin bonded with Hard Liner

Group III: Heat Cured Resin bonded with Soft Liner

Group IV: Microwave Cured Resin bonded with Soft Liner

Group I ,Group II, Group III and Group IV was for Tensile Bond Strength

GROUPING OF SAMPLES

Group V: Heat Cured Resin bonded with Hard Liner

Group VI: Microwave Cured Resin bonded with Hard Liner

Group VII: Heat Cured Resin bonded with Soft Liner

Group VIII: Microwave Cured Resin bonded with Soft Liner

Group V ,Group VI, Group VII and Group VIII was for Shear Bond Strength

Preparation Of Test Samples Using Conventional Heat Cure Resin Material Samples prepared from wax models were invested in the flask . Dewaxing was done by keeping flask in boiling water for 5 min. Separating media was applied to facilitate removal, Polymer and monomer were mixed in the ratio of 3:1 by volume . The material was packed in mould upon achieving dough consistency. Trial closure was done under 20 KN and kept for 30 min. Curing was done in water bath in an acrylizer at room temperature . Thereafter the flasks were placed in water for 72 hours for complete polymerization. Then heat cured acrylic resin samples were retrieved followed by finishing & polishing . A total of 80 samples were prepared by means of this procedure.

Preparation Of Test Samples Using Microwave Cured Resin Material

(ACRON MC) microwave-cured acrylic resin was used in the present study to prepare test samples. In this technique a special dental FRP (Fibre reinforced plastic) flask was used for preparing the samples.. The samples were cured by microwave irradiation. The output power was controlled by adjustment of the variable power controller unit. The polymerization method of curing acrylic involves 2 stages:

1). First Stage – Power was set to 86-90 watts (12%) for 13 min.

2). Second Stage – Power was set to 500 watts (70%) for 1 min 30 sec.

Then the flask was left for bench curing for 30 min. The microwave cured acrylic resin samples were retrieved followed by finishing & polishing . A total of 80 samples were prepared by means of this procedure.

SECTIONING OF DENTURE BASE RESIN SPECIMENS

The test samples (heat cured & microwave cured denture base resin) were placed back in the respective portion of the cylindrical mould. The centre of cylinder was marked using marker and 4mm was cut off from the midsection using water cooling Disc.

REPACKING WITH RELINE RESIN

The sectioned surface of denture base resin to be relined was made rough. Separating medium was applied over the mould containing these samples. A mix of 15ml powder and 6ml liquid (KOOLINER) was mixed in mixing jar for 30 seconds. Approximately after 1-2 minutes, the mixture was packed in the 4mm empty mid portion of the cylinders (Figure 2,3).

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Figure 2 : Heat Cured Denture Base Resin samples relined with Hard liners

Figure 3 : Microwave Cured Denture Base Resin samples relined with Hard liners

The flasks were closed and allowed to cure. Each sample was retrieved from the flasks and finishing was completed with diamond burs and scissor. The denture base resin samples were also relined with soft liner by using a powder/liquid ratio of 2:1 in a mixing jar then immediately, the mixture was packed in the 4mm empty mid portion of the cylinders (Figure 4,5). The flasks were closed and allowed to cure. Each sample was retrieved from the flasks and finishing was done by using diamond burs and scissor.

Figure 4 : Heat Cured Denture Base Resin samples relined with Soft liners

Figure 5 : Microwave Cured Denture Base Resin samples relined with Soft liners

TENSILE BOND STRENGTH TEST

Samples were subjected to a tensile load at cross head speed of 1mm/ min on Universal Testing Machine (Figure 6).

Figure 6 :Tensile Bond strength Test

The tensile bond strength was calculated as failure load divided by bonding area of the resin. The Following Equation was used ie. F=N/A .Where F is the tensile bond strength (Mpa), N is the vertical uniaxial load

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exerted on the specimen (in Newton) and A is the bonding area that is 56.26 mm^2

20 samples of each Group I, Group II, Group III, Group IV, were tested for Tensile Bond Strength

SHEAR BOND STRENGTH TEST

A Shear bond strength test (Figure 7) was carried out on Instron Machine at cross head speed of 1mm/ min, the Compressive load was applied with the knife edge blade placed parallel to machine interface in the Universal Testing Machine. 20 samples of each Group V, Group VI, Group VII, Group VIII, were tested for Shear Bond Strength. The maximum shear stress before the failure was recorded for each specimen.

Figure 7 : Shear Bond strength Test

STATISTICAL ANALYSIS

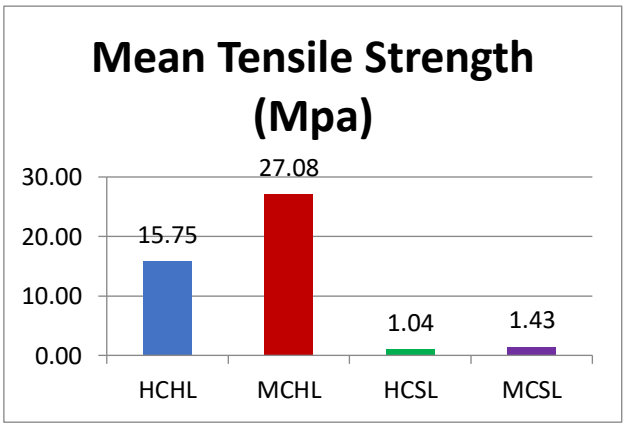
The data was analyzed using Kruskal -Wallis test and Mann-Whitney U test . A (p-value) less than 0.001 meant there was significant difference in mean tensile and shear strength.)

RESULTS

The present study was conducted to evaluate and compare the Tensile and Shear Bond Strength of Hard and Soft Denture Relining Materials Bonded to Conventional Heat Cured Denture Base Resin and Microwave Cured Denture Base Resin. Microwave cured denture base resin material relined with Hard reliner (Koo liner) showed the highest Tensile bond strength (27.08 MPa) while conventional heat activated denture base resin relined with G C soft denture reliner showed the least tensile strength value (1.04MPa) .(Table I, Graph I)

Table I: Comparison of mean Tensile Strength (Mpa) between Group I (HCHL), Group II (MCHL), Group III (HCSL), Group IV (MCSL) using the **Kruskal-wallis test**.

	Tensile Strength (Mpa)			
Groups	Mean	Std. Deviation	Critical value	p-value
HCHL	15.75	2.70	136.111	< 0.001*
MCHL	27.08	6.21		
HCSL	1.04	0.44		
MCSL	1.43	0.32		



Graph I: Comparison of Mean Tensile Strength of Hard and Soft Denture Relining Materials Bonded to Conventional Heat Cured Denture Base Resin and Microwave Cured Denture Base Resin

Similarly, Microwave cured denture resin relined with G C Reline Hard liner material (Koo liner) (27.24 MPa)

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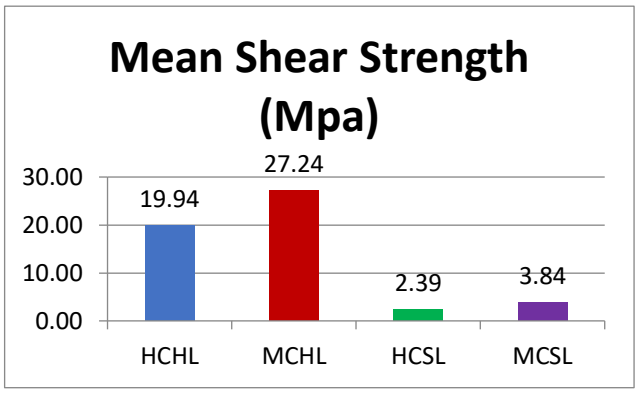
showed the highest shear bond strength values and Heat cured denture base resin with G C soft denture reliner (1.43MPa) showed the least. (Table II, Graph II)

Table II: Comparison of mean Shear Strength (Mpa) between Group V (HCHL), Group VI (MCHL), Group VII (HCSL) and Group VIII (MCSL) using the **Kruskal-wallis test**.

	Shear Strength (Mpa)			
	Mean	Std. Deviation	Critical value	p-value
HCHL	19.94	2.37	59.224	< 0.001*
MCHL	27.24	2.83		
HCSL	2.39	0.32		
MCSL	3.84	0.84		



Graph II: Comparison of Mean Shear Strength of Hard and Soft Denture Relining Materials Bonded to Conventional Heat Cured Denture Base Resin and Microwave Cured Denture Base Resin

DISCUSSION

Residual ridge resorption is an important consequence of tooth loss. Complete Dentures have been one of the most effective way of rehabilitating edentulous patients. However, continuous residual ridge resorption makes the dentures to become loose and unstable causing discomfort, chewing disability, and speech problems [8]. The gradual changes of oral tissue frequently require relining of complete or partial dentures in order to improve their adaptability to the supporting tissues. Denture Relining is resurfacing of the side of the denture by adding new material that contacts the soft tissues within the mouth. Clinically the use of resilient liners in the management of Prosthodontic patients is well known and they are supportive [9].As per the current literature, it is evident that there is no standard testing method for evaluating the bond strength of denture relining materials. In the present study, the testing methodology adopted is through tensile & shear bond strength analysis, since a simple load is applied to the joint which allows a comparison among different materials**.** Graham et al[10] reported that the clinical use of resilient denture liners is based on their flexibility and elasticity.

Craig and Gibbons [11] stated that the tensile strength of resilient denture lining materials increased after storage in water. Recent studies indicate that the bond strength of auto polymerizing resin to denture base polymer is not significantly influenced by the water content of the denture base polymer. However, the bond strength is influenced by the type of resin, thermal cycling, and surface treatment. Dootz et al [12] have shown that accelerated aging dramatically affects the physical and mechanical properties of many of the elastomers. Braden M, Wright PS [13] and Khan Z, Martin J, Collard S [14] evaluated the tensile strength of resilient lining materials and claimed that 10 psi (4.5 kg/cm2) is adequate adhesive value for an optimal bond between relining materials to denture base polymers. But Kawano et al [15] suggested that the force for failure was at least 9.6 kg/cm2 or higher for all materials tested. Mutluay et al [16] evaluated the adhesion of chair side hard relining materials to denture base polymers and stated that the chemical composition of the bonding agents and the relining materials and their combinations affected the depth of the swollen layers of denture base polymers and the tensile strength of adhesion. The results of adhesive Bond Strength between the Denture Reliner and Denture Base Polymer of various studies were mixed and conflicting and moreover the studies on the Bond Strength of the Reline Resins to Microwave Cured Denture Base Resins are not in literature .Therefore the present study was conducted to evaluate and compare the tensile strength and shear bond strength of hard and soft denture relining materials to the conventional heat cured denture base resin and microwave denture base resin.

According to the present study, the mean tensile bond strength value for Conventional Heat Cure Resin samples relined with Hard Liner (Group I) was 15.75Mpa (Table

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I and Graph I).The Mean Tensile Bond Strength value for Microwavable Resin samples relined with hard Liner (Group II) was 27.08Mpa (Table I and Graph I).The Mean Tensile Bond Strength value for Conventional Heat Cure Resin Samples relined with Soft Liner (Group III) was 1.04Mpa (Table I and Graph I).The Mean Tensile Bond Strength value for Microwavable Resin Samples relined with Soft Liner (Group IV) was 1.43Mpa (Table 1 and Graph 1).

Kawano F, Dootz ER, Koran A, Craig R G [15] reported that adhesive value for an optimal bond between denture base resin and liner is 0.96 Mpa. The results in this present study indicated that tensile bond strength value for all group samples was higher than 0.96 Mpa. Therefore DPI resin samples relined with soft liners, Microwavable resin samples relined with soft liners, DPI resin samples relined with hard-liners and Microwavable resin samples relined with hard-liners can be used clinically.

The mean Shear Bond Strength value for Conventional Heat Cure Resin samples relined with Hard Liner (Group V) was 19.94Mpa. (Table II and Graph II) The mean Shear Bond Strength value for Microwavable Resin samples relined with Hard Liner (Group VI) was 27.74Mpa (Table II and Graph II). The mean Shear Bond Strength value for Conventional Heat Cure Resin Samples relined with Soft Liner (Group VII) was 2.39 Mpa (Table II and Graph II). The mean Shear Bond Strength value for Microwavable Heat Cure Resin Samples relined with Soft Liner (Group VIII) was 3.84 Mpa (Table II and Graph II).The results in this present study indicated that shear bond strength value for all group samples was higher than 0.45 Mpa. Al-Athel MS, Jagger RG, Jerolimov V [17] stated that 0.45 Mpa is optimum shear bond strength between denture base resin and liners. Therefore DPI Resin samples Relined with Soft Liners, Microwavable Resin samples relined with Soft Liners, DPI Resin samples Relined with Hard Liners and Microwavable Resin samples relined with Hard Liners can be used clinically.

Lau M, Amarnath GS, Muddugangadhar ,Swetha MU ,Das KAAK [18] reported that mechanism for adhesion of hard relining material to PMMA Denture base material is due to the diffusion of monomer into the swollen PMMA denture base material polymerization and formation of the interprismatic network. Kooliner has MMA which has good swelling properties and also has the ability to introduce small MMA molecules penetrating into denture base polymer for good bonding. The bonding agent for Kooliner has small molecule i.e the acetone for swelling and 2 HEMA for swelling and penetration. Kreve S. Andrea C, Dosreis [19] reported that the tensile and shear bond strength is dependent on the chemical composition of liners.A Mese, K.G Guzel [20]suggested that the adhesion of liner to denture base polymer is influenced by the type of denture base resin. Though relining materials have good mechanical properties that could match PMMA denture base materials, bonding of the material still cause reline to fail and would require replacement of the lining resulting in midline fractures. A clinician should consider the use of materials with good bonding and handling properties. Therefore in the present study it was concluded that among the resin specimens relined with liners, the microwave resin samples relined with hard-liners exhibited maximum adhesion and showed highest tensile and shear bond strength value followed by heat cure resin samples relined with hardliners, microwave resin samples relined with soft liners and lastly, heat cure resin samples relined with soft liners.

CONCLUSION

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

1. The microwave resin samples relined with hard liners exhibited maximum adhesion and showed highest tensile and shear bond strength value followed by heat cure resin samples relined with hard liners, microwave resin samples relined with soft liners and lastly heat cure resin samples relined with soft liners.
2. The microwave resin samples relined with hard liners and heat cure resin samples relined with hard liners can be used in dental condition for high stress bearing area requiring long term application e.g. In bony undercut regions.
3. The microwave resin samples relined with soft liners and heat cure resin samples relined with soft liners can be used in low stress bearing area for short duration of time e.g. In areas of injury, trauma, and healing which require good resilient support.

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LEGENDS FOR FIGURES

1.Figure 1 : Cylindrical Metal Mould

2.Figure 2 : Heat Cured Denture Base Resin samples with Hard liners

3.Figure 3 : Microwave Cured Denture Base Resin samples Hard liners

4. Figure 4 : Heat Cured Denture Base Resin samples with Soft liners

5. Figure 5 : Microwave Cured Denture Base Resin samples Soft liners

6. Figure 6 Tensile Bond strength Test

7. Figure 7 Shear Bond strength Test