ORIGINAL ARTICLE

EFFECT OF PREPOLYMERIZED ZIRCONIUM REINFORCED COMPOSITE RESIN DOUBLE MEGA INSERTS ON THE MARGINAL ADAPTATION OF RESIN BASED COMPOSITE RESTORATIONS

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ABSTRACT

The purpose of this in vitro experimental study was to assess the effect of pre-polymerized zirconium reinforced composite resin double mega inserts on the marginal adaptation of resin based composite restorations.

Resin based composite (RBC) is the most commonly used as direct restorative material in anterior and posterior teeth. The drawback of polymerization shrinkage in RBC that is maximum 3% by volume can produce stress at composite-tooth interface and may initiate failure of RBC restorations.

Eighty human mandibular molars were prepared for class II and class V cavities with dimensions of 3.5mm depth, 3mm height and 3.5mm width. The specimens were divided into control and experimental groups with forty specimens in each group. Both groups were further divided into two sub-groups by type of prepared cavity as A1, A2 for control group and B1, B2 for experimental group respectively with 20 specimens in each group. The cavities in control group were filled with conventional composite resin while cavities in experimental group were filled with pre-polymerized zirconium (30% by weight) reinforced resin composite double mega-inserts. All the specimens were cured and microleakage was assessed by dye penetration method using microscope. The dye penetration test revealed that control group specimens had more microleakage than experimental group specimens.

It was concluded from the present study that pre-polymerized zirconium reinforced resin composite double mega inserts reduced the marginal leakage and improved the marginal adaptation in both class II and class V restorations.

Key Words: *Pre-polymerized zirconium reinforced composite resin, marginal adaptation double mega inserts, restorations*

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INTRODUCTION

Dental composite resin as tooth colored restorative material viewed as one with the numerous achievements in advanced biomaterials since they restore tooth structure in terms of appearance and function.[1, 2] Composite resins are common in dental community because of conservative technique; acceptable esthetics and economic. The composite resins have improved in terms of physical properties since its introduction but still needs improvement. The shrinkage of composite resins after polymerization leads to a decreased free volume. This result in stresses on the restoration-tooth interface resulting in micro leakage, sensitivity and secondary caries.[3] In posterior teeth 50% of the restorations were with resin based composite materials. The defects at the composite/tooth interface cause stress generation during polymerization of restoration

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and subsequent thermal, functional, and mechanical stresses.[4] The main drawback of resin based composite restorative materials is polymerization shrinkage which may reach up to 3% by volume.[5] The polymerization process and the extent of the volumetric shrinkage are influenced by the composition of the composite resin. Higher the extent of triethylene glycol dimethacrylate (TEGDMA) higher will be the polymerization shrinkage. A negative correlation of polymerization shrinkage and fillers exists. Pre-polymerized fillers can provides same results as were produced through incorporation of pre-polymerized fillers in basic composition of microfilled composites. Increased filler contents results in decrease polymerization shrinkage, water absorption and coefficient of linear expansion. The compressive and tensile strengths, modulus of elasticity and wear resistance are also increased. The filler content can be increased to a limit without adversely affecting the working properties.[6] Shrinkage stress can affect the marginal integrity and can result in debonding, leakage, recurrent caries and dentine hypersensitivity.[7]

Fillers are the organic or inorganic particles like silica, quartz and ceramic designed to strengthen the composite. The type and size of filler in addition to bonding to resin matrix further influences the physical properties of composite resin.[8] To reduce the bulk of matrix phase, mega-fillers can be incorporated into the composite resin.[9] Insertions of single mega insert fillers in composite resins at direct restorative stage has resulted in better marginal adaptation and decreased polymerization shrinkage.[10] The literature indicates that marginal adaptation depends on inserts size.[11] No informative data on zirconium reinforced double mega inserts into the composite resin was found thorough literature search. In order to reduce the marginal gap and microleakage in composite resin, an attempt was made through zirconium reinforced double mega insert fillers like other researchers performed experiments for minimizing the draw backs associated with it. Null hypothesis for this study is, "there will be no difference in polymerization shrinkage and marginal gap formation in a composite restoration with placement of double mega inserts".

Present study was done to know the effect of pre-polymerized zirconium reinforced resin composite double mega inserts on the quality of the marginal adaptation (measured as microleakage) using the dye penetration method of resin based composite restoration.

MATERIALS AND METHODS

This in vitro experimental study was carried out in Physics Department, University of Peshawar and Department of Science of Dental Materials, Peshawar Dental College from 15th Jan to 20th June 2016. This study was started with collection of caries free; periodontaly involved eighty (80) mandibular molars teeth. The teeth obtained were cleaned with normal saline and placed in normal saline solution for 24 hours. The teeth were divided into two main groups with forty teeth in control group (n=40) and forty teeth in experimental group (n=40) respectively. The teeth in each of the groups were further divided into two sub groups by type of prepared cavity as A1, A2 for control group and B1, B2 for experimental group respectively with 20 specimens in each group. The teeth in the control subgroup A1 were subjected to class V cavities and the teeth in the control subgroup A2, class II cavities were prepared. The teeth in the experimental subgroup A1 were subjected to class V cavities and the teeth in the experimental subgroup A2, class II cavities were prepared. All the cavities were prepared with a high-speed air turbine (NSK, Japan) at 360,000- 450,000rpm under constant irrigation with water spray using diamond burs (Mani Incorporation, Tochigi, Japan). The prepared cavities were standardized to dimensions of 3.5mm deep 3mm height and 3.5mm wide with the help of a periodontal probe.

The cavities in control group A1 and A2 were filled and cured incrementally with conventional composite resin (3M ESPE, USA) after following the protocol of etching with 37% phosphoric acid gel (Fill Echant-37 Vericom Korea), bonding agent (Solare X GC Corporation Tokyo, Japan) and curing with LED light (Woodpecker, USA) for 20 seconds.

The cavities in experimental group B1 and B2 were etched with 37% phosphoric acid gel (Fill Echant-37 Vericom Korea) followed by application of bonding agent (Solare X GC Corporation Tokyo, Japan) and curing with LED light (Woodpecker, USA) for 20 seconds. The cavities in both sub-groups were then filled with increments of composite resin (3M ESPE, USA) and were left uncured. The zirconium reinforced double mega insert fillers were coated with bonding agent (3M ESPE, USA) and two mega insert fillers were placed in each cavity with the help of tweezers, containing uncured composite resin. The zirconium reinforced composite resin with double mega insert filler was then cured with LED light (Woodpecker, USA) for 20 seconds. All the specimens were kept in water baths having normal saline at 37˚C for 24 hours. Specimens were subjected to 250 cycles of thermo cycling between 52˚C to 60˚C with dwell time of 30 seconds in each water bath and 10 seconds interval between the baths.[12] Nail varnish (Revlon, USA) two coats were applied to the tooth structure 1mm short of the restorative margins. The specimens were then stored in a solution of 10% methylene blue in distilled water for 24 hours. The specimens were longitudinally sectioned in centre of the restoration using a diamond disc (Shofu Inc. Japan). The extent of dye penetration was recorded for each specimen and values for microleakage were recorded in millimeters. Dye penetrations were examined on light microscope at 40X magnification.

Statistical analysis was performed by SPSS version 16 for the evaluation of paired sample t-test. Significant value was considered less than 0.05 for the statistical test.

RESULTS

The distribution of microleakage score in class II and class V restorations for both control and experimental groups are shown (Table 1 & 2). It was found that microleakage score in the specimens of control group was significantly higher as compared to experimental group. Control group with class II restorations nine out of twenty specimens showed no dye penetration and eleven specimens showed 1mm microleakage. Experimental group with class II restorations, sixteen out of twenty specimens showed no dye penetration and four specimens showed 1mm penetration. The control group with class V restorations eleven out of twenty specimens showed no dye penetration and nine specimens showed 1mm microleakage. While experimental group with class V restorations, seventeen out of twenty specimens showed no dye penetration and three specimens showed 1mm penetration. All the specimens with class II cavities were also analyzed which provided significant values (Table 3).

DISCUSSION

Marginal microleakage of dental composite resin is one of the most common shortcomings in restorative dentistry and can lead to failure of composite resin restoration. This downside occurs as a result of fatigue-cycling, thermal changes and polymerization shrinkage.[6] In this study pre-polymerized zirconium double mega inserts have been added to composite resin to reduce the microleakage in both class II and class V cavities. The reinforcement of composite resin improved the marginal gap values and thus confirms the rejection of null hypothesis.

The results of current study are in accordance with Rocca et al[13] who reported reduced marginal gaps by employing multiple inserts containing resin composite in his study, suggesting that fiber reinforced insert could reduce marginal microleakage. This lowers the occurrence of marginal discrepancies caused by polymerization shrinkage stresses. Insert systems matching the cavity preparation increase the custom-fit of the inserts, so the overall volume of the un-polymerized composite resin can be reduced, resulting in a better marginal adaptation.[13] Results of present study were similar to the findings of the Ozcan et al[14], who evaluated the marginal integrity of class II composite restorations with SDS (Schumacher Dental System) inserts and class II composite restorations placed with an incremental technique. The addition of inserts permitted the reduction in composite volume responsible for contraction and thermal volume changes and thus optimized marginal adaptation.[14] The decrease in the marginal gap by addition of zirconium filled composite mega fillers can be explained by the fact that the marginal gap formation depends on the polymerization shrinkage stresses at the composite-tooth interface, which in turn depends on the volume of the un-polymerized composite in the cavity. The addition of inserts into composite restoration increases the filler loading inside a restoration without increasing its volume that result in decrease polymerization shrinkage.

The idea of incorporating mega fillers or inserts was marketed by Donly et al.[15] It was also determined that the use of pre-cured resins composite inserts improved the marginal seal.[15] Lezaja et al[16] also determined in their studies that the use of glass ceramic inserts reduces

TABLE 1: DISTRIBUTION OF THE MICRO-LEAKAGE SCORES IN CLASS II RESTORATIONS IN THE EXPERIMENTAL AND CONTROL SUB GROUPS

Groups	Microleakage Scores				Total Specimens
	0.00mm	1.0mm	2.0mm	3.0mm	
Control	9	11	0	0	20
Experimental	16	4	0	0	20

TABLE 2: DISTRIBUTION OF THE MICRO-LEAKAGE SCORES IN CLASS V RESTORATIONS IN THE EXPERIMENTAL AND CONTROL SUB GROUPS

Groups	Microleakage Scores				Total Specimens
	0.00mm	1.0mm	2.0mm	3.0mm	
Control	11	9	0	0	20
Experimental	17	3	0	0	20

TABLE 3: REULTS OF PAIRED T-TEST

	Groups	N	T-value	P-value
Pair 1	Control Group: Class II restorations	40	0.452	0.045
	Experimental Group: Class II restorations			
Pair 2	Control Group: Class V restorations	40	0.464	0.039
	Experimental Group: Class V restorations			

the marginal leakage. These studies showed that use of beta quartz ceramic insert exhibits significantly less microleakage compared to pre cured resin composite inserts.

Brand et al[17] stored the specimens at 37°C for one week after restoration, finishing, polishing and thermo-cycling. To identify the bucco-lingual plane the teeth were embedded in clear resin before sectioning. The length of the interface in each section was kept equal as in the current study 1mm was left uncovered for dye penetration. Both surfaces of each section were scored and gave several measurements available for analysis this technique was in accordance with the protocol and recommendations of Brand et al[17] and Raskin et al[18]. In vitro findings regarding improvements in the marginal adaptation in these studies have been confirmed through dye penetration which was in accordance with the current study. Short and long-term controlled clinical studies for clinical success of this alternative restoration procedure requires further investigations regarding the stability of the insert/composite bond, the fracture and wear resistance of the overall restoration.

CONCLUSION

The use of pre-polymerized zirconium reinforced resin composite double mega inserts reduced the marginal leakage in both class II and class V restorations.

Limitations of the Study

It was an in vitro study; clinical trials are needed to observe improved adaptation in the restorations made in clinical setup. Since the materials used in this study are proven nontoxic and biocompatible so no animal studies are required. Standardization of cavities and filling procedure and not using the SEM were also the limitation of the study.

Recommendations

It was an in vitro study and clinical trials are suggested to see the effect of decreasing microleakage in RBCs using zirconium reinforced mega filler inserts. An indigenous method of fabrication of mega filler made of the same composite material will be used in the restoration of the cavity and air abraded before bonding so as to increase micromechanical bond. Controlled clinical studies are of great importance in evaluating the longevity and clinical success of insert systems.

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