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Dentistry

COMPARISON BETWEEN THE COMPOMER, ORMOCERS, NANOCOMPOSITES AND ACTIVA BIOACTIVE REGARDING SHEAR PUNCH STRENGTH UNDER INFLUENCE OF DIFFERENT DIETARY SOLUTIONS: A PROSPECTIVE STUDY

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ABSTRACT **Background:** Mechanical causes alone do not destroy restorative materials; chemical considerations also play a part in the deterioration process. This could be accountable for the destruction, and untimely rupture of dental composites in the oral cavity. Dietary solvents are one of the most important substances in this regard. The introduction of composite-based restorative materials like compomer, Activa Bioactive, Nano-ceramics and Ormocers has improved the clinical use of ordinary glass ionomer cements. **Objectives:** To compare the shear strength of recently used esthetic restorative materials, i.e. Compomer, Ormocer, Nanocomposite and Activa Bioactive under the influence of different dietary solvents. **Methodology:** 128 specimens in which 32 specimens of each of the following four materials were chosen for this study,: Compomer (F2000 3M ESPE), Ormocer (Admira VOCO), ACTIVA Bioactive (Pulpdent Corporation), and Nanocomposite (Filtek Z350XT). The conditioning media were divided into four subgroups (three different meal imitating materials): i) Heptane (37°C) ii) 50 percent ethanol-water solution (37°C) iii) 0.02 M Citric acid (37°C) iv) distilled water (37°C). The specimens after treating with dietary solutions were subjected for testing of the shear punch strength. Custom designed shear punch apparatus in Universal Testing Machine was used. The cross head speed was adjusted at 2.0 mm/min and recording of the maximum load to make punch through the specimen was carried out. **Results:** It was observed that shear punch strength of nanocomposites was maximum in all four dietary solvents used in study. On the other hand compomer had least shear punch strength. It was further analysed that shear strength of ormocer was greater than bioactive but less than nanocomposites in citric acid and haptane treatment. While bioactive had more shear strength than ormocer but less than nanocomposites when the dietary solvent was 50%ethanol. It was observed that strength of bond was significantly affected by dietary solvents in restorative materials ormocers and bioactive materials. **Conclusion:** On the basis of results of this research it can be concluded that nanofilled composites had maximum shear strength while compomers had the minimum shear strength in all dietary solvents. Besides strength of bond was significantly affected by dietary solvents in restorative materials ormocers and bioactive materials.

KEYWORDS : Activa bioactive, Compomer, dietary solvents, nanofilled composite, ormocers,

INTRODUCTION

The durability of the restorative material, the development of a flawless bond on the material-tooth contact, and excellent aesthetics are the most essential goals of restorative dentistry. The introduction of composite-based restorative materials like compomer, Activa Bioactive, Nano-ceramics and Ormocers has improved the clinical use of ordinary glass ionomer cements. Due to advancements in formulation, bonding processes, and improved aesthetics, the usage of such restorative materials has increased in recent decades.[1,2]

"Compomers" are composite based restorative materials in which the benefits of composites and glass ionomers are believed to be integrated. Therefore its name have got contibution from both constituents i.e "comp" for composites and "omer" for glass ionomer cements. A new class of materials called ORMOCERs (ORganically MOdified CERamics) was developed in Germany for the first time in which the sol-gel method was used. For the manufacture of such organic based copolymer composites, recently developed thioether oligo (meth) acrylate alkoxysilanes and multifunctional urethane were used as sol-gel precursors.[3,4]

Nanofilled composites, a new brand of composite resins made employing nanofiller technique and mixed with nanocluster filler particles and nanomer, has been introduced.[5-6] A bioactive substance induces an unique biological reaction at the material's surface, resulting in the creation of a link between both the biological tissues as well as the restorative material.[7,8] Activa BioActive resins are tough, long-lasting, anion restoration resins that discharge and replenish extra calcium, flouride and phosphate than glass ionomers and standard RMGIs, and have composite-like physical qualities and aesthetics.[8-11]

Mechanical causes alone do not destroy restorative materials; chemical considerations also play a part in the deterioration process. This could be accountable for the destruction, and untimely rupture of dental composites in the oral cavity. Dietary solvents are one of the most important substances in this regard.[12-15] The aspect of influence of oral dietary solvents on the shear punch strength of newly introduced composite based restorative materials described above need to explored with more details because it would help in understanding the efficacy of these restorative resins in the oral environment. Unfortunately there has been no such study according to the knowledge of authors being conducted earlier which has evaluated this important aspect.[16-19]

Hence this study was carried out to compare the shear strength of recently used esthetic restorative materials, i.e. Compomer, Ormocer, Nanocomposite and Activa Bioactive under the influence of different dietary solvents.

METHODS AND MATERIALS

It was a prospective study in which 32 specimens of each of the following materials were chosen for this study: Compomer (F2000 3M ESPE), Ormocer (Admira VOCO), ACTIVA Bioactive (Pulpdent Corporation), and Nanocomposite (Filtek Z350XT). The study was conducted after obtaining clearance from the institutional ethical committee.

The Four Conditioning Media (three Types Of Food Imitating Materials) Are As Follows:

The conditioning media were divided into four subgroups (three different meal imitating materials):

1. Heptane (37°C) – mimics vegetable oils, fatty meats and butter.
2. A 50 percent ethanol-water solution (37°C) was used to simulate alcoholic beverages, as well as vegetables, candies, syrup and fruits,.
3. 0.02 M Citric acid (37°C), to mimic acidic food
4. Distilled water (37°C), which mimics a moist oral environment.

I- Shear Punch Testing:

Specimen Preparation:

Brass washers were chosen with following dimensions: Inner diameter was 5 mm, outer diameter was 14 mm, and thickness of 1mm. Restorative materials were placed inside these brass washers to prepare specimens for shear strength. Mylar strips were attached to the glass slides. Then brass washers with restorative material were placed at these glass slides. Then another mylar strip was put on the brass washers. After that second glass slab was put over the top of brass washers having restorative materials. Gentle pressure with finger was applied so that extra restorative material can be extruded. Thereafter, light curing was carried out. Densply spectrum 800 polymerization unit was used for light curing.(Figure 1) The parameters used were 400 to 500 nm visible light range. 800 mW/cm^2 was output power used in

light curing. For each material to be analysed, 32 specimens were prepared and kept in distilled water separately in airtight containers. The temperature was adjusted at 37˚C for a duration of one week.

Grouping Of Samples

Shear punch testing was performed on a total of 128 specimens. They were separated into four groups based on the resin composites used. Each group was further divided into four primary sub groups, each with 32 specimens to represent the four distinct conditioning media.

Group 1: Nanocomposites
Group 2: ACTIVA Bioactive
Group 3: Compomers
Group 4: Ormocers

Method Of Shear Punch Testing

The specimens were removed from the distilled water after one week and then placed in the different dietary solvents for another week.(Figure2) At the end of week specimens were removed from dietary solvents. Then they were wash, dry blotted. Now the specimens were subjected for testing of the shear punch strength.(Figure 3) Custom designed shear punch apparatus in Universal Testing Machine were used. The cross head speed was adjusted at 2.0 mm/min and recording of the maximum load to make punch through the specimen was carried out.

Statistical Analysis

SPSS 20.0 (IBM,USA) was used for statistical analysis. The interaction between materials and conditioning mediums was evaluated using two-way ANOVA. One-way ANOVA and Bonferroni post-hoc tests were used to determine inter-material differences. $p \leq 0.05$ was considered as statistically significant.

RESULTS

It was observed that shear punch strength of nanocomposites was maximum in all four dietary solvents used in study. On the other hand compomer had least shear punch strength. It was further analysed that shear strength of ormocer was greater than bioactive but less than nanocomposites in citric acid and haptane treatment. While bioactive had more shear strength than ormocer but less than nanocomposites when the dietary solvent was 50%ethanol.(Table 4). It was observed that strength of bond was significantly affected by dietary solvents in restorative materials ormocers and bioactive materials.(Table 3).

The maximum shear strength in nanocomposites was on being treated with 50% ethanol while it was minimum on being treated with citric acid. But the difference was not statisticall y significant. ($p>0.05$). When Bioactiva was treated with different dietary solvents then it was found that maximum shear strength was on being conditioned with distilled water while minimum shear punch strength was on being conditioned with citric acid. The difference was statistically significant.($p=0.0001$). In case of compomer specimens, maximum shear strength was observed when they were put in the distilled water and it was minimum when specimens placed in haptane. The difference was statistically non significant. ($p>0.05$). On the other hand minimum strength was observed when ormocer was placed and treated with distilled water and maximum strength was on being treated with haptane. The difference was statistically significant. ($p<0.01$).(Table 1, Figure 4)

Then intergroup comparisons were made between the four restorative materials regarding difference in mean shear strength between different groups. It was observed that difference between Group 1and Group 2, Group 1vs Group 3, Group 1vs Group 4, Group 2vs Group 3 and Group 3vs Group 4 was statistically significant. It was non significant when comparison was between Group 2 vs Group 4.(Table 2)

DISCUSSION

The biochemical environment in the mouth may have a significant impact on composite resin breakdown in vivo. The development of a stable bonding between restorative materials and the tooth substructure is necessary for successful restorative treatment. It is required from both a biological and mechanical point of view.[20-24] Under the impact of various dietary solvents like distilled water, 50% ethanol, citric acid, and haptane. the shear strength of recently employed aesthetic restorative materials, such as Compomer, Ormocer, Nanocomposite, and Activa Bioactive, was compared in this study.

It was observed that Nanofilled composite showed maxumum shear strength in all dietary solvents while compomers showed the least shear strength as compared to other composites used in the study. It's possible due to the fact that the higher volume of the fillers reduces the amount of water absorbed into the matrix in nanofilled composites.

Kaur et al discovered that Nanocomposite has a higher shear strength, suggesting that it may be used more widely.[25] Bisphenol Aethoxylate dimethacrylate (BisEMA) and Bisphenol Aglycidyl methacrylate (BisGMA) were used to make the nanofilled composite. BisEMA strengthened it against the weakening effects of an ethanol based water solution. BisEMA-based composites were found to be very resilient to the deteriorating impact of meals liquids such as ethanol, according to Nayak et al.[26]

In all of the dietary fluids used in this study, ormocer demonstrated a lower shear strength compared to nanofilled composites. It could be due to the availability of triethyleneglycol dimethacrylate, which contributes to solvent vulnerability and plasticization. This is something Kaur and Nandlal agree on.[27] When compared to citric acid, 50% ethanol, and distilled water, conditioning in heptanes dramatically enhanced the shear strength of ormocer used in this study. The greater strength properties could be attributable to the reason that heptane prevents silica and mixed metals from leaching out of fillers. Cramer et al. discovered that after treating with distilled water, the shear strength of active bioactive resin was much higher.[28]

The increased shear strength is attributed to the reason that they comprise zones or sections of water, and their ion based ingredients are frequently released and recharged. KocVural et al. investigated the strength of bond of old resin-based nanocomposites composites, finding that bulkfill repaired materials had the highest bond strength.[29] Jayasree attempted to investigate the strength properties and micro leakage of conventional and light cured Glass Ionomer resins, composite and Compomer.[30] It was discovered that Compomer exhibited greater strength properties and the minimum microleakage. Korkut et al. evaluated the structural qualities of four distinct RMGI cements versus ACTIVA Bioactive Restorative material and discovered that ACTIVA Bioactive Restorative material had improved physical and mechanical properties.[31]

In primary molars, Omidi et al. evaluated by comparing the microleakage of Class II cavity restorative materials like composite, RMGI and ACTIVA Bioactive Restorative Glass. It was observed that the microleakage of ACTIVA Bioactive Restorative material was nearly equivalent to the microleakage of composites.[32] Cond et al. studied the structural and morphological features of giomers in comparison to composite and Compomer.[33] It was discovered that giomers behaved similarly towards the other resin composites studied. Shathi et al. carried out a study to compare ormocer and giomers regarding the marginal microleakage. It was observed that microleakage was lesser in ormocers.[34]

In this study authors observed that shear strength of the nanofilled composites was maximum when treated with dietary solvents in compared to other restorative materials namely ormocers, compomers and bioactive materials while compomers had minimum shear strength showing that nanofilled composites are least affected by the dietary solvents while compomers were most affected. The findings of this study aid in estimating the impact of dietary solution on the shear strength of different dental restorations; as a result, caution should be exercised in selection of dental materials and type of restoration so that success of restorations can be achieved for longer duration.

There were certain limitations of this study. Specimens were kept in the dietary solvents for one week and then evaluated for shear strength. The duration of one week was shorter and evaluation should have been for longer duration. Another limitation was that the findings of this study was for in vitro analysis. Therefore the results may vary in the actual conditions of oral cavity. Hence more studies should be carried out in vivo conditions, larger sample size and longer duration of immersion of specimens in the dietary solvents.

CONCLUSION

On the basis of results of this research it can be concluded that nanofilled composites had maximum shear strength while compomers had the minimum shear strength in all dietary solvents. Besides strength of bond was significantly affected by dietary solvents in restorative materials ormocers and bioactive materials.

Table 1: Shear Punch Strength Of Different Composites In Different Dietary Solvents

Composite	Medium	Mean	Std. Deviation	p-value
Nanocomposite	Distilled water	1172.50	83.779	0.140
	50% ethanol	1238.75	201.290	
	Citric acid	1012.50	95.570	
	Haptane	1145.75	93.189	
Bioactiva	Distilled water	958.50	1.291	0.0001
	50% ethanol	727.50	150.132	
	Citric acid	566.00	64.068	
	Haptane	717.75	42.225	
Compomer	Distilled water	496.00	10.708	0.057
	50% ethanol	485.75	19.636	
	Citric acid	471.75	12.285	
	Haptane	470.50	7.724	
ormocer	Distilled water	588.75	108.963	0.0001
	50% ethanol	767.50	24.839	
	Citric acid	798.75	15.086	
	Haptane	863.00	44.557	

p≤0.05 is statistically significant

Table 2: Inter Group Comparison Among The Four Groups Using Post Hoc Bonferroni

Composite (I)	Composite (J)	Mean Difference	Std. Error	Sig.
1	2	399.938	45.149	0.0001
	3	707.250	45.149	0.0001
	4	387.875	45.149	0.0001
2	3	307.313	45.149	0.0001
	4	-12.063	45.149	0.995
3	4	-319.375	45.149	0.0001

* The mean difference is significant at the p ≤0.05 level.

Table 3: Results Of Statistical Analysis Based On Materials

Material	Differences
Nanocomposite	NS (p=0.140)
Bioactiva	Significant (p=0.0001)
Compomer	NS(p=0.057)
Ormocer	Significant (p=0.0001)

One way ANOVA applied, p≤0.05 is statistically significant

Table 4: Results Of Statistical Analysis Based On Dietary Solvents

Material	Differences
Distilled water	NC>Bioactiva>ormocer>compomer
50% ethanol	NC>Bioactiva>ormocer>compomer
Citric acid	NC>Ormocer>Bioactiva>compomer
Haptane	NC>Ormocer>Bioactiva>compomer

One way ANOVA applied

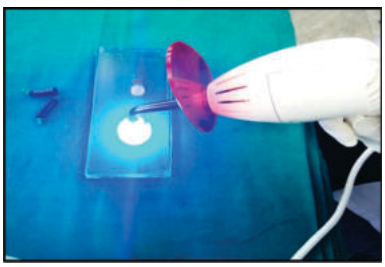

Figure-1: Curing Of Composites

Figure-2: Prepared Samples Stored In Respective Dietary Solvents For A Week

Figure 3: Prepared Light Cured Sample Mounted In Custom Designed Shear Punch Apparatus.

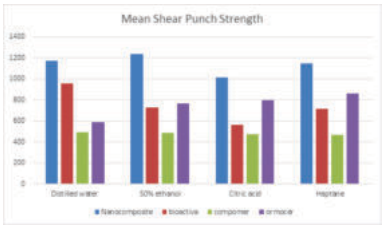

Figure 4: Graph Showing Shear Punch Strength Of Different Composites In Different Dietary Solvents

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