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Comparative Evaluation of the Compressive Strength of A Ceramic Reinforced Glass Ionomer and Resin High Strength Glass Ionomer Cement with A Nanohybrid Composite Material: An In Vitro Study

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ABSTRACT

Aim: To evaluate and compare the compressive strength of a ceramic-reinforced glass ionomer and resin-based high strength glass ionomer cement with a nanohybrid composite

Material and methods: 30maxillary premolar teeth were selected. Selected teeth after cleaning were mounted in acrylic resin blocks exposing the crown. Class II cavities were prepared. Samples were divided into three groups of 10teeth; *Group 1:* Class II cavity restored with nanohybrid composite (control group). *Group 2:* Class II cavity restored with ceramic reinforced GIC *Group 3:* Class II cavity restored with resin-based GIC. Restored samples stored in artificial saliva for two weeks and thermocycling were done for 500 cycles between the temperature of 4-degree Celsius to 45 degree Celsius and subjected to compressive strength test using the universal testing machine at a crosshead speed of 0.5 mm/min. The failure load was recorded. SPSS software was employed for statistical analysis. Mean compressive strength and mean compressive load was calculated

Results: One-way analysis of variance (ANOVA) followed by post hoc tests served for comparison of compressive strength among the study groups. The significance level was set at 0.001.

Conclusion: Nanohybrid composite has high compressive strength compared to ceramic reinforced glass ionomer cement, and resin-coated glass ionomer cement.

Keywords: Amalgomer CR, Compressive strength, Equia Forte, Posterior class II restorations, Tetric N Ceram.

INTRODUCTION

As none of the dental restorative material is equivalent to the strength of natural teeth, Dental restorative materials which substitute the lost tooth structure should be consistent &stable and replicate the function of natural teeth in different oral environment conditions. Degradation of the materials in saliva leads to deterioration and disintegration of the material in the course of time, limiting the efficacy longevity of the restorative material. Higher failure rates of restorations in class II cavities can be attributed due to the absence of proximal surface or wall and of mechanical stresses due to occlusal loading leading to cuspal flexure as well as fracture of restoration..[1] Recently, a new ceramic reinforced glass ionomer (amalgomer CR) and resin-coated high strength GIC (equia forte GC America) have been introduced to the dental market. These tooth-coloured products are claimed

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to be superior in withstanding masticatory load than conventional composite and conventional restorative GIC.

Even now, there are concerns regarding the strength of glass ionomer cement. More recently, amalgomer CR, a ceramic reinforced GIC, has gained popularity on the grounds of better mechanical properties. However, there is no evidence regarding long term mechanical properties like compressive strength of this material. Together with this, there is no information regarding the nature of reinforcement of Amalgomer CR.

Moisture is integral to the setting of Glass Ionomer Cement (GIC), especially for conventional acid-base reaction GIC (C-GIC). Water is the essential reaction medium, and it hydrates the siliceous hydrogel facilitating formation of polyacid salts.2 Therefore, mechanical properties of GIC depend on water balance, i.e. the uptake and release of water during storage and manipulation. C-GIC is sensitive to both hydration and desiccation during initial setting. Desiccation retards the setting reaction decreasing strength; shrinkage and crazing also may happen. Hydration or water uptake during setting may compensate for setting shrinkage, but causes wash out of calcium and aluminium ions retarding setting and decreasing surface integrity. All restorative materials serve in the warm, moist oral environment. Such an aggressive environment will alter the mechanical properties of materials affecting the stability of restorations. This makes it very important to study the changes in mechanical properties like strength, hardness, wear resistance, solubility, etc., of restorative materials in the simulated oral environment.

AIM

To compare and evaluate the compressive strength of a new ceramic reinforced glass ionomer (Amalgomer CR) and resin-coated high strength GIC (equia forteGC America) with a Nanohybrid composite (tetric N ceram)

MATERIALS AND METHODS

Thirty maxillary premolar teeth were selected.

Inclusion criteria:

- Caries free
- Teeth removed due to orthodontic purposes.

The teeth were cleaned with running tap water, immersed in NaOCl for 5 minutes and stored in physiologic saline at room temperature to prevent it dehydration. Samples were mounted on an acrylic block, and class II cavities were prepared with a width of 1/3rd the intercuspal distance and a depth of 1 mm for the occlusal step and 1.5 mm for the proximal box (Fig. 1).

Sampling

Samples were divided into three groups of 10 teeth each (Fig. 3).

Group 1: Class II cavity restored with tetric N Ceram composite (control group)
Group 2: Class II cavity restored with amalgam CR
Group 3: Class II cavity restored with equia forte (GC America)

Restored samples were stored in artificial saliva for 2 weeks, then subjected to thermocycling at an ice-cold water-bearing temperature of 2-degree Celcius and hot water-bearing temperature of 45-degree Celcius to simulate the oral environment than subjected to compressive strength testing using the universal testing machine (Instron 3300 universal testing system, North America) at a crosshead speed of 0.5 mm/min. The failure load was recorded.

RESULTS

Statistical Package for Social Sciences (SPSS) software was used for statistical analysis. Mean compressive strength and mean compressive load was calculated. One-way ANOVA and post-hoc tests served for comparison of compressive strength among the study groups. The significance level was set at 0.001

Mean compressive strength and mean compressive loads are shown in Table 1. Group, I showed the highest mean compressive strength followed by the group I followed by group III. Mean compressive load also followed the same pattern. The mean compressive load and mean compressive strength between the three different materials were assessed using one-way ANOVA. There was a statistically significant difference in mean compressive strength and load among all the groups ($p < 0.001$)

Table 1: One-way ANOVA test.

Ceramic reinforced GIC(Amalgomer)	10	10	1846.01	189.07	13231	22	<0.0012
Nanohybrid composite	10	10	2464.352	545.088			
Resin modified GIC	10	10	1276.21	437.012			
TOTAL	30	30	1900.402	601.818			
Ceramic reinforced GIC(Amalgomer	10	10	29047.105	2986.852			
Nanohybrid composite	10	10	38781.501	8588.865			
Resin modified GIC	10	10	21875.201	6899.111			

DISCUSSION

In this study, compressive strength obtained was highest for tetric N Ceram followed by amalgomer CR and least for equia forte. Compressive strength testing is important in vitro studies since it is considered a good indicator for simulating the forces that the restorative materials are subjected to under mastication. Compressive strength is measured using the Instron Universal testing machine, as it is a simpler way to analyze the compressive strength.[2,3]

Artificial saliva was chosen to simulate the natural environment conditions of the oral cavity, though, exact duplication of human saliva is impossible due to the inconsistent and unstable nature of saliva. Its use is well justified in other in vitro studies.[4] thermocycling procedure is used to simulate the oral environment as restorative material has to withstand various food materials at the different temperature inside the oral cavity.

In this study, the tetric N Ceram showed the highest compressive strength. The combination of a nanohybrid with the prepolymer technology is used in tetric N cream, which is composed of pre polymerized and milled micro fillers, ytterbium fluoride particles and nanofillers.[5,6] These nanohybrid composites have high filler content and monomers which imparts better mechanical properties and surface finish. Tetric N Ceram is made of Bis-GMA, Bis-EMA and UDMA and shows low volumetric polymerisation shrinkage.[7] Tetric N Ceram is produced by coordinated and optimised mixing of monomer matrix and fillers.[8,9]

Ytterbium fluoride added to obtain high radiopacity also releases fluoride. Spherical mixed oxide particles reduce wear and provide favourable consistency.[3] They also minimize the thickening effects of fillers, as they provide large volume with the smallest surface area possible.10 Primary particles, (individual bodies) are combined with secondary particles (agglomerates) to achieve the ideal consistency.[3]

A patented special filler, partially functionalized by silanes, performs as a unique shrinkage stress reliever, reducing the shrinkage stress of tetric N Ceram to a minimum level.[7,11] Reduced polymerization shrinkage leads to lower volumetric shrinkage, improves marginal integrity and reduces shrinkage stress over the composite surface and on the adhesive bond.[12]

Newly added light initiator Ivocerin–a dibenzoyl germanium derivative facilitate application and curing of larger increments of up to 4 mm, without adversely affecting the optical properties such as translucency or colour.13

amalgomer CR (ceramic-reinforced glass ionomer) combines the high strength of a metallic restorative, esthetics and other advantages of glass ionomers, which not only complies with the international standards of GIC but with the standard for amalgam.[14] The ceramic particles in the Amalgomer helps in imparting excellent wear, erosion and fracture resistance and also enhances the radi-opacity and all-round strength of the cement.[15]

Ayad et al. (2008) determined the compressive strength (CS), diametric tensile strength (DTS), surface hardness (SH), and surface roughness (SR) of Amalgomer CR in comparison to high-copper dental amalgam. It was concluded that the physic mechanical properties of the tooth-coloured ceramic reinforced glass ionomer were so close and sometimes significantly superior to dental amalgam.[2,16]

Setting mechanism of amalgomer CR is like conventional acid-base reaction GIC. The material has a particulate ceramic component that increases its strength, with other general characteristics of GIC. Gu, in his study, stated that zirconia is the most important crystalline ingredient of amalgomer CR. Zirconia is added for strengthening and toughening of some composites because it undergoes a phase transformation from tetragonal to monoclinic when subjected to stress.8 This change in phase causes a 4% change in volume producinga local compressive stress, which counteracts crack opening tension, inhibiting crack propagation leading to increased fracture resistance.17 This increase in fracture resistance prompted its use in GIC, although there is no evidence to prove that it would behave in the same manner in the more ductile matrix. The manufacturer claims that the partial reaction of ceramic filler with the matrix produce some bonding and also alters the polysalt matrix.18

Resin modified GIC (equira forte) has claimed that the material has increased fracture toughness, flexural strength, and flexural fatigue resistance.[19] The surface coating agent of the equia system is made of a nano filled resin that significantly increases the resistance of the material to mechanical forces. Its adhesion with a micromechanical interlocking and a chemical bonding with the hydroxyapatite in enamel and dentin.[20]

CONCLUSION

From this study, it can be concluded that Nanohybrid filled composite had the highest compressive strength compared to ceramic-based GIC FOLLOWED BY RESIN BASED GIC.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

REFERENCES

1. Vaid DS, Shah NC, Bilgi PS. One year comparative clinical evaluation of EQUIA with resin-modified glass ionomer and a nanohybrid composite in noncarious cervical lesions. Journal of conservative dentistry: JCD. 2015 Nov;18(6):449-452.

2. Ayad NM, Elnogoly SA, Badie OM. An in-vitro study of the physico-mechanical properties of a new esthetic restorative versus dental amalgam. Archives of Oral Research. 2008 Nov 29;4(3):137-144.

3. Terry DA, Leinfelder KF, Blatz MB. A comparison of advanced resin monomer technologies. Dent Today. 2009 Jul 1;28(7): 122-123.

4. Leung VH, Darvell BW. Artificial salivas for in vitro studies of dental materials. Journal of dentistry. 1997 Nov 1;25(6):475-484.

5. Jain N, Wadkar A. Effect of Nanofiller Technology on Surface Properties of Nanofilled and Nanohybrid Composites. Int J Dent Oral Health, Volume1. 2015;1.

6. Hegde MN, Hegde P, Bhandary S, Deepika K. An evalution of compressive strength of newer nanocomposite: An in vitro study. Journal of conservative dentistry: JCD. 2011 Jan;14(1):36.

7. Tetric SD. Available from URL: http://www. ivoclarvivadent. co. kr/ko/products/restorative-materials/composites/tetric-n-ceram-bulk-fill 2014.

8. Xu HH, Eichmiller FC, Antonucci JM, Schumacher GE, Ives LK. Dental resin composites containing ceramic whiskers and precured glass ionomer particles. Dental materials. 2000 Sep 1;16(5):356-363.

9. Kim KH, Ong JL, Okuno O. The effect of filler loading and morphology on the mechanical properties of contemporary composites. The

Journal of prosthetic dentistry. 2002 Jun 1;87(6):642-649.

10. Suzuki S, Leinfelder KF, Kawai K, Tsuchitani Y. Effect of par¬ticle variation on wear rates of posterior composites. American Journal of Dentistry. 1995 Aug;8(4):173-178.

11. Agarwal RS, Hiremath H, Agarwal J, Garg A. Evaluation of cervical marginal and internal adaptation using newer bulk fill composites: An in vitro study. Journal of conservative dentistry: JCD. 2015 Jan;18(1):56-61.

12. Ferracane JL. Resin composite—state of the art. Dental materi¬als. 2011 Jan 1;27(1):29-38.

13. Palaniappan S, Elsen L, Lijnen I, Peumans M, Van Meerbeek B, Lambrechts P. Three-year randomised clinical trial to evaluate the clinical performance, quantitative and qualitative wear patterns of hybrid composite restorations. Clinical oral investigations. 2010 Aug 1;14(4):441-458.

14. Bhattacharya A, Vaidya S, Tomer AK, Mangat P, Raina AA. Evaluation and comparison of physical properties and fluoride release of newly introduced ceramic reinforced glass-ionomer restorative material with other glass ionomer cements–An in vitro study. International Journal of Applied Dental Sciences 2017; 3(4): 486-492.

15. Nigam AG, Jaiswal JN, Murthy RC, Pandey RK. Estimation of Fluoride Release from Various Dental Materials in Different Media—An In Vitro Study. International journal of clinical pediatric dentistry. 2009 Jan;2(1):1-8.

16. Wang Y, Darvell BW. Hertzian load-bearing capacity of a ceramic-reinforced glass ionomer cement stored wet and dry. dental materials. 2009 Aug 1;25(8):952-955.

17. Gu YW, Yap AU, Cheang P, Khor KA. Effects of incorporation of HA/ZrO2 into glass ionomer cement (GIC). Biomaterials. 2005 Mar 1;26(7):713-720.

18. Kasuga T, Yoshida M, Ikushima AJ, Tuchiya M, Kusakari H. Stability of zirconia-toughened bioactive glass-ceramics: in vivo study using dogs. Journal of Materials Science: Materials in Medicine. 1993 Jan 1;4(1):36-39.

19. Zoergiebel J, Ilie N. Evaluation of a conventional glass ionomer cement with new zinc formulation: effect of coating, aging and storage agents. Clinical oral investigations. 2013 Mar 1;17(2):619-626.

20. Gururaj M, Shetty R, Nayak M, Shetty S, Kumar CV. Fluoride releasing and uptake capacities of esthetic restorations. Journal of Contemporary Dental Practice. 2013 Sep 1;14(5):887-891.