Research Article

Comparative evaluation of different composite materials on the basis of erosion

Shamit Thaper, James David Raj*

ABSTRACT

Aim: The aim of the study was to compare and evaluate the erosiveness of different composite materials for Class 1 restorations. **Objective:** The objective of the study is to find the best tooth-colored restorative material for Class 1 cavities on the basis of erosiveness. **Background/Materials and Methods:** The study is done to compare three composite materials on the basis of erosiveness under *in vitro* condition. The three materials being used are bulk fill, incremental, and flowable type of composite. These three materials will undergo stimulated environment of erosion in artificial saliva, the extent of wear of each restorative material will then be determined by radiographic methods. **Results:** The results obtained through this study state that conventional composite had the least amount of erosion, followed by bulk fill composite. Whereas the flowable composite had the most amount of erosion. **Reason:** This study was done to know the best suited composite material on the basis of erosiveness.

KEY WORDS: Composite, Erosion, Restorations

INTRODUCTION

The pursue esthetics by both patients and dentists have led to the continuous improvement of dentistry as regard innovations in restorative materials, leading to restorations with an appearance similar to natural teeth. The characteristics of simulating tooth color, translucence, and smoothness of surface have made resin composite the first choice among the various restorative materials used in dentistry. Among the improvements attained in contemporary resin composites are properties such as lower polymerization shrinkage and greater compressive strength, they are easier to manipulate and make it possible to obtain anatomically correct restorations.[1] Nevertheless, erosiveness, color stability, etc., were still a problem inherent to the material and researchers are unanimous to recognize that direct restorations performed with conventional composites undergo changes in color[1-3] and surface roughness[4-7] with time.

Over the past 3–4 years, wine consumption has dramatically increased across most markets and wine sectors and so has the consumption of carbonated drinks. There are many people who drink wine or carbonated drinks between meals or in social drinking. Several studies showed that wine tasters have dental erosion due to the frequency of tasting wine and that erosion is related to the acidity of wine.[8] In addition, drinking wine or carbonated drinks may affect the esthetic and physical properties of resin-based composite (RBC) restorations.[9]

The longevity of the materials used is one of the main factors for the success of the esthetic restoration. Surface erosion and abrasion may be one of the factors used to predict the longevity of the restoration due to surface degradation and erosive properties.[10] The high sugar content and acidic pH affects the physical properties of composites. Alcohol composition in wine may affect the esthetic and physical properties of the RBC restorations because alcohol is also thought to act as a plasticizer of the polymer matrix.[11] When RBC restorations are eroded, the teeth may sustain loss of anatomy, marginal discrepancy of restoration, secondary caries,[12] and an increase in the surface roughness of restorations. Surface roughness of restoration results in plaque and staining deposits at restoration, tissue irritation, possible gingivitis,[13] and reduced longevity of restorations.[14].

Access this article online

Website: jprsolutions.info | ISSN: 0974-6943

Department of Endodontics, Saveetha Dental College and Hospital, Saveetha University, Chennai, Tamil Nadu, India

***Corresponding author:** Dr. James David Raj, Department of Endodontics, Saveetha Dental College and Hospitals, Saveetha University, 162, Poonamallee High Road, Chennai - 600 077, Tamil Nadu, India. Phone: +91-9600194042/9789043634. E-mail: jamesdraj@gmail.com

Received on: 26-04-2018; Revised on: 29-05-2018; Accepted on: 30-06-2018

This study was done to evaluate the differences among three different types of composite restorative materials on the basis of erosion and abrasiveness. This is especially useful for those materials that are used as a thin lining over a cavity surface. The objective of this *in vitro* study was to investigate the effects of carbonated drinks and wine on the erosion of different types of composite materials used in dentistry, also to evaluate the effects of brushing time on the abrasion of the surface.

This study aims to find the best-suited composite material on the basis of erosion and abrasion.

MATERIALS AND METHODS

The three types of composite materials - composite charisma (conventional incremental type), flowable composite, and bulk fill composite (3M Filtek bulk fill) - were taken as samples. Figure 1 lists the differences in properties of these three materials.

Specimen Preparation

A total of 9 disc-shaped specimens of nanohybrid and nanofilled resin composites (shade A2) were prepared (9.0 mm in diameter and 2.5 mm in thickness) in an acrylic cylindrical mold on a glass plate. The cylindrical mold was covered with a mylar matrix strip. A second glass plate was then placed over the mylar strip. A static load of approximately was applied to extrude excess resin composites and to obtain a smooth and flat surface on each specimen. The specimens were then polymerized for 40 s with a light-activated polymerization unit. After polymerization, the mylar strip and the glass plate on the top and bottom of the mold were removed, and the specimen was then removed from the cylindrical mold. No mechanical preparation or abrasions of the specimens were performed.

Carbonated drinks such as Pepsi, Sprite, Coca-Cola, and red wine were taken as to stimulate an acidic environment along with artificial saliva.

Pre-operative radiographs were taken using a standardized frame for all the samples. The samples were subjected to daily 5 min of brushing with horizontal strokes to account for abrasion during normal brushing. The samples were kept in carbonated drink for 15 min daily to account for the acidic environment and in wine for another 15 min. After 1 week of testing, post-operative radiographs of the samples were taken and measured for the erosion by comparing pre-operative to post-operative radiographs through software called FACAD. The erosion of the materials was then analyzed by a three-way analysis of variance (ANOVA) [Figure 1].

Statistical Analysis [Tables 1 and 2, Figure 2]

The ANOVA done for single factor variance shows that the average values are xxxx for the mentioned three samples and the variance noticed between the three groups was significant. With *P* value being 0.005 that shows the study is significant and the *F* value being 14.33 and the *F* critical being 5.14 [Table 3].

RESULTS

Table 1 clearly states that conventional composite (sample A) had the least amount of erosion, followed by bulk fill composite (sample B). Whereas the flowable composite (sample C) had the most amount of erosion [Figure 3].

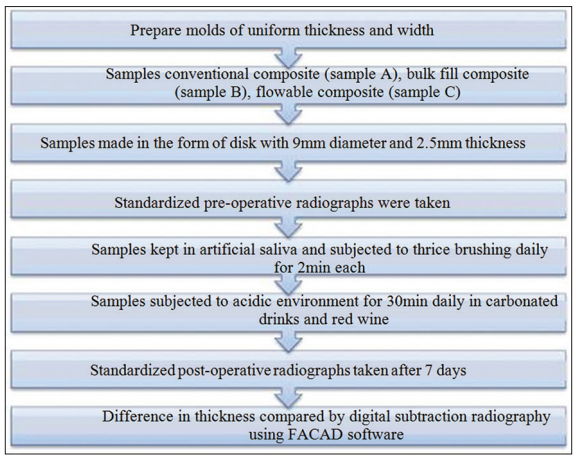

Figure 1: Sample preparation

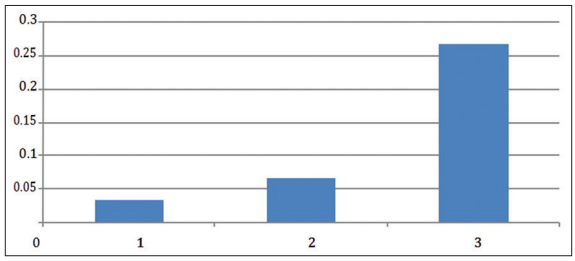

Figure 2: Average amount of erosion

Table 1: Post-operative thickness

Sample A	Sample B	Sample C
2.5 mm	2.4 mm	2.2 mm
2.5 mm	2.5 mm	2.3 mm
2.4 mm	2.4 mm	2.2 mm

Table 2: ANOVA single factor

Groups	Count	Sum	Average	Variance
Column 1	3	0.1	0.033	0.0033
Column 2	3	0.2	0.066	0.0033
Column 3	3	0.8	0.266	0.0033

ANOVA: Analysis of variance

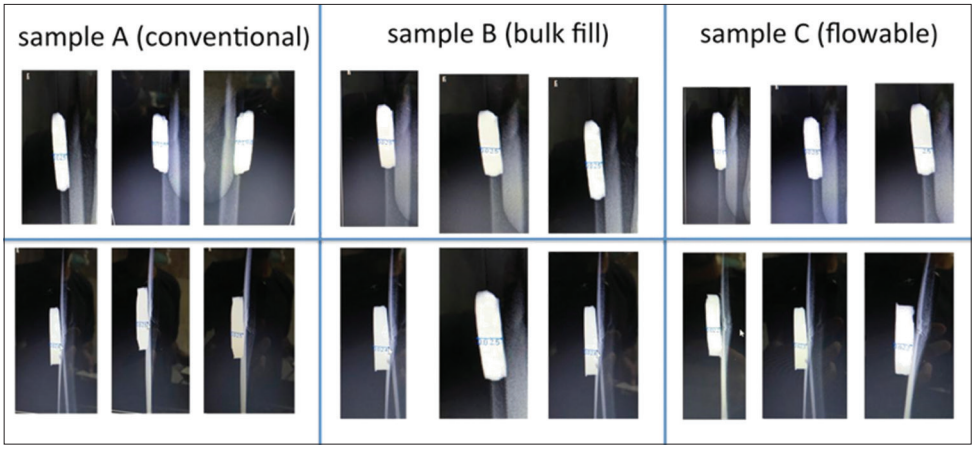

Figure 3: Samples

Table 3: ANOVA result

ANOVA						
Source of variation	**SS**	**df**	**MS**	***F***	***P* value**	***F* criteria**
Between groups	0.0955	2	0.0477	14.33	0.00518	5.143
Within groups	0.02	6	0.0033			

ANOVA: Analysis of variance

DISCUSSION

The loss of tooth structure due to erosive or acidic materials has become a significant issue.[15] The matrix of the composite is the most susceptible part of the set cement when exposed to acids. Acids such as acetic, citric, and lactic have all been used to evaluate erosion.[16] The composites are sensitive to long-standing acidic saliva in the oral cavity. The acidity will damage and erode the surface of the composite over a period of time if oral health is not taken care of properly.

In the present study, bulk fill composite was found to have more erosion resistance as compared to flowable composite [Table 2]. This can be because of more amounts of hybrid filler particles present in bulk fill that makes it more resistant to erosion. The conventional composite was, however, found to have the most resistance to erosion as compared to bulk fill and flowable. This is because it contains a higher proportion of resin component in the composition.

The results of the current study are found to be similar to a study conducted by Tanthanuch *et al.* in which bulk fill composite and conventional composite were evaluated through Vickers microhardness test and surface characteristics were examined through scanning electron microscopy. The samples were immersed in spicy and sour soup and different juices, the result states that acidic food simulating liquids and beverages increases the surface roughness and decreases surface microhardness of bulk fill composites.[17] In another study done by Han *et al.* investigated the erosion of flowable composites by acidic and alcoholic drinks. It was observed that the acidic erosion severely degrades flowable composites and increases the surface roughness. The article states that the distribution density of fillers on resin surface was related to the surface degradation of flowable resins.[19-20] A number of studies have reported surface degradation of composite resins due to an acidic environment.[21-23]

CONCLUSION

Under the limitation of the study, we can conclude that resin composite (conventional) has the maximum resistance to erosion as compared to bulk fill composite and flowable composite having the least wear resistance among the three materials tested. We can also conclude that further research is needed in finding out the best type of composite material on the basis of different parameters using a larger sample size.

REFERENCES

1. Janda R, Roulet JK, Kaminsky M, Steffin G, Latta M. Color stability of resin matrix restorative materials as a function of the method of light activation. Eur J Oral Sci 2004;112:280-5.
2. Pires-de-Souza Fde C, Garcia Lda F, Hamida HM, Casemiro LA. Color stability of composites subjected to accelerated aging after curing using either a halogen or a light emitting diode source. Braz Dent J 2007;18:119-23.
3. Mundim FM, Pires-de-Souza FC, Garcia LF, Consani S. Colour stability, opacity and cross-link density of composites submitted to accelerated artificial aging. Eur J Prosthodont Restor Dent 2010;18:89-93.
4. Wang L, Garcia FC, Araujo PA, Franco EB, Mondelli RF. Wear resistance of packable resin composites after simulated toothbrushing test. J Esthet Restor Dent 2004;16:303-314.

5. Amaral CM, Rodrigues JA, Erhardt MC, Araujo MW, Marchi GM, Heymann HO, *et al.* Effect of whitening dentifrices on the superficial roughness of esthetic restorative materials. J Esthet Restor Dent 2006;18:102-8.
6. da Costa J, Adams-Belusko A, Riley K, Ferracane JL. The effect of various dentifrices on surface roughness and gloss of resin composites. J Dent 2010;38:123-128.
7. Heintze SD, Forjanic M, Ohmiti K, Rousson V. Surface deterioration of dental materials after simulated toothbrushing in relation to brushing time and load. Dent Mater 2010;26:306-19.
8. Lupi-Peguruer L, Muller M, Leforestier E, Bertrand MF, Bolla M. *In vitro* action of Bordeaux red wine on the microhardness of human dental enamel. Arch Oral Biol 2003;48:141-5.
9. Dietschi D, Campanile G, Holz J, Meyer JM. Comparison of the color stability of ten new-generation composites: An *in vitro* study. Dent Mater 1994;10:353-62.
10. Wu SS, Yap AU, Chelvan S, Tan ES. Effect of prophylaxis regimens on surface roughness of glass ionomer cements. Oper Dent 2005;30:180-4.
11. Ferracane JL, Marker VA. Solvent degradation and reduced fracture toughness in aged composites. J Dent Res 1992;71:13-9.
12. Yap AU, Wu SS, Chelven S, Tan ES. Effect of hygiene maintenance procedures on surface roughness of composite restoratives. Oper Dent 2005;30:99-104.
13. Quirynen M. The clinical meaning of the surface roughness and the surface free energy of intra-oral hard substrata on the microbiology of the supra- and subgingival plaque: Results of *in vitro* and *in vivo* experiments. J Dent 1994;22 Suppl 1:S13-6.
14. Dunkin RT, Chambers DW. Gingival response to class V composite resin restorations. J Am Dent Assoc 1983;106:482-4.
15. Xie D, Brantley WA, Culbertson BM, Wang G. Mechanical properties and microstructures of glass-ionomer cements. Dent Mater 2000;16:129-38.
16. Wilson AD, Mc Lean JW. Glass-Ionomer Cements. London: Quintessence; 1988.
17. Tanthanuch S, Kukiattrakoon B, Eiam-O-Pas K, *et al*. Surface changes of various bulk-fill resin- based composites after exposure to different food-simulating liquid and beverages. J Esthet Restor Dent 2018;126:135-10. Available from; https://doi.org/10.1111/jerd.12349
18. Han L, Okamoto A, Fukushima M, Okiji T. Evaluation of flow able resin composite surfaces eroded by acidic and alcoholic drinks. Dent Mater J 2008;27:455-65.
19. Obrien W, Yee J. Surface structure of class-II Composite restorations after clinical wear. Int J Dent Res 1979;58:327.
20. Powers JM, Fan PL. Erosion of composite resins. J Dent Res 1980;59:815-9.
21. Thaper S, Ranjan M. Comparative evaluation of three types of tooth colored restorative materials on the basis of wear resistance. Int J Curr Res 2017;9:56987-9.
22. Biswas S, Satapathy A, Patnaik A. Erosion wear behavior of polymer composites: A review. J Reinforced Plast Compos 2010;29:2898-924.
23. Roy M, Vishwanathan B, Sundararajan G. The solid particle erosion of polymer matrix composites. Wear 1994;171:149-61.