Original Research Paper

University J Dent Scie 2022; Vol. 8, Issue 2

Comparing Radiopacity of Nanohybrid Composite and Giomers: An In Vitro Study.

Abstract:

Aim: The aim of this study was to evaluate and compare the radiopacity of three different composite resins; one nanohybrid and two giomers.

Material and Methods: For evaluation of radiopacity of composites, ten specimens of each material [(3 groups) (total 30) (n=10] with thicknesses of 2 mm were prepared and radiographed alongside aluminum step wedge and human enamel and dentin. Occlusal radiograph was taken and mean gray values of the test materials were measured using Image J software. Then a conversion was performed to establish the radiopacity of the test materials, in millimeters of equivalent Aluminum (Al). Data were analyzed using one-way analysis of variance and Scheffe's Post Hoc tests ($P < 0.05$).

Results: The radiopacity values varied among the restorative materials ($p < 0.05$) with the highest for Filtek followed by Beautifil Injectable, Beautifil 2, enamel and dentin.

Conclusion: All materials tested had radiopacity values greater than dentin and had sufficient radiopacity to meet International Organization for Standardization 4049 standard.

Key Words: Radiopacity, aluminum stepwedge, composites, opacifing-fillers.

Introduction:

Currently, esthetic restorations are at the forefront of dentistry. Tooth colored restorations have become popular because of the development of certain materials that have better esthetic and functional features.[1]Adequate radiopacity is required in order todistinguish a restorative material from the surrounding tissues. It is certainly difficult to locate enamel-composite margins radiographically because of the relatively low radiopacity of composites.[2] Restorative composites are not inherently radiopaque and without modification of their composition, would not be visible on an x-ray film except as a dark spot when deposited into the tooth structure. The addition of radiopacifiers like zirconium dioxide, barium oxide or ytterbium oxide to any radiolucent material will impart the property of radiopacity.[3]

Radiopacity is an essential property of all dental restorative materials in order to assess restorations for marginal defects, overhangs, evaluation of the proximal contour and integrity of the restoration, diagnosing repetitive dental caries and also to distinguish dental caries from tooth tissue and restorative material.1 Also, in case of accidental ingestion or traumatic impaction, radiopacity provides the determination of dental devices or fragments lodged in soft tissues. Additionally, the location of radiopaque restorative materials that were accidentally aspired or inhaled can be easily made.[4]

In adults, almost half of the restoration renewals are done because of repetitive dental caries, which usually occur at the edge of the gingival interface whose detection is done using radiography. So, it is extremely important that the composite material presents sufficient radiopacity.[4] The radiopacity of restorative materials has been established as an important requirement because it regulates the material reflection degree, allowing a proper contrast from the tooth structure on a radiograph.[5] In case of accidental aspiration or traumatic

Access this article online	
Website: www.ujds.in	Quick Response Code
DOI: https://doi.org/10.21276/ujds.2022.8.2.5	

[1]SHILPA SHAH, [2]NISHTHA PATEL, [3]AARSHATI VYAS, [4]KRUTI YAGNIK, [5]KRUSHNANGI YAGNIK, [6]PRERAK DOSHI

[1-6]College of Dental Sciences and Research Centre, Bopal, Ahmedabad, Gujarat

Address for Correspondence: Dr. Aarshati A. Vyas
Postal address: 22, Janvishram Society, B/H Sahjanand College, Ambawadi, Ahmedabad, Gujarat 380015.
Email: aarshativyas15@gmail.com

Received : 15 Jan., 2022, **Published :** 30 June, 2022

How to cite this article: Vyas, A., Shah, S., Patel, N., Yagnik, K., & Yagnik, K. (2022). Comparing Radiopacity of Nanohybrid Composite and Giomers: An In Vitro Study. UNIVERSITY JOURNAL OF DENTAL SCIENCES, 8(2). 24-28

impaction, the location and the removal of fragments of the radiopaque restorative materials may be extremely important.[6]

Composites selected in this study were Filtek Universal Z250XT (3M ESPE) and two Giomers [(Beautifil Injectable and Beautifil 2) (Shofu)]. Filtek universal is a nanohybrid composite which comprises of filler content of zirconia and silica with the filler loading of 82% by weight (68% by volume).6 It combines physical, mechanical, and esthetic properties and incorporates a high-volume fraction of filler particles with a wide particle size distribution (5-100 nm).7 In a study by Ermis et al. (2014)6 Filtek Z550 (3M ESPE) showed superior radiopacity as compared to other composites tested.

Giomer is a relatively new innovative filler technology of resin composite. Instead of applying purely glass or quartz as the typical fillers, the giomer encompasses inorganic fillers (ranges between 0.01 and 5 mm).[7] It is a fluoride-releasing, resin-based dental adhesive material that comprises of Prereacted glass (PRG) fillers.8Beautifil Injectable (Shofu) and Beautifil 2 (Shofu), both are novel composites based on Giomer technology. Since, there have not been studies comparing these materials, we have selected Filtek and Giomers in this study and also because of their enhanced properties, we have selected to compare and evaluate them. Therefore, the aim of this study was to measure radio-opacity of 3 different composite resins i.e Filtek Universal Z250XT (3M ESPE), Beautifil Injectable (Shofu) and Beautifil 2 (Shofu). The null hypothesis was that there the material type would not affect the radiopacity of resin composites.

Materials And Methods:

Composite Specimen preparation:

For preparation of specimens, three different light-cured resin composites were used and grouped as follows, with 10 samples in each group (n=10):

Group 1: Filtek Z250XT(3M ESPE),

Group 2: Beautifill Injectable (Shofu) and

Group 3: Beautifill 2 (Shofu).

30 samples (n=10) were prepared by placing them in the 2-mm deep and 5-mm internal diameterplastic rings, interplaced between two glass slides and pressed, allowing for a smooth surface and no gapformation. The specimens were then light-cured for 40 seconds by pacing the light polymerization unit against the glass slide.The specimens were storedunder moist conditions at 37oC until the radiographic part ofthe experiment was conducted.

Procedures for evaluating radiopacity:

· Tooth slice preparation:

Two pre molars were used for preparation of tooth slices. Slices were prepared by sectioning the teeth in cross section involving each enamel and dentin substrate which were then ground flat with low-speed diamond disc under water coolant and later were ground flat with carbide paper keeping 2.0 mm in thickness of the specimens. The tooth slices were kept in distilled water until use.

Aluminum stepwedge model preparation:

An aluminum stepwedge (6063 alloy, 98% purity) ranging from 2.0 to 12.0 mm in thickness was used. It was constructed with 6 steps (with 2 mm increase in each step). Slices of aluminium were kept on top of each other vertically to construct a block. The aluminum step wedge was used as an internal standard for each radiographic exposure, which allowed the radiopacity of each material to be calculated in terms of aluminum thickness [Figure 1]

Figure 1: Aluminum stepwedge

· Radiographic procedure for evaluating radio-opacity:

Three groups with tenspecimens of each material (30 specimens) were placed directly on a 57 × 76 mm Ultra-speed occlusal radiographic film (Eastman Kodak Co, Rochester, NY, USA), together with an Al step wedge and 2 tooth slices of both enamel and dentin, which were used for comparison [Figure 2]. All specimens were placed at a 40 cm focus-film distance for 0.32 s in a dental X-ray unit with2 mm Al equivalent total filtration at 63 Kv, 8 mA. The radiographwas processed in an automatic processor.

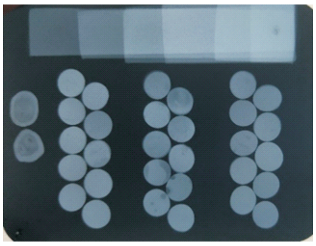

Figure 2: Composite specimens with aluminium wedge and tooth slices

The radiographs were digitized using a desktop scanner with a transparent adapter (Epson Perfection V700, Japan) at 16-bit gray value and 300 dpi resolution and saved in tag image file format. On each radiographic image, a 20 × 20pixel region of interest was selected on the center of each test material, on dentin and enamel of each tooth specimen and on each step of the step wedge. The image was enlarged in order to accurately define the enamel and dentin layers. Mean gray values (MGV) of each test material, step wedge and enamel and dentin were measured using ImageJ 1.46r software (National Institutes of Health, USA). The mean of all samples'MGVs were accepted as the MGV of test materials.

The radiopacity value was determinedaccording to the radiographic density and converted into millimeters of Aluminum (Al) (mm Al). Conversion was performed using the following conversion equation:

A×2 +mmAl immediatelybelow RDM

B

Where:A = Radiographic density of the material (RDM) – radiographic density of the aluminum step wedge

B = Radiographic density of the aluminum step wedge increment immediately above RDM – radiographicdensity of the aluminum step wedge increment immediately below RDM.

2 = 2 mm increments of the aluminum step wedge

Statistical Analysis:

ANOVA (Analysis of variance) and Scheffe's Post hoc procedure were done for evaluating the radio-opacity.

Results:

There were statistically significant differences among the composites when the results were compared using the one-way ANOVA ($P < 0.05$). The means and standard deviations for the MGV and radiopacity values expressed as Al equivalent millimeters of the restorative materials tested and enamel and dentin are presented in Table 1. The mean radiopacity values of the resin composites ranged from 4.30 mm Al to 5.07mm Al.

Table 1: One way analysis of variance results

Score	Sum of squares	df	Mean Square	F	Sig (p value)
Between groups	3846.01	5	769.20	4.429	.003
Within groups	5904.36	34	173.65		
Total	9750.38	39			

Dentin had the lowest radiopacity value (2.94 mm Al) (Table 2). All the resin composites tested had radiopacity values greater than the radiopacity of dentin and 2mm aluminum stepwedge (1.56 mm Al).

Table 2: Mean ± SD

Material	Mean Gray Value	Radioopacity value (mm Al equivalent)
Filtek	122.56	5.07
Beautifil Injectable	113.87	4.38
Beautifil 2	116.44	4.30
Enamel	98.20	3.18
Dentin	95.39	2.94
Step Wedge (2mm)	84.27	1.56

Filtek showed the highest radioopacity (5.07 mm Al equivalent) followed by Beautifil Injectable (4.38 mm Al equivalent) and Beautifil 2 (4.30 mm Al equivalent). All the tested materials had higher radioopacities than both, enamel (3.18 mm Al equivalent) and dentin (2.94 mm Al equivalent).

Discussion:

It is desirable for the clinician to differentiate radiographically between restorative composites and dentin and that, the materials should present a radiopacity not less than that of the dentin that is being replaced, in order not to be misinterpreted as decalcified dentin. In this study, all the resin composites evaluated provided higher radiopacity than the same thickness of aluminum and the dentin specimen that fulfilled the requirements of ISO 4049 in terms of radiopacity.6

Salzedas et al.5 stated that knowledge of radiopacities of materials may help dentists to select the correct restorative material during treatment. They also indicated that materials with low radiopacities may cause misdiagnosis of the defects in radiography.1,9 It has been proposed that the radiopacity of restorative materials should be evaluated by using comparison with the radiopacity of the same thickness of enamel and dentin, and with an aluminum stepwedge as an internal standard. The relative radiopacities of materials, enamel and dentin are expressed as aluminum equivalent values, in millimeters.[5,10,11]

The methodology used to measure radiopacity value in the present study is based on measurement of the pixel grey scalevalue using specific software (Image J) after digitalization of conventional film. The digital radiographic system has been used effectively in recent studies for radiopacity measurements of composite materials.[12, 3] Each composite material was radiographed along with aluminum step wedge that was used for reference. For every radiograph the average greyscale value of the material was converted into absorbance and compared with that of the reference step wedge using image J software in order to determine the equivalent radiopacity in terms of millimeters of Al per millimeter of material. The material's radiopacity value is related to the relative atomic mass of its constituent elements.[3,13]

The radiopacity of restorative materials may change according to the variety and amount of the fillers added to the material (silver, zinc, barium, and strontium). The content of the restorative materials is always changed to be able to provide a sufficient clinical radiopacity. Adding some chemical elements with a high atomic number, such as zinc, strontium, zirconium, barium, and lanthanum, to the restorative materials provides the opportunity to produce more radiopaque materials.[1]

In this study, Filtek Z250XT (3M ESPE) had the highest radioopacity of 122.56 Mean Gray Value as compared to other materials tested owing to its filler content of zirconia and silica with the filler loading of 82% by weight (68% by volume). This was in accordance to a study done by Ermis et al. (2014).[6] The radiopacity of a resin is higher if the composition of the resin includes larger amounts of elements with high atomic numbers at higher filler content. Although barium is considered to be strongest radiopacifier for the filler of composites, some authors stated that barium ions are not biocompatible when leached out into the oral fluid. In contrast, zirconium has been stated as a chemically inert, biocompatible material that slightly reduces the chemical stability of SiO_2 fillers of resin composites in the oral environment.[6]

In modern composites, radioactive compounds such as thorium and uranium have been used in order to mimic fluorescence of human dentine, opalescence of human enamel and to achieve the necessary X-ray opacity. Zirconia contains small amounts of radionuclides from the uranium-radium and thorium actinide series.[14,15] This might have resulted in lower radiopacity values of giomers as they donot contain zirconia as filler particles. Hence, as therewere significant differences between the materials tested, the null hypothesis of this study was rejected.

Conclusion:

Under the limitations of this study, it can be concluded that all materials tested had radiopacity values greater than dentin and was in decreasing order of Filtek> Beautifil Injectable> Beautifil 2> enamel >dentin.

References:

1. Gul P, Çaglayan F, Akgul N, Akgul HM. Comparison of radiopacity of different composite resins. J Conserv Dent. 2017 Jan-Feb;20(1):17-20. doi: 10.4103/0972-0707.209071. PMID: 28761247; PMCID: PMC5514803.
2. Ergücü Z, Türkün LS, Onem E, Güneri P. Comparative radiopacity of six flowable resin composites. Oper Dent. 2010 Jul-Aug;35(4):436-40.
3. Nadhum NS, Jehad RH, AbdulKareem S, Al-Hashimi RA. Assessing The Radiopacity of Three Resin Composite Materials Using a Digital Radiography Technique. J Bagh Coll Dent [Internet]. 2017 Sep. 15
4. Yildrim D, Ermis RB, Gormez O, Yildiz G. Comparison of radiopacities of different flowable composites. J Oral Maxillofac Radiol 2014;2:21-5
5. Salzedas LM, Louzada MJ, de Oliveira Filho AB. Radiopacity of restorative materials using digital images. J Appl Oral Sci. 2006 Apr;14(2):147-52.
6. Ermis RB, Yildirim D, Yildiz G, Gormez O. Radiopacity evaluation of contemporary resin composites by digitization of images. Eur J Dent. 2014 Jul;8(3):342-347.
7. Tanthanuch S, Kukiattrakoon B, Siripornanon C, Ornprasert N, Mettasitthikorn W, Likhitpreeda S et al. The effect of different beverages on surface hardness of

nanohybrid resin composite and giomer. J Conserv Dent. 2014 May;17(3):261-5.

8. Najma Hajira NSW, Meena N (2015) GIOMER- The Intelligent Particle (New Generation Glass Ionomer Cement). Int J Dent Oral Health 2(4)
9. Espelid I, Tveit AB, Erickson RL, Keck SC, Glasspoole EA. Radiopacity of restorations and detection of secondary caries. Dent Mater. 1991 Apr;7(2):114-7.
10. Wayne D. Cook An investigation of the radiopacity of composite restorative materials. Australian Dental Journal, April, 1981 Volume 26, No. 2
11. Williams JA, Billington RW. A new technique for measuring the radiopacity of natural tooth substance and restorative materials. J Oral Rehabil. 1987 May;14(3):267-9.
12. Nomoto R, Mishima A, Kobayashi K, McCabe JF, Darvell BW, Watts DC et al. Quantitative determination of radio-opacity: equivalence of digital and film X-ray systems. Dent Mater. 2008 Jan;24(1):141-7.
13. Dukic W, Delija B, Derossi D, Dadic I. Radiopacity of composite dental materials using a digital X-ray system. Dent Mater J. 2012 Feb 3;31(1):47-53.
14. Vagkopoulou T, Koutayas SO, Koidis P, Strub JR. Zirconia in dentistry: Part 1. Discovering the nature of an upcoming bioceramic. Eur J Esthet Dent. 2009 Summer;4(2):130-51.
15. Piconi C, Maccauro G. Zirconia as a ceramic biomaterial. Biomaterials. 1999 Jan;20(1):1-25.