Original Article

Evaluation Of Radiopacity of Nanoparticle Incorporated Root Canal Sealer with Epoxy Resin Incorporated Root Canal Sealers – An Invitro Study

Chitharanjan Shetty[1], Aditya Shetty[2], Sudarshan Kini[3], Veena Shetty[4], Neevan Dsouza[5]

Abstract:

Aim: of this study was to assess and compare, the radiopacity of nanoparticle-based (NPB) root canal sealers with Epoxy Resin Based(ERB) root canal sealer using an aluminium step wedge in accordance with ISO 6876/2012 standards.

Materials and methods: The specimens, which were made of each sealer material, had a 10mm diameter and a 1mm thickness. The creation of metallic matrices, which were used in the fabrication of the impressions, was done using a light-bodied silicone-based impression medium. Using an aluminium step-wedge, the radiopacity of the NPB sealer and the ERB sealer was assessed in accordance with international standards. The optical density was measured using a sample of enamel, dentin, and aluminium of the appropriate thickness, all measuring 1 mm thick.

Results: The radiopacity of the ERB sealer was 2.37, with a minimum value of 179 and a maximum value of 215. The radiopacity value for the NPB sealer was 3.47, with a minimum value of 185 and a maximum value of 255.

Conclusion: Within the limits of the study, the NPB root canal sealers has better radiopacity than the ERB sealers. It has radiopacity values of the sealers are within the ADA/ISO recommendations.

Clinical Significance: The radiopacity of the NPB sealer can be compared with other commercially available sealers for in vivo applications.

Keywords: Laser capture microdissection, dentistry, LOH analysis, genome, tumor cells.

Bangladesh Journal of Medical Science Vol. 22: Special Issue 2023 Page : 63-66
DOI: https://doi.org/10.3329/bjms.v22i20.66311

Introduction:

Endodontic sealants must possess the proper physical and chemical properties. For the sealer and obturating materials to be easily distinguishable from the nearby dental structures, they should have superior radiopacity in addition to flow and setting time[1]. A sealer's radiopacity needs to be distinguished. Eliasson and HAASKEN completed the first radiopacity analysis

1. NITTE Deemed to be University, A.B. Shetty Memorial Institute of Dental Sciences, Department of Conservative Dentistry and Endodontics Deralakatte Mangalore – 575018
2. NITTE Deemed to be University, A.B. Shetty Memorial Institute of Dental Sciences, Department of Conservative Dentistry and Endodontics Deralakatte Mangalore – 575018
3. NITTE Deemed to be University, Nitte University Centre for Science Education and Research, Mangalore, Karnataka-575018.
4. NITTE Deemed to be University, K. S. Hegde Medical Academy, Department of Microbiology, Deralakatte Mangalore – 575018
5. NITTE Deemed to be University, K. S. Hegde Medical Academy, Department of Biostatistics,Deralakatte Mangalore, Karnataka-575018.

Correspondence: Aditya Shetty, NITTE Deemed to be University, A.B. Shetty memorial Institute of dental sciences, Department of conservative dentistry and Endodontics, Deralakatte, Mangalore, Karnataka-575018.; Email: shetty_aditya1@yahoo.co.in

comparison in 1979 using optical radiography density measurements for imprint materials and an equivalent layer of aluminium that could provide a same radiographic density. [2]. Using an aluminium step wedge with 2mm intervals, Beyer-Olsen and Orstavik2 developed a repeatable comparison standard to assess root canal sealers in 1981 [3]. The method used by Tagger and Katz 16 to evaluate the radiopacity of root-end filling materials was the same. Among other physical/chemical characteristics, the ideal root canal sealer should be radiopaque enough to distinguish itself from adjacent biological structures like bone and tooth. [4,5].

Nanotechnology, which enables molecular-scale matter manipulation, has totally changed modern dentistry. The practise of "nanodentistry," which combines nanotechnology and dentistry, allows for the development of novel materials with a variety of clinical applications [6]. Nanoscale materials can interact differently with biomolecules due to their increased surface area, regulated manufacture, and capacity to change desired physical and chemical properties. [7]. They also have a higher percentage of surface atoms, which boosted their effectiveness due to a rise in surface reactivity. (Rasmussen et al., 2010)[8].

Nanoparticles are added to the sealants to improve the seal and the sealers' capacity to stick to the tooth dentine. It will facilitate the sealer's fusion with the structural elements of the tooth.

In the current work, the radiopacity characteristics of sealers based on chitosan and zinc oxide nanoparticles are compared. The radiopacity of the NPB sealer and the traditional Epoxy Resin Based (EPB) sealer were also evaluated. The objective of this study was to assess and compare, the radiopacity of nanoparticle-based (NPB) root canal sealers with Epoxy Resin Based(ERB) root canal sealer using an aluminium step wedge in accordance with ISO 6876/2012 standards.

Materials and Methods:

Preperation of Experimental Samples:

In this study, two sealers were used to measure the radiopacity. The components were produced in accordance with the manufacturer's instructions. The specimens, which were made of each sealer material, had a 10mm diameter and a 1mm thickness. The creation of metallic matrices, which were used in the fabrication of the impressions, was done using a light-bodied silicone-based impression medium. Following that, samples of the produced sealers were applied to the impressions and allowed to fully set in an incubator at 37°C in a wet atmosphere. [8].

Evaluation of Radiopacity:

Using an aluminium step-wedge, the radiopacity of the NPB sealer and the ERB sealer was assessed in accordance with international standards. The optical density was measured using a sample of enamel, dentin, and aluminium of the appropriate thickness, all measuring 1 mm thick [8].

30 cm focus-film distance, 54 kV tube voltage, 4 mA tube current, and an exposure length of 18.7 seconds were the exposure parameters, After the digital radiographs were exported, Image J software was used to examine the samples' radio-opacity. Using the software cursor, this programme may create a Mean Grey Value by creating a region in the centre of the image (MGV). The mean of these values was found to equal the sample's ultimate radio-opacity. Adapting the equation presented by Vivan et al [9]., these numbers were also translated into millimetres of aluminium (mmAl).
A–B /C–B x sample thickness + 1 mmAl below material MGV

A is the material's MGV, B is the MGV of the aluminium stepwedge increment immediately below the material's MGV, and C is the MGV of the aluminium stepwedge increment immediately above the material's MGV.
One-way analysis of variance (ANOVA) was used to compare the radiopacity values (in mm Al) for each material and dentin, and the Tukey test was used for individual comparisons, both at the 5% significant level.

Results:

The radiopacity of the ERB sealer was 2.37, with a minimum value of 179 and a maximum value of 215. The radiopacity value for the NPB sealer was 3.47, with a minimum value of 185 and a maximum value of 255.

Discussion:

Tagger and Katz created a method that entailed radiographing samples adjacent to an aluminium step-wedge to gauge the radiopacity of endodontic cements [4,5]. This method involves digitising radiographs and comparing the radiopacity to the step-wedge using specialised software. The examination of digitised radiography images using specialised software was the most efficient method for promptly, precisely, and reproducibly assessing a material's radiopacity. [10]. Numerous radiopacity tests have employed aluminium step-wedges. Katz et al. examined the radiopacity of gutta-percha cones using an aluminium step-wedge and discovered that the mean radiopacity was 7.4 mm. Al[11]. Tanomaru et al. evaluated the radiopacity of endodontic sealers using a similar method. The results of the investigation show that the Ah Plus has the highest radiopacity value when compared to other sealers. In the current experiment, the NPB sealer had a higher value than the Ah plus, demonstrating that the sealer's radiopacity is enough. Compared to dentine and enamel, the NPB and ERB sealers have a higher radiopacity value. This will make it easier to distinguish between obturating materials and the surrounding enamel and dentin.[12]

According to ISO 6876/20019, root canal sealants must be at least as radiopaque as 3mm of aluminium thickness. Endodontic filling materials are required to have a radiopacity differential between bone or dentin and at least 2mm of aluminium, according to ANSI/ADA1 standard #57[13]. The radiopacity value of the root canal sealer should be greater than 3mmAl in order to achieve better material separation from the dentine and enamel of normal teeth[14]. The samples' values for ERB and NPB sealers in the present investigation range from 2.37 to 3.61, respectively. The radiopacity value for the NPB sealer is 3.4733, which is within the acceptable range (Image 1). When barium sulphate, a radiopacifier, is added to the sealer, the sealer turns radiopaque. It has been demonstrated that the ERB sealer (AH plus) has better radiopacity than other commercially available sealers. Its radiopacity is increased by using both the obturating substance and the root canal sealant. The obturating substance is attached to the root dentine by a root canal sealer. The sealer must have greater radiopacity than the nearby tooth structure. [15]. Compared to the dentine and enamel samples, both of the sealers used in this experiment have a higher radiopacity. The NPB sealer's formulation also contains additional nanoparticles and barium sulphate. The radiopacifier in the NPB sealer and the ERB sealer is barium sulphate. According to the current analysis, NPB sealers have a greater radiopacity value. This might be because different amounts of barium sulphate were used in the sealer's composition. The research has also shown that using a radiopacifier in conjunction with a zinc oxide nanoparticle would increase the material's radiopacity. This could be the reason why the NPB sealer produced results with a higher radiopacity than the ERB sealer.

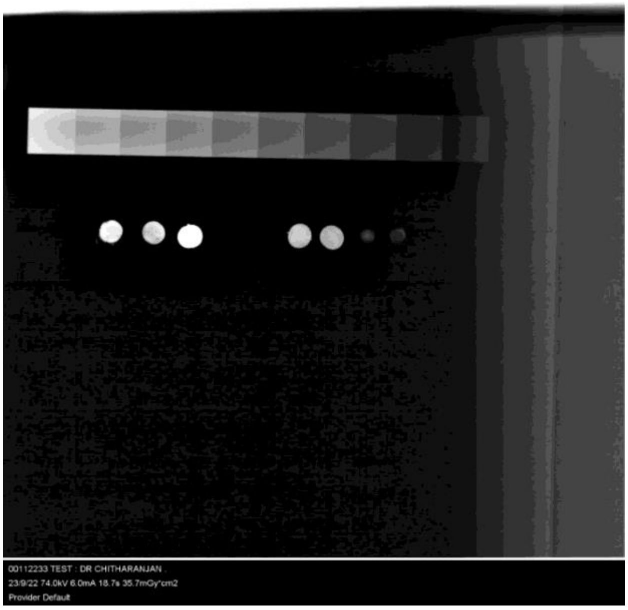
Conclusion:

Within the limits of the study, the NPB root canal sealers has better radiopacity than the ERB sealers. It has radiopacity values of the sealers are within the ADA/ISO recommendations.

Clinical Significance:

The radiopacity of the NPB sealer can be compared with other commercially available sealers for in vivo applications.

Image 1 : Radiographic image showing the radiopacities of different study samples:



References:

1. Al-Haddad A, Che Ab Aziz ZA. Bioceramic- based root canal sealers: a review. International journal of biomaterials. 2016 May 3;2016.
2. Gümrü B, Tarçin B, Türkaydin DE, İriboz E, Ovecoglu HS. Evaluation of the radiopacityof a mta-based root-canal filling material using digital radiography. Clinical and Experimental Health Sciences. 2013;3(1):19.
3. Guerreiro-Tanomaru JM, Duarte MA,Gonçalves M, Tanomaru-Filho M. Radiopacity evaluation of root canal sealers containing calcium hydroxide and MTA. Brazilian oral research. 2009;23:119-23.
4. Tagger M, Katz A. Radiopacity of endodontic sealers: development of a new method fordirect measurement. Journal of Endodontics. 2003 Nov 1;29(11):751-5.
5. Tagger M, Katz A. A standard for radiopacity ofroot-end (retrograde) filling materials is urgently needed. I Endod J 2004;37:260-4.
6. Panda DS, Alam MK, Mahmod AKA. Nanotechnology for making a paradigm shift in COVID-19 vaccine. Bangladesh J Med Sci. 2022 Jan;21(1):5-7.
7. Fadil F, Affandi NDN, Misnon MI, Bonnia NN, Harun AM, Alam MK. Review on Electrospun Nanofiber-Applied Products. Polymers (Basel). 2021 Jun;13(13):2087.
8. Fonseca RB, Branco CA, Soares PV, Correr- Sobrinho L, Haiter-Neto F, Fernandes-Neto AJ, Soares CJ. Radiodensity of base, linerandluting dental materials. Clinical Oral Investigations. 2006 Jun;10(2):114-8.
9. Baksi BG, Sen BH, Eyuboglu TF. Differences in aluminum equivalent values of endodontic sealers: conventional versus digital radiography. Journal of endodontics. 2008 Sep 1;34(9):1101-4.
10. Tanomaru-Filho M, Torres FF, Chávez-Andrade GM, de Almeida M, Navarro LG, Steier L, Guerreiro-Tanomaru JM. Physicochemical properties and volumetric change of silicone/bioactive glass and calcium silicate–based endodontic sealers. Journal of Endodontics. 2017 Dec 1;43(12):2097-101.
11. International Organization for Standardization (ISO) 6876:2001, Geneva, Switzerland. Dental Root Canal Sealing Materials 2001.
12. Bodrumlu E, Sumer P, Gungor K. Radiopacity of a new root canal sealer, epiphany. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;104:e59-e61.
13. Tyagi S, Mishra P, Tyagi P. Evolution of root canal sealers: An insight story. European Journal of General Dentistry. 2013 Sep;2(03):199-218.