OPEN ACCESS

ORIGINAL ARTICLE

PUSHOUT BOND STRENGTH OF NOVEL INJECTABLE BIOACTIVE GLASS SEALER IN COMPARISON WITH COMMERCIALLY AVAILABLE SEALERS

[1]ABDUR REHMAN, [2] ABDUL SAMAD KHAN, [3]NADEEM HAFEEZ KHOKHAR,[4]WASIF IQBAL, [5]HINA IMRAN, [6]SYED JUNAID MEHMOOD

ABSTRACT

It can be difficult to select the appropriate dental material for a particular therapeutic task. Many dental materials are advertised as being fresh and improved while criticizing the drawbacks of competing goods. The history and proven clinical performance of the materials in any material category, however, might occasionally serve as the deciding factor in choosing when there are numerous possibilities available. Since the invention of root canal sealers in the early 20th century, numerous root canal sealers have been created to better meet those requirements. One of the bioceramics, bioactive glass, has recently focus on the study of biocompatible biomaterials for endodontics. As a result, we developed an injectable bioactive glass-based root canal sealant and form of data pertaining to its physicochemical characteristics. Total 30 permanent single rooted rabbit incisors were used in this study. After gained access the canal and prepared with standard protocol, canal was obturated with CS BAG sealer(n=10), Total Fill BC Sealer(n=10) and Indigenous BAG sealer(n=10) sealers. The results of the present study revealed that sealers would probably favor bioactivity and would be expected to interact with the dentin. Within the limitation of the study we concluded that CS BAG sealer showed superior POBS than Indigenous bioactive glass sealer and Total Fill BC Sealer. On the basis of this data it can be concluded that CS BAG sealer has high resistance to dislodgement in general. Compared to all the sealers used in this study CS BAG showed superior marginal adaptation and TotalFill showed poor adaptation.

Keywords: *Bioactive glass sealer, Root canal, Push out bond strength and Analysis of failure.*

This article may be cited as: Rehman A, Khan AS, Khokhar HN, Iqbal W, Imran H, Mehmood SJ. Pushout Bond Strength of Novel Injectable Bioactive glass sealer in comparison with commercially available sealers. Pak Oral Dent J 2022; 42(4):205-208.

INTRODUCTION

One of the most prevalent disorders in endodontics is apical periodontitis.[1] It is frequently accompanied with periradicular bone changes that can be seen on periapical X-rays.[2] In the modern practice of endodontics, the management of apical periodontitis has long been a key task. The failure has been linked to non-hermetic root canal filling, and research has shown a success rate of up to 87%.[3] Interesting properties to improve the outcome of root canal therapy include sealing ability and bioactivity.[4] Apical periodontitis is intended to be treated and prevented by root canal therapy.[5] Complete bacterial clearances from the canal is necessary for achieving this goal, as is the selection of the filling material.[6] There have been no substantial developments in dentistry since the advent of gutta-percha as a root canal filling material in the middle of the 19th century, with the exception of the development of silver cones.[7] The chemical and physical characteristics of the sealer have received more attention in root canal filling material advancements.[8] By filling the area between the gutta-percha (GP) and dentinal wall, root canal sealers are utilized to get around the drawbacks

[1] Corresponding Author: Associate Professor, Science of Dental Materials Department, Hamdard University Dental Hospital, Hamdard University Karachi. Email address: abdurrehmanmds@gmail.com Contact No: +92 333 2382612

[2] Associate Professor (Dental Biomaterials), Department of Restorative Dental Sciences, College of Dentistry, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia. Email: akhan@iau.edu.sa Contact No: +966 59 478 1075

[3] Professor & HOD Science of Dental Material Department, Hamdard University Dental Hospital, Hamdard University Karachi. Email address: nadeemdmd@gmail.com Contact No: +92 321 2014262

[4] Associate Professor, Science of Dental Material Department, Sindh Institute of Oral Health Sciences, Jinnah Sindh Medical University Karachi. Email address: wasif.vp@gmail.com Contact No: +92 332 3484729

[5] Senior Scientific Officer, Pharmaceutical Research Centre PCSIR Laboratories Complex, Karachi Email address: dr_hinaimran@yahoo.com Contact No: +92 344 3497848

[6] Senior Scientific Officer, Applied Chemistry Research Center (ACRC), PCSIR Laboratories Complex, Karachi. Email address: junaid070880@gmail.com Contact No: +92 300 2432897

Received for Publication: Jan 13, 2022
Revised: Aug 3, 2022
Approved: Aug 10, 2022

of gutta-percha (GP) cones and obturation methods.[9] In order to prevent bacteria from reentering the canal and to inactivate bacteria that have already entered the channel following root canal obturation, root canal sealers with higher sealing ability and antibacterial activity would be clinically advantageous.[10] The root canal system is sealed up with root canal sealers, which also fix imperfections in the prepared channel and encase any leftover bacteria. A root canal sealer must have the necessary physical, chemical, and biological characteristics.[11] Excellent sealing ability, slow setting time, insolubility, dimensional stability and biocompatibility, according to Ogura et al., are necessary for the perfect root canal sealer. [12] A variety of root canal sealers have been created since the first ones were created in the early 20th century to better fulfil those needs.[13, 14] One of the bioceramics, bioactive glass, has recently focus on the study of biocompatible biomaterials for endodontics. As a result, we developed an injectable bioactive glass-based root canal sealant and form of data pertaining to its physicochemical characteristics.

MATERIAL AND METHODS

This Experimental study was conducted in the department of Science of Dental Material Department, Hamdard University from 1st February 2021 to 31st October 2021 after approval of institutional review board. The total duration of the study was 9 months after the approval from Ethical committee. The total sample size calculated was 26 which rounded up to 30. The sampling was done by purposive sampling method. The sample size was calculated by Openepi software version 3. Mean of group 1 was 3.52(±1.41) and group 2 was 2.31(±1.31) with confidence interval 95% and power of the study was 80%. Total 30 permanent single rooted rabbit incisors were extracted and stored according to ISO/TS 11405.Following standard protocol access of the root canal was prepared. Access of the root canal was gained with high speed rotary diamond cutting bur and canal was endodontically instrumented under air and water coolant manually until working length achieved. The barbed broaches of suitable size were used to remove the pulpal tissues. Each tooth was bisected at Cemento Enamel Junction horizontally using sectioning disc (Noritake Dental Supply Co. LTD) in straight slow speed hand piece. Once the orifice gained access canal was prepared by crown down technique. X-Smart Protaper system (NiTi) was used to prepare as per manufacturer instruction in following sequence S1, SX, S1, S2, F1 & F2 consecutively. The canal was obturated by using single cone technique with ISO standardized Protaper F2 Gutta percha along with CS BAG sealer(n=10), Total Fill BC Sealer(n=10) and Indigenous BAG sealer(n=10) sealers. These sealers were placed into prepared canal according to manufacturer's instruction. The tip of match taper cone was coated into the sealer and placed slowly in up and down motion until it reached full working length. The coronal access of the master cone was precut to the coronal orifice with a predetermined length. Every root which were stored in distilled water for a period of (1 week, 4weeks and 8weeks) were evaluated for bond strength testing. Roots which were obturated horizontally sectioned into 1.0+0.2mm thick slices in middle third using (Micracut 125) low speed precision cutter. Digital caliper was used to measure the thickness of each slice The slices of the roots were secured with an acrylic block made by metal framework with dimensions of 1.5mm x 1.5mm centrally hollow to allow easy movement of plunger. Using Universal Testing Machine; (MODEL 4301, INSTRON Lloyd Instrument Ltd. Fareham, UK) was used to evaluate the bonding strength.

Push out bond strength i.e. (MPA) = maximum load N/

Adhesion area of root filling mm2

(Adhesion) calculated by: area = (Dc+Da2).h

Where = 3.14 , Dc and Da are the root canal inner diameters of coronal and apical portion and h is thickness of specimen and were measured in mm.

Analysis of Failure Mode:

Failure modes were analyzed by examining each deboned specimen under stereo microscope (Motic Hong Kong) (stereo microscope with image analyze software, microscope, NED University, Karachi) at 20x magnification.

Adhesive Failure: If filling material was completely separated from dentine, adhesive failure occurs in between dentine and sealer interface.

Cohesive Failure: It was in between sealer and core materials.

Mixed Failure: It was a mixture of two types of failure.

SPSS Version 23 was used to analyzed the data. ANOVA test was used to find the mean difference between the experimental groups. P value ≤ 0.05 was taken as significant. Failure mode Analysis were expressed in percentages.

RESULTS

The Mean values of all push out bond strength was 1.82 (± 1.21 - 2.40). As shown in **Table 1.** Analysis of failure mode was express in percentages**.**

DISCUSSION

A popular method to assess a sealer's resistance to dislodgment is to investigate the push out bond strength (POBS). The interaction of a sealer with root dentin is an incredibly crucial aspect for the success of

TABLE 1: MEAN DIFFERENCE OF OVERALL PUSH OUT BOND STRENGTH WITH RESPECT TO EXPERIMENTAL GROUPS AND CONTROL

Groups	Mean	SD	p-value
TotalFill	1.71	1.19-1.97	<0.001*
CS BAG	2.58	1.51-2.98	
Indigenous Bioactive Blass Sealer	1.47	1.01-1.89	
Overall	1.82	1.21-2.40	

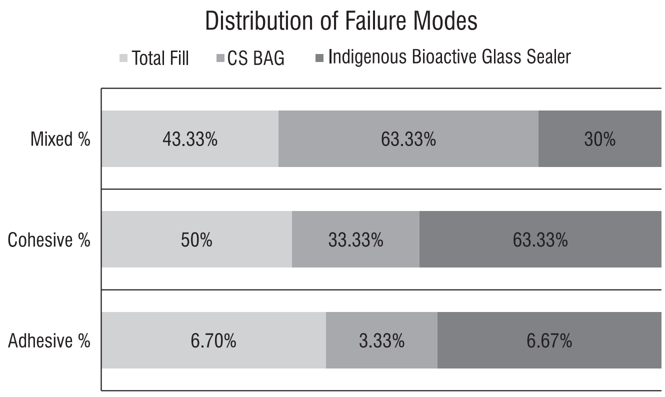

Fig 1: Distribution of failure mode between experimental group

endodontic procedures, and within the parameters of the POBS inquiry, the bond of the sealer either to the root canal wall or to the core material is analysed.[15] Numerous distinct testing techniques have been established, despite their widespread use.[16, 17] The pin diameter to specimen diameter ratio is the most important component of the experimental setup.[15, 18] In both studies, a ratio of less than 0.6 was found to have an impact on the POBS. A ratio greater than 0.85 may affect the POBS test, according to Chen et al.[15]; however, Pane et al.[18] did not agree. The pin diameter for the current investigation was intended to fall within this range. The variance in results may also be explained by various experimental protocols that were established in the past regarding root canal preparation (diameter and taper), root canal obturation (cold versus warm obturation techniques), the type and portion of the tooth, slice thickness, load velocity, and other parameters. Recently, it was demanded that the push-out test be standardized in order to look at specific questions relating to the sealer-dentin interface. These investigations established the root canal filling without using a core substance like gutta-percha.[19,20] In the current study, CS BAG sealer performed Total Fill BC Sealer and Indigenous bioactive glass sealer in terms of POBS. Based on the data provided, it can be said that CS BAG sealer generally has strong resistance to dislodgment. The "mineral infiltration zone" and tag-like structures create a weaker bond to the dentin by interacting chemically and micromechanically with the calcium silicate-based sealant on the root canal wall.[21] Any root filling material must adhere to the root dentin in order to function properly. [5] To assess the marginal adaptation to root dentin, the current study used three root canal sealers, including TotalFill, CS BAG, and Indigenous bioactive sealer. TotalFill had inadequate adaptation, but CS BAG demonstrated exceptional marginal adaptation when compared to all sealers. All sealer types showed greater interfacial gaps at the apical level than at the coronal level. This finding agreed with findings from other studies.[22] The difference between the apical and coronal levels may be explained by the apical level's reduced density and diameter of dentinal tubules, which leads to less sealer penetration.[23] The removal of the smear layer at the apical third is also challenging and may serve as a physical barrier that hindered the sealer's ability to adhere to the root canal dentin.[24]

CONCLUSION

Within the limitation of the study we concluded that CS BAG sealer showed superior POBS than Indigenous bioactive glass sealer and Total Fill BC Sealer. On the basis of this data it can be concluded that CS BAG sealer has high resistance to dislodgement in general. Compared to all the sealers used in this study CS BAG showed superior marginal adaptation and TotalFill showed poor adaptation.

REFERENCES

1 Segura-Egea J, Martín-González J and Castellanos-Cosano L. Endodontic medicine: connections between apical periodontitis and systemic diseases. Int. Endod. J. 2015; 48: 933-51.

2 Khalighinejad N, Aminoshariae MR, Aminoshariae A, et al. Association between systemic diseases and apical periodontitis. J. Endod. 2016; 42: 1427-1434.

3 Somani R, Jaidka S, Singh DJ, et al. Hermetic Seal in Obturation: An Achievable Goal with Recently Introduced Cpoint. Int J Clin Pediatr Dent. 2019; 12: 410.

4 Desouky AA, Negm MM and Ali MM. Sealability of Different Root Canal Nanosealers: Nano Calcium Hydroxide and Nano Bioactive Glass. Open Dent. J. 2019; 13.

5 Wu M, Wesselink P and Shemesh H. New terms for categorizing the outcome of root canal treatment. Int. Endod. J. 2011; 44: 1079.

6 Wu MK, Dummer P and Wesselink P. Consequences of and strategies to deal with residual post-treatment root canal infection. Int. Endod. J. 2006; 39: 343-56.

7 Lim M, Jung C, Shin D-H, et al. Calcium silicate-based root canal sealers: a literature review. Restor. Dent. Endod. 2020; 45.

8 Washio A, Morotomi T, Yoshii S, et al. Bioactive Glass-Based Endodontic Sealer as a Promising Root Canal Filling Material without Semisolid Core Materials. Mater. 2019; 12: 3967.

9 Cañadas PS, Berástegui E, Gaton-Hernández P, et al. Physicochemical properties and interfacial adaptation of root canal sealers. Braz. Dent. J. 2014; 25: 435-41.

10 Siqueira Jr JF, Favieri A, Gahyva SM, et al. Antimicrobial ac-

tivity and flow rate of newer and established root canal sealers. J. Endod. 2000; 26: 274-77.

11 Jo SB, Kim HK, Lee HN, et al. Physical properties and biofunctionalities of bioactive root canal sealers in vitro. J. Nanomater. 2020; 10: 1750.

12 Ogura Y and Katsuumi I. Setting properties and sealing ability of hydraulic temporary sealing materials. Dent. Mater. J. 2008; 27: 730-35.

13 Tyagi S, Mishra P and Tyagi P. Evolution of root canal sealers: An insight story. European J Gen Dent . 2013; 2: 199.

14 Al-Haddad A and Che Ab Aziz ZA. Bioceramic-based root canal sealers: a review. Int. J. Biomater. 2016; 2016 May 3;2016.

15 Chen W-P, Chen Y-Y, Huang S-H, et al. Limitations of push-out test in bond strength measurement. J. Endod. 2013; 39: 283-87.

16 Ahmed HT and Al-Mezouri AR. Push out bond strength of different root canal sealers used with the single cone obturation technique: An vitro study. Duhok Uni J. 2019; 22: 151-58.

17 Dabaj P, Kalender A and Unverdi Eldeniz A. Push-out bond strength and SEM evaluation in roots filled with two different techniques using new and conventional sealers. Mater. 2018; 11: 1620.

18 Pane ES, Palamara JE and Messer HH. Critical evaluation of the push-out test for root canal filling materials. J. Endod. 2013; 39: 669-73.

19 Do Carmo S, Néspoli F, Bachmann L, et al. Influence of early mineral deposits of silicate-and aluminate-based cements on push-out bond strength to root dentine. Int. Endod. J. 2018; 51: 92-101.

20 Mokhtari H, Rahimi S, Reyhani MF, et al. Comparison of push-out bond strength of gutta-percha to root canal dentin in single-cone and cold lateral compaction techniques with AH Plus sealer in mandibular premolars. J. Dent. Res. Dent. Clin. Dent. Prospects 2015; 9: 221.

21 Atmeh A, Chong E, Richard G, et al. Dentin-cement interfacial interaction: calcium silicates and polyalkenoates. J. Dent. Res. 2012; 91: 454-59.

22 Al-Haddad A, Kasim NHA and Ab Aziz ZAC. Interfacial adaptation and thickness of bioceramic-based root canal sealers. Dent. Mater. J. 2015; 34: 516-21.

23 Ferrari M, Mannocci F, Vichi A, et al. Bonding to root canal: Structural characteristics of the substrate. Am. J. Dent. 2000; 13: 255-60.

24 Violich D and Chandler N. The smear layer in endodontics–a review. Int. Endod. J.2010; 43: (2) 15.

CONTRIBUTIONS BY AUTHORS

1 **Abdur Rehman:**	Methodology, Statistical analysis, Results, Literature review.
2 **Abdul Samad Khan:**	Study design, Data collection, Discussion, Conclusion.
3 **Nadeem Hafeez Khokhar:**	Data collection, Literature review.
4 **Wasif Iqbal:**	Introduction, Data collection.
5 **Hina Imran:**	Literature review.
6 **Syed Junaid Mehmood:**	Data collection, Literature review