International Journal of Dental Sciences
www.dentaljournal.in
E-ISSN: 2663-4708, P-ISSN: 2663-4694
Received: 13-06-2025; Accepted: 13-07-2025; Published: 28-07-2025
Volume 7, Issue 3, 2025, Page No. 35-38

Comparative evaluation of fracture resistance of endodontically treated teeth obturated using different sealers: An *In vitro* study

Dr. Dhanushree DR[1], Dr. Ananthakrishna S[2], Dr. Pradeep PR[3], Dr. Maneesha[4] Dr. Sowmya S [5]

[1] Postgraduate Student, Department of Conservative Dentistry and Endodontics, M.R Ambedkar Dental College and Hospital, Bangalore, Karnataka, India

[2] Professor and HOD, Department of Conservative Dentistry and Endodontics, M.R Ambedkar Dental College and Hospital, Bangalore, Karnataka India

[3] Professor and Principal, Department of Conservative Dentistry and Endodontics, M.R Ambedkar Dental College and Hospital, Bangalore, Karnataka, India

[4] Postgraduate Student, Department of Conservative Dentistry and Endodontics, M.R Ambedkar Dental College and Hospital, Bangalore Karnataka, India

[5] Department of conservative dentistry and endodontics, MR Ambedkar dental college, Bengaluru, Karnataka, India

Abstract

Background and Objectives: It is a well-known fact that endodontically treated teeth are more prone to fracture. The most common causes have been high pressure used during obturation, dehydration of dentin and loss of tooth structure during endodontic therapy. Gutta Percha is the most commonly used obturating material; however, because it has a lower elastic modulus than dentin it has less of an impact on strengthening roots following root canal therapy. Therefore, a root canal sealer that has the ability to secure the tooth against root fracture would undoubtedly be beneficial. The aim of this study was to compare the effect of five different root canal sealers on the fracture resistance of endodontically treated teeth.

Methodology: 50 single rooted teeth with mature apices were used for this study. Samples were randomly divided into 5 groups. Root canal shaping was done using Protaper file system for all five groups with copious irrigation and gutta percha was used as an obturating material. **Group 1**: Canals coated with AH plus; **Group 2:** Canals coated with Maarc Ceraseal MTA based sealer; **Group 3**: Canals coated with MTA fillapex; **Group 4:** Canals coated with Angelus Bioceramic sealer; **Group 5**: Canals coated with Prime Bioceramic sealer. After storing these teeth for 2 weeks in 100% humidity, fracture force was measured using a universal testing machine.

Results: The results indicated that bioceramic sealers provided the highest fracture resistance, followed by MTA-based sealers, while AH Plus demonstrated the lowest resistance. Additionally, no significant differences were observed between the two bioceramic and between the two MTA-based sealers evaluated in the study.

Conclusion: Within the limitations of this study, it can be concluded that both Bioceramic and MTA sealers could significantly reinforce the endodontically treated teeth and improve their fracture resistance.

Keywords: AH Plus sealer, Bioceramic Sealer, MTA Fillapex sealer, universal testing machine, vertical root fracture.

Introduction

Root canal treatment plays a vital role in managing pulpal and periapical pathologies. The core objectives of endodontic therapy are the thorough cleaning, shaping and obturation of the root canal system. It also aims to prevent reinfection, preserve periodontal health and facilitate optimal healing. [1]

The structural integrity of endodontically treated teeth is largely determined by the quantity and quality of the remaining tooth structure. [2] Factors such as excessive instrumentation, dehydration of dentin, high obturation pressure and occlusal stress can heighten the risk of root fractures. [3-5] Moreover, the combined effects of intracanal irrigants and medicaments may negatively impact dentin's mechanical properties, contributing to failure. [6] Although gutta-percha used with sealers is a standard filling material, its low elasticity limits its ability to reinforce tooth structure. [7] Thus, sealers capable of bonding effectively to dentin are valuable in enhancing fracture resistance and overall tooth strength [8]

The sealing capacity of gutta-percha when used with conventional zinc oxide eugenol (ZOE) sealers has been considered suboptimal. [13] To overcome these limitations, various advanced sealers have been developed with improved physical and biological properties. Among them, resin-based sealers, particularly AH Plus, have gained wide acceptance due to their superior performance. AH Plus exhibits excellent handling characteristics, enhanced wettability for both dentin and gutta-percha surfaces, and reliable sealing ability. Its capacity to penetrate dentinal tubules and chemically bond to dentin has positioned it as the reference standard in modern endodontic practice. [9]

In recent years, attention has shifted toward MTA-based and bioceramic sealers, which offer additional biological benefits. These materials promote mineralization through controlled inorganic deposition on dentin surfaces. [10] One such material, MTA-Fillapex (Angelus, Londrina, Brazil), combines approximately 13% mineral trioxide aggregate (MTA) with a salicylate resin matrix, resulting in a formulation with excellent antimicrobial activity and biocompatibility. Its desirable properties include high radiopacity, low solubility, minimal setting expansion, and a reliable sealing ability. Additionally, it promotes cementum

regeneration and releases calcium ions (Ca^{2+}), which play a critical role in stimulating tissue repair and regeneration. [11,12]

Another material, Maarc Ceraseal, is a calcium silicate-based, resin- and monomer-free bioceramic sealer. It is characterized by zero shrinkage, high alkaline pH, and bioactivity, facilitating hydroxyapatite formation and remineralization of the dentin structure, while maintaining excellent biocompatibility.

In general, bioceramic sealers are valued for their chemical bonding to dentin, dimensional stability, and bioactive behavior. Their alkaline pH provides antibacterial action, while calcium ion release supports mineralization and tissue healing. These features not only enhance the sealing efficiency of the root canal system but also potentially reinforce the tooth structure, improving the fracture resistance of endodontically treated teeth.

In the present study, two bioceramic sealers were selected to evaluate their effect on the fracture resistance of root canal-treated teeth.

- **Bio-C sealer (Angelus):** A premixed, resin-free, calcium silicate-based material with a high pH (~12) and hydrophilic setting properties. It sets reliably in the presence of moisture and chemically bonds to dentin. The release of calcium ions promotes biological healing and may contribute to the mechanical reinforcement of the root structure.

- **Prime Bioceramic Sealer (Prime Dental):** A ready-to-use, MTA-based bioceramic sealer that contains 13% mineral trioxide aggregate suspended in a salicylate resin matrix. It combines antimicrobial efficacy, biocompatibility and bioactivity, releasing calcium ions to support cementum regeneration and potentially improve the mechanical strength of the treated root.

The present study aimed to evaluate and compare the impact of five different root canal sealers on the fracture resistance of teeth following endodontic treatment.

Methodology

Fifty single rooted teeth, both maxillary and mandibular, caries free, no fracture and extracted purely for periodontal reasons were collected. The teeth were decoronated apical to the cemento-enamel junction to standardize the canal length to 14mm using a low-speed circular diamond disk.

Biomechanical preparation of the root canal was done using Protaper Files upto size F3 followed by irrigation with 2ml of 3%NaOCl after each file and 17% EDTA was used to remove the smear layer

The teeth were then assigned into five groups depending upon the sealer used (10 teeth per group)

Group 1: Canals coated with AH plus
Group 2: Canals coated with Angelus Bioceramic sealer
Group 3: Canals coated with Prime Bioceramic sealer
Group 4: Canals coated with MTA fillapex
Group 5: Canals coated with Maarc Ceraseal MTA based sealer

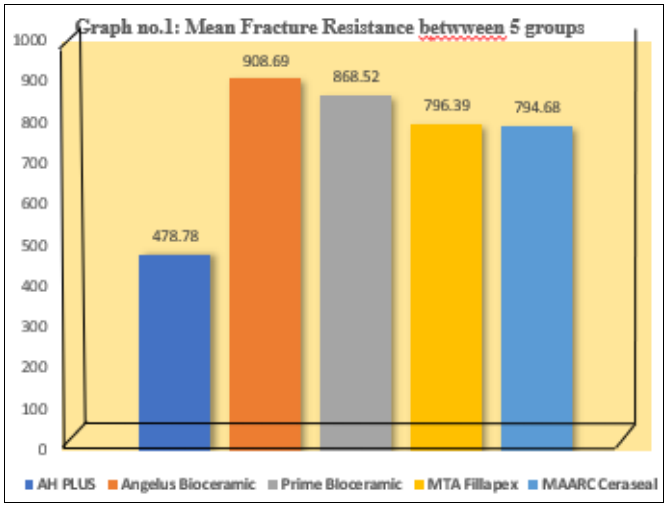
Following this, they were embedded in an acrylic mould exposing only 2mm of root. After storing these teeth for 2 weeks in 100% humidity, fracture force was measured using a universal testing machine.

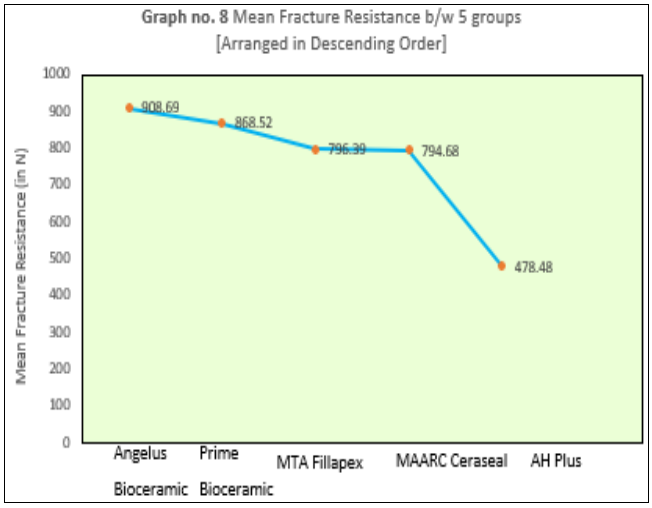
Statistical Analysis

One-way ANOVA Test followed by Tukey's post hoc test / Kruskal Wallis Test followed by Dunn's post hoc test [Based on Data distribution] was used to compare mean diff. in mean Fracture Resistance (in N) b/w 5 Sealers.

Results

Multiple comparison of mean difference between groups revealed that Group 1(AH Plus) 478.78N showed the least and Group 2(Angelus Bio-C) 908.69N showed the highest mean fracture resistance as compared to the other groups and the mean differences were statistically significant at $p<0.001$. No significant difference was observed between group 4(MTA Fillapex)796.39N and group 5 (MAARC Ceraseal) 794.68N





Sl	FRACTURE RESISTANCE(in N)				
	AH Plus Sealer	Prime Bioceramic	Angelus Bioceramic sealer	MTA Fillapex	MAARC Ceraseal
S 1	555.3	947.8	968.3	887.5	824.3
S 2	528.1	825.5	867.2	798.7	765.3
S 3	489.0	825.0	955.0	902.2	873.2
S 4	452.2	860.5	1012.3	792.4	729.0
S 5	513.5	789.2	989.2	898.2	995.2
S 6	363.5	1048.0	1057.5	825.5	735.4
S 7	484.9	704.8	812.0	855.0	793.5
S 8	534.6	905.3	888.0	1008.3	798.3
S 9	437.5	828.0	772.1	934.2	831.0
S 10	429.2	908.4	765.3	783.2	882.4

Discussion

Sealers and root canal filling materials are two of the factors that may be known to boost a tooth's resistance to fracture. Therefore, when the tooth has been chemically and mechanically prepared, a filling material that reinforces the compromised tooth structure must be chosen for root canal obturation.

Over the years, a variety of sealers have been utilized, including ZOE, Ca (OH)2 sealer, glass ionomer sealer, epoxy-based and urethane dimethacrylate-based resin sealers, and most recently, bioceramic and MTA-based root canal sealers.

The current study evaluated the effect of 5 different sealers on fracture strength of roots.

Mandibular premolars were chosen for this study because of their high incidence of root fractures due to their crown size, anatomy, crown/ root ratio, and function. Also because of their placement in the dental arch, they are exposed to both shear and compressive forces. [14]

The single cone obturation technique was used because it reduces the removal of excessive dentin and the effect of manual reamers using in the lateral condensation technique, and pluggers in warm condensation. [15] Therefore, the forces applied during canal filling were neutralized and the effect of only the filling pastes was studied.

Standardization of teeth was done by measuring both mesio -distal and bucco -lingual dimensions using a caliper and by taking pre-op x-rays to eliminate single rooted premolars with two canals.

Protaper Universal Rotary files were used to prepare the canals in order to get a round- section which resulted in equal distribution of stress.

EDTA was used as an irrigating solution to remove the smear layer which would otherwise block the dentinal tubules and prevent sealer penetration thereby, decreasing the fracture resistance. [16, 17]

Various studies have shown that AH Plus sealer demonstrated greater fracture resistance when compared to other sealers. [18, 19] AH Plus forms covalent bonds with the exposed amino group of dentine. The better flow and long polymerization time of the sealer enables improved penetration into tubules and canal irregularities causing mechanical interlocking between the sealer and root dentin. However, in our study, the AH Plus sealer showed the least resistance to fracture. This could be because of the reduced tensile and compressive strength of AH Plus in comparison with dentine as demonstrated by a similar study done by Jainaen *et al*.

The two Bioceramic sealers showed the highest fracture resistance when compared to the remaining sealers.

This can be explained due to the fact that these sealers can penetrate deep into the dentinal tubules and canal irregularities owing to their nanoparticle composition and interact with tissue fluids and produce a coating that resembles hydroxyapatite and form a mineral infiltration zone. This increases adherence to dentinal walls due to the formation of a chemical bond∴ increasing resistance to fracture. This is in accordance with previous studies conducted by Gervini *et al*., Varghese *et al*., and Yendrembam *et al*.

With little variation, both MTA sealers displayed the second-highest level of fracture resistance. The Calcium hydroxide released by the interaction of calcium silicate particles of MTA with water combines with the Phosphate ions from body fluids to form a dentin-MTA interfacial layer. This interstitial layer resembles hydroxyapatite in composition and structure demonstrating superior marginal adaptation. However, MTA Fillapex did not strengthen the root as much as Bioceramic did in the present study. This could be due to low bonding of MTA to dentin when compared to bioceramics.

Conclusion

Within the limitations of the present study, it can be concluded that bioceramic sealers enhance the fracture resistance of endodontically treated teeth more effectively than MTA-based sealers or epoxy resin-based sealers

Financial support and sponsorship Nil

Conflicts of interest There are no conflicts of interest

References

1. Yendrembam B, Mittal A, Sharma N, Dhaundiyal A, Kumari S, Abraham A. *et al*. Relative assessment of fracture resistance of endodontically treated teeth with epoxy resin-based sealers, AH Plus, MTA Fillapex, and Bioceramic Sealer: An *In vitro* study. Indian J Dent Sci,2019:11:46-50
2. Sornkul E, Stannard JG. Strength of roots before and after endodontic treatment and restoration. J Endod,1992:18(9):440–443. DOI: 10.1016/ S0099-2399(06)80845-9.
3. Sedgley CM, Messer HH. Are endodontically treated teeth more brittle? J Endod,1992:18(7):332–335. DOI: 10.1016/S0099 2399(06)80483-8.

4. Reinhardt RA, Krejci RF, Pao YC, *et al*. Dentin stresses in post reconstructed teeth with diminishing bone support. J Dent Res,1983:62(9):1002–1008. DOI: 10.1177/00220345830620090101.
5. Trope M, Ray Jr HL. Resistance to fracture of endodontically treated roots. Oral Surg Oral Med Oral Pathol,1992:73(1):99–102. DOI: 10.1016/0030-4220(92)90163-K.
6. Bhat SS, Hegde SK, Rao A, *et al*. Evaluation of resistance of teeth subjected to fracture after endodontic treatment using different root canal sealers: an *in vitro* study. J Indian Soc Pedod Prev Dent,2012:30(4):305–309. DOI: 10.4103/0970-4388.108926.
7. Ribeiro FC, Souza-Gabriel AE, Marchesan MA, *et al*. Influence of different endodontic filling materials on root fracture susceptibility. J Dent,2008:36(1):69–73. DOI: 10.1016/j.jdent.2007.10.007.
8. Phukan AH, Shivani M, Sandhu M, *et al*. The effect of different root canal sealers on the fracture resistance of endodontically treated teeth-*in vitro* study. Dent Res J (Isfahan),2017:14(6):382–388. DOI: 10.4103/1735-3327.218558.
9. Patil SA, Dodwad PK, Patil AA. An *in vitro* comparison of bond strengths of Guttapercha/AH plus, Resilon/Epiphany self-etch and EndoREZ obturation system to intraradicular dentin using a push-out test design. J Conserv Dent,2013:16(3):238–242. DOI: 10.4103/0972 0707.111323.
10. Tyagi S, Tyagi P, Mishra P. Evolution of root canal sealers: an insight story. Eur J Gen Dent,2013:2(3):199–215. DOI: 10.4103/2278 9626.115976.
11. Shantiaee Y, Dianat O, Janani A, *et al*. *In vitro* evaluation of the antibacterial activity of three root canal sealers. Iran Endod J,2010:5(1):1–5.
12. Sagsen B, Ustün Y, Demirbuga S, *et al*. Push-out bond strength of two new calcium silicate-based endodontic sealers to root canal dentine. Int Endod J,2011:44(12):1088–1091. DOI: 10.1111/j.1365 2591.2011.01925.x.
13. Sebastian VM, Nasreen F, Junjanna P, Hassan A, Rajasekhar R, Maratt VH. Comparative Evaluation of Root Reinforcement Using MTA-based, Epoxy Resin-based, and Silicone-based Endodontic Sealers in Canals Instrumented with Single-file Rotary System: An *In Vitro*Study. J Contemp Dent Pract,2021:22(10):1098-1104. PMID: 35197375.
14. Kala M, Shaktidar PR, Allappanavarkeerti S, Gupthanagendra VR. A comparative evaluation of fracture resistance of endodontically treated teeth obturated with AH plus with gutta percha, guttaflow with gutta percha and resilon epiphany- an *in vitro* study. IOSR J Dent Med Sci,2014:13:54-8.
15. Shaheen NA, Farag AM, Alhadainy HA, Darrag AM. Fracture resistance of endodontically treated roots using different preparation–obturation combinations. Tanta Dent. J,2013:10:97–102.
16. Weiger R, Heuchert T, Hahn R, *et al*. Adhesion of a glass ionomer cement to human radicular dentine. Endod Dent Traumatol,1995:11(5):214–219. DOI: 10.1111/j.1600-9657. 1995.tb00491. x.
17. White RR, Goldman M, Lin PS. The influence of the smeared layer upon dentinal tubule penetration by plastic filling materials. J Endod,1984;10(12):558–562. DOI: 10.1016/S0099-2399(84)80100-4.
18. Teixeira FB, Teixeira EC, Thompson JY, *et al*. Fracture resistance of roots endodontically treated with a new resin filling material. J Am Dent Assoc,2004:135(5):646–652. DOI: 10.14219/jada. archive.2004.0255.
19. Topçuoğlu HS, Tuncay Ö, Karataş E, *et al*. *In vitro* fracture resistance of roots obturated with epoxy resin-based, mineral trioxide aggregate based, and bioceramic root canal sealers. J Endod,2013:39(12):1630–1633. DOI: 10.1016/j.joen.2013.07.034.