



Effect of separated instruments on apical seal of root canals obturated with different sealers and techniques – An *in vitro* stereomicroscopic study

Dr. Pooja kumari¹, Dr. Madhu Pujar²

¹ Martha Mandal's Nathajirao G. Halgekar Institute of Dental Sciences and Research Centre, Belagavi, Karnataka, India

² Head, Department of Conservative and Endodontics at Martha Mandal's Nathajirao G. Halgekar Institute of Dental Sciences and Research Centre, Belagavi, Karnataka, India

DOI: <https://doi.org/10.66856/ijds.2026.8.3.8110>

Abstract

Background: one of most common procedural errors during clinical procedure is instrument separation during canal preparation, which can compromise apical seal. Whether to remove or bypass the fragment depends on its location and canal anatomy, but often the fragment remains, which can impact apical sealing. The effectiveness of a root canal filling is influenced by the quality of canal preparation, the type of sealer used, and the obturation technique.

AIM: To evaluate and compare the extent of apical microleakage in root canals containing fractured instruments obturated using two different sealers and three different obturation techniques.

Materials and Methods: This *in-vitro* study was conducted at Maratha Mandal's Nathajirao G. Halgekar institute of dental sciences and research centre, Belgavi, Karnataka, India over a duration of 2 month from August 2025 to October 2025. Total 36 mandibular molars were decoronated and prepared with hand and rotary files upto size 20. An intentional scratch was made on a #F1 protaper gold rotary file, positioned 3 mm from its tip, using a high-speed handpiece, and it was deliberately fractured at the root apex. Radiographs were taken after the file was fractured to ensure the location of file in the canal. Again with smaller no. file bypassing of separated instrument was done followed by enlarging the canal with hyflex 20/4%. Then the samples were randomly divided into 3 groups each group containing 12 sample, Group A: Samples obturated by lateral compaction technique with AH plus and bioceramic sealer, Group B: Samples obturated using the thermoplasticised obturation technique with AH plus and bioceramic sealer, and Group C: Samples obturated using single cone technique with AH plus and bioceramic sealer. Roots were coated with nail varnish, sparing the apical 2 mm and glass ionomer cement was used to seal the coronal opening. The roots were submerged in methylene blue dye for a duration of 48 hours. After rinsing, mesiodistal sectioning of the roots was done using a cutting saw. A stereomicroscope, Magnification: (20X) was used to observe the segments, and the dye penetration depth was measured using an Image Analysis System.

Results: One-way ANOVA and Tukey's post hoc test was used compare apical microleakage (dye penetration) across all groups, revealing statistically significant differences between sealers and techniques ($p < 0.001$).

Conclusion: The thermoplastized obturation technique achieved the most effective apical seal, particularly when used with bioceramic sealer.

Keywords: Separated instruments, apical microleakage, thermoplastized, bioceramic sealer

Introduction

Endodontic success relies on effective cleaning, shaping, and three-dimensional obturation of the root canal system, with a hermetic apical seal being crucial to prevent reinfection. Proper instrumentation and preparation are essential for successful therapy, allowing for effective flow of irrigants and thorough canal debridement. Establishing a glide path and accurately negotiating the canal are vital initial steps. Both hand and rotary files can be used for preparation, with rotary files offering quicker results. Nickel-titanium (NiTi) rotary files are flexible and strong, ideal for narrow, curved canals, but have a fracture risk of 0.4% to 5%, especially in molars. While fractured instruments may not require surgery or extraction, they can impede healing, particularly in teeth with periapical radiolucency.

Retrieving broken instruments from the root canal is often difficult and rarely successful, with no established removal protocol. Extraction attempts may damage dentin, lead to perforations, complicate thin or curved roots, and risk fragment extrusion. Some experts recommend leaving the broken instrument in place and continuing with standard

canal obturation, as studies show this does not adversely affect prognosis if the canals are properly cleaned and sealed.

Poor apical sealing accounts for about 60% of endodontic treatment failures. With the increasing use of rotary NiTi files leading to more instrument separations, it's crucial to investigate their impact on apical sealing quality. Sealers, which fill irregularities and act as an interface between core material and dentin, play a vital role. Different sealers, like epoxy resin-based (AHplus) and calcium silicate-based (bio-C), vary in flow, adhesion, and bioactivity, influencing their sealing ability, especially in complex anatomies. Additionally, obturation techniques like cold lateral condensation, thermoplasticized gutta-percha, and single cone obturation affect how well filling material adapts to canal walls. Techniques using heat or pressure may enhance flow and fit, while others might leave voids. However, there's limited research integrating separated instruments, sealer types, and obturation methods to assess their collective impact on apical sealing. This study aims to address these clinical challenges by evaluating

contemporary materials and techniques to improve root canal treatment predictability.

Methodology

Total 36 mandibular molars were decoronated and prepared with hand and rotary files upto size 20. An intentional scratch was made on a #F1 protaper gold rotary file, positioned 3 mm from its tip, using a high-speed handpiece, and it was deliberately fractured at the root apex. Radiographs were taken after the file was fractured to ensure the location of file in the canal, Again with smaller no. file bypassing of separated instrument was done followed by enlarging the canal with hyflex 20/4% .Then the samples was randomly divided into 3 groups each group containing 12 sample, Group A: Samples obturated by lateral compaction technique with AH plus and bioceramic sealer, Group B: Samples obturated using the thermoplasticised obturation technique with AH plus and bioceramic sealer, and Group C: Samples obturated using single cone technique with AH plus and bioceramic sealer. Roots were coated with nail varnish, sparing the apical 2 mm and glass ionomer cement was used to seal the coronal opening. The roots were submerged in methylene blue dye for a duration of 48 hours. After rinsing, mesiodistal sectioning of the roots was done using a cutting saw. A stereomicroscope, Magnification: (20X) was used to observe the segments, and the dye penetration depth was measured using an Image Analysis System.

Statistical Analysis

One-way ANOVA and Tukey’s post hoc test was used compare apical microleakage (dye penetration) across all groups, revealing statistically significant differences between sealers and techniques ($p < 0.001$). Significant difference between bioceramic and AH Plus sealers within each obturation technique ($p < 0.001$). Thermoplastized technique groups had significantly lower microleakage compared to lateral compaction and single cone groups ($p < 0.001$). Statistical results (f value = 5.276, p value = 0.003) confirm these differences are significant.

Discussion

The present study evaluated the impact of separated instruments on apical sealing ability when different sealers and obturation techniques were used, employing a stereomicroscopic dye penetration method. The results showed that the bioceramic sealer (Bio-cAngelus) consistently outperformed AH Plus in apical sealing across all methods. This superiority is due to its better flow, biomineralization potential, and strong chemical bonding with dentin, creating a tight interface that resists

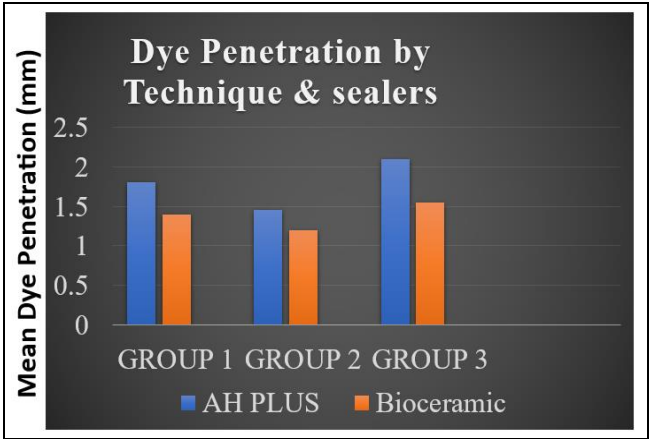
leakage. In contrast, AH Plus relies on micromechanical retention, making it more prone to leakage. Among the obturation techniques, the thermoplastized gutta-percha method resulted in the least microleakage, as its flow allows better adaptation to canal irregularities. These findings align with those of Godiny *et al.* (2017) [2] and Hasheminia *et al.* (2022), who also noted improved sealing with bioactive materials and warm obturation methods in the presence of fractured files. The lateral compaction technique showed moderate leakage, likely due to voids between accessory cones and limited sealer flow at the apex. In comparison, single cone groups had the highest leakage with AH Plus, attributable to lower filling density and inconsistent sealer thickness.

Conclusion

Bioceramic sealer groups in all obturation techniques showed significantly less dye penetration compared to AH Plus sealer groups, indicating better apical sealing ability. The thermoplastized obturation technique achieved the most effective apical seal, particularly when used with bioceramic sealer. The presence of a separated instrument does compromise the apical seal, but selection of an appropriate sealer and technique can substantially minimize microleakage, and enhance the treatment outcome.

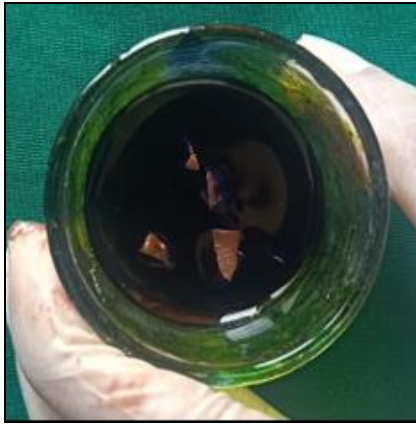
Obturation Technique	Sealer type	Mean Dye Penetration (mm)	Standard Deviation
Lateral compaction	AH Plus	2.21	0.43
Lateral compaction	Bioceramic	1.84	0.38
Thermoplastized	AH Plus	1.76	0.41
Thermoplastized	Bioceramic	1.42	0.36
Single cone	AH Plus	2.36	0.47
Single cone	Bioceramic	1.98	0.45

Results





(e)

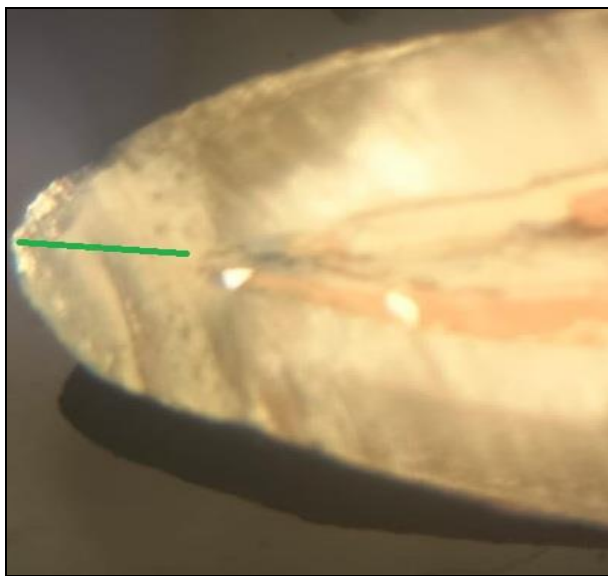


(f)

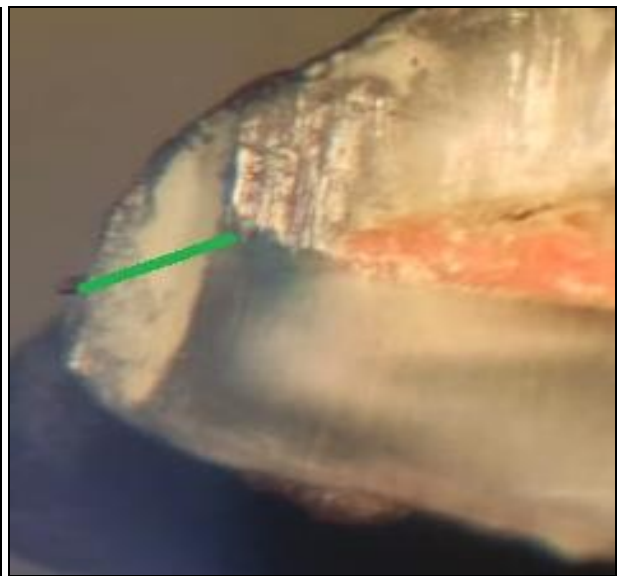


(g)

Stereo microscopic image
Group 1

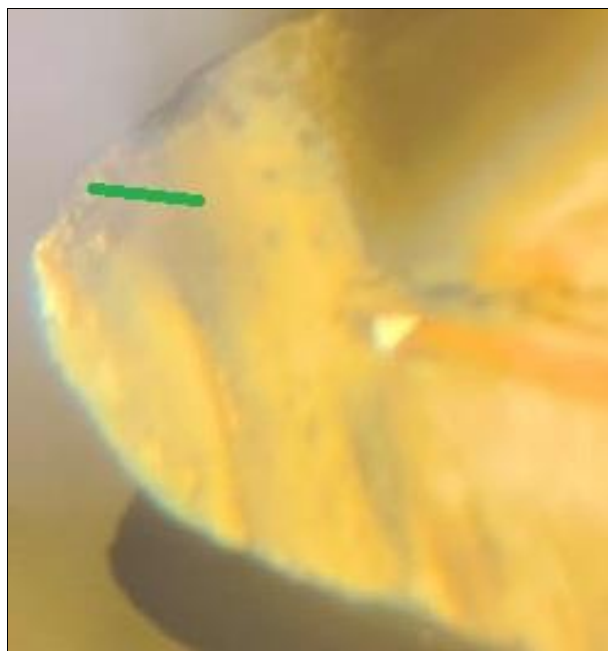


AH Plus

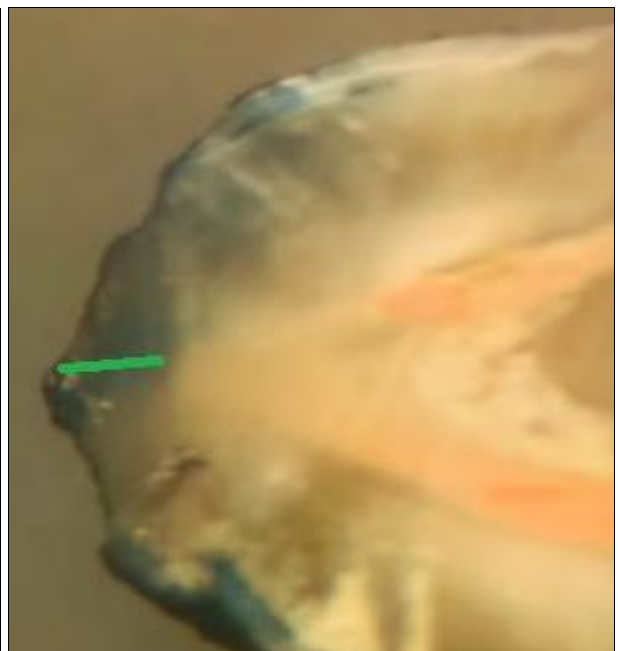


BIO-C (h)

Group2



AH Plus



BIO-C (i)

Group 3



Fig 1:(a) 36 mandibular molars decoronated (b) An intentional scratch was made on a #F1 protaper gold rotary file, positioned 3 mm from its tip, using a high-speed handpiece, and it was deliberately fractured at the root apex. (c) Radiographs were taken after the file was fractured to ensure the location of file in the canal. (d) obturated tooth sample (e) Roots were coated with nail varnish, sparing the apical 2 mm and glass ionomer cement was used to seal the coronal opening.(f) The roots were submerged in methylene blue dye for a duration of 48 hours.(g) mesiodistal sectioning of the roots was done using a cutting saw.(h) Group A: Stereomicroscopic image of samples obturated by lateral compaction technique with AH plus and bioceramic sealer.(i) Group B: Stereomicroscopic image of Samples obturated using the thermoplasticised obturation technique with AH plus and bioceramic sealer.(j) Group C: Stereomicroscopic image of Samples obturated using single cone technique with AH plus and bioceramic sealer

References

1. Narayanan AA, Mandlik JS, Singh SV, Jadhav AB, Bhamare R, Ingale VP, *et al.* Effect of Separated Instruments on Apical Seal of Root Canals Obturated with Different Techniques: An In-vitro Stereomicroscopic Study. *Journal of Clinical and Diagnostic Research*,2025;19(4):27–ZC32. <https://www.doi.org/10.7860/JCDR/2025/74463/20867>
2. Godiny M, Hatam R, Khavid A, Khanlari S. Apical microleakage in root canals containing broken rotary instruments. *Iranian Endodontic Journal*,2017;12:360–365.
3. Lone MM, Khan FR, Lone MA. Evaluation of microleakage in single-rooted teeth obturated with thermoplasticized gutta-percha using various endodontic sealers: An *in-vitro* study. *Journal of the College of Physicians and Surgeons Pakistan*,2018;28:339–343.
4. Manjila JC, Vijay R, Sreirekha A, Santhosh L, Reddy J, Srinivasan A, *et al.* Apical microleakage in root canals with separated rotary instruments obturated with different endodontic sealers. *Journal of Conservative Dentistry and Endodontics*,2022;25(3):274–277.
5. El Sayed MA, Taleb AA, Balbahaith MS. Sealing ability of three single-cone obturation systems: An: In-Vitro: Glucose leakage study. *Journal of Conservative Dentistry and Endodontics*,2013;16(6):489–493.
6. Saeidi A, Hajipour R, Mahmoudi E, Feizi F, Khafri S. Comparison of the apical seal obtained by Adseal, Proseal, and AH26 sealers in root canal obturation with lateral compaction technique. *Dental Research Journal*,2023;20(1):94.