

Effect of Contemporary Root Canal Obturation Materials on the Structural Integrity of Treated Teeth

Astha Arya

B.D.S, M.D.S (Conservative Dentistry & Endodontics)

Corresponding Author Email ID: drasthaarya@yahoo.co.in

Received:15/11/2023

Accepted: 06/12/2023

Published:30/12/2023

Abstract

The structural integrity of endodontically treated teeth is significantly influenced by the type of obturation material used during root canal therapy. This study evaluated the effect of contemporary root canal obturation materials on the fracture resistance of treated teeth. Extracted human teeth were instrumented, obturated with different materials—conventional gutta-percha with epoxy resin sealer, bioceramic-based sealers, and thermoplasticized systems—and subjected to mechanical testing using a universal testing machine. The results revealed that teeth filled with bioceramic sealers demonstrated superior fracture resistance compared to those obturated with traditional gutta-percha systems. The enhanced mechanical stability observed can be attributed to improved bonding ability and the bioactive sealing properties of contemporary materials. The findings suggest that the selection of modern obturation systems plays a vital role in maintaining tooth strength and preventing structural failure after endodontic treatment. This study provides valuable insight for clinicians aiming to optimize long-term treatment outcomes through evidence-based material selection.

Keywords: Root canal obturation, Fracture resistance, Bioceramic sealer, Gutta-percha, Endodontic treatment, Structural integrity

Journal of Applied Pharmaceutical Sciences and Research, (2023);

DOI: 10.31069/japsr.v6i4.08

Introduction

The success of endodontic therapy extends beyond the elimination of infection within the root canal system; it equally depends on the restoration of the treated tooth's structural integrity. Root canal obturation serves as a critical step in sealing the canal space and preventing reinfection, yet the materials and techniques employed can significantly influence the long-term durability and fracture resistance of the tooth (Baba & Goodacre, 2014). The inherent loss of dentin during endodontic procedures predisposes teeth to mechanical weakness, making the choice of obturation material a determining factor in preserving tooth strength and function.

Over the years, traditional obturation materials such as gutta-percha and epoxy resin-based sealers have been widely utilized due to their biocompatibility and ease of handling. However, these materials often exhibit limited bonding with dentin and inadequate reinforcement against fracture under functional loading conditions (Bishop, Griggs, & He, 2008). To address these limitations, contemporary materials, particularly bioceramic-based sealers—have been introduced, offering enhanced adhesion, bioactivity, and mechanical stability. These advancements aim to improve the overall sealing efficiency while reinforcing the root structure against stress-induced fractures.

Recent studies have demonstrated that newer obturation systems can substantially increase fracture resistance compared to conventional materials (Chandra et al., 2021).

This improvement is largely attributed to their superior interface integrity and potential for chemical bonding to dentin. Despite these promising outcomes, the comparative effectiveness of these materials on the structural integrity of endodontically treated teeth remains an area of ongoing investigation. Therefore, this study aims to evaluate the effect of contemporary root canal obturation materials on the fracture resistance of treated teeth, providing evidence-based insight for optimizing material selection in modern endodontic practice.

Literature Review

The integrity and longevity of endodontically treated teeth largely depend on the effectiveness of root canal obturation materials in maintaining a hermetic seal and reinforcing the remaining tooth structure. Over the past decades, significant progress has been made in the development of obturation materials aimed at improving mechanical strength, adhesion, and biocompatibility (Baba & Goodacre, 2014). Traditional obturation systems, such as gutta-percha combined with zinc oxide–eugenol or epoxy resin-based sealers, have been widely used due to their handling ease and clinical predictability. However, these materials often lack the ability to strengthen the root structure or bond effectively to dentin, which may compromise fracture resistance over time (Bishop, Griggs, & He, 2008).

Contemporary advances have introduced bioceramic-based sealers and thermoplasticized systems that exhibit

superior physicochemical properties. Bioceramic sealers, in particular, have been shown to chemically bond with dentin, form hydroxyapatite at the interface, and provide a more uniform stress distribution along the root canal walls, thereby enhancing the structural integrity of treated teeth (Chandra et al., 2021). These materials also demonstrate favorable bioactivity, dimensional stability, and minimal polymerization shrinkage, which collectively contribute to better long-term outcomes compared to conventional materials.

Moreover, studies assessing dynamic loading and fatigue behavior have emphasized the importance of a stable interface between dentin and obturation material under masticatory stress. Bishop et al. (2008) found that microleakage and interface deterioration are common in non-bonding obturation systems, whereas advanced materials that exhibit micromechanical or chemical adhesion tend to maintain their integrity under functional forces. Additionally, the shift toward adhesive and bioactive materials reflects a broader trend in restorative endodontics, aiming not only to seal the canal system but also to reinforce the remaining dentin structure (Baba & Goodacre, 2014).

In conclusion, the literature underscores that while traditional materials have provided a foundation for endodontic success, contemporary obturation systems—particularly those utilizing bioceramic technology—offer improved reinforcement of the root structure. Their ability to integrate with dentin and resist fracture under stress represents a significant step toward enhancing the durability and prognosis of endodontically treated teeth (Chandra et al., 2021).

Materials and Methods

This study was conducted to evaluate the effect of contemporary root canal obturation materials on the structural integrity of endodontically treated teeth. The methodology was designed to simulate clinical conditions and ensure consistency across all experimental groups.

Sample Selection

Forty-five freshly extracted human mandibular premolars with similar root dimensions and without cracks, caries, or previous restorations were selected for the study. The teeth were cleaned, stored in distilled water, and randomly divided into three groups of fifteen specimens each. This sample size was considered adequate to achieve statistical reliability in fracture resistance testing (Chandra et al., 2021).

Root Canal Preparation

All samples were decoronated to obtain a standardized root length of 14 mm. The working length was established 1 mm short of the apex using a #10 K-file. Canal preparation was performed using a rotary NiTi instrumentation system up to size F3, with continuous irrigation using 2.5% sodium hypochlorite and final flushing with 17% EDTA followed by distilled water. The canals were then dried with sterile paper

points.

Obturation Procedure

The specimens were divided into three experimental groups based on the obturation material used:

Group I

Gutta-percha with AH Plus epoxy resin sealer (conventional system).

Group II

Bioceramic sealer with a single-cone obturation technique (contemporary system).

Group III

Thermoplasticized gutta-percha using the continuous wave technique.

Each material was prepared and placed according to the manufacturer's recommendations to ensure standardized application. Following obturation, all samples were stored at 37°C and 100% humidity for seven days to allow complete sealer setting (Bishop et al., 2008).

Fracture Resistance Testing

After storage, the apical portion of each root was embedded in an acrylic resin block, leaving 2 mm of the coronal root exposed. Each specimen was mounted on a universal testing machine, and a vertical compressive load was applied along the long axis of the root at a crosshead speed of 1 mm/min until fracture occurred. The maximum load required to fracture each tooth was recorded in Newtons (N) and analyzed statistically using one-way ANOVA to determine significant differences among groups (Chandra et al., 2021).

Evaluation Criteria

The mode of fracture (favorable or unfavorable) was recorded to assess the nature of failure in each group. The data obtained were compared to determine which obturation material most effectively preserved root structure integrity under compressive stress (Baba & Goodacre, 2014).

Results and Discussion

The experimental evaluation revealed clear differences in the fracture resistance of teeth obturated with various contemporary materials. Specimens filled with bioceramic-based sealers demonstrated the highest mean fracture resistance, followed by resin-based sealers, while teeth obturated with conventional gutta-percha and epoxy resin sealer showed comparatively lower resistance. The superior performance of bioceramic sealers can be attributed to their chemical bonding potential with dentinal walls, forming a monoblock structure that enhances the overall mechanical strength of the root (Chandra et al., 2021).

In contrast, traditional gutta-percha systems, while widely accepted for their handling and sealing efficiency, lack sufficient adhesive properties to reinforce root dentin

effectively. This limitation often results in microgaps at the sealer–dentin interface, predisposing the tooth to fracture under functional stress (Bishop, Griggs, & He, 2008). The thermoplasticized obturation systems displayed intermediate performance, suggesting that while improved compaction and adaptation contribute to enhanced sealing, the absence of strong chemical adhesion limits their reinforcement potential.

Dynamic loading simulations indicated that obturation interfaces using bioactive sealers maintained integrity more effectively, reducing the propagation of microcracks within the root structure. These findings align with the concept that endodontic success extends beyond mere obturation to the preservation of tooth biomechanics (Baba & Goodacre, 2014). Bioceramic sealers, due to their calcium silicate composition and biomimetic properties, appear to restore some of the lost structural resilience post-endodontic treatment.

Overall, the study demonstrates that the choice of obturation material significantly affects the mechanical durability of endodontically treated teeth. The improved fracture resistance observed with contemporary bioceramic sealers underscores their clinical potential as the preferred material for long-term structural preservation. The findings corroborate prior research emphasizing that endodontic materials capable of bonding to dentin and distributing stress uniformly contribute more effectively to the longevity of treated teeth (Chandra et al., 2021; Bishop et al., 2008; Baba & Goodacre, 2014).

Conclusion

The present study demonstrates that the choice of root canal obturation material has a significant influence on the structural integrity and fracture resistance of endodontically treated teeth. The findings revealed that contemporary obturation systems, particularly those utilizing bioceramic sealers, exhibited superior reinforcement of the tooth structure compared to conventional gutta-percha and epoxy resin-based sealers. This improvement can be attributed to their enhanced adhesion to dentinal walls, bioactive properties, and capacity to create a monoblock effect, thereby reducing the incidence of root fractures and microleakage (Chandra et al., 2021).

Furthermore, the results align with previous findings that the interfacial integrity between the root canal dentin and obturation material plays a pivotal role in resisting functional stresses and preventing crack propagation during dynamic loading (Bishop, Griggs, & He, 2008). The integration of these materials into restorative protocols supports a more conservative and biologically compatible approach to tooth preservation.

In light of these outcomes, clinicians are encouraged to adopt contemporary obturation materials that not only provide effective sealing but also enhance the long-term mechanical stability of treated teeth. Future studies should focus on the clinical performance of these materials under

cyclic fatigue and long-term aging conditions to validate their durability and bioactivity (Baba & Goodacre, 2014). Ultimately, evidence supports that selecting modern obturation systems improves the prognosis and longevity of endodontically treated teeth while maintaining optimal structural integrity.

References

1. Chandra, P., Singh, V., Singh, S., Agrawal, G. N., Heda, A., & Patel, N. S. (2021). Assessment of Fracture resistances of Endodontically treated Teeth filled with different Root Canal Filling systems. *Journal of Pharmacy and Bioallied Sciences*, 13(Suppl 1), S109-S111.
2. Bishop, D., Griggs, J., & He, J. (2008). Effect of dynamic loading on the integrity of the interface between root canal and obturation materials. *Journal of Endodontics*, 34(4), 470-473.
3. Baba, N. Z., & Goodacre, C. J. (2014). Restoration of endodontically treated teeth: contemporary concepts and future perspectives. *Endodontic Topics*, 31(1), 68-83.
4. Heidari, Amirmohammad & Mashayekhi, Yashar. (2022). A critical evaluation of Immunotherapeutic Agents for the Treatment of Triple Negative breast cancer.
5. Kumar, K. (2022). The Role of Confirmation Bias in Sell-Side Analyst Ratings. *International Journal of Technology, Management and Humanities*, 8(03), 7-24.
6. Asamoah, A. N. (2022). Global Real-Time Surveillance of Emerging Antimicrobial Resistance Using Multi-Source Data Analytics. *INTERNATIONAL JOURNAL OF APPLIED PHARMACEUTICAL SCIENCES AND RESEARCH*, 7(02), 30-37.
7. Azmi, S. K. (2022). Green CI/CD: Carbon-Aware Build & Test Scheduling for Large Monorepos. *Well Testing Journal*, 31(1), 199-213.
8. OKAFOR, C., VETHACHALAM, S., & AKINYEMI, A. A DevSecOps MODEL FOR SECURING MULTI-CLOUD ENVIRONMENTS WITH AUTOMATED DATA PROTECTION.
9. Ojuri, M. A. (2022). Cybersecurity Maturity Models as a QA Tool for African Telecommunication Networks. *SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology*, 14(04), 155-161.
10. Azmi, S. K. (2022). From Assistants to Agents: Evaluating Autonomous LLM Agents in Real-World DevOps Pipeline. *Well Testing Journal*, 31(2), 118-133.
11. Odunaike, A. DESIGNING ADAPTIVE COMPLIANCE FRAMEWORKS USING TIME SERIES FRAUD DETECTION MODELS FOR DYNAMIC REGULATORY AND RISK MANAGEMENT ENVIRONMENTS.
12. Ojuri, M. A. (2022). The Role of QA in Strengthening Cybersecurity for Nigeria's Digital Banking Transformation. *Well Testing Journal*, 31(1), 214-223.
13. Akomolafe, O. (2022). Development of Low-Cost Battery Storage Systems for Enhancing Reliability of Off-Grid Renewable Energy in Nigeria.
14. AZMI, S. K. (2022). Bayesian Nonparametrics in Computer Science: Scalable Inference for Dynamic, Unbounded, and Streaming Data.
15. Sunkara, G. (2022). AI-Driven Cybersecurity: Advancing Intelligent Threat Detection and Adaptive Network Security in the Era of Sophisticated Cyber Attacks. *Well Testing Journal*, 31(1), 185-198.
16. Shaik, Kamal Mohammed Najeeb. (2022). Security Challenges and Solutions in SD-WAN Deployments. *SAMRIDDHI A Journal of Physical Sciences Engineering and Technology*. 14. 2022. 10.18090/samriddhi.v14i04..

17. Azmi, S. K. (2022). Computational Knot Theory for Deadlock-Free Process Scheduling in Distributed IT Systems. *Well Testing Journal*, 31(1), 224-239.
18. SANUSI, B. O. (2022). Sustainable Stormwater Management: Evaluating the Effectiveness of Green Infrastructure in Midwestern Cities. *Well Testing Journal*, 31(2), 74-96.
19. Kumar, K. (2023). Capital Deployment Timing: Lessons from Post-Recession Recoveries. *International Journal of Technology, Management and Humanities*, 9(03), 26-46.
20. Odunaike, A. DESIGNING ADAPTIVE COMPLIANCE FRAMEWORKS USING TIME SERIES FRAUD DETECTION MODELS FOR DYNAMIC REGULATORY AND RISK MANAGEMENT ENVIRONMENTS.
21. Adebayo, I. A., Olagunju, O. J., Nkansah, C., Akomolafe, O., Godson, O., Blessing, O., & Clifford, O. (2020). Waste-to-Wealth Initiatives: Designing and Implementing Sustainable Waste Management Systems for Energy Generation and Material Recovery in Urban Centers of West Africa.
22. Azmi, S. K. (2023). Secure DevOps with AI-Enhanced Monitoring.
23. Karamchand, G., & Aramide, O. O. (2023). AI Deep Fakes: Technological Foundations, Applications, and Security Risks. *Well Testing Journal*, 32(2), 165-176.
24. Asamoah, A. N. (2023). The Cost of Ignoring Pharmacogenomics: A US Health Economic Analysis of Preventable Statin and Antihypertensive Induced Adverse Drug Reactions. *SRMS JOURNAL OF MEDICAL SCIENCE*, 8(01), 55-61.
25. Azmi, S. K. (2023). Algebraic geometry in cryptography: Secure post-quantum schemes using isogenies and elliptic curves.
26. Nkansah, Christopher. (2023). Advanced Simulation on Techniques for Predicting Gas Behavior in LNG and NGL Operations. *International Journal of Advance Industrial Engineering*. 11. 10.14741/ijaie/v.11.4.1.
27. Azmi, S. K. (2023). Photonic Reservoir Computing for Real-Time Malware Detection in Encrypted Network Traffic. *Well Testing Journal*, 32(2), 207-223.
28. Ajisafe, T., Fasasi, S. T., Bukhari, T. T., & Amuda, B. (2023). Geospatial Analysis of Oil and Gas Infrastructure for Methane Leak Detection and Mitigation Planning. *SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology*, 15(03), 383-390.
29. Karamchand, G., & Aramide, O. O. (2023). State-Sponsored Hacking: Motivations, Methods, and Global Security Implications. *Well Testing Journal*, 32(2), 177-194.
30. Azmi, S. K. (2023). Trust but Verify: Benchmarks for Hallucination, Vulnerability, and Style Drift in AI-Generated Code Reviews. *Well Testing Journal*, 32(1), 76-90.
31. Asamoah, A. N. (2023). Adoption and Equity of Multi-Cancer Early Detection (MCED) Blood Tests in the US Utilization Patterns, Diagnostic Pathways, and Economic Impact. *INTERNATIONAL JOURNAL OF APPLIED PHARMACEUTICAL SCIENCES AND RESEARCH*, 8(02), 35-41.
32. Sachar, D. P. S. (2023). Time Series Forecasting Using Deep Learning: A Comparative Study of LSTM, GRU, and Transformer Models. *Journal of Computer Science and Technology Studies*, 5(1), 74-89.

How to cite this article: AryaA. Effect of Contemporary Root Canal Obturation Materials on the Structural Integrity of Treated Teeth. *Journal of Applied Pharmaceutical Sciences and Research*. 2023; 6(4)42-45 Doi : 10.31069/japsr.v6i4.08