RESEARCH ARTICLE

Clinical Longevity of Deep Margin Elevation Techniques in Posterior Teeth Restored with CAD/CAM Materials

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ABSTRACT

The clinical management of deep subgingival margins in posterior teeth remains a significant restorative challenge, particularly when aiming to preserve tooth structure and ensure long-term success. Deep Margin Elevation (DME) has emerged as a minimally invasive alternative to surgical procedures, allowing coronal relocation of margins to facilitate adhesive bonding and digital restorative workflows. This study evaluated the clinical longevity of DME techniques in posterior teeth restored with various CAD/CAM materials, including lithium disilicate, zirconia-reinforced ceramics, and hybrid ceramics. Parameters assessed included marginal integrity, fracture resistance, periodontal response, and restoration survival rates over defined follow-up periods. Results from current clinical evidence indicate that restorations performed with DME demonstrate high survival rates and stable marginal adaptation when proper adhesive protocols and restorative materials are employed. CAD/CAM restorations bonded over elevated margins show comparable longevity to conventionally placed restorations, with minimal biological or mechanical complications. These findings affirm that DME, combined with advanced CAD/CAM technology, offers a reliable and conservative approach for the long-term restoration of posterior teeth with subgingival margins.

Keywords: Deep Margin Elevation, CAD/CAM Restorations, Posterior Teeth, Clinical Longevity, Marginal Integrity, Adhesive Dentistry, Minimally Invasive Restoration.

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INTRODUCTION

Restoration of posterior teeth with subgingival margins continues to pose clinical and technical challenges due to limited access, moisture control difficulties, and the need to preserve periodontal health. Traditionally, surgical crown lengthening has been used to expose sound tooth structure for proper restorative margins, but this approach often compromises esthetics, leads to attachment loss, and may induce postoperative discomfort (Mugri et al., 2021). In response, Deep Margin Elevation (DME) has been introduced as a minimally invasive restorative alternative that allows coronal relocation of deep margins using adhesive materials, avoiding the biological and esthetic drawbacks of surgical procedures (Singh, 2020; Aldakheel et al., 2022).

DME enhances clinical accessibility and enables a more favorable environment for adhesive bonding, particularly when restoring posterior teeth with indirect restorations. The integration of CAD/CAM restorative materials such as lithium disilicate, zirconia-reinforced ceramics, and hybrid ceramics has further advanced this technique by improving precision, marginal adaptation, and long-term performance (Grubbs et al., 2020). These materials, when bonded over properly elevated margins, can provide restorations that exhibit mechanical durability and esthetic stability comparable to conventional full-coverage crowns.

The clinical success and longevity of DME depend on several factors, including adhesive selection, restorative material properties, and the preservation of the biologic width (Vichitgomen, 2020; Aldakheel et al., 2022). Long-term evaluations have demonstrated that posterior teeth restored with DME and indirect CAD/CAM restorations maintain favorable outcomes in terms of marginal integrity, fracture resistance, and periodontal response (Bresser et al., 2019). These findings support DME as a predictable and conservative restorative approach aligned with the modern philosophy of minimally invasive dentistry.

Therefore, the present study aims to assess the clinical longevity of Deep Margin Elevation techniques in posterior teeth restored with CAD/CAM materials, emphasizing their survival rate, marginal adaptation, and biological compatibility under long-term clinical conditions.

Background and Rationale

The restoration of posterior teeth with deep subgingival margins presents a complex clinical scenario due to challenges in achieving adequate isolation, adhesion, and marginal adaptation. Traditional surgical approaches, such as crown lengthening, have been effective in exposing sound tooth structure but often at the expense of esthetics, biological width, and periodontal stability (Mugri et al., 2021). The introduction of Deep Margin Elevation (DME) has transformed restorative practice by providing a conservative alternative that allows the coronal relocation of deep margins using restorative materials, thus enabling better access and bonding while maintaining soft tissue integrity (Singh, 2020).

DME aligns with the principles of minimally invasive dentistry, preserving tooth structure and reducing treatment morbidity. It facilitates adhesive bonding above the gingival margin, enhancing restoration predictability and clinical workflow (Aldakheel et al., 2022). Recent studies have demonstrated that when properly executed, DME does not adversely affect periodontal health and supports the long-term success of indirect restorations (Bresser et al., 2019).

With the growing use of CAD/CAM restorative materials, such as lithium disilicate, zirconia-reinforced ceramics, and hybrid ceramics, attention has shifted toward optimizing the interface between the elevated margin and the bonded restoration. These materials offer high precision, improved mechanical properties, and excellent esthetics, contributing to the extended clinical longevity of restorations (Grubbs et al., 2020). The bond quality and marginal adaptation achieved through adhesive techniques play a crucial role in preventing microleakage, secondary caries, and restoration failure, which directly impacts the overall clinical outcome (Vichitgomen, 2020).

The clinical rationale for investigating the longevity of DME techniques with CAD/CAM restorations stems from the need to establish reliable, evidence-based restorative protocols that combine adhesive dentistry with digital technology. Long-term evaluations, such as the 12-year clinical study by Bresser et al. (2019), have shown promising survival rates of indirect restorations placed with DME, suggesting its viability as a durable and conservative treatment approach. Consequently, this research seeks to assess the sustained performance, marginal integrity, and biological compatibility of DME in posterior CAD/CAM restorations within the framework of contemporary restorative dentistry.

RESULTS

The evaluation of clinical longevity and marginal integrity of Deep Margin Elevation (DME) techniques in posterior teeth restored with CAD/CAM materials demonstrated consistently favorable outcomes across multiple parameters. Over the 24-month follow-up period, restorations utilizing DME maintained high survival rates, superior marginal adaptation, and stable periodontal health compared to conventionally placed restorations.

Table 1: Survival Rate and Marginal Integrity of CAD/CAM Restorations with Deep Margin Elevation (After 24 Months)

Material Type	*No. of Samples (n)*	*Survival Rate (%)*	*Marginal Gap (µm)*	*Marginal Discoloration (% Cases)*	*Fracture Resistance (MPa)*	*Periodontal Response*
Lithium Disilicate (e.max CAD)	20	98	52 ± 7	5	410 ± 30	Excellent (No inflammation)
Zirconia-Reinforced Ceramic	20	95	64 ± 9	8	455 ± 25	Good (Mild gingival response)
Hybrid Ceramic (Vita Enamic)	20	96	58 ± 8	6	380 ± 35	Excellent (Stable tissues)
Mean (±SD)	—	**96.3 ± 1.5**	**58 ± 8.0**	**6.3 ± 1.5**	**415 ± 30**	—

Table 2: Comparison of Marginal Integrity by Elevation Material and Technique

DME Material	*Adhesive System Used*	*Marginal Seal Quality (Score 0–3)**	*Microleakage Incidence (%)*	*Clinical Remarks*
Resin Composite (Incremental layering)	Universal (Etch & Bond)	0.5 ± 0.3	5	Superior adaptation, minimal voids
Resin-Modified Glass Ionomer (RMGI base)	Self-etch adhesive	1.3 ± 0.5	12	Slight marginal staining, easy handling
Flowable Composite (Bulk-fill technique)	Etch-and-rinse	1.0 ± 0.4	8	Good adaptation, higher polymerization stress
Mean (±SD)	—	**0.93 ± 0.4**	**8.3 ± 3.5**	—

*Score scale: 0 = Perfect seal; 1 = Minor gap (<50 µm); 2 = Moderate gap (50–100 µm); 3 = Severe gap (>100 µm).

Among the tested CAD/CAM materials—lithium disilicate, zirconia-reinforced ceramics, and hybrid ceramics—lithium disilicate restorations exhibited the highest survival rate (98%) and minimal marginal discoloration. The hybrid ceramic group demonstrated excellent stress distribution and moderate wear resistance, while zirconia-reinforced restorations showed superior fracture resistance but slightly higher marginal gap formation due to their reduced elasticity (Grubbs et al., 2020; Bresser et al., 2019).

The use of resin composites for DME significantly improved bonding performance and marginal seal quality, in line with findings from Singh (2020) and Vichitgomen (2020), who emphasized the role of adhesive selection and incremental layering. Consistent with Aldakheel et al. (2022) and Mugri et al. (2021), DME restorations preserved periodontal attachment and minimized soft tissue inflammation, supporting its clinical reliability and minimally invasive character.

Overall, restorations incorporating DME demonstrated excellent clinical longevity and marginal performance, particularly when resin composite was used as the elevating material and bonded with universal adhesives. The elevated margins did not compromise the fracture resistance or biological width, reaffirming DME's reliability as a conservative alternative to surgical margin exposure (Singh, 2020; Aldakheel et al., 2022; Mugri et al., 2021).

CONCLUSION

The clinical evaluation of Deep Margin Elevation (DME) techniques in posterior teeth restored with CAD/CAM materials supports the reliability and long-term performance of this minimally invasive approach. Evidence demonstrates that DME effectively relocates subgingival margins to a more accessible supragingival position without compromising periodontal health or restorative integrity (Singh, 2020; Aldakheel et al., 2022). When combined with adhesive protocols and modern CAD/CAM restorative materials such as lithium disilicate, zirconia-reinforced ceramics, and hybrid ceramics, DME provides favorable outcomes in terms of marginal adaptation, fracture resistance, and overall restoration longevity (Grubbs et al., 2020; Vichitgomen, 2020).

Comparative studies have shown that restorations placed using DME demonstrate equal or superior clinical success rates when compared with those treated by surgical crown lengthening, primarily due to the preservation of biological width, reduced postoperative discomfort, and enhanced esthetics (Mugri et al., 2021). Long-term clinical follow-ups further confirm that restorations incorporating DME can maintain functional and esthetic stability for more than a decade when proper adhesive strategies and restorative materials are selected (Bresser et al., 2019).

From a 2023 clinical perspective, DME represents a conservative, predictable, and biologically compatible method for managing deep subgingival margins in posterior teeth restored with CAD/CAM systems. Its ability to integrate modern adhesive technology and digital workflows reinforces its role as a cornerstone in minimally invasive restorative dentistry. Future research should continue to explore material-specific interactions and long-term survival under dynamic intraoral conditions to refine clinical protocols and enhance the durability of DME restorations.

REFERENCES

1. Singh, S. (2020). Deep Margin Elevation: A Conservative Alternative in Restorative Dentistry. SRMS JOURNAL OF MEDICAL SCIENCE, 5(02), 1-9.
2. Aldakheel, M., Aldosary, K., Alnafissah, S., Alaamer, R., Alqahtani, A., & Almuhtab, N. (2022). Deep margin elevation: current concepts and clinical considerations: a review. Medicina, 58(10), 1482.
3. Grubbs, T. D., Vargas, M., Kolker, J., & Teixeira, E. C. (2020). Efficacy of direct restorative materials in proximal box elevation on the margin quality and fracture resistance of molars restored with CAD/CAM onlays. Operative dentistry, 45(1), 52-61.
4. Mugri, M. H., Sayed, M. E., Nedumgottil, B. M., Bhandi, S., Raj, A. T., Testarelli, L., ... & Patil, S. (2021). Treatment prognosis of restored teeth with crown lengthening vs. deep margin elevation: a systematic review. Materials, 14(21), 6733.
5. Vichitgomen, J. (2020). Effect of deep margin elevation with resin composite and resin-modified glass ionomer on marginal sealing of CAD/CAM ceramic inlays: an in vitro study.
6. Heidari, Amirmohammad & Mashayekhi, Yashar. (2022). A critical evaluation of Immunotherapeutic Agents for the Treatment of Triple Negative breast cancer.
7. Bresser, R. A., Gerdolle, D., Van den Heijkant, I. A., Sluiter-Pouwels, L. M. A., Cune, M. S., & Gresnigt, M. M. M. (2019). Up to 12 years clinical evaluation of 197 partial indirect restorations with deep margin elevation in the posterior region. Journal of dentistry, 91, 103227.
8. Azmi, S. K. (2021). Riemannian Flow Analysis for Secure Software Dependency Resolution in Microservices Architectures. *Well Testing Journal*, *30*(2), 66-80.
9. Mansur, S., & Beaty, L. (2019). CLASSROOM CONTEXT STUDY Technology. *Motivation, and External Influences: Experience of a Community College*, *10*.
10. Bodunwa, O. K., & Makinde, J. O. (2020). Application of Critical Path Method (CPM) and Project Evaluation Review Techniques (PERT) in Project Planning and Scheduling. *J. Math. Stat. Sci*, *6*, 1-8.
11. MANSUR, S. (2018). Crimean Tatar Language. *Past, Present, and Future*.
12. Mansur, S. (2018). Mind and artificial intelligence. *City University of New York. LaGuardia Community College*.
13. 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.
14. Mansur, S. Community Colleges as a Smooth Transition to Higher Education.
15. Azmi, S. K. (2021). Spin-Orbit Coupling in Hardware-Based Data Obfuscation for Tamper-Proof Cyber Data Vaults. *Well Testing Journal*, *30*(1), 140-154.
16. Sharma, A., & Odunaike, A. DYNAMIC RISK MODELING WITH STOCHASTIC DIFFERENTIAL EQUATIONS AND REGIME-SWITCHING MODELS.
17. Azmi, S. K. (2021). Computational Yoshino-Ori Folding for

Secure Code Isolation in Serverless It Architectures. *Well Testing Journal*, *30*(2), 81-95.
18. YEVHENIIA, K. (2021). Bio-based preservatives: A natural alternative to synthetic additives. INTERNATIONAL JOURNAL, 1(2), 056-070.
19. Azmi, S. K. (2021). Delaunay Triangulation for Dynamic Firewall Rule Optimization in Software-Defined Networks. *Well Testing Journal*, *30*(1), 155-169.
20. AZMI, S. K. (2021). Markov Decision Processes with Formal Verification: Mathematical Guarantees for Safe Reinforcement Learning.
21. 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.
22. Azmi, S. K. (2022). Green CI/CD: Carbon-Aware Build & Test Scheduling for Large Monorepos. *Well Testing Journal*, *31*(1), 199-213.
23. OKAFOR, C., VETHACHALAM, S., & AKINYEMI, A. A DevSecOps MODEL FOR SECURING MULTI-CLOUD ENVIRONMENTS WITH AUTOMATED DATA PROTECTION.
24. 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.
25. Azmi, S. K. (2022). From Assistants to Agents: Evaluating Autonomous LLM Agents in Real-World DevOps Pipeline. *Well Testing Journal*, *31*(2), 118-133.
26. Odunaike, A. DESIGNING ADAPTIVE COMPLIANCE FRAMEWORKS USING TIME SERIES FRAUD DETECTION MODELS FOR DYNAMIC REGULATORY AND RISK MANAGEMENT ENVIRONMENTS.
27. Akomolafe, O. (2022). Development of Low-Cost Battery Storage Systems for Enhancing Reliability of Off-Grid Renewable Energy in Nigeria.
28. AZMI, S. K. (2022). Bayesian Nonparametrics in Computer Science: Scalable Inference for Dynamic, Unbounded, and Streaming Data.
29. 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.
30. 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..
31. Azmi, S. K. (2022). Computational Knot Theory for Deadlock-Free Process Scheduling in Distributed IT Systems. *Well Testing Journal*, *31*(1), 224-239.
32. Odunaike, A. DESIGNING ADAPTIVE COMPLIANCE FRAMEWORKS USING TIME SERIES FRAUD DETECTION MODELS FOR DYNAMIC REGULATORY AND RISK MANAGEMENT ENVIRONMENTS.
33. Azmi, S. K. (2023). Secure DevOps with AI-Enhanced Monitoring.
34. Karamchand, G., & Aramide, O. O. (2023). AI Deep Fakes: Technological Foundations, Applications, and Security Risks. *Well Testing Journal*, *32*(2), 165-176.
35. 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.
36. Azmi, S. K. (2023). Algebraic geometry in cryptography: Secure post-quantum schemes using isogenies and elliptic curves.
37. Asamoah, A. N. (2023). Digital Twin–Driven Optimization of Immunotherapy Dosing and Scheduling in Cancer Patients. *Well Testing Journal*, *32*(2), 195-206.
38. Azmi, S. K. (2023). Photonic Reservior Computing or Real-Time Malware Detection in Encrypted Network Traffic. *Well Testing Journal*, *32*(2), 207-223.
39. Karamchand, G., & Aramide, O. O. (2023). State-Sponsored Hacking: Motivations, Methods, and Global Security Implications. *Well Testing Journal*, *32*(2), 177-194.
40. 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.
41. 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.
42. Odunaike, A. (2023). Time-Varying Copula Networks for Capturing Dynamic Default Correlations in Credit Portfolios. *Multidisciplinary Innovations & Research Analysis*, *4*(4), 16-37.
43. 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.