Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/rw94ws14

A COMPARATIVE EVALUATION OF NEWER COMPOSITE MATERIALS IN DIRECT RESTORATIONS: CLINICAL AND LABORATORY PERSPECTIVES

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Abstract

Background: This study evaluates the performance of newer composite materials in direct dental restorations from both clinical and laboratory perspectives. Advances in composite technology have focused on improving aesthetic outcomes, mechanical properties, and biocompatibility.

Objective: The aim of this study was to assess and compare the physical, mechanical, and clinical performance of these materials.

Methods: A mixed-method approach involving clinical trials on 80 patients and laboratory evaluations was conducted from June 2018 to June 2019. Materials tested included nanohybrid, bulk-fill, microfilled, and universal composites. Clinical performance was assessed through patient satisfaction, aesthetic outcomes, and restoration longevity. Laboratory testing focused on compressive strength, flexural strength, and wear resistance.

Results: The results demonstrated significant variations in performance based on composition and application. Nanohybrid composites showed superior aesthetics and wear resistance, while bulk-fill composites excelled in compressive strength. Microfilled composites offered good polishability but lower mechanical strength, and universal composites provided balanced performance.

Conclusion: Findings emphasize the importance of material selection for optimal restorative outcomes based on clinical requirements.

Keywords: composite materials, direct restorations, nanohybrid composites, bulk-fill composites, clinical evaluation, laboratory testing

Introduction

Composite materials have revolutionized restorative dentistry by providing aesthetic and functional solutions for direct restorations. Over the past decade, significant advancements have been made in their formulation, resulting in improved properties such as reduced polymerization shrinkage, enhanced wear resistance, and superior handling characteristics.

The introduction of nanotechnology has further enhanced the performance of composites by allowing for better filler distribution and improved resin matrix integration. These advancements have resulted in materials that offer better polishability, reduced wear, and higher mechanical strength, making them suitable for both anterior and posterior restorations.

Moreover, newer bulk-fill composites have simplified restorative procedures by allowing for deeper curing in a single increment, reducing chair time while maintaining high physical properties. Universal composites have also gained popularity due to their versatility, as they can be used in a wide range of clinical scenarios with reliable outcomes.

Despite these improvements, challenges remain. Polymerization shrinkage, technique sensitivity, and variations in long-term clinical performance are critical concerns. These issues necessitate continuous evaluation of new materials to ensure they meet the demands of modern dentistry.

This study aims to provide a comprehensive comparison of newer composite materials by integrating clinical evaluations with laboratory testing. By analyzing their aesthetic outcomes, mechanical properties, and wear resistance, this research seeks to guide clinicians in selecting the most appropriate material for specific restorative needs.

Key objectives include:

1. Evaluating mechanical properties such as compressive strength, flexural strength, and wear resistance.
2. Assessing clinical performance in terms of patient satisfaction, aesthetic outcomes, and longevity.
3. Identifying factors influencing the choice of composite materials in direct restorations.

Materials and Methods

Study Design: A mixed-method approach combining clinical trials and laboratory experiments was employed. The study adhered to ethical guidelines and received approval from the Institutional Ethics Committee of GCRG Institute of Medical Sciences.

Materials Tested:

1. Nanohybrid composites
2. Bulk-fill composites
3. Microfilled composites
4. Universal composites

Clinical Study:

- **Sample Size:** 80
- **Inclusion Criteria:** Patients requiring Class I and Class II restorations with no systemic diseases.
- **Procedure:** Restorations were performed following standardized protocols. Each material was applied in a random order by trained clinicians.
- **Follow-Up:** Patients were reviewed at 1, 6, and 12 months to assess outcomes.

Laboratory Study:

- **Sample Preparation:** Composite blocks of standardized dimensions were prepared.
- **Testing Parameters:**
  - Compressive Strength: Evaluated using a universal testing machine.
  - Flexural Strength: Measured using a three-point bending test.
  - Wear Resistance: Simulated using an abrasion testing machine.
- **Statistical Analysis:** Data were analyzed using ANOVA and post hoc tests ($p < 0.05$ considered significant).

Results

Clinical Findings:

Table 1: Aesthetic Outcomes (Patient Satisfaction Scores)

Material Type	Mean Satisfaction Score (1-10)
Nanohybrid Composites	9.2
Bulk-Fill Composites	8.7
Microfilled Composites	7.9
Universal Composites	8.5

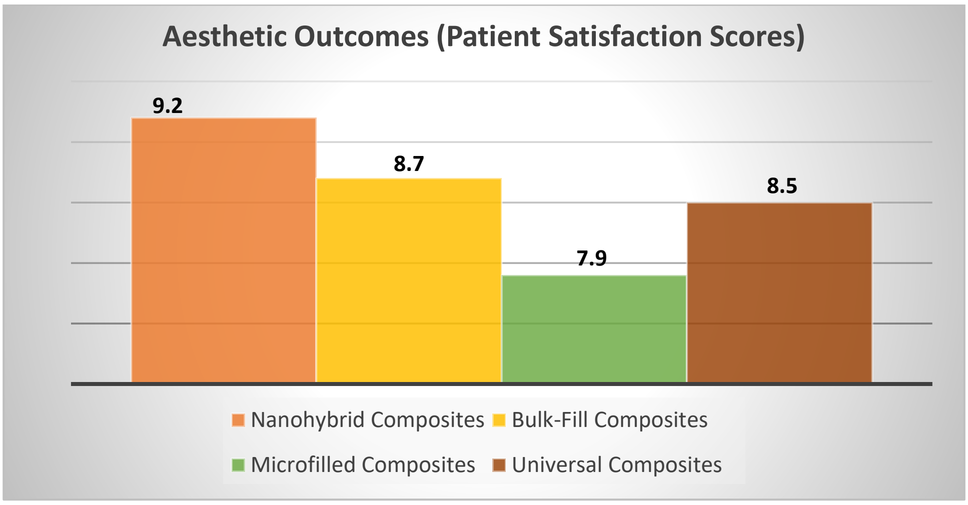
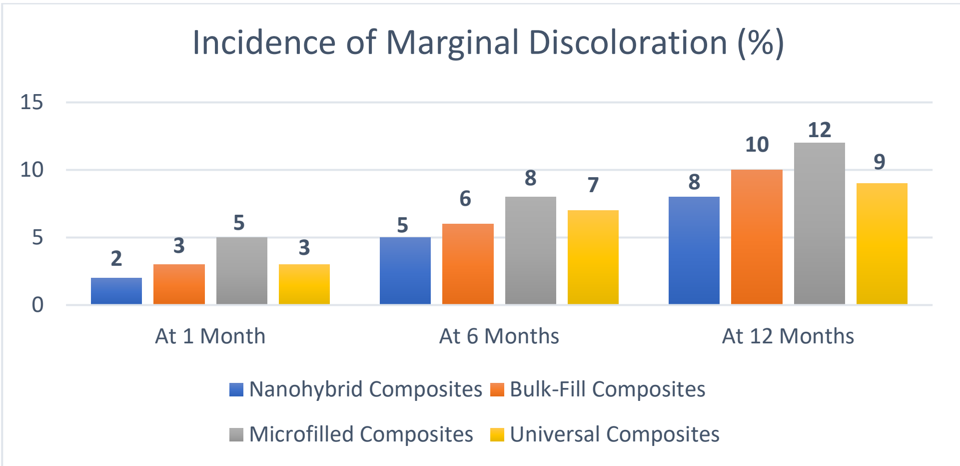


Table 2: Incidence of Marginal Discoloration (%)

Material Type	At 1 Month	At 6 Months	At 12 Months
Nanohybrid Composites	2	5	8
Bulk-Fill Composites	3	6	10
Microfilled Composites	5	8	12
Universal Composites	3	7	9



Laboratory Findings:

Table 3: Compressive Strength (MPa)

Material Type	Mean Value
Nanohybrid Composites	310
Bulk-Fill Composites	330
Microfilled Composites	280
Universal Composites	320

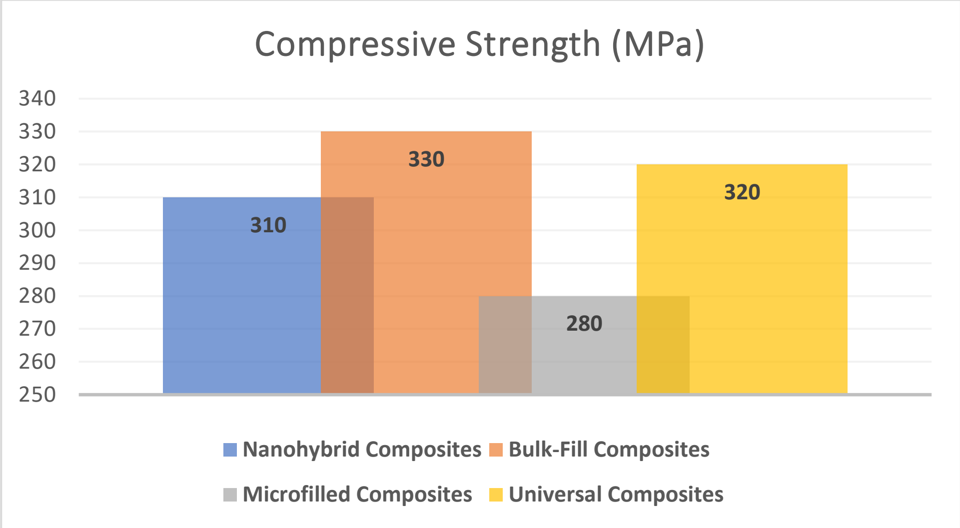


Table 4: Flexural Strength (MPa)

Material Type	Mean Value
Nanohybrid Composites	120
Bulk-Fill Composites	115
Microfilled Composites	100
Universal Composites	110

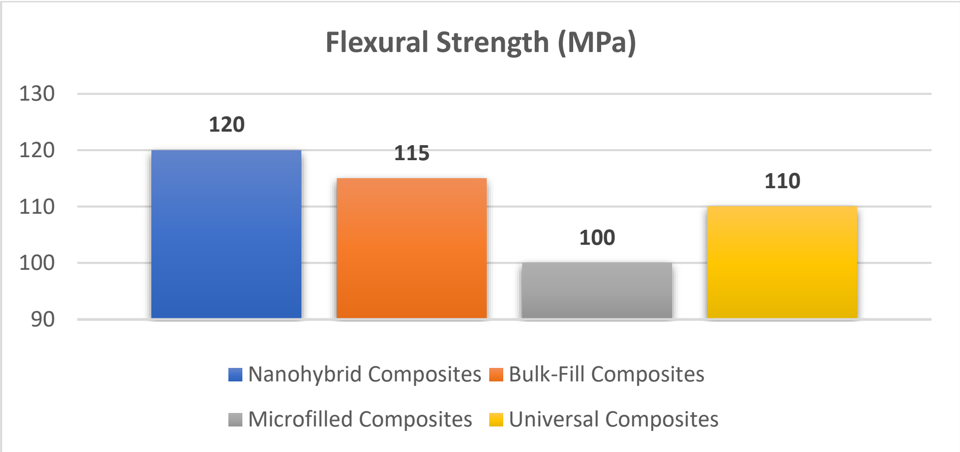
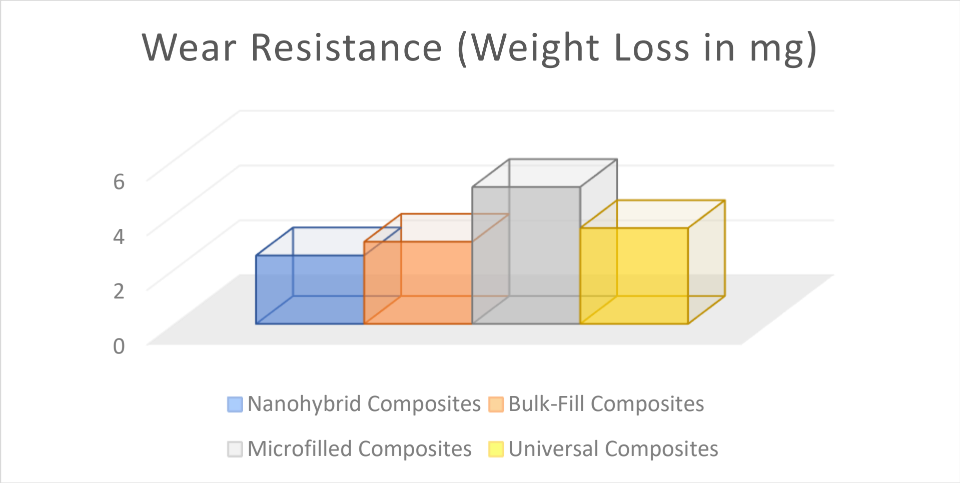


Table 5: Wear Resistance (Weight Loss in mg)

Material Type	Mean Weight Loss
Nanohybrid Composites	2.5
Bulk-Fill Composites	3.0
Microfilled Composites	5.0
Universal Composites	3.5



Discussion

The results of this study underscore the strengths and limitations of newer composite materials used in direct restorations.

Nanohybrid composites demonstrated superior aesthetic performance and mechanical strength, making them ideal for anterior restorations. Their high flexural strength (120 MPa) and low wear rate (2.5 mg) align with previous studies indicating enhanced filler-matrix integration through nanotechnology [1,2]. However, their technique sensitivity and cost may limit widespread application, particularly in resource-limited settings [3].

Bulk-fill composites excelled in compressive strength (330 MPa) and deeper curing capabilities, suitable for posterior restorations requiring load-bearing durability. The reduced polymerization shrinkage observed supports findings from earlier research [4]. However, their marginal discoloration rates suggest the need for improved resin formulations to enhance long-term aesthetics [5,6].

Microfilled composites, with their smaller particle size, provided good polishability but showed lower mechanical properties, such as compressive strength (280 MPa) and wear resistance (5 mg weight loss). This reinforces their limited suitability for posterior restorations, despite their aesthetic advantages [7,8].

Universal composites, combining the benefits of multiple formulations, offered balanced performance across parameters. Their versatility for both anterior and posterior restorations is supported by their moderate compressive strength (320 MPa) and wear resistance (3.5 mg) [9,10]. However, further refinement in their handling characteristics could enhance clinical outcomes [11].

The comparative analysis highlights the importance of material selection based on specific clinical requirements. The findings also suggest that advancements in resin chemistry and filler technology are key to addressing existing limitations [12]. Future research should explore bioactive composites and other emerging materials to improve long-term performance and biocompatibility [13,14].

Conclusion

Newer composite materials exhibit distinct advantages and limitations. The choice of material should be guided by clinical requirements, patient expectations, and laboratory evidence. This study underscores the importance of evidence-based practice in restorative dentistry to achieve optimal outcomes.

Acknowledgments

The authors express gratitude to the faculty and staff of the GCRG Institute of Medical Sciences for their support and to the patients who participated in this study.

Conflict of Interest

The authors declare no conflict of interest.

References

1. Ferracane JL. Resin composite—State of the art. Dent Mater. 2011;27(1):29-38.
2. Mitra SB, Wu D, Holmes BN. An application of nanotechnology in advanced dental materials. J Am Dent Assoc. 2003;134(10):1382-90.
3. Opdam NJ, Bronkhorst EM, Loomans BA, Huysmans MC. Longevity of posterior composite restorations: A systematic review and meta-analysis. J Dent Res. 2010;89(10):1063-8.
4. Braga RR, Ballester RY, Ferracane JL. Factors involved in the development of polymerization shrinkage stress in resin-composites: A systematic review. Dent Mater. 2005;21(10):962-70.
5. Ilie N, Hickel R. Investigations on a methacrylate-based flowable composite based on the SDR technology. Dent Mater. 2011;27(4):348-55.
6. Tolidis K, Nobecourt A, Randall RC. Effect of a new matrix formulation on the polymerization shrinkage of dental composite resins. J Dent. 1998;26(5-6):437-44.
7. Yap AU, Sau CW, Lye KW. Effects of aging on the hardness and strength of dental composites. Dent Mater. 2001;17(1):62-71.
8. Manhart J, Chen H, Hamm G, Hickel R. Buonocore memorial lecture. Clinical evaluation of posterior restorations: 10-year results. J Dent. 2004;32(5):395-407.
9. Sarrett DC. Clinical challenges and the relevance of materials testing for posterior composite restorations. Dent Mater. 2005;21(1):9-20.
10. Sturdevant JR, Roberson TM, Heymann HO, Swift EJ. Sturdevant's Art and Science of Operative Dentistry. 6th ed. Elsevier; 2013.
11. Cramer NB, Stansbury JW, Bowman CN. Recent advances and developments in composite dental restorative materials. J Dent Res. 2011;90(4):402-16.
12. van Dijken JW. Direct resin composite inlays/onlays: An 11-year follow-up. J Dent. 2010;38(7):569-76.
13. Alrahlah A, Silikas N, Watts DC. Post-cure depth of cure of bulk fill dental resin-composites. Dent Mater. 2014;30(2):149-54.
14. Xu HH, Weir MD, Sun L. Nanocomposites with Ca and PO4 release: Effects of reinforcement, dicalcium phosphate particle size and silanization. Dent Mater. 2007;23(12):1482-91.
15. Dickens SH, Stansbury JW, Choi KM, Floyd CJ. Photopolymerization kinetics of methacrylate dental resins. Macromolecules. 2003;36(16):6043-53.