JRAAS
Special Issue in Medicine & Surgery
www.internationalmedicalpublishing.com

Research Article

Section: Conservative Dentistry & Endodontics

Fracture Resistance of MOD Cavities Restored with Short Fibre, Long Fibre, & Ribbond Reinforcements: An in-vitro Comparative Study

Gayatri H. Giramkar[1*], Anu Narang[2], Santosh Kumar Singh[3], Shivani Rawat[4], Sadhvi Pateriya[5] & Naman Keshwani[6]

[1,4,5,6]Post Graduate Student, Department of Conservative Dentistry & Endodontics, Peoples College of Dental Sciences & Research Centre, Bhopal, Madhya Pradesh, India

[2]Professor, Department of Conservative Dentistry & Endodontics, Peoples College of Dental Sciences & Research Centre, Bhopal, Madhya Pradesh, India

[3]Professor & Head, Department of Conservative Dentistry & Endodontics, Peoples College of Dental Sciences & Research Centre, Bhopal, Madhya Pradesh, India

HIGHLIGHTS

- Short fibre highest strength
- Fibre reinforcement improves durability
- Enhanced fracture resistance observed
- More favorable failure patterns
- Superior MOD restoration performance

Key Words:
Fracture resistance
MOD cavity
Short fibre composite
Long fibre reinforcement
Ribbond
Fibre-reinforced composite

ABSTRACT

Introduction: Mesio-occluso-distal (MOD) cavity preparations significantly weaken posterior teeth by reducing cuspal stiffness and increasing susceptibility to fracture. Fibre-reinforced composite systems have been introduced to enhance the mechanical performance and longevity of restorations. **Aim & Objective:** To compare the fracture resistance and failure patterns of MOD cavities restored with short fibre composite, long fibre reinforcement, and Ribbond reinforcement with those restored using conventional composite resin. **Materials & Methods:** Forty extracted human molars with standardized MOD cavity preparations were randomly allocated into four groups ($n = 10$ each): Group I (conventional composite), Group II (short fibre composite), Group III (long fibre reinforcement), and Group IV (Ribbond reinforcement). Following restoration, specimens underwent compressive loading in a universal testing machine until fracture. Fracture resistance was recorded in Newtons (N), and failure modes were classified as restorable or non-restorable. Data were analyzed using one-way ANOVA and Tukey's post-hoc test. **Results:** Fracture resistance differed significantly among the groups ($F = 1357.26$, $p < 0.001$). Group II showed the highest mean fracture resistance (1197.50 ± 15.14 N), followed by Group III (1037.50 ± 15.14 N), Group IV (956.30 ± 9.83 N), and Group I (787.00 ± 16.02 N). Compared with the control group, short fibre, long fibre, and Ribbond reinforcement increased fracture resistance by 52.2%, 31.8%, and 21.5%, respectively. Reinforced restorations also demonstrated a higher proportion of restorable fractures, with the short fibre group showing the most favorable failure pattern (80%). **Conclusion:** Fibre reinforcement significantly improves fracture resistance and promotes more favorable failure modes in MOD restorations. Short fibre composite demonstrated the best overall performance.

*** Corresponding Author:** Dr. Gayatri H. Giramkar, e-mail: 7558578883g@gmail.com
Article History: Received 15 May 2026; Received in Revised form 18 June 2026; Accepted 25 June 2026
How To Cite: Gayatri H. Giramkar, Anu Narang, Santosh Kumar Singh, Shivani Rawat, Sadhvi Pateriya & Naman Keshwani. Fracture Resistance of MOD Cavities Restored with Short Fibre, Long Fibre, & Ribbond Reinforcements: An in-vitro Comparative Study. *JRAAS : Special Issue in Medicine & Surgery.* 2026;41(1):1-7. DOI: https://doi.org/10.71393/5hft8114

INTRODUCTION

Mesio-occluso-distal (MOD) cavity restorations represent one of the greatest biomechanical challenges in restorative dentistry. Preparation of MOD cavities results in substantial loss of tooth structure, particularly the marginal ridges, leading to a significant reduction in cuspal stiffness and fracture resistance. Consequently, teeth restored after extensive MOD preparations are more susceptible to fracture under functional occlusal loads than intact teeth. Although resin-based composite restorations have become the preferred restorative material because of their superior esthetics, adhesive properties, and conservative preparation requirements, they may not adequately reinforce weakened tooth structures when used alone in large posterior restorations. Fracture of restored teeth remains a major cause of restoration failure and often necessitates complex retreatment or extraction [1-3].

To overcome these limitations, fibre-reinforced composite (FRC) systems have been developed to improve the mechanical performance of direct restorations. Fibre reinforcement acts by absorbing and distributing stresses within the restoration, reducing crack propagation and enhancing fracture toughness [4]. Among the available reinforcement strategies, short fibre-reinforced composites (SFRCs) have gained considerable attention because of their randomly oriented glass fibres, which create a three-dimensional reinforcing network within the composite matrix. These fibres effectively hinder crack initiation and propagation, thereby increasing load-bearing capacity and fracture resistance [5,6].

Long fibre reinforcement represents another approach to strengthening weakened posterior teeth. Continuous or strategically positioned fibres act as stress-bearing frameworks that redirect functional forces and reduce cusp deflection. Previous investigations have demonstrated that long fibres improve the resistance of restored teeth to catastrophic fracture and enhance structural integrity under compressive loading conditions [7,8]

Ribbond, a high-strength polyethylene fibre reinforcement material, has also been widely used in restorative dentistry. Its leno-woven architecture provides multidirectional reinforcement and improved stress distribution throughout the restoration. Unlike fibres incorporated within the composite bulk, Ribbond is placed as an internal reinforcement layer, producing a splinting effect that may improve both fracture resistance and fracture pattern. Studies have reported that restorations reinforced with Ribbond frequently exhibit more favorable and repairable failure modes compared with conventional composite restorations [9,10]. Schematic comparison of fracture resistance in MOD cavities restored with conventional composite, SFRC, long fibre, and Ribbond reinforcements **(Figure 1)**.

Despite the growing popularity of fibre-reinforced restorative techniques, direct comparisons among short fibre composites, long fibre reinforcements, and Ribbond under standardized experimental conditions remain limited. Most published studies have evaluated these materials independently, making it difficult to determine the most effective reinforcement strategy for large MOD restorations [6,8-10]. Therefore, the present in vitro study

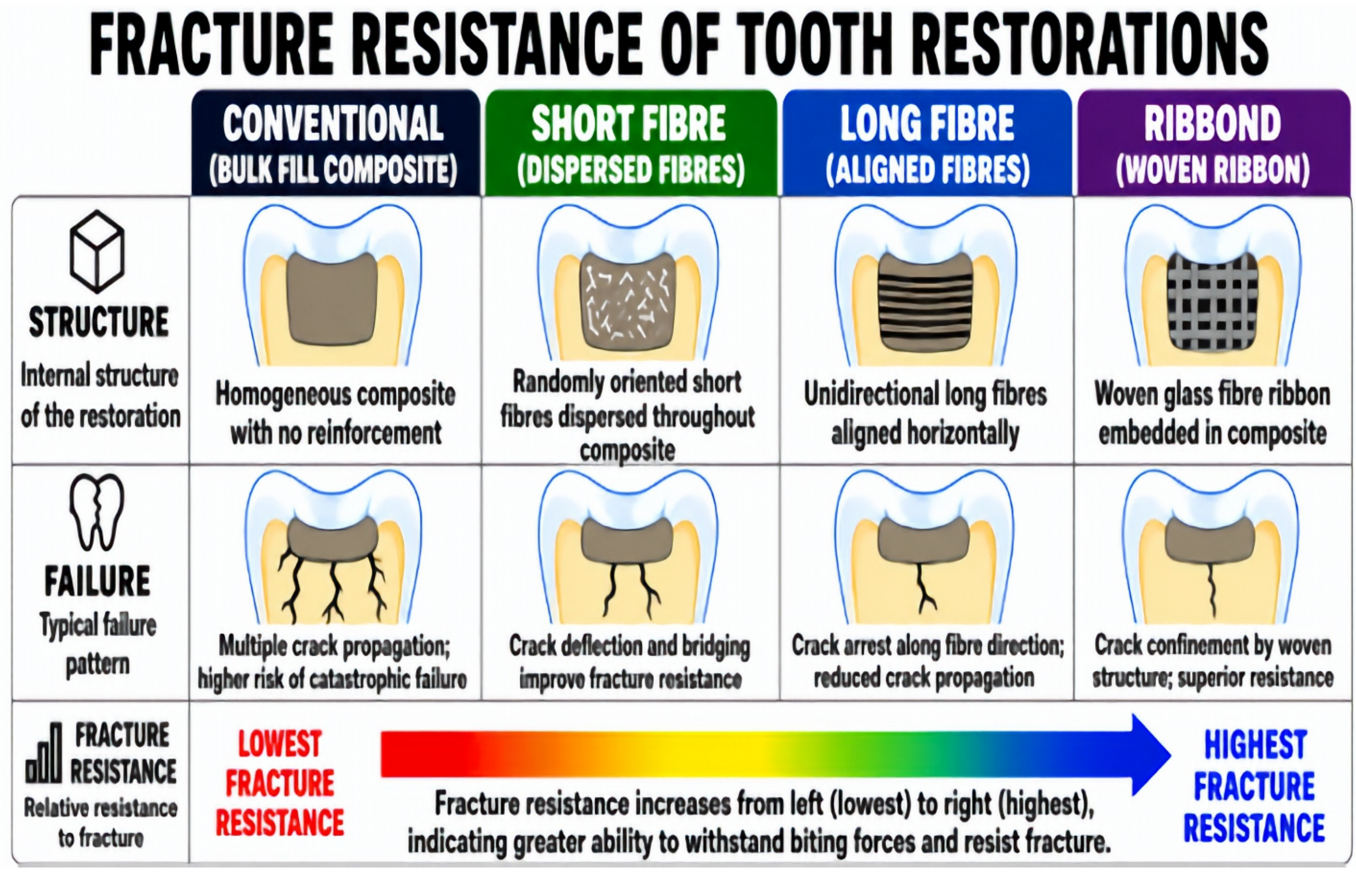

Figure 1. Comparative schematic illustration of fracture resistance in MOD cavities restored with conventional composite, short fibre-reinforced composite (SFRC), long fibre reinforcement, and Ribbond reinforcement.

was undertaken to compare the fracture resistance and failure modes of MOD cavities restored with short fibre composite, long fibre reinforcement, and Ribbond reinforcement, in comparison with conventional composite restorations. The findings may provide clinically relevant evidence to guide material selection and improve the longevity of extensively restored posterior teeth.

MATERIALS & METHODS

This in vitro experimental study was conducted on forty extracted human permanent molars of similar dimensions that were free of caries, cracks, restorations, hypoplastic defects, or previous endodontic treatment. Following removal of adherent soft tissue, the teeth were stored in distilled water at room temperature until use. Standardized mesio-occluso-distal (MOD) cavities were prepared in all specimens using a high-speed handpiece with diamond burs under continuous water cooling. The cavity dimensions were standardized with an isthmus width equal to one-third of the intercuspal distance, a depth of 4 mm from the central groove, a proximal box width of 2 mm, and a gingival seat positioned 1 mm above the cementoenamel junction. Burs were replaced after every five preparations to ensure uniformity.

The specimens were randomly divided into four groups (n = 10 each): Group I (Control) restored with conventional nanohybrid composite resin; Group II restored with short fibre-reinforced composite (everX Flow, GC); Group III restored with composite resin reinforced with long fibres; and Group IV restored with composite resin reinforced with Ribbond polyethylene fibre placed across the cavity floor and embedded within the composite. All cavities were etched with 37% phosphoric acid for 15 seconds, rinsed, and dried, followed by application of a universal adhesive and light curing for 20 seconds. Restorations were completed incrementally in 2-mm layers, each cured for 40 seconds using an LED curing unit with an intensity of 1000 mW/cm². Reinforcement materials were incorporated according to the respective manufacturer's instructions, and all restored teeth were subsequently stored in distilled water at 37°C for 24 hours before testing.

For fracture resistance evaluation, each tooth was mounted vertically in an acrylic resin block, leaving 2 mm of the root exposed to simulate the alveolar bone level. Specimens were subjected to compressive loading using a universal testing machine (Instron), with a 4-mm diameter steel ball positioned at the central fossa to apply force along the long axis of the tooth. Load was applied at a crosshead speed of 1 mm/min until fracture occurred, and the maximum fracture load was recorded in Newtons (N). Fractured specimens were then examined visually and under a stereomicroscope at ×10 magnification. Failure modes were classified as restorable fractures when confined above the cementoenamel junction and non-restorable fractures when extending below it.

Statistical analysis was performed using one-way analysis of variance (ANOVA) to compare mean fracture resistance among the groups, followed by Tukey's post-hoc test for pairwise comparisons. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The mean fracture resistance values of the four experimental groups are presented in **Table 1**. Group II (Short Fibre Composite) demonstrated the highest fracture resistance, with a mean value of 1197.50 ± 15.14 N, followed by Group III (Long Fibre Reinforcement) (1037.50 ± 15.14 N) and Group IV (Ribbond Reinforcement) (956.30 ± 9.83 N). The control group restored with conventional composite alone (Group I) exhibited the lowest fracture resistance (787.00 ± 16.02 N). Compared with the control group, short fibre reinforcement increased fracture resistance by approximately 52.2%, long fibre reinforcement by 31.8%, and Ribbond reinforcement by 21.5%. The maximum fracture resistance was observed in Group II (1220 N), whereas the minimum value was recorded in Group I (760 N). The relatively low standard deviation values across all groups indicate consistent performance within each experimental group **(Figure 2)**. Overall, fibre reinforcement significantly improved the load-bearing capacity of MOD restorations, with short fibre composite showing the greatest reinforcing effect, followed by long fibre reinforcement and Ribbond reinforcement. These findings suggest that the incorporation of reinforcing fibres enhances the fracture resistance of restored molars compared with conventional composite restorations.

Statistical Analysis of Fracture Resistance

A one-way Analysis of Variance (ANOVA) was performed to compare fracture resistance among the four experimental groups. The analysis demonstrated a highly statistically significant difference in mean fracture resistance values between the groups ($F = 1357.26$, $p < 0.001$), indicating that the type of reinforcement significantly influenced the fracture resistance of MOD restorations **(Table 2)**.

Pairwise Comparison of Fracture Resistance

Post-hoc Tukey's test was performed to identify intergroup differences in fracture resistance. All pairwise comparisons were statistically significant ($p < 0.001$). Group II (Short Fibre Composite) exhibited significantly greater fracture resistance than all other groups. Group III (Long Fibre Reinforcement) also showed significantly higher fracture resistance than Group IV (Ribbond Reinforcement) and the control group. These findings confirm the superior reinforcing effect of short fibre composites, followed by long fibre reinforcement and Ribbond reinforcement **(Table 3)**.

Failure Mode Analysis

The distribution of fracture patterns among the experimental groups is presented in **Table 4**. Reinforced restorations demonstrated a greater proportion of favorable (restorable) fractures compared with the control group.

Group II (Short Fibre Composite) exhibited the highest percentage of restorable fractures (80%), followed by Group IV (Ribbond Reinforce-ment) (70%) and Group III (Long Fibre Reinforcement) (60%). In contrast, the control group predomi-nantly showed non-restorable fractures (80%). These findings suggest that fibre reinforcement not only increases fracture resistance but also promotes more clinically favorable failure patterns, enhancing the possibility of restoration repair rather than extraction **(Figure 3).** Overall, both the magnitude of fracture resistance and the pattern of failure were significantly influenced by the type of rein-forcement used. Short fibre composite reinforcement demon-strated the highest fracture resistance and the greatest proportion of favorable fractures, followed by long fibre and Ribbond rein-forcements. In contrast, conventional composite restorations exhibited the lowest fracture resistance and predominantly non-restorable fracture patterns. These findings indicate that fibre reinforcement not only enhances the mechanical strength of MOD restorations but also improves their clinical prognosis by promoting more repairable modes of failure.

Table 1. Mean Fracture Resistance Values (N) of Different Groups

Group	Reinforcement Type	Mean ± SD (N)	Minimum (N)	Maximum (N)
I	Control (Composite only)	787.00 ± 16.02	760	810
II	Short Fibre Composite	1197.50 ± 15.14	1175	1220
III	Long Fibre Reinforcement	1037.50 ± 15.14	1015	1060
IV	Ribbond Reinforcement	956.30 ± 9.83	940	970

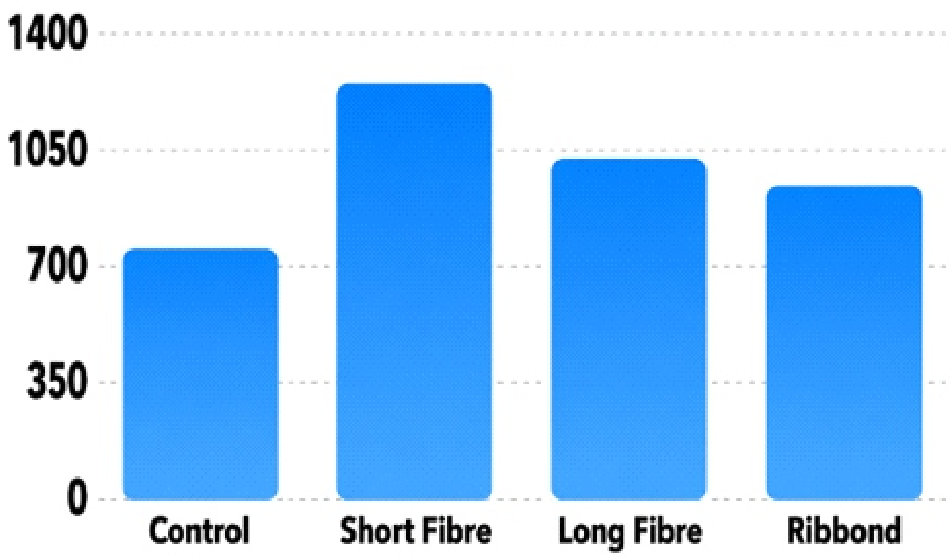

Figure 2. Comparison of mean fracture resistance values among the four experimental groups. Short fibre composite reinforcement demonstrated the highest fracture resistance (1197.5 N), followed by long fibre reinforcement (1037.5 N) and Ribbond reinforcement (956.3 N), while the control group exhibited the lowest fracture resistance (787.0 N).

Table 2. One-Way ANOVA Analysis of Fracture Resistance

Source of Variation	Sum of Squares (SS)	df	Mean Square (MS)	F-value	P-value
Between Groups	905850.08	3	301950.03	1357.26	<0.001*
Within Groups	8008.90	36	222.47	–	–
Total	913858.98	39	–	–	–

*Statistically significant (p < 0.05)

Table 3. Pairwise Comparison of Fracture Resistance (Tukey's Post-hoc Test)

Comparison	Mean Difference (N)	P-value
Group II vs Group I	410.50	<0.001
Group III vs Group I	250.50	<0.001
Group IV vs Group I	169.30	<0.001
Group II vs Group III	160.00	<0.001
Group II vs Group IV	241.20	<0.001
Group III vs Group IV	81.20	<0.001

Table 4. Distribution of Failure Modes Among Experimental Groups

Group	Reinforcement Type	Restorable Fractures n (%)	Non-Restorable Fractures n (%)
I	Control (Composite only)	2 (20%)	8 (80%)
II	Short Fibre Composite	8 (80%)	2 (20%)
III	Long Fibre Reinforcement	6 (60%)	4 (40%)
IV	Ribbond Reinforcement	7 (70%)	3 (30%)

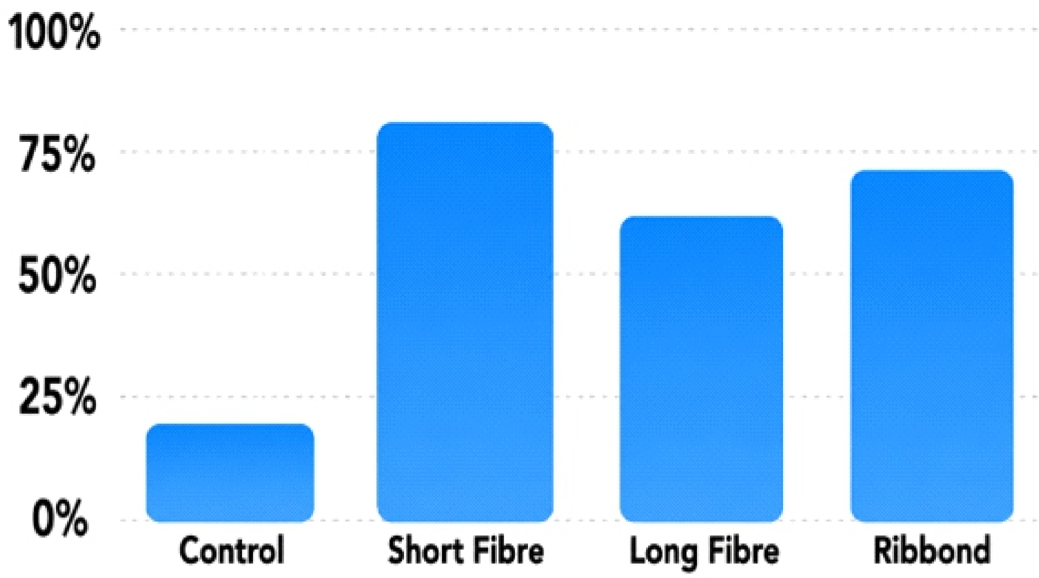

Figure 3. Percentage distribution of restorable fractures among the experimental groups. Fibre-reinforced restorations demonstrated a greater proportion of favorable (restorable) fractures compared with conventional composite restorations. Short fibre composite showed the highest percentage of restorable fractures (80%), followed by Ribbond reinforcement (70%) and long fibre reinforcement (60%), whereas the control group showed predominantly non-restorable fractures.

DISCUSSION

The present in vitro study compared the fracture resistance and failure modes of MOD cavity restorations reinforced with short fibre composite, long fibre reinforcement, and Ribbond reinforcement. The results demonstrated that all fibre-reinforced groups exhibited significantly greater fracture resistance than conventional composite restorations. Among the tested materials, the short fibre composite showed the highest fracture resistance, followed by the long fibre reinforcement and Ribbond reinforcement. Furthermore, reinforced restorations demonstrated a greater proportion of favorable, restorable fractures compared with the control group.

The lower fracture resistance observed in the conventional composite group is consistent with previous evidence demonstrating that extensive MOD cavity preparations significantly weaken tooth structure by removing marginal ridges and reducing cuspal stiffness [1-3]. As reported by Demarco et al., large posterior composite restorations remain susceptible to fracture despite advances in adhesive dentistry because of stress concentration within weakened tooth tissues [3]. The superior performance of the short fibre composite group observed in the present study corroborates the findings of Garoushi et al., who reported that short glass fibres dispersed within the resin matrix effectively arrest crack propagation and improve fracture toughness [5,6].

The randomly oriented fibres form a three-dimensional reinforcing network that redistributes occlusal stresses and enhances load-bearing capacity. Vallittu et al. further emphasized that fibre reinforcement improves the biomechanical behavior of restorations by mimicking the stress-modulating properties of dentin [4]. The 52.2% increase in fracture resistance observed in the present study highlights the effectiveness of this mechanism in strengthening weakened posterior teeth.

Long fibre reinforcement also significantly improved fracture resistance compared with the control group. These findings are in agreement with those of Belli et al., who demonstrated that strategically positioned continuous fibres reduce cuspal deflection and act as stress-bearing frameworks within MOD restorations [7]. The reinforcing effect of long fibres has been attributed to their ability to bridge crack lines and redirect functional stresses away from vulnerable tooth structures. Although long fibre reinforcement performed better than Ribbond in the present study, its fracture resistance remained lower than that of the short fibre composite, possibly due to the more localized nature of reinforcement provided by continuous fibres. Ribbond reinforcement demonstrated intermediate fracture resistance values but produced a high percentage of favorable fractures. Similar findings were reported by Samadzadeh et al., who observed that woven polyethylene fibres improve stress distribution and reduce catastrophic failures by creating an internal splinting effect within the restoration [8]. Alander et al. further demonstrated that fibre-reinforced composites dissipate stresses more effectively than conventional composites, thereby reducing crack propagation and enhancing repairability [9]. The favorable fracture patterns observed in the Ribbond group support its clinical usefulness in situations where preservation and repair of tooth structure are important considerations.

A notable finding of the present study was the significant improvement in failure mode among all reinforced groups. While 80% of fractures in the control group were non-restorable, the majority of fractures in the fibre-reinforced groups were restorable. This observation is consistent with the review by Khan et al., who concluded that fibre reinforcement not only improves fracture resistance but also alters crack propagation pathways, resulting in more clinically manageable fracture patterns [10].

The limitations of this study include its in vitro design, absence of thermocycling and fatigue loading, and relatively small sample size. Nevertheless, the standardized methodology allowed direct comparison among different reinforcement strategies. Future studies incorporating aging protocols and clinical evaluation are required to validate these findings under functional oral conditions.

Overall, the results indicate that fibre reinforcement significantly enhances both the fracture resistance and failure behavior of MOD restorations, with short fibre composite demonstrating the most favorable overall performance.

CONCLUSION

Within the limitations of this in vitro study, it can be concluded that fibre reinforcement significantly enhances the fracture resistance of MOD cavity restorations compared with conventional composite restorations. Among the tested reinforcement strategies, short fibre composite demonstrated the highest fracture resistance, followed by long fibre reinforcement and Ribbond reinforcement. The findings indicate that incorporating fibres into composite restorations effectively improves stress distribution and fracture resistance under compressive loading.

In addition to increasing fracture strength, fibre reinforcement positively influenced failure patterns. The reinforced groups exhibited a substantially greater proportion of restorable fractures, whereas conventional composite restorations predominantly showed non-restorable failures. This suggests that fibre reinforcement not only improves the mechanical performance of restored teeth but may also enhance their long-term clinical prognosis by preserving repairability.

Among the evaluated materials, short fibre composite appears to be the most effective option for reinforcing extensively restored posterior teeth. Further long-term clinical studies are recommended to confirm these results under functional oral conditions.

LIMITATIONS & FUTURE PERSPECTIVES

The study's limitations include a single-centre setting, a relatively small sample size, and a short study duration, which may limit the broader applicability of the results. Future studies should incorporate multicentre designs with larger populations to enhance validity, assess long-term outcomes, and investigate advanced diagnostic & management approaches. Such efforts will improve overall patient care & help minimize complications.

CLINICAL SIGNIFICANCE

The clinical significance of this study lies in its potential to bridge the gap between research findings and practical healthcare applications. It emphasizes the importance of translating scientific observations into meaningful improvements in patient care, diagnosis, and treatment outcomes. By highlighting real-world relevance, the study contributes to evidence based medical practice and supports informed clinical decision making. Ultimately, the findings aim to enhance patient quality of life, optimize therapeutic strategies, and promote better disease management in clinical settings.

ABBREVIATIONS

MOD: Mesio-Occluso-Distal
SFC: Short Fibre Composite
LFR: Long Fibre Reinforcement
RF: Ribbond Reinforcement
CR: Conventional Composite Resin
FR: Fracture Resistance
FM: Failure Mode
UTM: Universal Testing Machine
FRC: Fibre-Reinforced Composite
GFRC: Glass Fibre-Reinforced Composite
PFRC: Polyethylene Fibre-Reinforced Composite

AUTHOR INFORMATION

Dr. Gayatri H. Giramkar: Post Graduate Student
Dr. Anu Narang: Professor
Dr. Santosh Kumar Singh: Professor & Head
Dr. Shivani Rawat: Post Graduate Student
Dr. Sadhvi Pateriya: Post Graduate Student
Dr. Naman Keshwani: Post Graduate Student

AUTHOR CONTRIBUTIONS

All authors significantly contributed to the study conception and design, data acquisition, or data analysis and interpretation. They participated in drafting the manuscript or critically revising it for important intellectual content, consented to its submission to the current journal, provided final approval for the version to be published, and accepted responsibility for all aspects of the work. Additionally, all authors meet the authorship criteria outlined by the International Committee of Medical Journal Editors (ICMJE) guidelines.

ACKNOWLEDGEMENT

The authors sincerely acknowledge the seniors of the Department of Conservative Dentistry & Endodontics, Peoples College of Dental Sciences & Research Centre, Bhopal, Madhya Pradesh, India. We are grateful to our college for providing the necessary resources to carry out this work. We also extend our heartfelt thanks to our colleagues and technical staff for their valuable assistance during the study.

CONFLICT OF INTEREST

Authors declared that there is no conflict of interest.

FUNDING

None

ETHICAL APPROVAL & CONSENT TO PARTICIPATE

All necessary consent & approval was obtained by authors.

CONSENT FOR PUBLICATION

All necessary consent for publication was obtained by authors.

DATA AVAILABILITY

All data generated and analyzed are included within this research article. The datasets utilized and/or analyzed in this study can be obtained from the corresponding author upon a re-asonable request.

USE OF ARTIFICIAL INTELLIGENCE (AI) & LARGE LANGUAGE MODEL (LLM)

The authors confirm that no AI & LLM tools were used in the writing or editing of the manuscript, and no images were altered or manipulated using AI & LLM.

AUTHOR'S NOTE

This article serves as an important educational tool for the scientific community, offering insights that may inspire future research diretions. However, they should not be relied upon independently when making treatment decisions or developing public health policies.

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Dr. Dinesh Kumar Verma
Research Assistant Professor, School of Allied Health Sciences, Boise State University, Boise, Indiana, USA
e-mail: dineshkumarverma@boisestate.edu

REFERENCE

1. Sakaguchi RL, Ferracane JL. Ferracane's materials in dentistry: principles and applications. 3rd ed. Chicago: Quintessence; 2019:1-332.
2. Opdam NJ, Bronkhorst EM, Loomans BA, Huysmans MC. 12-year survival of composite vs. amalgam restorations. J Dent Res. 2010;89(10):1063-1067.
3. Demarco FF, Corrêa MB, Cenci MS, Moraes RR, Opdam NJ. Longevity of posterior composite restorations: not only a matter of materials. Dent Mater. 2012;28(1):87-101.
4. Vallittu PK. An overview of development and status of fiber-reinforced composites as dental and medical biomaterials. Acta Biomater Odontol Scand. 2018;4(1):44-55.
5. Garoushi S, Vallittu PK, Lassila LV. Short glass fiber reinforced restorative composite resin with semi-interpenetrating polymer network matrix. Dent Mater. 2007;23(11):1356-1362.
6. Garoushi S, Gargoum A, Vallittu PK, Lassila LVJ. Short fiber-reinforced composite restorations: a review. Dent Mater. 2018;34(9):1340-1352.
7. Belli S, Erdemir A, Ozcopur M, Eskitascioglu G. The effect of fibre insertion on fracture resistance of root-filled molar teeth with MOD preparations restored with composite. Int Endod J. 2005;38(2):73-80.
8. Samadzadeh A, Kugel G, Hurley E, Aboushala A. Fracture strengths of provisional restorations reinforced with plasma-treated woven polyethylene fiber. J Prosthet Dent. 1997;78(5):447-450.
9. Alander P, Lassila LV, Tezvergil A, Vallittu PK. Acoustic emission analysis of fiber-reinforced composite in flexural testing. Dent Mater. 2004;20(4):305-312.
10. Khan AA, Zafar MS, Fareed MA, Almufareh N, et al. Fiber-reinforced composites in dentistry: an insight into adhesion aspects of the material and the restored tooth construct. Dent Mater. 2023;39(2):57-73.