

Comparative Evaluation of Load Bearing Capacity of Inter Rim Fixed Partial Dentures Reinforced with E-Glass Fibers and Polypropylene Fibres: An in Vitro Study

¹Dr.Madhusudhan Amudalapalli, MDS, PG Student, Department of Prosthodontics & Crown and Bridge, Sree Sai Dental College and Research Institute, Srikakulam, Andra Pradesh, India

²Dr.Ch.Siddesh Kumar, MDS, Professor & HOD, Department of Prosthodontics & Crown and Bridge, Sree Sai Dental College and Research Institute, Srikakulam, Andra Pradesh, India

³Dr.K.Jagadish, MDS, Professor, Department of Prosthodontics & Crown and Bridge, Sree Sai Dental College and Research Institute, Srikakulam, Andra Pradesh, India

⁴Dr.L.Srikanth, MDS, Reader, Department of Prosthodontics & Crown and Bridge, Sree Sai Dental College and Research Institute, Srikakulam, Andra Pradesh, India

⁵Dr.M.Vasavi, MDS, Reader, Department of Prosthodontics & Crown and Bridge, Sree Sai Dental College and Research Institute, Srikakulam, Andra Pradesh, India

⁶Dr.B.Rajasekhar, MDS, PG Student, Department of Prosthodontics & Crown and Bridge, Sree Sai Dental College and Research Institute, Srikakulam, Andra Pradesh, India

Corresponding Author: Dr.Madhusudhan Amudalapalli, MDS, PG Student, Department of Prosthodontics & Crown and Bridge, Sree Sai Dental College and Research Institute, Srikakulam, Andra Pradesh, India

Citation of this Article: Dr. Madhusudhan Amudalapalli, Dr. Ch. Siddesh Kumar, Dr. K. Jagadish, Dr. L. Srikanth, Dr. M. Vasavi, Dr. B. Rajasekhar, “Comparative Evaluation of Load Bearing Capacity of Inter Rim Fixed Partial Dentures Reinforced with E-Glass Fibers and Polypropylene Fibres: An in Vitro Study”, IJDSIR- March – 2026, Volume – 9, Issue – 2, P. No. 173 – 181.

Copyright: © 2026, Dr.Madhusudhan Amudalapalli, et al. This is an open access journal and article distributed under the terms of the creative common’s attribution non-commercial License. Which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given, and the new creations are licensed under the identical terms.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Inter-rim fixed partial dentures (FPDs) used as interim restorations are subjected to occlusal forces that may lead to fracture. Fiber reinforcement is recommended to enhance their mechanical strength, but comparative evidence between different fiber types remains limited.

Aim: To compare the load-bearing capacity of inter-rim FPDs reinforced with E-glass fibers and polypropylene fibers.

Materials and Methods: Forty three-unit interim FPD specimens were fabricated and divided into four groups (n=10) based on pontic design (hygienic and modified ridge lap) and type of fiber reinforcement (E-glass or

polypropylene). Load-bearing capacity was evaluated using a universal testing machine (Autograph AG-IS 50 kN, Shimadzu Corporation) at a crosshead speed of 2.5 mm/min. The maximum fracture load was recorded in Newtons and analyzed using one-way ANOVA ($\alpha=0.05$).

Results: The overall mean fracture load was 1344 N. The hygienic pontic reinforced with polypropylene fibers showed the highest mean value (1518 N), whereas the modified ridge lap pontic reinforced with polypropylene fibers demonstrated the lowest mean value (1077 N). No statistically significant difference was observed among the groups ($p>0.05$).

Conclusion: Both E-glass and polypropylene fibers improved the load-bearing capacity of interim inter-rim FPDs. Within the limitations of this in vitro study, both fiber types can be considered clinically acceptable reinforcement options.

Keywords: Airtor, Fixed Partial Dentures, Hygienic, Mandrel Bur, Thyodont Teeth

Introduction

Restoration of partially edentulous arches using fixed partial dentures remains a key component of prosthodontic treatment. Inter-rim fixed partial dentures are commonly used as interim restorations but are often subjected to significant occlusal forces^{1,2}. Inadequate strength may lead to fracture and failure of these prostheses. Fiber-reinforced composite materials have been introduced to enhance the mechanical properties of such restorations^{3,4}. Among available fibers, E-glass fibers offer high tensile strength and rigidity, while polypropylene fibers provide toughness and resistance to crack propagation^{5,6}. Reinforcement with these fibers improves stress distribution within the prosthesis. However, limited evidence exists comparing their load-bearing capacity in inter-rim fixed partial dentures⁷. A comparative evaluation is therefore necessary.

Aim

To comparatively evaluate the load-bearing capacity of inter-rim fixed partial dentures reinforced with E-glass fibers and polypropylene fibers.

Objective of the Study

Primary Objective

- To comparatively evaluate the load-bearing capacity of inter-rim fixed partial dentures reinforced with E-glass fibers and polypropylene fibers.

Secondary Objectives

- To assess the fracture resistance of inter-rim fixed partial dentures reinforced with E-glass fibers.
- To assess the fracture resistance of inter-rim fixed partial dentures reinforced with polypropylene fibers.
- To compare the maximum load at fracture between the two fiber-reinforced groups.
- To determine the influence of different fiber reinforcements on the mechanical performance of inter-rim fixed partial dentures under static loading conditions.

Need of the Study

Inter-rim fixed partial dentures are widely used as interim restorations and are frequently subjected to functional occlusal loads, increasing the risk of fracture and mechanical failure. Although fiber reinforcement has been shown to improve the strength of composite prostheses, limited comparative data are available regarding the effectiveness of different fiber types. E-glass fibers and polypropylene fibers differ in their mechanical properties and stress distribution behavior, which may influence the load-bearing capacity of inter-rim fixed partial dentures. A direct comparison of these fiber reinforcements is essential to identify the most suitable material for enhancing prosthesis strength. Therefore, this in vitro study is needed to provide scientific evidence to guide material selection and

improve the clinical performance and longevity of interim fixed partial dentures.

Materials and Methods

The materials used included dental die stone, dental plaster, and cold mould seal for model preparation and processing. A micromotor handpiece, airtor, TC burs, mandrel bur, cotton buff bur, and Super Endo tooth preparation bur kit were used for tooth preparation and finishing. E-glass fibers and polypropylene fibers were used as reinforcement materials. DPI tooth moulding powder, Zeta Plus putty by Zhermack, typodont teeth set, porcelain jar, and dispenser were also utilized.(Figure 1)

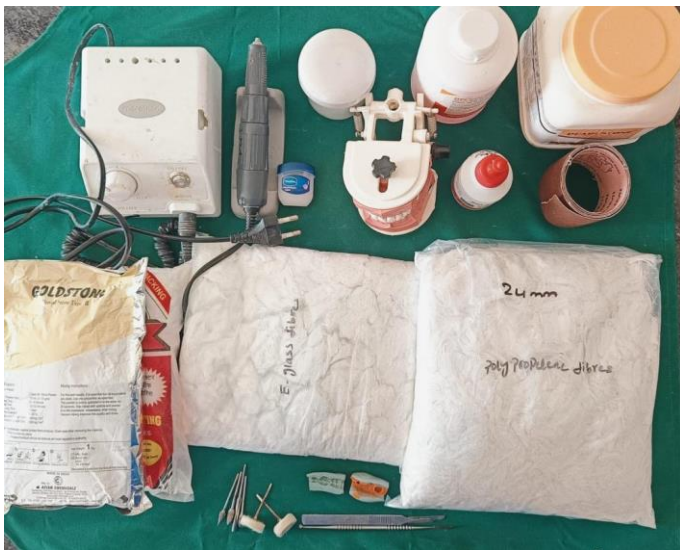


Figure 1: Armamentarium for interim fixed partial denture using E-glass and Polypropylene fibers.

Preparation of Teeth for Three Unit Bridge

Tooth preparations for porcelain fused metal (PFM)-FPDs on typodont teeth were done. For three-unit bridge, 35 and 37 were prepared using diamond points. Once prepared, impressions were made with the addition of silicone putty and light body India) with wax-shaped according to the two types of pontics (modified ridge lap and hygienic) placed in the pontic area of the typodont. Impressions, each was made for three unit bridge with the type of pontic design needed. (Figure 2&3)



Figure 2: Three unit preparation on typodont teeth



Figure 3: Three unit preparation on typodont jaw set

Repair of Dies for Each Group

A die for unprepared three-unit was made out of die stone (type IV) with the help of a putty index of the typodont teeth before preparation. Modeling wax was added to the dies for increasing its height and width by 10 cm each for making a base. Putty index of these two were made to pour in all the 40 dies in the exact dimension of plaster base.(Figure 4)



Figure 4: 40 die samples preparation with plaster base

Preparation of Reinforced Interim Restorations

Die was coated with a layer of petroleum jelly as a separating medium. The glass fibers were placed at each die in its position and DPI Tooth moulding temporary material was dispensed into the putty index. The index was placed over the die till the material was set. Once set, the temporary bridge was removed from the die. The fibers were embedded into the DPI Temporary tooth moulding interim bridge.(Figure 5&6)

Table 1: Groups included in the study

Group-1	Three-unit F.P.D With Hygienic pontic reinforced with E-glass fiber
Group-2	Three-unit F.P.D With Hygienic pontic reinforced with Polypropylene fiber
Group-3	Three-unit F.P.D With modified ridge lap pontic reinforced with E-glass fiber
Group-4	Three-unit F.P.D With modified ridge lap pontic reinforced with Polypropylene fiber

All specimens were tested for load-bearing capacity using a universal testing machine until fracture, and the maximum fracture load was recorded and statistically analyzed.



Figure 5: Putty index of unprepared teeth (Left 3 unit FPD 35 TO 37)



Figure 6: Preparation of three unit bridge
Standardized inter-rim fixed partial denture specimens were fabricated and divided into four groups based on fiber reinforcement.

Testing of Samples

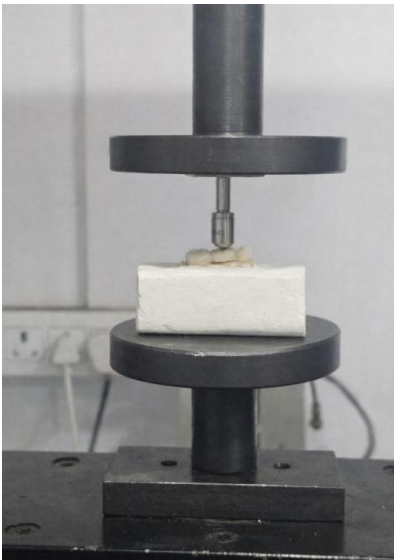


Figure 7: Load bearing capacity tested by Universal testing machine

The load-bearing capacity was evaluated using a Autograph AG-IS 50 kN Universal Testing Machine (Shimadzu Corporation, Japan). The machine had a

Results

Table 2: Descriptives of Load bearing (N) across study groups

Group	Material	Mean	Std. Error	Std. Dev	Median	Min	Max
Group-1	Hygienic Pontic + E-glass	1342	204.23	645.85	1630	500	2140
Group-2	Hygienic Pontic + Polypropylene	1518	47.39	149.87	1540	1280	1730
Group-3	Modified Ridge Lap + E-glass	1439	222.50	703.61	1700	580	2450
Group-4	Modified Ridge Lap + Polypropylene	1077	137.64	435.27	1150	520	1820
Overall (Avg)		1344	152.94	483.65	1505	720	2035

Table 3: Inter-group comparison of Load bearing (N) across all the study groups

	Sum of Squares	df	Mean Square	F	p-Value
Between Groups	1105940	3	368646.667	1.312	0.286
Within Groups	10117220	36	281033.889		
Total	11223160	39			

One way ANOVA test: p-Value >0.05-Non-significant

Table 4: Pairwise comparison of Load bearing (N) across all the study groups

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	p-Value	95% CI Lower Bound	95% CI Upper Bound
Modified Ridge	Hygienic Pontic + E-	97	237.08	1.0	-564.92	758.92

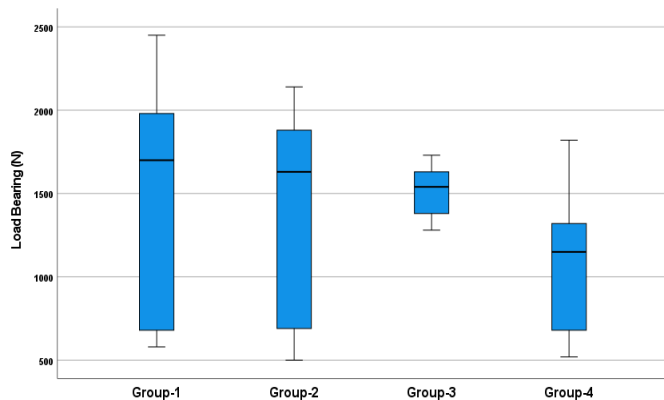
maximum load capacity of 50 kN and was operated at a crosshead speed of 2.5 mm/min.

A stainless-steel ball indenter of 6 mm diameter was used to apply the load. The force was applied at the center of the pontic region corresponding to tooth 36 in the three-unit fixed partial denture specimens, and this loading position was standardized for all samples.

The load was applied continuously until fracture of the interim restoration occurred. The maximum load at fracture was recorded in Newtons (N) using the inbuilt software of the testing machine. The collected data were collated, tabulated, and subjected to statistical analysis.

Lap + E-glass	glass					
	Hygienic Pontic + Polypropylene	-79	237.08	1.0	-740.92	582.92
	Modified Ridge Lap + Polypropylene	362	237.08	0.813	-299.92	1023.92
Hygienic Pontic + E-glass	Modified Ridge Lap + E-glass	-97	237.08	1.0	-758.92	564.92
	Hygienic Pontic + Polypropylene	-176	237.08	1.0	-837.92	485.92
	Modified Ridge Lap + Polypropylene	265	237.08	1.0	-396.92	926.92
Hygienic Pontic + Polypropylene	Modified Ridge Lap + E-glass	79	237.08	1.0	-582.92	740.92
	Hygienic Pontic + E-glass	176	237.08	1.0	-485.92	837.92
	Modified Ridge Lap + Polypropylene	441	237.08	0.426	-220.92	1102.92
Modified Ridge Lap + Polypropylene	Modified Ridge Lap + E-glass	-362	237.08	0.813	-1023.92	299.92
	Hygienic Pontic + E-glass	-265	237.08	1.0	-926.92	396.92
	Hygienic Pontic + Polypropylene	-441	237.08	0.426	-1102.92	220.92

Graph 1: Load bearing (N) across study groups



The overall mean load-bearing capacity was 1344 N (SD 483.65 N; range 720–2035 N).

Among the study groups, Hygienic Pontic + Polypropylene (Group-2) showed the highest mean value (1518 N) with the least variability (SD 149.87 N), indicating more consistent performance. Modified Ridge Lap + Polypropylene (Group-4) demonstrated the lowest mean load-bearing capacity (1077 N). The greatest variability was observed in Modified Ridge Lap + E-glass (Group-3) (SD 703.61 N).

One-way ANOVA revealed no statistically significant difference in load-bearing capacity among the four groups ($F = 1.312$; $p = 0.286$).

Post-hoc Bonferroni analysis confirmed the absence of significant pairwise differences, with all comparisons showing $p > 0.05$ and 95% confidence intervals crossing zero. The largest observed mean difference (441 N between Group-2 and Group-4) was also non-significant ($p = 0.426$).

Limitations of the Study

- Being an in vitro study, it does not completely replicate intraoral conditions such as thermal cycling, saliva exposure, and cyclic fatigue loading.
- Only static loading was evaluated; dynamic fatigue testing may provide additional insights.
- Variations in fiber positioning and resin impregnation could influence outcomes.
- Sample size may have limited the statistical power to detect small differences.

Discussion

Interim fixed partial dentures are subjected to functional occlusal forces, particularly in the posterior region, making reinforcement essential to prevent fracture^{8,9}. In this in vitro study, the overall mean load-bearing capacity (1344 N) exceeded average physiological masticatory forces, indicating that fiber-reinforced inter-rim FPDs can withstand functional loading^{10,11}.

Among the groups, the hygienic pontic reinforced with polypropylene fibers demonstrated the highest mean load-bearing capacity and the most consistent performance^{12,13}. This may be attributed to the toughness and crack-arresting ability of polypropylene fibers, along with favorable stress distribution in the hygienic pontic design^{14,15}. The modified ridge lap pontic reinforced with E-glass fibers also showed high mean values but greater variability, possibly due to differences in fiber orientation and bonding within the resin matrix^{16,17,18}. The lowest mean load was observed in the modified ridge lap pontic reinforced with polypropylene fibers, suggesting that

pontic design may influence stress concentration and fracture behavior^{19,20}.

However, statistical analysis (ANOVA and Bonferroni post-hoc test) revealed no significant difference among the groups ($p > 0.05$). Within the limitations of static loading and in vitro conditions, both E-glass and polypropylene fibers provided comparable reinforcement^{21,22}. Therefore, either fiber type may be considered suitable for strengthening interim inter-rim fixed partial dentures^{23,24}.

Conclusion

Within the limitations of this study, both E-glass and polypropylene fiber reinforcements improved the load-bearing capacity of inter-rim fixed partial dentures. Although polypropylene fibers in hygienic pontic design showed the highest mean fracture resistance, no statistically significant difference was found between groups. Therefore, both fiber types can be considered viable reinforcement options for interim fixed partial dentures.

References

1. Federick DR. The provisional fixed partial denture. *J Prosthet Dent* 1975;34(5):520–526.
2. Krug RS. Temporary resin crowns and bridges. *Dental Clinics of North America*. 1975;19(2):313–320. PMID: 1090465.
3. McCabe JF. Temporary crown and bridge resins. In: McCabe Anderson applied dental materials. Oxford: Blackwell scientific publications. 1985;153–154.
4. Russell MD. The role of provisional restorations. *Dental update*.1986 ;13(9):425.
5. Vallittu PK. The effect of glass fiber reinforcement on the fracture resistance of a provisional fixed partial denture. *J Prosthet Dent* 1998;79(2):125–130.
6. Foo H, Lindquist TJ, Aquilino SA, et al. Effect of polyaramid fiber reinforcement on the strength of 3

- denture base polymethyl methacrylate resins. *J Prosthodont* 2001;10(3):148–153.
7. Ellakwa AE, Shortall AC, Shehata MK, et al. The influence of fibre placement and position on the efficiency of reinforcement of fibre reinforced composite bridgework. *J Oral Rehabil* 2001; 28 (8):785–791.
 8. John J, Gangadhar SA, Shah I. Flexural strength of heat-polymerized polymethyl methacrylate denture resin reinforced with glass, aramid, or nylon fibers. *J Prosthet Dent* 2001;86(4):424–427.
 9. Gratton DG, Aquilino SA. Interim restorations. *Dent Clin* 2004 Apr 1;48(2):487–497.
 10. Hamza TA, Rosenstiel SF, Elhosary MM, et al. The effect of fiber reinforcement on the fracture toughness and flexural strength of provisional restorative resins. *J Prosthet Dent* 2004;91(3):258–264. DOI: 10.1016/j.prosdent.2004.01.005.
 11. Hamza TA, Rosenstiel SF, El-Hosary MM, et al. Fracture resistance of fiber-reinforced PMMA interim fixed partial dentures. *Journal of Prosthodontics* 2006;15(4):223–228.
 12. Vojvodić D, Komar D, Schauerperl Z, et al. Influence of different glass fiber reinforcements on denture base polymer strength (Fiber reinforcements of dental polymer). Official Publication of the Medical Association of Zenica-Doboj Canton Bosnia and Herzegovina. 2009;6(2):227–234. Corpus ID: 136277100.
 13. Kamble VD, Parkhedkar RD, Mowade TK. The effect of different fiber reinforcements on flexural strength of provisional restorative resins: an in-vitro study. *The journal of advanced prosthodontics*. 2012 Feb 1;4(1):1-6.
 14. Alla R, Sajjan S, Alluri VK, et al. Influence of fiber reinforcement on the properties of denture base resins. *J Biomater Nanobiotechnol* 2013; 4(1):91–97.
 15. Poonacha V, Poonacha S, Salagundi B, et al. In vitro comparison of flexural strength and elastic modulus of three provisional crown materials used in fixed prosthodontics. *Journal of Clinical and Experimental Dentistry* 2013;5(5):e212–e217.
 16. Dokania R, Nayakar RP, Patil R. Comparative evaluation of fracture resistance of three commercially available resins for provisional restorations: an in vitro study. *Curr J ApplSci Technol* 2015;7(5):520–527. DOI: 10.9734/BJAST/2015/15767.
 17. Khan AS, Azam MT, Khan M, et al. An update on glass fiber dental restorative composites: a systematic review. *Mater Sci Eng C* 2015;47:26–39.
 18. Kapri A. Comparison of fiber reinforcement placed at different locations of pontic in interim fixed partial denture to prevent fracture: an in vitro study. *J Indian Prosthodont Soc* 2015;15(2):142–147.
 19. Singh A, Garg S. Comparative evaluation of flexural strength of provisional crown and bridge materials-an invitro study. *J Clin Diagn Res JCDR* 2016;10 (8):ZC72–ZC77.
 20. Gupt P, Nagpal A, Samra RK, et al. A comparative study to check fracture strength of provisional fixed partial dentures made of autopolymerizing polymethylmethacrylate resin reinforced with different materials: an in vitro study. *J Indian ProsthodontSoc*2017;17(3):301–309.
 21. Jasim Ah, Alwan Le, Abood Az. Comparison of fracture resistance of CAD/CAM interim bridge and conventional interim resin bridge. *Worl J Pharm Res* 2019;8:262–275.

22. Natarajan K, Srinivasan S, Krishnan M, et al.
Evaluation of flexural strength of autopolymerizing polymethyl methacrylate and bisacrylic composite provisional restorative resins reinforced with bamboo fibers: an in vitro study. *Int J Prosthodont Restor Dent* 2021;11(3):112–118.
23. Jamel RS, Al-Murad MA, Alkhalidi EF. The efficacy of reinforcement of glass fibers and ZrO₂ nanoparticles on the mechanical properties of autopolymerizing provisional restorations (PMMA). *The Saudi Dental Journal*. 2023 Sep 1;35(6):707-13.