DOI: 10.7860/JCDR/2025/80784.21488

Original Article

Dentistry Section

Fracture Resistance of Endodontically Treated Premolar Teeth Restored with Glass Ionomer Cement, Glass Ionomer Cement with Fibres and Nanoceramic Composite Restorative Material: An In-vitro Study

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ABSTRACT

Introduction: Restoring endodontically treated maxillary premolars is challenging due to their weakened state from caries, trauma, and the endodontic access itself, making them prone to fracture. Long-term success hinges on their ability to withstand biting forces. The core build-up, replacing lost tooth structure, is crucial. The restorative materials chosen for both the core and final crown significantly influence the tooth's overall fracture resistance, as their mechanical properties dictate stress response.

Aim: To evaluate the fracture resistance of endodontically treated premolar teeth restored with Glass Ionomer Cement (GIC), GIC with fibres and nanoceramic composite restorative material.

Materials and Methods: The present in-vitro study included eighty maxillary premolar teeth which were extracted due to orthodontic purpose were collected and divided into four groups with 20 teeth in each group. Group I was noted as negative control with no preparation. Groups II, III and IV were restored with GIC, GIC with fibres and with nanoceramic composite, respectively. After restoration, the samples were subjected to evaluation of fracture resistance by using universal testing machine and values were subjected to statistical analysis.

Results: The highest fracture resistance of 913.858 N(newtons) was noted for nanoceramic composite. There was no statistically significant difference observed between Groups III and IV ($p=0.9870$); however, both groups exhibited higher fracture resistance compared to Group II.

Conclusion: The fracture resistance with fibre reinforcement was higher than conventional CIC and similar to that of nanoceramic composite.

Keywords: Core build-up, Maxillary premolars, Root canal treated teeth

INTRODUCTION

Endodontic therapy is a common dental procedure, and the prognosis of devitalised teeth is significantly impacted by core build-up, a critical aspect of modern restorative dentistry [1]. Teeth that have undergone endodontic treatment are inherently weaker than healthy teeth due to the loss of tooth structure from decay, cavity preparation, and the necessary widening of the root canal in the cervical region [2]. The restorative material used and the amount of tooth structure left are of paramount importance [3]. Deprivation of moisture due to endodontic therapy causes adverse outcomes such as reduced resilience and higher risk of fracture [4]. A crucial element of this treatment is the core build-up, which enhances the remaining tooth structure's resistance and retention, thus preserving its proper form and function. Morgano SM and Brackett SE outlined several key characteristics for core build-up materials [5]. These materials must possess sufficient compressive strength to withstand forces within the mouth, appropriate flexural strength, and be biocompatible [5].

Beside amalgam and resin composites, Glassionomer Based Cements (GICs') have slowly emerged as a highly user-friendly material. Despite having enormous advantages, glass ionomer restorations have exhibited few drawbacks like poor surface finish, greater porous nature and inferior mechanical properties like low impact strength, excessive brittle nature and higher surface loss [6]. Various approaches have been recommended and proved to be successful in overcoming the drawbacks of glass ionomers [6-8]. The incorporation of discontinuous fibres like glass, polyethylene, carbon to GICs can improve its mechanical properties. Studies by Kobayashi M et al., Lucksanasombool P et al., Garoushi S et al., have shown an appreciable rise in flexural capacity and fracture toughness, on discontinuous glass fibres incorporation to GICs [7-9]. Incorporation of discontinuous fibres also decreases the brittleness of GIC, thereby reducing the incidence of failures. On the other hand, composites are being used widely since many decades. Neo Spectra ST is a nano-ceramic, universal composite with novel SphereTEC filler technology. SphereTEC filler technology utilises granulated spherical fillers (a manufacturing process at the micron level that creates spherical superstructures incorporating submicron glass particles) along with an optimised resin matrix [10].

Premolars, being transitional teeth, experience different occlusal forces compared to molars, making specific research on them valuable [11]. While fibre-reinforced composites are well-studied [12], the application and specific fracture resistance of fibre-reinforced GICs as direct restorative materials for endodontically treated premolars require more dedicated investigation. There are limited studies [13,14] on GIC with fibre reinforcement. Many in-vitro studies [11-13] use static load tests. While useful, they don't fully simulate the complex, dynamic forces of mastication. Studies incorporating cyclic loading or thermocycling (or both) to mimic the oral environment more closely are crucial for evaluating fracture resistance, especially for materials like GIC and fibre-reinforced GIC whose properties might change over time under such stresses.

Thus, the purpose of this study was to evaluate the fracture resistance of endodontically treated premolar teeth restored with GIC, GIC with fibres and nanoceramic composite restorative material

MATERIALS AND METHODS

The present in-vitro study was carried out in the department of Conservative Dentistry and Endodontics at GITAM dental college and hospital, Visakhapatnam, India, over a period spanning from February 2025 to April 2025. Before commencement, consent was procured and clearance pertaining to ethical issues was obtained from the institutional ethical committee. (IEC No.35086040923).

Inclusion and exclusion criteria: Current study included premolars which were extracted due to periodontal weakening or as part of orthodontic treatment were used. Teeth were excluded if caries, prior fillings, crack lines (or) fractures were present on the crown or root surfaces. Teeth which were non carious completely root formed teeth with absence of restorations (or) fractures were included in the study.

Sample size selection: A sample size of 80 extracted maxillary premolar teeth was selected after consultation with a statistician, using G*Power software (version 3.1) for statistical estimation.

Study Procedure

The collected samples were cleaned (ultrasonic scaler-Cavitron) after taking preoperative radiographs and stored in physiological saline at 4°C for three days as it maintains moisture, structure, mechanical properties and cooler temperature slows growth of any contaminants [12].

Eighty human premolars that were recently extracted were collected. They were equally divided into four groups of twenty specimens each [Table/Fig-1] [6,10,14,15].

Product name	Composition	Manufacturer	Application
GC Gold Label HYBRID glass hybrid self-adhesive posterior restorative - A2 shade	**Powder:** Fluoroalumino-silicate glass and pigments. **Liquid:** High molecular weight polyacrylic acid, low molecular weight polyacrylic acid	GC Corp., Tokyo, Japan	Powder and liquid -3.0g: 1.0g. The mixture was applied on the surface-treated and allowed to chemical cure for 3 to 6 minutes
Glass fibres	Discontinuous sialinised fibres of length 0.5 mm and 6 microns diameter	Cellusuede products, INC dba Engineered Fibres Technology, USA	They are added in 5% weight proportions i.e., 0.75 gm of the fibre was mixed manually in motor and pestle with 15 gm of Glass Ionomer Cements (GIC)
Actino gel	37 wt% Phosphoric acid in water, thickeners and pigments	Prevest DenPro Limited India	Applied on enamel for 20s and then on dentin for 10s. Rinsed thoroughly for 10s and gently air-dried for 2s
G-Premio BOND One component light-cure adhesive	25-50% Acetone, 10 - 20% 2- hydroxyl-1-3-dimethacrylaxypropane, 5-10% MDDP, 4- META, 1-5% 2,2-ethylenedioxydiethyl Dimethacrylate, 0.5% 2,6 di-tetra butyl-p cresol	GC Dental Products Corp, Tokyo, Japan	Two consecutive coats is applied evenly with microbrush for 10s, light curing is done
Neo Spectra ST HV (Nano hybrid)	Methacrylate modified polysiloxane (organically modified ceramic) dimethacrylate resins, ethyl-4 (dimethylamino) benzoate, and bis iodonium hexafluorophosphate. Filler load: 78–80% by wt	Dentsply, Konstans, Germany	Placed in cavity in two increments and light cured. Finishing and polishing done

[Table/Fig-1]: Composition and application mode of the materials used in the study [6,10,14,15].

Group I: (n=20) samples were neither cavity prepared nor root canal treated and were named as control group.

Group II: (n=20) samples were restored with GIC (GC Gold Label Hybrid).

Group III: (n=20) samples were restored with experimental GIC + fibres (E-glass® fibres).

Group IV: (n=20) samples were restored with nanoceramic composite (Neo Spectra ST, Dentsply).

In groups II, III and IV, the samples underwent endodontic procedure followed by restorations.

Endodontic procedure: All the specimens were embedded in acrylic and the radicular teeth portion were lined with light body impression material to simulate Periodontal Ligament (PDL). Access cavity (4 mm×2 mm) preparations were done with Endoaccess bur, canal orifices were explored with DG-16 explorer and patency was established with #10K files. A 3% NaOCl solution was utilised for irrigation and canals were prepared as per manufacturer's recommendations [13], by using R-Motion reciprocating files (#30, 4% reciprocating files). After completely drying the root canals with paper points, gutta-percha was used for obturation via cold lateral condensation. The gutta-percha was sealed below the Cemento Enamel Junction (CEJ), and the obturation was then radiographically confirmed. The access cavities were then restored using the following restorative materials [11].

Group II: cavities were restored with GC Gold Label Hybrid and finishing of the restorations was done after six minutes from the start of cement mixing. GC Fuji varnish was applied as a final coat.

Group III: Discontinuous sialinised short glass fibres (E- glass® fibres, EFT, USA) with a diameter of 6 μm were cut by the manufacturer into a uniform length of 0.5 mm to create fibres with an aspect ratio of ~100 [14]. The cut fibres were added in 5 wt% (0.75 gm) to 15gm of powder before mixing with the liquid [6]. Weight adjustment was carried out with an electronic scale. Hand mixing is done by using mortar and pestle where 0.75 gm of fibre was combined with 15 gm of GC Gold Label Hybrid [Table/Fig-2] [15].

[Table/Fig-2]: E- glass® fibres.

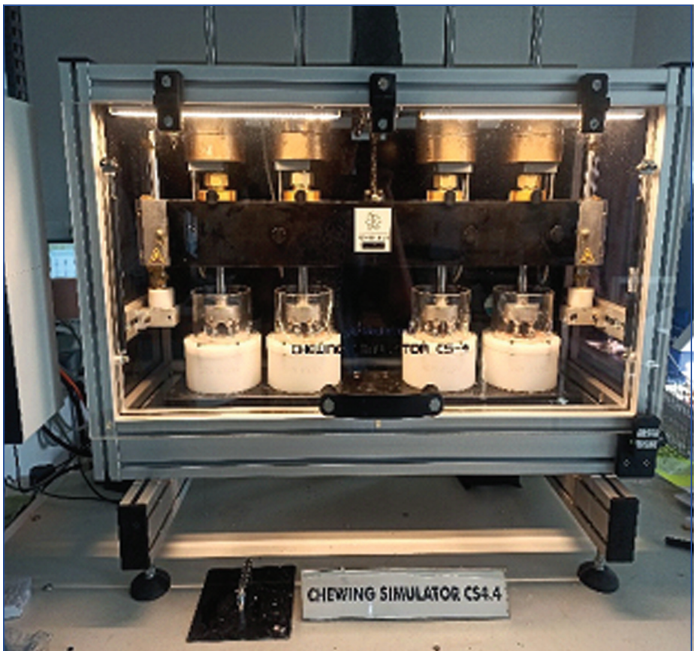
The manipulation of GICs without and with fibre was done according to the recommendations of manufacturer.

In the GC Gold Label HYBRID glass hybrid restoration without fibre (n=20) and with fibre (n=20), surface conditioning of samples was done before the placement of the restoration. All the flat dentinal surfaces were preconditioned with a GC cavity conditioner using a microbrush for 10 seconds. After that, the specimens were washed with distilled water and blot dried with sterile cotton pellet before receiving restoration [15].

Manipulation of the cement was done after dispensing A2 shade powder and liquid in a ratio of 3.0g/1.0g (1 scoop of powder to 1 drop of liquid) on the mixing pad. Using a plastic spatula, one scoop of powder was divided into two equal parts and the first portion was blended with one drop of liquid in accordance with the manufacturer's guidelines for 10 seconds. The remaining powder was incorporated and mixed for 15-25 seconds thoroughly. The application of this mixture was done on treated dentinal surface using a cement carrier and allowed to chemical cure for three to six minutes [15].

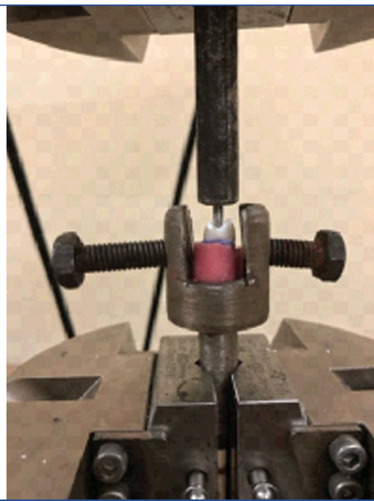
Group IV: Etching of the access cavities were done with 37% phosphoric acid etching gel (30 seconds for enamel and 15 seconds for dentin) followed by rinsing with water for 15 seconds. Cavities were then gently blow-dried. Bonding agent application was done with microapplicator tips and light cured for 20 seconds. Restoration was done using Neospectra ST with 2 mm increments up to the occlusal level and light cured as per the manufacturer's manual suggestion. As recommended by the manufacturer's guidelines, the restoration was completed using Neospectra ST in 2 mm increments up to the occlusal level and light-cured [10].

All the 80 teeth specimens were subjected to thermomechanical cyclic loading to simulate clinical scenario. A chewing simulator (Willytec chewing simulator (CS-4.4, SD Mechatronik, Westerham, Germany), with four separate chambers was opted [Table/Fig-3]. Each chamber has an individual bar upon which precise and desired quantity of weight can be placed. All the bars are interconnected by a transverse bar and are operated by a motor. The specimens are arranged such that the stylus makes slight contact. During dynamic loading, a steel antagonist of 4 mm diameter hits the sample at a speed of 20 mm/sec. Load of 50 N was applied to simulate typical chewing forces and accelerate the aging process. A 3D sensor was also present in the unit which verified the load and controlled different forces, thereby ensuring the accuracy and reliability of the experimental results. Each chamber's samples have been flooded with deionised water for 20,000 cycles at 5ºc for 105 seconds and 55ºc for 105 seconds alternatively with five seconds transit time. The test was performed at a frequency of 1.75 Hz with occlusal loading of 50 Newtons and continued for 240.000-250.000 cycles/year, to mimic the aging process [16].



[Table/Fig-3]: Willytec chewing simulator (CS-4.4).

After the thermomechanical cyclic loading the samples were subjected to fracture resistance, a holder slot that had previously been fitted on the lower arm of a universal testing machine was used to hold the prepared specimens. (Instron Electropuls E3000, Massachusetts, USA). A 0.5 mm metal indenter was attached to the machine's upper arm, which was used to apply increasing weights to the tooth's core until the restoration broke. At a crosshead speed of one mm/minute, the applied load was oriented vertically along the tooth's long axis. In Newton, the force that was observed to fracture each tooth was noted [Table/Fig-4] [17].



[Table/Fig-4]: Universal testing machine.

STATISTICAL ANALYSIS

For the statistical analysis, data were entered into an Excel sheet and Statistical Package for Social Sciences (SPSS) Statistics Windows 22.0 software (IBM, Armonk, NY) was used. One-way ANOVA was used for evaluating the specimens' mean fracture resistance, and Tukey's post-hoc analysis was used to compare groups. The confidence and significance levels were established at 95% and α=0.05, respectively.

RESULTS

The highest fracture resistance of 913.858 N(newtons) was noted for nanoceramic composite followed by fibre reinforced GIC i.e., 897.874 N(newtons). The lowest mean value was noted for GIC with a value of 701.034. So, the mean fracture resistance of groups in descending order: Control group > composite group > GIC with fibres > GIC [Table/Fig-5].

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	p-value	95% Confidence Interval	
					Lower Bound	Upper Bound
Control	GIC	301.26	48.24	0.0001*	174.54	427.98
	GIC + fibres	104.42	48.24	0.1430	-22.30	231.14
	Composite	88.44	48.24	0.2660	-38.28	215.16
GIC	GIC + fibres	-196.84	48.24	0.0010*	-323.56	-70.12
	Composite	-212.82	48.24	0.0001*	-339.54	-86.10
GIC + fibres	Composite	-15.98	48.24	0.9870	-142.71	110.74

[Table/Fig-5]: Mean fracture resistance in newtons(N) of the four groups.
Tukeys multiple posthoc procedures.*p<0.05

Pair wise mean fracture resistance comparison of four groups revealed statistically significant difference between the control group and the GIC group. GIC group showed significant difference with composite group and the GIC reinforced with fibres group (p<0.05) [Table/Fig-6].

Groups	Mean	Std. Dev.	Std. Err.	95% CI for mean	
				Lower	Upper
Control	1002.295	178.580	39.932	918.717	1085.873
GIC	701.034	138.667	31.007	636.136	765.932
GIC + fibres	897.874	150.285	33.605	827.538	968.209
Composite	913.858	139.231	31.133	848.696	979.020

[Table/Fig-6]: Pairwise comparisons of mean fracture resistance in newtons (N) between the groups.

DISCUSSION

The key finding of this study was that nanoceramic composite restorations demonstrated the highest fracture resistance among the three tested materials, followed closely by glass fibre-reinforced GIC, while conventional GIC showed the lowest resistance to fracture. These results underline the critical role that material selection plays in restoring endodontically treated maxillary premolars, which are especially prone to fracture due to their anatomical and biomechanical vulnerabilities [18-22].

Among the GIC groups, the fibre-reinforced formulation outperformed conventional GIC, highlighting the effectiveness of fibre reinforcement as a strategy to enhance the mechanical behaviour of restorative materials. The improvement in fracture resistance can be attributed to several factors [23]. First, the incorporation of short glass fibres into the GIC matrix increases its capacity to absorb and dissipate stress. These fibres act as microstructural bridges across developing cracks, thereby interrupting crack propagation and requiring more energy for fracture to occur [7,8]. Second, the fibre pull-out mechanism plays a pivotal role in energy dissipation. As cracks advance, fibres begin to pull out from the matrix, absorbing energy and slowing crack growth. This not only delays the fracture process but also alters the material's failure mode from brittle to more ductile. Furthermore, the use of silane coupling agents ensures effective bonding between the glass fibres and the GIC matrix, improving load transfer and structural cohesion during functional stress [24,25].

In contrast, conventional GIC lacks these reinforcement mechanisms, and its inherent brittleness and low tensile strength make it less capable of withstanding occlusal forces, especially in stress-bearing areas like the premolars [6]. While conventional GICs offer advantages such as chemical adhesion to tooth structure, fluoride release, and ease of use, their poor fracture resistance limits their application in posterior load-bearing restorations [13]. The results of this study reinforce the need for mechanical reinforcement strategies to make GICs more clinically viable in such scenarios.

When comparing the performance of fibre-reinforced GIC with the nanoceramic composite (Neo Spectra ST), it is notable that both materials exhibited fracture resistance values well above the physiological occlusal forces typically experienced by premolars, which range between 200-300 N [24]. The nanoceramic composite demonstrated superior resistance (913.86 N), which can be attributed to its advanced filler technology, particularly the SphereTEC technology used in Neo Spectra ST [10]. This system utilises granulated spherical fillers that enhance matrix homogeneity, packing density, and energy dissipation, thereby increasing the material's ability to resist functional and parafunctional stress. Additionally, composites benefit from their high flexural strength, modulus of elasticity closer to dentin, and excellent bonding to tooth structure when placed using adhesive techniques. These properties help them better mimic the biomechanical behaviour of natural teeth and provide durable support to weakened cusps [11].

Despite its slightly lower fracture resistance, the fibre-reinforced GIC group (897.87 N) performed comparably to the composite group. This is a significant observation, as GICs offer benefits that composites do not, including fluoride release, chemical bonding without the need for etching or bonding agents, and better biocompatibility in certain clinical contexts [6]. Therefore, in situations where moisture control is compromised or fluoride release is desirable, fibre-reinforced GIC may be a more suitable alternative to composite materials.

The results of this study align with and are supported by several findings in the literature. For instance, Kobayashi M et al., investigated the effect of incorporating 40-60% by volume of reactive glass fibres into GIC and observed significant improvements in fracture strength and material toughness [7]. The authors attributed these enhancements to the interaction of short fibres with the GIC matrix and their effectiveness in bridging microcracks. Similarly, Garoushi S et al., evaluated fibre-reinforced GICs containing discontinuous hollow and solid fibres and reported a direct relationship between fibre content and mechanical performance, supporting the notion that fibre reinforcement is a viable method to overcome GIC's mechanical limitations [9].

In another study, Lucksanasombool P et al., documented a 370% increase in work-of-fracture when 30 wt% of fibres were incorporated into conventional GIC [8]. The study highlighted the importance of the fibre pull-out mechanism as the principal energy-absorbing process responsible for the observed improvement. This phenomenon aligns with the current findings and emphasises that fibre length, orientation, and adhesion to the matrix are critical factors influencing fracture resistance.

When comparing these outcomes with the performance of composite restorations, several studies confirm the superior mechanical behaviour of nanohybrid and nanoceramic composites. For instance, Burke FJ and Watts DC demonstrated that composites with optimised filler distribution and high matrix integrity showed enhanced resistance to fracture under vertical loads, closely mimicking clinical masticatory conditions [23]. Similarly, Ellis SG et al., reported that endodontically treated teeth restored with composite resins exhibited fracture resistance comparable to that of intact teeth, provided the adhesive technique and cusp coverage were appropriately executed [19].

Overall, the findings of this study are consistent with the broader body of literature, [7,8,14,25,26] reinforcing the clinical relevance of selecting appropriate restorative materials for endodontically treated posterior teeth. While nanoceramic composites remain the gold standard for high-load applications, the performance of fibre-reinforced GICs approaches that of composites, offering a promising alternative in specific clinical scenarios where composites may not be ideal.

Despite these advantages, there is a scarcity of research on the behaviour of discontinuous glass fibres in currently marketed GIC formulations [26]. More extensive studies, particularly long-term clinical evaluations, are essential to fully validate the potential and durability of fibre-reinforced GICs in routine dental practice.

Limitation(s)

In-vitro studies have certain limitation of simulating biological aspects of intraoral conditions. Inter-relationship of numerous factors affects the wear resistance which was not assessed in this study. The preparation of teeth and packing of GIC was performed under good isolation and access unlike clinical case scenario.

CONCLUSION(S)

Considering the limitations of this study, this study concludes that GIC with fibre reinforcement showed increased fracture resistance similar to that of nanoceramic composite. Hence, GIC with fibre reinforcement can be used as a core build-up material. More in-vivo clinical studies are essential to establish evidence pertaining to discontinuous short fibre incorporation and the restoration longevity.

REFERENCES

[1] Cheung W. A review of the management of endodontically treated teeth: Post, core and the final restoration. J Am Dent Assoc. 2005;136(5):611-19.
[2] Sengun A, Cobankara FK, Orucoglu H. Effect of a new restoration technique on fracture resistance of endodontically treated teeth. Dent Traumatol. 2008;24(2):214-19.
[3] Do TT, La PK, Le LN, Le KPV. Direct restoration of endodontically treated premolar by glass fiber post and fiber-reinforced composite. J Int Dent Med Res. 2023;16(2):455-61.
[4] Nagasiri R, Chitmongkolsuk S. Long-term survival of endodontically treated molars without crown coverage: A retrospective cohort study. J Prosthet Dent. 2005;93(2):164-70.
[5] Morgano SM, Brackett SE. Foundation restorations in fixed prosthodontics: Current knowledge and future needs. J Prosthet Dent. 1999;82(6):643-57.
[6] Garoushi S, Vallittu P, Lassila L. Hollow glass fibers in reinforcing glass ionomer cements. Dent Mater J. 2017;33(2):e86-e93.

[7] Kobayashi M, Kon M, Miyai K, Asaoka K. Strengthening of glass– ionomer cement by compounding short fibers with CaO-P2O5-SiO2-Al2O3 glass. Biomaterials. 2000;21(4):2051-58.

[8] Lucksanasombool P, Higgs WA, Higgs RJ, Swain MV. Toughness of glass fibres reinforced glass-ionomer cements. J Mater Sci. 2002;37:101-08.

[9] Garoushi S, Vallittu PK, Lassila L. Reinforcing effect of discontinuous microglass fibers on resin-modified glass ionomer cement. Dent Mater. 2018;37(3):484-92.

[10] Gurgan S, Koc Vural U, Miletic I. Comparison of mechanical and optical properties of a newly marketed universal composite resin with contemporary universal composite resins: An in-vitro study. Microscopy Research and Technique. 2022;85(3):1171-79.

[11] Taha NA, Palamara JE, Messer HH. Fracture strength and fracture patterns of root-filled teeth restored with direct resin composite restorations under static and fatigue loading. Oper Dent. 2014;39(2):181-88.

[12] Goteti SV, Anwarullah A, Mandava J, Kantheti S, Pulidindi H, Chandolu V. Evaluation of microtensile bond strength and marginal adaptation of fiber-reinforced composites. J Conserv Dent Endod. 2024;27(11):1120-25.

[13] Hamdy TM. Effect of E-glass fibers addition on compressive strength, flexural strength, hardness, and solubility of glass ionomer based cement. BMC Oral Health. 2024;24:739. Doi: 10.1186/s12903-024-04447-8.

[14] Tanaka CB, Ershad F, Ellakwa A, Kruzic JJ. Fiber reinforcement of a resin modified glass ionomer cement. Dent Mater. 2020;36(12):1516-23.

[15] GC Gold Label Glass Hybrid [package insert on the Internet]. GC Corp.[2021] Available from URL: https://www.gcindiadental.com/wp-contentuploads/brochures/GC_Gold_Hybrid_Brochure.pdf.

[16] Güleç C, Sarıkaya I. The influence of aging on the fracture load of milled monolithic crowns. BMC Oral Health. 2022;22(1):516. Doi: 10.1186/s12903-022-02529-z.

[17] Hshad ME, Dalkılıç EE, Ozturk GC, Dogruer I, Koray F. Influence of different restoration techniques on fracture resistance of root-filled teeth: In-vitro investigation. Oper Dent. 2018;43(2):162-69.

[18] Tabassum S, Khan FR. Failure of endodontic treatment: The usual suspects. Eur J Dent. 2016;10(1):144-47.

[19] Ellis SG, McCord JF, Burke FJ. Predisposing and contributing factors for complete and incomplete tooth fractures. Dent Update. 1999;26(4):150-52.

[20] Larson TD, Douglas WH, Geistfeld RE. Effect of prepared cavities on the strength of teeth. Oper Dent. 1981;6(1):02-05.

[21] Mincik J, Urban D, Timkova S, Urban R. Fracture resistance of endodontically treated maxillary premolars restored by various direct filling materials: An in-vitro study. Int J Biomater. 2016;2016:9138945.

[22] Tamse A, Zilburg I, Halpern J. Vertical root fractures in adjacent maxillary premolars: An endodontic-prosthetic perplexity. Int Endod J. 1998;31(2):127-32.

[23] Burke FJ, Watts DC. Fracture resistance of teeth restored with dentin-bonded crowns. Quintessence Int. 1994;25(5):335-40.

[24] Liu X, Li H, Li J, Lu P, Fok ASL. An acoustic emission study on interfacial debonding in composite restorations. Dent Mater. 2011;27(9):934-41.

[25] Salehi G, Behnamghader A, Pazouki M, Houshmand B, Mozafari M. Synergistic reinforcement of glass-ionomer dental cements with silanized glass fibres. Mater Tech. 2020;35(7):433-45.

[26] Khan AA, Siddiqui AZ, Syed J, El Sharahy M, Alghamdi AM, Matinlinna JP. Effect of short E-glass fiber reinforcement on surface and mechanical properties of glass-ionomer cements. J Molecular & Eng Mater. 2017;5(4):1740007.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: May 27, 2025
- Manual Googling: Jul 12, 2025
- iThenticate Software: Jul 15, 2025 (9%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? No
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **May 22, 2025**
Date of Peer Review: **Jun 12, 2025**
Date of Acceptance: **Jul 17, 2025**
Date of Publishing: **Sep 01, 2025**