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Fracture resistance and failure modes of endodontically-treated permanent teeth restored with Ribbond posts vs other post systems: a systematic review and meta-analysis of *in vitro* studies

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ABSTRACT

Objectives: This systematic review aimed to investigate the fracture resistance and mode of failure of endodontically-treated permanent teeth restored with Ribbond posts (Ribbond, Inc.) compared with endodontically-treated permanent teeth restored with other post systems.

Methods: A comprehensive, systematic literature search was carried out using several electronic databases: MEDLINE/PubMed, Google Scholar, and Cochrane Library. Two separate researchers were appointed to identify the studies meeting the eligibility criteria, and to perform the data extraction, risk of bias, and quality assessment.

Results: Twelve studies were included in the quantitative analysis. Meta-analysis was performed with 11 of the 12 included articles. The meta-analysis showed that Ribbond posts have a fracture strength less than prefabricated metal posts, cast metal posts, and prefabricated fiber posts and greater than custom e-glass fiber posts. Mode of failure analysis revealed that Ribbond posts have the most favorable non-catastrophic fractures.

Conclusions: Although Ribbond posts have lower fracture resistance, their favorable mode of failure makes them potentially the most biomimetic post system.

Keywords: Fracture strength; Post and core technique; Ribbond; Systematic review

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INTRODUCTION

Restoration of endodontically-treated teeth presents a persistent clinical challenge as they are frequently structurally compromised due to a variety of reasons, including caries, restorations, and endodontic access interventions [1]. The loss of tooth structure involving one or both marginal ridges or the loss of a facial/lingual wall of the tooth significantly increases the risk of fracture [2]. Root-filled teeth show a greater association with fractures as compared to vital teeth [3].

Determining the optimal type of post-endodontic restoration is influenced by the type of teeth and their position in the arch, forces of occlusion, and the remaining coronal tissue structure [4]. The quantity of the remaining tooth structure comprises the ferrule, which is defined as "a 360° collar of the crown that surrounds the parallel walls of the dentin and extends coronally to the shoulder of the preparation" [5]. An abundance of literature demonstrates increased fracture resistance of endodontically-treated teeth in the presence of at least 1 mm of ferrule height [5–7]. When the coronal structural loss is greater than 50%, the literature suggests the placement of an intraradicular post to reinforce structurally compromised teeth, increase their fracture resistance, and support the final crown restoration [8]. Posts do not directly increase the strength of endodontically-treated teeth but rather they facilitate the core retention [9,10].

Cast posts and cores have conventionally been employed to reinforce pulpless teeth. Metal posts have excellent rigidity and the ability to withstand loads without undergoing deformation. They are resilient to axial stresses whose intensity is along the post's axis. However, they have poor stress distribution ability, and they exhibit a concentration of forces at the root apex [11,12] since they possess a high modulus of elasticity, much different from that of dentin. This also holds true for other post and core systems with a high modulus of elasticity, such as prefabricated zirconium or prefabricated metal posts. Employing posts with an elastic modulus closer to that of dentin reduces the chances of catastrophic radicular fractures [13]. Other than biological concerns, metal posts also present aesthetic problems, especially in anterior teeth.

This led to a shift in the trend from using more rigid posts to using prefabricated fiber posts which had greater elasticity and better esthetics [14]. Their lower elastic modulus leads to a uniform distribution of stresses along the post-dentin interface, thus avoiding critical stress concentration and catastrophic fractures of the root [15–18]. Prefabricated fiber posts are cemented with a dual cure luting agent. The thickness of the resin cement used affects the strength of the restoration at the post-dentin interface [19], thus suggesting the need for dowels that adapt to the canal anatomy and have a good intracanal fit.

Recently, custom-made fiber post and core systems that employ polyethylene fibers (Ribbond fibers; Ribbond, Inc., Seattle, WA, USA) [20] have been introduced. Ribbond is an ultra-thin, leno-weaved, high molecular weight, reinforcement ribbon with excellent bondability and fracture toughness. Ribbond fibers are embedded in resin composite which are then condensed within the canal in the form of an endodontic post [21]. Ribbond posts are said to be biologic posts with improved esthetics and translucency, and relative ease of manipulation. They can also be placed in a single visit without the need for a laboratory phase [22].

Literature regarding the behavior and performance of Ribbond post and core systems in terms of their retentive ability, fracture strength, and fracture repairability as compared to that of conventional post and core systems needs further evaluation. Thus, this systematic review was undertaken to analyze the outcome of *in vitro* studies comparing the fracture resistance and mode of failure of Ribbond post and core systems with that of other post and core systems.

METHODS

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol for systematic reviews and meta-analyses was undertaken and was registered on PROSPERO (CRD42023472726). Using the PICOS (Population; Intervention; Comparison; Outcome; Study Design) framework, a review question was composed as follows: "Does the use of a Ribbond post and core system influence the fracture resistance and failure modes of endodontically-treated permanent teeth as

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compared to those of other post and core systems?"

Search strategy

A comprehensive, systematic literature search was carried out using several electronic databases: MEDLINE/PubMed, Google Scholar, and Cochrane Library. The following keywords or terms were employed and adjusted according to each database: ((Ribbond) OR (fiber reinforced composite) OR (polyethylene fiber)) AND ((Post) OR (Dowel) OR (endodontically-treated teeth) OR (post-core technique) OR (post and cores) OR (endodontic post)) AND ((fracture resistance) OR (fracture strength)).

Eligibility criteria

The studies were selected based on the following inclusion and exclusion criteria.

1. Inclusion criteria

- Studies published from 1990 to 2022 in peer-reviewed journals
- Studies published in the English language
- *In vitro* comparative studies between Ribbond post and core systems and other post and core systems
- Studies included endodontically-treated permanent teeth, restored with different types of post and core systems

2. Exclusion criteria

- *In vivo* and *ex vivo* studies, animal studies, reviews, case reports, case series
- Studies that did not include Ribbond post and the core group
- Studies that included indirect restorations

Screening and selection of studies

All the results obtained underwent title screening and abstract screening based on the eligibility criteria. After the elimination of duplicates, full-text articles were retrieved if screening data was inconclusive. Two researchers who were blinded to each other were appointed to identify the studies meeting the eligibility criteria. A third reviewer was appointed to eliminate any disagreements during the selection of studies between the two authors.

Data extraction and synthesis

For all the selected studies, the following information was reported: authors, year, type of teeth, post type, study groups, remaining tooth structure, evaluated outcomes, mean fracture strength, mode of failure, luting agent used, thermocycling, fracture testing equipment used, statistical analysis software used, and statistical tests performed. Studies with homogeneous study populations were subjected to meta-analyses using a fixed-effect model. Only if the heterogeneity was substantial (>50%) then a random-effect model was employed.

Assessment of heterogeneity

Assessment of heterogeneity was performed using the Review Manager (RevMan) software (Cochrane Collaboration, London, UK) [23]. The results were presented as the standardized mean difference (SMD) with a 95% confidence interval (CI). Heterogeneity was considered statistically significant if $p < 0.05$. The Cochran Q test and the I^2 inconsistency tests were also performed to assess the heterogeneity of the treatment effects. A general guide to interpreting the I^2 test is as follows [24]: 0% to 40%, heterogeneity might not be important; 30% to 60%, may represent moderate heterogeneity; 50% to 90%, may represent substantial heterogeneity; 75% to 100%, may represent considerable heterogeneity.

Quality assessment

For risk of bias analysis, two separate reviewers were appointed to analyze each individual study. The domains used for the quality assessment were based on the reporting of items as per the modified CONSORT (Consolidated Standards of Reporting Trials) statement for *in vitro* studies [25] which were: teeth size and form standardization, teeth free of caries or restorations, sample size calculation, randomization of specimens, implementation of sequence generation, outcome, statistical methods, standardized teeth preparation, standardized and replicable methodology, material application measures followed, blinded evaluation, complete results, and funding. When a study described a domain, it was allotted 'yes' and if it failed to describe a domain 'no information' was allotted. If 10 to 13 domains were described, the study was determined to have a low risk of bias. If seven to nine domains were described, the study was determined to have some concerns or a moderate risk of bias. If less than seven domains were described, a high risk of bias was reported.

Investigation of publication bias

The presence of publication bias was assessed visually by the relative symmetry of individual studies around the overall estimates using Begg's funnel plot. The funnel plots were drawn of effect size versus standard error for each subgroup analysis. Asymmetry of the funnel plots may imply publication bias.

RESULTS

Search strategy and characteristics of the studies

A total of 597 records were obtained from searching electronic databases. After the removal of duplicates, a total of 407 records remained which were then subjected to title screening and abstract reading. A total of 389 records were excluded, and 18 articles underwent full-text evaluation. Of those, 12 articles met the eligibility criteria and were included in the present systematic review and underwent quality assessment and data extraction. Meta-analysis was performed with 11 of the 12 studies included. The search strategy and process of study selection are reported in Figure 1 along with the reasons for exclusion.

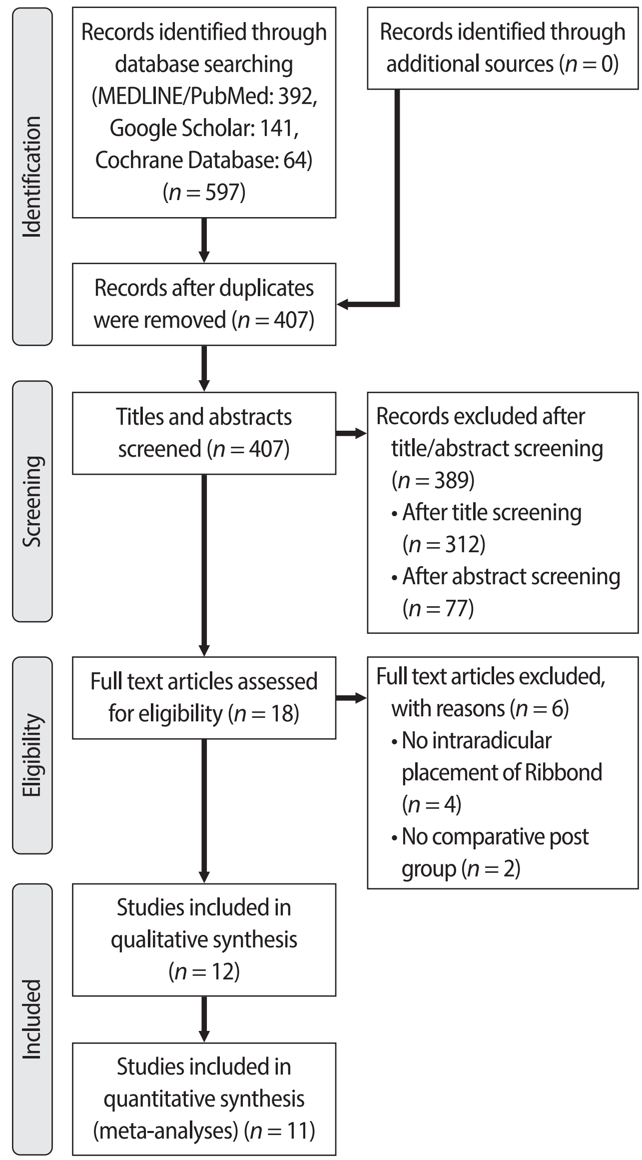

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart showing search strategy and selection of studies.

Characteristics of included studies

The chief characteristics of the 12 studies included are presented in Table 1. In comparison to Ribbond posts, all 12 studies tested prefabricated glass fiber posts [18,26–36], four studies tested custom glass fiber (EverStick; GC Europe N.V., Leuven, Belgium) posts [28,29,31,32], two studies tested cast metal posts [33,35], four studies tested prefabricated metal posts [18,31–33], and one study also tested zirconia and quartz post [27]. Nine of the 12 studies also assessed the fracture patterns in which three studies tested reattached fragment samples [29,32,36] whereas the other five studies tested a composite resin core build-up [26,30,31,33,35]. Amongst the three reattached fragment studies, two studies described the fracture patterns as repairable/nonrepairable [32,36] while the third study described it as a fracture at the original site/fracture at new sites [29]. One study did not provide an adequate description of the fracture patterns [18]. Amongst the five composite resin core studies, two studies described the fracture pattern based on restorability as favorable/unfavorable [31] or repairable/nonrepairable [35], while the other three studies described the fracture pattern based on fracture line propagation along the root [26,30,33]. Some additional characteristics are also mentioned in Table 2.

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Table 1. Main characteristics extracted from selected studies

Study (year)	Type of teeth	Post type	Study group	Remaining structure	Evaluated outcome	Mean Fracture strength	Mode of failure (catastrophic)
Sirimai *et al.* (1999) [33]	Maxillary central incisors (N = 60, n = 10)	· Cast metal post · Prefabricated metal post · Polyethylene fiber post	· Group 1: CPC · Group 2: VPT · Group 3: PWFH · Group 4: PWFH-VPT · Group 5: PWFH-PP · Group 6: PP	Decoronated at the level of the most incisal point of the CEJ	Fracture resistance and mode of failure	· Group 1 (CPC): 288.61 ± 51.74 N · Group 2 (VPT): 254.70 ± 55.66 N · Group 3 (PWFH): 127.01 ± 26.85 N · Group 4 (PWFH-VPT): 218.34 ± 20.48 N · Group 5 (PWFH-PP): 233.63 ± 42.92 N · Group 6 (PP): 201.39 ± 29.1 N	· Group 1: 100% · Group 2: 60% · Group 3: 10% · Group 4: 40% · Group 5: 20% · Group 6: 80%
Newman *et al.* (2003) [18]	Maxillary central incisors (N = 90, n = 10)	· Prefabricated glass fiber post · Prefabricated metal post · Polyethylene fiber post	Control: · 1,4: Parapost XH 1.5 mm Narrow canals: · 1,1: Fiberkor fiber post 1.5 mm · 1,2: Luscent fiber post 1.6 mm · 1,3: Ribbond 1.6 mm · 1,5: Ribbond nonstandardized 2 mm Flared canals: · 2,1: Fiberkor fiber post 1.5 mm · 2,2: Luscent fiber post 1.6 mm · 2,3: Ribbond 1.6 mm · 2,5: Ribbond nonstandardized 2 mm	Decoronated 2 mm incisal to the CEJ of the buccal surfaces	Fracture resistance and mode of failure	· 1,4: 18.33 ± 3.27 kg · 1,1: 9.79 ± 1.29 kg · 1,2: 12.90 ± 1.64 kg · 1,3: 4.55 ± 1.49 kg · 1,5: 24.91 ± 11.53 kg · 2,1: 9.04 ± 1.76 kg · 2,2: 12.87 ± 2.69 kg · 2,3: 12.87 ± 3.54 kg · 2,5: 31.95 ± 11.98 kg	· 1,4: 30% · 1,1: 0% · 1,2: 0% · 1,3: 0% · 1,5: 0% · 2,1: 0% · 2,2: 0% · 2,3: 0% · 2,5: 0%

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Table 1. Continued

Study (year)	Type of teeth	Post type	Study group	Remaining structure	Evaluated outcome	Mean Fracture strength	Mode of failure (catastrophic)
Ozcan and Valandro (2009) [31]	Maxillary canines (N = 70, n = 10)	· Prefabricated metal post · E-glass fiber post · Polyethylene fiber post	· Group 1: Titanium posts (ParaPost) + Silano-Pen (Bredent) + silane · Group 2: Titanium posts + 30 µm CoJet-Sand (3M ESPE) + silane · Group 3: Titanium posts + 50 µm Al_2O_3 + V-primer (Sun Medical) · Group 4: Titanium posts + 50 µm Al_2O_3 + Alloy primer (Kuraray) · Group 5: E-glass FRC post (EverStick) · Group 6: Polyethylene fiber (Ribbond) + resin impregnation · Group 7: Resin composite core only, with no posts	2 mm above the buccal CEJ	Fracture resistance and mode of failure	· Group 1: 521 ± 153 N · Group 2: 525 ± 91 N · Group 3: 550 ± 149 N · Group 4: 408 ± 122 N · Group 5: 321 ± 131 N · Group 6: 267 ± 108 N · Group 7: 175 ± 70 N	No catastrophic fractures for any group
Ozcopur *et al.* (2010) [32]	Single rooted teeth (N = 80, n = 10)	· Prefabricated metal post · Prefabricated glass fiber post · E-glass fiber post · Polyethylene fiber post	Sound roots: control · Unicore · EverStick · Ribbond · Parapost Reattached fragments · Unicore · EverStick · Ribbond · Parapost	Decoronated keeping a root length of 12 mm	Fracture resistance and mode of failure	Sound roots: control · Unicore: 1,472.78 ± 195.29 N · EverStick: 1,265.94 ± 81.46 N · Ribbond: 976.74 ± 103.7 N · Parapost: 1,342.29 ± 370.13 N Reattached fragments · Unicore: 1070.77 ± 178.42 N · EverStick: 1042.23 ± 147.06 N · Ribbond: 995.32 ± 88.75 N · Parapost: 1318.3 ± 240.9 N	Sound roots: control · Unicore: 80% · EverstickEverStick: 40% · Ribbond: 0% · Parapost: 60% Reattached fragments · Unicore: 58% · EverstickEverStick: 47% · Ribbond: 25% · Parapost: 68%

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Table 1. Continued

Study (year)	Type of teeth	Post type	Study group	Remaining structure	Evaluated outcome	Mean Fracture strength	Mode of failure (catastrophic)
Aggarwal *et al.* (2012) [35]	Uni-radicular mandibular premolar teeth (N = 50, n = 10)	· Cast metal post · Prefabricated glass fiber post · Polyethylene fiber post	· Group I/CD: cast dowel · Group II/FD: single glass fiber dowel · Group III/AFD: glass fiber-reinforced resin dowel with accessory fiber dowels · Group IV/DL: relined glass fiber-reinforced resin dowel · Group V/RRR: dowels formed with the help of polyethylene fiber ribbon-reinforced resin composite	Decoronated	Fracture resistance and mode of failure	· Group I/CD: 484 ± 41 N · Group II/FD: 338 ± 28 N · Group III/AFD: 352 ± 34 N · Group IV/DL: 368 ± 24 N · Group V/RRR: 256 ± 22 N	· Group I/CD: 90% · Group II/FD: 20% · Group III/AFD: 30% · Group IV/DL: 30% · Group V/RRR: 0%
Jindal *et al.* (2012) [30]	Maxillary incisors (N = 75, n = 15)	· Prefabricated glass fiber post · Polyethylene fiber post	Control group Glass fiber post · 10 mm · 5 mm Ribbond fiber post · 10 mm · 5 mm	Decoronated 2 mm above CEJ	Fracture resistance and mode of failure	Control: 437.87 ± 32.81 N Glass fiber post · 10 mm: 740.21 ± 29.87 N · 5 mm: 425.18 ± 42.73 N Ribbond fiber post · 10 mm: 216.93 ± 53.39 N · 5 mm: 299.62 ± 53.42 N	Glass fiber post · 10 mm: 0% · 5 mm: 30% Ribbond fiber post · 10 mm: 40% · 5 mm: 30%
Kumar *et al.* (2013) [29]	Mandibular premolars (N = 60, n = 15)	· E-glass fiber post · Polyethylene fiber post	· Group 1: Only dual cure resin cement · Group 2: Ribbond · Group 3: EverStick (vertical fractures simulated in all three groups) · Group 4: Unfractured control group	Decoronated root length: 10 mm	Fracture resistance and mode of failure	· Group 1: 181.26 ± 2.90 N · Group 2: 279.56 ± 0.80 N · Group 3: 224.09 ± 3.43 N · Group 4: 328.14 ± 1.06 N	· Group 1: 73% · Group 2: 0% · Group 3: 60%

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Table 1. Continued

Study (year)	Type of teeth	Post type	Study group	Remaining structure	Evaluated outcome	Mean Fracture strength	Mode of failure (catastrophic)
Braga *et al.* (2015) [26]	Maxillary premolars (N = 100, n = 10)	· Prefabricated glass fiber post · Prefabricated polyfiber post · Polyethylene fiber post	· Group 1: sound teeth (positive control) · Group 2: unrestored (negative control) · Group 3:MR · Group 4:FR+ MR · Group 5: glass fiber post (Reforpost) + MR · Group 6: Reforpost + FR + MR · Group 7:polyethylene fiber (Ribbond) + MR · Group 8: Ribbond + FR + MR · Group 9: polyfiber post (Spirapost) + MR · Group 10: Spirapost + FR + MR	Class II MOD cavities,1m above CEJ on both sides, with palatal extension cusps reduced to dimension 3 mm thick and 3.5 mm in height	Fracture resistance and mode of failure	· Group 1: 0.83 ± 0.15 N · Group 2: 0.14 ± 0.05 N · Group 3: 0.43 ± 0.09 N · Group 4: 0.53 ± 0.07 N · Group 5: 0.41 ± 0.12 N · Group 6: 0.48 ± 0.13 N · Group 7: 0.50 ± 0.17 N · Group 8: 0.54 ± 0.14 N · Group 9: 0.79 ± 0.16 N · Group 10: 0.84 ± 0.11 N	· Group 1: 0% · Group 2: 50% · Group 3: 50% · Group 4: 40% · Group 5: 0% · Group 6: 10% · Group 7: 50% · Group 8: 10% · Group 9: 30% · Group 10: 20%
Ramesh *et al.* (2016) [36]	Reattached maxillary central incisor fragments (N = 60, n = 30)	· Prefabricated glass fiber post · Polyethylene fiber post	Group 1: labiopalatal fracture · Subgroup 1: prefabricated fiber post · Subgroup 2: Ribbond post Group 2: palatolabial fracture · Subgroup 1: prefabricated fiber post · Subgroup 2: Ribbond post	Group 1: 2 mm palatally, 6 mm labially Group 2: 6 mm palatally, 2 mm labially	Fracture resistance and mode of failure	Group 1: · Subgroup 1: 568.4 ± 18.65 N · Subgroup 2: 519.7 ± 22.36 N Group 2: · Subgroup 1: 533.4 ± 19.62 N · Subgroup 2: 488.1 ± 34.41 N · Subgroup 2: 488.1 ± 34.41 N	Group 1: · Subgroup 1: 20% · Subgroup 2: 0% Group 2: · Subgroup 1: 13.3% · Subgroup 2: 0%

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Table 1. Continued

Study (year)	Type of teeth	Post type	Study group	Remaining structure	Evaluated outcome	Mean Fracture strength	Mode of failure (catastrophic)
Thakur and Ramarao (2019) [34]	Mandibular first premolars (N = 90, n = 10)	· E-glass fiber post · Polyethylene fiber post	Post length 2/3rd of the canal: · Subgroup 1A: custom polyethylene post · Subgroup 1B: custom glass fiber post · Subgroup 1C: prefabricated polyethylene post · Subgroup 1D: prefabricated glass fiber post Post length 1/2 of the canal: · Subgroup 2A: custom polyethylene post · Subgroup 2B: custom glass fiber post · Subgroup 2C: prefabricated polyethylene post · Subgroup 2D: prefabricated glass fiber post Control group: core without post	Decoronated at CEJ, root length 15 mm	Fracture resistance	· Subgroup 1A: 179.75 ± 33.52 N · Subgroup 1B: 166.84 ± 33.11 N · Subgroup 1C: 250.33 ± 15.40 N · Subgroup 1D: 201.39 ± 41.44 · Subgroup 2A: 146.44 ± 13.53 N · Subgroup 2B: 159.97 ± 34.06 N · Subgroup 2C: 224.2 ± 32.9 N · Subgroup 2D: 204.07 ± 29.63 N Control group: 57.34 ± 14.03 N	Not applicable
Khurana *et al*. (2021) [28]	Maxillary incisors (N = 60, n = 15)	· E-glass fiber post · Polyethylene fiber post	Group A: labiopalatal fracture · A1: Ribbond · A2: EverStick Group B: palatolabial fracture · B1: Ribbond · B2: EverStick	Labiopalatal: 2 mm palatally, 6 mm labially Palatolabial: 6 mm palatally, 2 mm labially	Fracture resistance	Group A: · A1: 517.4 ± 72.0 N · A2: 725.5 ± 59.6 N Group B: · B1: 423.2 ± 80.5 N · B2: 617.0 ± 81.8 N	Not applicable
Batra *et al*. (2022) [27]	Mandibularfirst premolars (N = 48, n = 12)	· Zirconia post · Prefabricated glass fiber post · Polyethylene fiber post · Quartz post	· Group I: Zirconia post, · Group II: Glass fiber post, · Group III: polyethylene -woven fiber posts, · Group IV: Quartz post	Not mentioned	Fracture resistance	· Group I: 463.5 ± 14.3 N · Group II: 425.2 ± 23.5 N · Group III: 410.4 ± 18.6 N · Group IV: 385.2 ± 14.2 N	Not applicable

The '*N*' and '*n*' in the "Type of teeth" column represent 'the population size of the study' and 'the sample size per group,' respectively.
CEJ, cementoenamel junction; CPC, cast post and core; FR, flowable resin; MOD, mesio-occluso-distal; MR, microhybrid resin; PP, Parapost Plus post; PWFH, polyethylene woven fiber/Heliobond resin; VPT, vario-passive titanium post.

Table 2. Additional characteristics extracted from selected studies

Study (year)	Material used to form custom polyethylene fiber posts	Luting cement used	Thermocycling	Fracture testing equipment	Statistical analysis software	Statistical tests performed
Sirimai *et al.* (1999) [33]	Variolink, Ivoclar	· Group 1 and 2: Zinc phosphate cement · Group 3, 4, 5 and 6: Variolink, Ivoclar	Not performed	Instron Universal Testing Machine 4202	SAS program	· One-way ANOVA · Student Newman-Keuls grouping · 2 × 2 chi-square analysis
Newman *et al.* (2003) [18]	Flow-it, Pentron Clinical Technologies	· 1,1; 1,2; 1,4: Cement-it, Pentron Clinical Technologies · 2,1; 2,2: Flow-it Self, Pentron Clinical Technologies · 1,3; 1,5; 2,3; 2,5: Flow-it, Pentron Clinical Technologies	Not performed	Instron Universal Testing Machine 5655	SYSTAT	· Two-way ANOVA · ANOVA test · Independent Student t-test · Tukey test
Ozcan and Valandro (2009) [31]	Panavia F 2.0, Kuraray	Panavia F 2.0, Kuraray	Subjected to thermocycling for 6,000 cycles between 5° and 55°C	Zwick ROELL Z2. 5MA Universal Testing Machine	SAS program	· One-way ANOVA · Tukey test
Ozcopur *et al.* (2010) [32]	Variolink II, Ivoclar	Variolink II, Ivoclar	Not performed	Instron Universal Testing Machine	Not mentioned	· One-way ANOVA · Independent t-test
Aggarwal *et al.* (2012) [35]	RelyX ARC, 3M ESPE	· Group I/CD: Zinc phosphate, SS White · Group II/FD: RelyX ARC, 3M ESPE · Group III/AFD: RelyX ARC, 3M ESPE · Group IV/DL: Filtek Z350, 3M ESPE · Group V/RRR: RelyX ARC, 3M ESPE	Not performed	Zwick Instron Universal Testing Machine	Not mentioned	· One-way ANOVA · Fischer exact test
Jindal *et al.* (2012) [30]	Monocem, Shofu	Monocem, Shofu	Not performed	LR 100 K digital Instron Universal Testing Machine	SPSS version 11.0	· One-way ANOVA and *post hoc* test
Kumar *et al.* (2013) [29]	RelyX U100, 3M ESPE	RelyX U100, 3M ESPE	Not performed	Universal Testing Machine	Not mentioned	· One-way ANOVA · Tukey *post hoc* test · Kruskall-Wallis and Mann-Whitney test
Braga *et al.* (2015) [26]	RelyX ARC, 3M ESPE	RelyX ARC, 3M ESPE	Not performed	Instron Universal Testing Machine 4444	SPSS version 17	· Kolmogorov-Smirnov test · One-way ANOVA · Tukey *post hoc* test
Ramesh *et al.* (2016) [36]	ParaCore, Coltene	ParaCore, Coltene	Not performed	Instron Universal Testing Machine	Excel and SPSS	· Student t-test · Chi-square test
Thakur and Ramarao (2019) [34]	Luxa core Z, DMG	Luxa core Z, DMG	Not performed	Hounsfield Universal Testing Machine, S-series	Not mentioned	· One-way and two-way ANOVA · Bonferroni adjustment test
Khurana *et al.* (2021) [28]	Solocem, Coltene	Solocem, Coltene	Not performed	Instron Universal Testing Machine	SPSS version 23	· One-way ANOVA and *post hoc* test
Batra *et al.* (2022) [27]	Panavia F 2.0, Kuraray	Panavia F 2.0, Kuraray	Not performed	Universal Testing Machine	SPSS	· One-way ANOVA · Bonferroni *post hoc* test

ANOVA, analysis of variance.

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Risk of bias of included studies

The risk of bias in the included studies is presented in Table 3, along with the overall risk of bias presented in Figure 2. All the included studies were largely comparable in methodological quality. All the included studies had a low risk of bias with all the respective domains. The highest risk of bias was seen for 'sample size calculation,' 'implementation of sequence generation,' and 'blinded evaluation' domains. As per the domains analyzed, all studies presented a low risk of bias.

Results of meta-analysis

The meta-analysis of the review was performed on 11 studies [26–36]. The meta-analysis of the included studies evaluating the fracture strength values is presented as forest plots in Figure 3.

Fracture resistance

Figure 3A shows the subgroup analysis comparing Ribbond posts with endodontically-treated teeth restored without a post; the use of Ribbond posts improved the fracture strength values significantly (SMD, –6.45 [95% CI, –11.05 to –1.85]; I^2 = 97%). Braga *et al.* [26], Kumar *et al.* [29], Ozcan and Valandro [31], and Thakur and Ramarao [34] showed higher fracture resistance in the Ribbond posts group. Jindal *et al.* [30] showed higher fracture resistance in endodontically-treated teeth without posts group. The analysis showed higher fracture resistance in the Ribbond posts group.

Figure 3B presents the subgroup analysis comparing Ribbond posts with prefabricated metal posts; fracture strength values were significantly higher with the use of prefabricated metal posts (SMD, 1.81 [95% CI, 1.12–2.50]; I^2 = 18%). Ozcan and Valandro [31], Ozcopur *et al.* [32], and Sirimai *et al.* [33] showed higher fracture resistance in the prefabricated metal posts group. The analysis showed higher fracture resistance in the prefabricated metal posts group compared to the Ribbond posts group.

Figure 3C presents the subgroup analysis comparing Ribbond posts with prefabricated fiber posts; the use of prefabricated fiber posts significantly increased the fracture strength values (SMD, 1.42 [95% CI, 0.03–2.81]; I^2 = 91%). Aggarwal *et al.* [35], Batra *et al.* [27], Jindal *et al.* [30], Ozcopur *et al.* [32], Thakur and Ramarao [34], and Ramesh *et al.* [36] showed higher fracture resistance in the prefabricated fiber posts group. Braga *et al.* [26] showed higher fracture resistance in the Ribbond posts group. The analysis showed higher fracture resistance in prefabricated fiber posts compared to the Ribbond posts group.

Figure 3D shows the subgroup analysis comparing

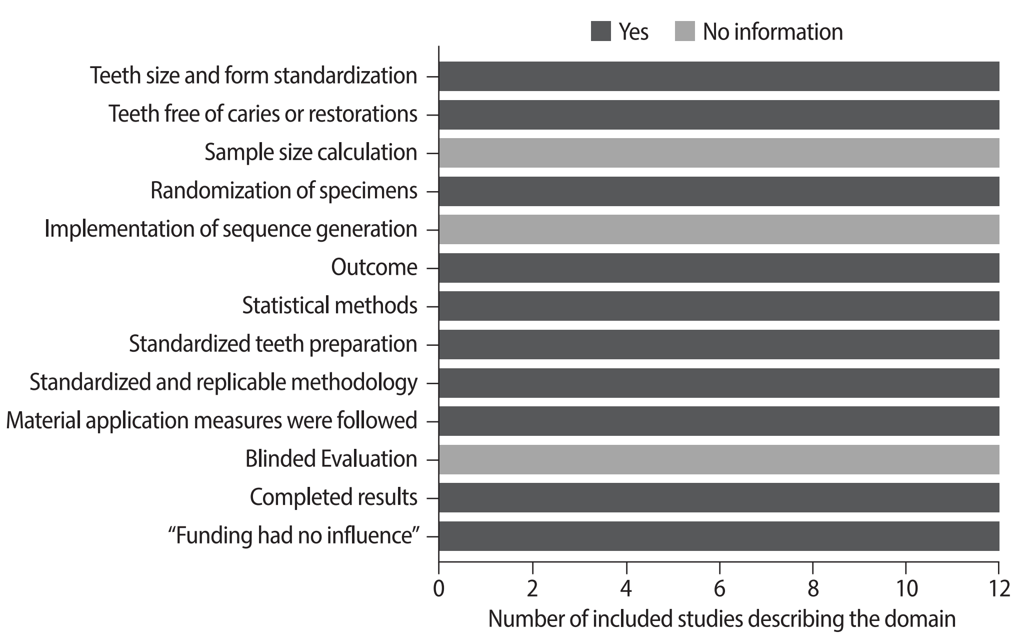

Figure 2. Overall summary of the risk of bias assessment.

Table 3. Risk of bias assessment based on reporting of items according to the modified CONSORT guidelines for *in vitro* studies

	Specimens' set-up			Randomization				Materials and methods			Evaluation and results			
Study	Teeth size and form standardization	Teeth free of caries or restorations	Sample size calculation	Randomization of specimens	Implementation of sequence generation	Outcome	Statistical methods	Standardized teeth preparation	Standardized and replicable methodology	Material application measures were followed	Blinded Evaluation	Complete results	"Funding had no influence"	Risk of bias
Ramesh *et al.* [36]	Yes	Yes	No information	Yes	No information	Yes	Yes	Yes	Yes	Yes	No information	Yes	Yes	Low
Ozcan and Valandro [31]	Yes	Yes	No information	Yes	No information	Yes	Yes	Yes	Yes	Yes	No information	Yes	Yes	Low
Braga *et al.* [26]	Yes	Yes	No information	Yes	No information	Yes	Yes	Yes	Yes	Yes	No information	Yes	Yes	Low
Aggarwal *et al.* [35]	Yes	Yes	No information	Yes	No information	Yes	Yes	Yes	Yes	Yes	No information	Yes	Yes	Low
Jindal *et al.* [30]	Yes	Yes	No information	Yes	No information	Yes	Yes	Yes	Yes	Yes	No information	Yes	Yes	Low
Sirimai *et al.* [33]	Yes	Yes	No information	Yes	No information	Yes	Yes	Yes	Yes	Yes	No information	Yes	Yes	Low
Ozcopur *et al.* [32]	Yes	Yes	No information	Yes	No information	Yes	Yes	Yes	Yes	Yes	No information	Yes	Yes	Low
Newman *et al.* [18]	Yes	Yes	No information	Yes	No information	Yes	Yes	Yes	Yes	Yes	No information	Yes	Yes	Low
Khurana *et al.* [28]	Yes	Yes	No information	Yes	No information	Yes	Yes	Yes	Yes	Yes	No information	Yes	Yes	Low
Kumar *et al.* [29]	Yes	Yes	No information	Yes	No information	Yes	Yes	Yes	Yes	Yes	No information	Yes	Yes	Low
Batra *et al.* [27]	Yes	Yes	No information	Yes	No information	Yes	Yes	Yes	Yes	Yes	No information	Yes	Yes	Low
Thakur and Ramarao [34]	Yes	Yes	No information	Yes	No information	Yes	Yes	Yes	Yes	Yes	No information	Yes	Yes	Low

CONSORT, Consolidated Standards of Reporting Trials.

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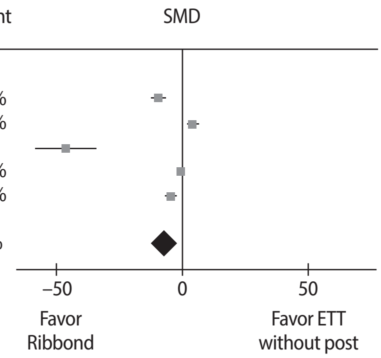
A

Study	ETT without post Mean	SD	Total	Ribbond Mean	SD	Total	SMD	95% CI	Weight
Braga *et al.* 2015	430	9	10	540	14	10	−8.95	[−12.17, −5.73]	21.3%
Jindal *et al.* 2012	437.87	32.81	15	299.62	53.42	15	3.03	[1.94, 4.13]	23.4%
Kumar *et al.* 2013	1,812	2.9	15	279.56	0.806	15	−44.97	[−57.19, −32.74]	8.9%
Ozcan *et al.* 2009	175	70	10	267	108	10	−0.97	[−1.91, −0.03]	23.5%
Thakur *et al.* 2019	57.34	14.03	10	179.75	33.5	10	−4.57	[−6.37, −2.76]	22.9%
Total (95% CI)			60			60	−6.45	[−11.05, −1.85]	100%

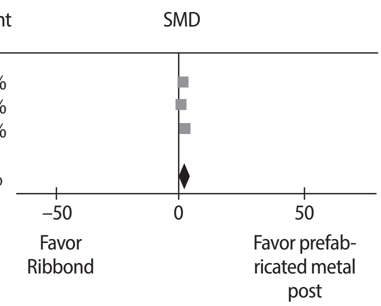
Heterogeneity $Tau^2 = 23.17$; $Chi^2 = 138.01$; $df = 4$ ($p < 0.00001$); $I^2 = 97\%$
Test for overall effect: $Z = 2.75$ ($p = 0.006$)



B

Study	Prefabricated metal post Mean	SD	Total	Ribbond Mean	SD	Total	SMD	95% CI	Weight
Ozcan *et al.* 2009	521	153	10	267	108	10	1.84	[0.75, 2.92]	33.8%
Ozcopur *et al.* 2010	1,342.29	370.13	10	967.74	103.69	10	1.29	[0.30, 2.27]	39.4%
Sirimai *et al.* 1999	201.39	29.1	10	127.01	26.85	10	2.54	[1.30, 3.79]	26.8%
Total (95% CI)			30			30	1.81	[1.12, 2.50]	100%

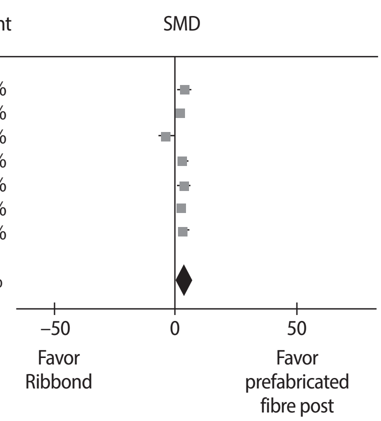
Heterogeneity $Tau^2 = 0.07$; $Chi^2 = 2.43$; $df = 2$ ($p < 0.00001$); $I^2 = 18\%$
Test for overall effect: $Z = 5.11$ ($p = 0.30$)



C

Study	Prefabricated fibre post Mean	SD	Total	Ribbond Mean	SD	Total	SMD	95% CI	Weight
Aggarwal *et al.* 2012	338	28	10	256	22	10	3.12	[1.73, 4.51]	13.8%
Batra *et al.* 2022	452.2	23.5	12	410	18.6	12	0.69	[−0.14, 1.52]	15.2%
Braga *et al.* 2015	480	13	10	540	14	10	4.25	[−5.97, −2.54]	12.9%
Jindal *et al.* 2012	425.18	42.73	15	299.62	53.42	15	2.53	[1.53, 3.52]	14.8%
Ozcopur *et al.* 2010	1,472.78	195.3	10	976.74	103.7	10	3.04	[1.67, 4.41]	13.9%
Ramesh *et al.* 2015	568.4	18.65	15	533.4	19.62	15	1.78	[0.92, 2.64]	15.1%
Thakur *et al.* 2019	250.33	15.4	10	179.75	33.52	10	2.59	[1.34, 3.85]	14.2%
Total (95% CI)			82			82	1.42	[0.03, 2.81]	100%

Heterogeneity $Tau^2 = 3.15$; $Chi^2 = 64.25$; $df = 6$ ($p < 0.00001$); $I^2 = 91\%$
Test for overall effect: $Z = 2.00$ ($p = 0.05$)



D

Study	Custom glass fiber post Mean	SD	Total	Ribbond Mean	SD	Total	SMD	95% CI	Weight
Khurana *et al.* 2021	725.5	59.6	15	517.4	72	15	3.06	[1.97, 4.16]	28.1%
Kumar *et al.* 2013	224.09	3.43	15	279.5	0.806	15	−21.64	[−27.56, −15.72]	15.9%
Ozcan *et al.* 2009	321	131	10	267	108	10	0.43	[−0.46, 1.32]	28.3%
Ozcopur *et al.* 2010	1,265.94	81.46	10	976.74	103.7	10	2.97	[1.62, 4.32]	27.7%
Total (95% CI)			50			50	−1.64	[−5.18, 1.89]	100%

Heterogeneity $Tau^2 = 11.26$; $Chi^2 = 76.62$; $df = 3$ ($p < 0.00001$); $I^2 = 96\%$
Test for overall effect: $Z = 0.91$ ($p = 0.36$)

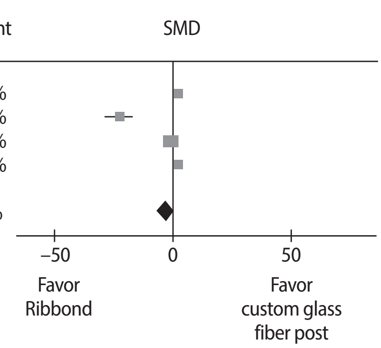


Figure 3. Meta-analysis comparing fracture resistance of the Ribbond post (Ribbond, Inc., Seattle, WA, USA) groups and other experimental groups. (A) Ribbond posts and endodontically-treated teeth (ETT) without posts. (B) Ribbond posts and prefabricated metal posts. (C) Ribbond posts and prefabricated fiber posts. (D) Ribbond posts and custom e-glass fiber posts. CI, confidence interval; SD, standard deviation; SMD, standardized mean difference.

Ribbond posts with custom e-glass fiber posts; the use of Ribbond posts improved the fracture strength values significantly (SMD, –1.64 [95% CI, –5.18 to 1.89]; I^2 = 96%). Khurana *et al.* [28] and Ozcopur *et al.* [32] showed higher fracture resistance in the custom glass fiber posts group. Ozcan and Valandro [31] showed no difference between the two groups. Kumar *et al.* [29] showed higher fracture resistance in the Ribbond group. The analysis showed higher fracture resistance in the Ribbond posts group compared to the custom glass fiber posts group.

Mode of failure

Table 4 shows the fracture patterns and modes of failure of different post systems as compared to those of Ribbond posts. As evident from the incidence rate of catastrophic vs non-catastrophic fractures, Ribbond posts consistently showed a favorable mode of fracture across all the included studies. Cast metal posts showed the most unfavorable fractures followed by prefabricated metal posts, prefabricated glass fiber posts, and custom e-glass fiber posts in decreasing order.

Publication bias

No significant publication bias was reported according to the funnel plots generated on subgroup analysis using the random effects model presented in Figure 4.

DISCUSSION

Teeth are susceptible to a variety of occlusal loads in the oral cavity during masticatory functions like chewing, biting, and sometimes parafunctional habits [37]. Endodontically-treated teeth are typically difficult to restore, and when they involve significant tissue loss, intraradicular reinforcements are sometimes required to keep the coronal restoration in place. This systematic review and meta-analysis comprised *in vitro* studies that assessed the placement of Ribbond posts as compared to other intraradicular posts based on the fracture strength and fracture patterns of structurally compromised endodontically-treated teeth.

The amount of coronal structural loss a tooth experiences dictates the type of post-endodontic restoration.

Table 4. Incidence rates of Modes of Failure (catastrophic vs non-catastrophic fractures) of Ribbond posts vs other post systems

Source	% of non-catastrophic fractures (repairable/favorable)	
Ribbond vs ETT without posts	ETT without posts	Ribbond posts
Ozcan and Valandro (2009) [31]	100%	100%
Kumar *et al.* (2013) [29]	27%	100%
Braga *et al.* (2015) [26]	100%	90%
Ribbond posts vs cast metal posts	Cast metal posts	Ribbond posts
Sirimai *et al.* (1999) [33]	0%	90%
Aggarwal *et al.* (2012) [35]	10%	100%
Ribbond posts vs prefabricated metal posts	Prefabricated metal posts	Ribbond posts
Sirimai *et al.* (1999) [33]	20%	90%
Newman *et al.* (2003) [18]	70%	100%
Ozcopur *et al.* (2010) [32]	40%	100%
Ribbond posts vs prefabricated glass fiber posts	Prefabricated glass fiber posts	Ribbond posts
Newman *et al.* (2003) [18]	100%	100%
Ozcopur *et al.* (2010) [32]	20%	100%
Aggarwal *et al.* (2012) [35]	80%	100%
Jindal *et al.* (2012) [30]	70%	70%
Braga *et al.* (2015) [26]	100%	90%
Ramesh *et al.*(2016) [36]	80%	100%
Ribbond vs custom e-glass fiber posts	Custom e-glass fiber posts	Ribbond posts
Ozcopur *et al.* (2010) [32]	60%	100%
Kumar *et al.* (2013) [29]	40%	100%
Braga *et al.* (2015) [26]	100%	100%

ETT, endodontically-treated teeth.

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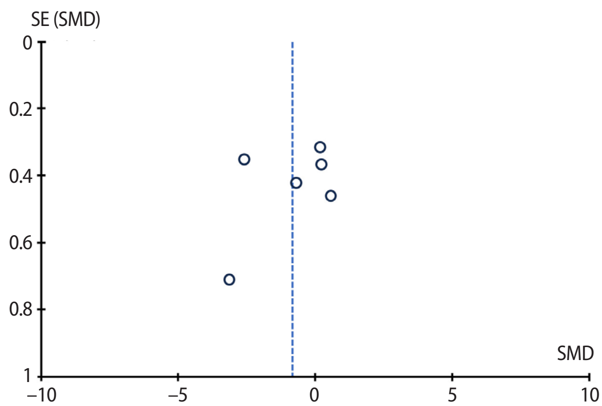

Figure 4. Begg's Funnel plot with 95% confidence intervals demonstrating symmetric distribution with the absence of systematic heterogeneity of individual study compared with the standard error (SE) of each study, indicating an absence of any publication bias. SMD, standardized mean difference.

According to Jotkowitz and Samet [38], the height and thickness of the remaining ferrule along with the lateral load a tooth undergoes directly affect the 'risk of failure' and the quality of the restoration. Dietschi *et al.* [39] recommended that weakened endodontically-treated posterior teeth can be restored functionally and aesthetically by direct and indirect adhesive techniques, avoiding an additional sacrifice of sound tissues and further stated that if there is less than half coronal residual tooth structure, post placement is indicated. The biomechanical properties of both, the remaining tooth structure and the material used for post and core, should be taken into consideration while restoring structurally compromised teeth.

Recently, Ribbond posts (custom polyethylene fiber posts) have been used to restore weakened endodontically-treated teeth [40]. Ribbond is made of leno-woven, ultra-high molecular weight polyethylene fibers [41]. Ribbond posts have several advantages over conventional post and core systems such as improved esthetics, excellent bondability, and a modulus of elasticity very close to that of dentin [40]. Polyethylene fiber-reinforced composites (FRCs) alter stress patterns, providing improved stress distribution [42]. According to a finite element analysis by Belli *et al.* [43], increased stress concentration was observed with an increase in the number of interfaces of the monoblocks created by the restorations. Ribbond fiber posts create a primary monoblock effect and thus dissipate the stresses along the long axis of the tooth [41]. Without necessitating structural alteration, Ribbond fibers can be cut and incorporated into dental composites. They adapt closely to the internal contours of the tooth and remain adhered to one another [40].

Traditionally, cast posts and cores have been employed due to their excellent strength and resistance to deformation [44]. Cast posts provide an accurate fit, eliminating the need for a thicker layer of cement thus contributing to its superior strength [44,45]. Likewise, in the present systematic review and meta-analysis, it was seen that cast metal posts had a significantly higher fracture strength when compared to Ribbond posts, but they resulted in catastrophic nonrepairable fractures. In the study by Sirimai *et al.* [33], it was seen that cast posts had the highest fracture strength while polyethylene fiber posts had the lowest fracture strength, but there was an unmistakable difference in the failure patterns for both groups. All of the teeth restored by cast posts suffered nonrepairable root fractures; 90% had a vertical root fracture pattern whereas 10% had a horizontal root fracture pattern at the junction of the middle and apical third of the root. Whereas, in the teeth restored with polyethylene fiber posts only 10% of the samples experienced a vertical root fracture and 80% of the samples had failure limited only to the composite core. Similar findings were seen in the study by Aggarwal *et al.* [35], with the cast post group having the highest fracture strength but nine out of 10 samples had a nonrepairable fracture pattern whereas the Ribbond post group showed a repairable fracture strength for all samples despite having the lowest fracture strength. Similar results were seen in the studies evaluating prefabricated metal posts (titanium posts). Ozcan and Valandro [31] reported that the fracture resistance of Paraposts (titanium posts; Coltene/Whaledent, Altstätten, Switzerland) was almost twice that of Ribbond posts, with no unfavorable fractures for either of the groups. The titanium post group reported core fractures whereas the Ribbond post group reported a loss of post retention. The possible reason for this could be that during the fracture test performed in the study, loading was arrested the moment core failure was observed and there was a high probability of root fracture if loading had been continued.

Sirimai *et al.* [33] reported that although titanium posts have a higher fracture strength than Ribbond posts, 90% of the posts fractured with a nonrepairable fracture pattern, whereas only 10% of Ribbond posts had a nonrepairable fracture pattern. Ozcopur *et al.* [32] reported similar findings where despite a higher fracture strength, 60% of the posts fractured in a non-restorable fashion whereas Ribbond posts exhibited 100% fracture repairability. This could be attributed to the material properties that cast metal posts and prefabricated metal posts exhibit, such as high stiffness, high modulus of elasticity, and poor stress distribution ability with a critical concentration of stresses apically [11,12]. Due to the aforementioned properties, the posts tend to fracture at the expense of the root structure.

Prefabricated fiber posts have been gradually replacing metal posts due to their improved aesthetic properties, low modulus of elasticity, and greater dissipation of stresses [14]. Since fiber posts are prefabricated, a layer of luting cement surrounds the post, serving as the weakest point of the tooth-post-core complex [19,46]. This creates a secondary monoblock as opposed to the primary monoblock that Ribbond posts provide, thus the stress dissipation is lesser than in custom-made fiber posts [43]. The advantage of having primary monoblock over secondary monoblock is that the homogeneity of the tooth-post-core complex achieved in the former is greater, thus opposing forces as a single unit [43]. All studies comparing prefabricated fiber posts with Ribbond posts in the present meta-analysis showed that the former had a fracture resistance greater than that of the latter. The mode of fracture analysis revealed that in four out of the five studies [32,34–36], Ribbond posts had 100% fracture repairability whereas in one study [30] the fracture repairability was 75%. Prefabricated fiber posts had a fracture repairability of 80% or less in all studies, with one study showing fracture repairability even as low as 60%. Although prefabricated fiber posts have higher fracture resistance than Ribbond posts, the fracture mode is not exceedingly favorable, resulting in nonrepairable root fractures significantly more often than Ribbond posts. Depending on the thickness of the cement layer, a large portion of the prefabricated fiber post and core restoration comprises the luting cement. Thus, the quality of the luting cement has a direct influence on the biomechanical properties of the post and core restoration. Furthermore, prefabricated fiber posts require post space preparation which results in additional root dentin removal, whereas custom fiber posts do not necessitate the need for root dentin removal since they adopt the canal anatomy [40].

With a deeper understanding of the biomechanics of the tooth system and improved material science and bonding protocols, aesthetic custom fiber posts have started coming into the limelight [28]. Custom FRC posts adapt to the internal anatomy of the canal system. They have a modulus of elasticity very close to that of dentin, which is advantageous due to excellent dissipation of stresses, with reduced incidence of root fractures [32]. Since custom fiber posts create a primary monoblock, stresses experienced during function and mastication get distributed more homogenously, thus avoiding critical stress concentration [32]. EverStick is a custom glass fiber post impregnated in unpolymerized resin which is pliable and can be condensed into the canal in the form of a post [47]. In the present meta-analysis, EverStick posts showed marginally higher fracture strength than Ribbond posts. This could possibly be attributed to the silanization of glass FRC posts which provides better adherence of the glass fibers to the resin, whereas the inherent difficulty to achieve silanization with polyethylene fibers leads to somewhat weaker adherence with the resin [28]. However, the mode of failure evaluation of EverStick posts when compared to Ribbond posts revealed that Ribbond posts have a higher fracture repairability than EverStick posts. This could be attributed to the differences in fiber orientation and intracanal adaptation. EverStick posts are unidirectional and congregate in the middle of the post space with a layer of resin cement around them, whereas polyethylene fibers are multidirectional and show close adaptation to the canal wall, minimizing the resin cement interface, possibly resulting in variations in the mode of failure [29].

Ribbond posts also present some added advantages over prefabricated fiber posts. Erkut *et al.* [48] studied the microleakage in overflared canals restored with adhesively luted posts and stated that Ribbond had the least amount of microleakage. Furthermore, custom Ribbond fiber posts have no shape memory and thus do not experience a “rebound” phenomenon once placed

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in the canal, whereas prefabricated glass fiber posts exhibit a significant memory and tend to revert to their original “straight” position. This gives Ribbond posts an edge while being placed in curved canals [49].

Clinical studies evaluating the survival rates of Ribbond posts are scarce. Despite having lower fracture resistance values, clinical survival rates of Ribbond posts have been promising, as seen in a clinical study performed by Piovesan *et al.* [50] which reported high survival rates of Ribbond posts after the 97-month follow-up period. This suggests that Ribbond posts may be advocated for long-term restorations.

Besides their lower fracture resistance, Ribbond posts also present another discernible drawback. They transfer stresses to the cervical third of the root [32], which could affect the retention of the post when there is a lack or absence of ferrule. The primary purpose of intraradicular post placement is not just retention of the core but to prevent the dislodgement of the tooth-core-post complex from the root at a level that is non-restorable [51]. When teeth are severely structurally compromised, with a ferrule of less than 2 mm, the need for a biologic post that does not compromise the tooth structure further or cause catastrophic failures is essentially heightened. Nilavarasan *et al.* [52] conducted a study on primary teeth with the remaining ferrule of only 1 mm and stated that Ribbond posts had a better fracture strength than prefabricated glass fiber posts. Further studies should be undertaken to evaluate the role of Ribbond posts in restoring severely structurally compromised teeth, with inadequate ferrule.

Although *in vitro* studies provide better standardization in terms of sample preparation and evaluation, well-designed randomized clinical trials with a long follow-up period are needed to eliminate the difference between *in vitro* and *in vivo* environments and reach a conclusive clinical opinion regarding the behavior and *in vivo* effectiveness of the Ribbond post and core system.

CONCLUSIONS

The focus of restoring teeth with compromised structure should shift to prevent the tooth from any harm during function in the long term. As seen within the limitations of the present systematic review, although Ribbond posts have less fracture resistance when compared to other contemporary post and core systems, they present the most favorable mode of failure. The fracture mode is almost never at the cost of the tooth-core-post complex, resulting in repairable non-catastrophic fractures. This makes Ribbond posts a suitable biomimetic restorative alternative for rehabilitating structurally compromised teeth.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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None.

AUTHOR CONTRIBUTIONS

Conceptualization, Formal analysis, Project administration: Vartak MA, Fanibunda U. Data curation, Funding acquisition: Vartak MA. Investigation: Vartak MA, Hegde SR, Fanibunda U. Methodology: Vartak MA, Hegde SR. Resources, Software, Visualization: Vartak MA, Fanibunda U. Supervision: Fanibunda U, Hegde VR. Validation: Fanibunda U. Writing - original draft: Vartak MA. Writing - review & editing: Vartak MA, Fanibunda U. All authors read and approved the final manuscript.

DATA SHARING STATEMENT

The datasets are not publicly available but are available from the corresponding author upon reasonable request.

REFERENCES

1. Jurema AL, Filgueiras AT, Santos KA, Bresciani E, Caneppele TM. Effect of intraradicular fiber post on the fracture resistance of endodontically treated and restored anterior teeth: a systematic review and meta-analysis. J Prosthet Dent 2022;128:13-24.
2. Reeh ES, Messer HH, Douglas WH. Reduction in tooth stiffness as a result of endodontic and restorative procedures. J Endod 1989;15:512-516.
3. Tang W, Wu Y, Smales RJ. Identifying and reducing risks for potential fractures in endodontically treated teeth. J Endod

2010;36:609-617.
4. Zarow M, Ramírez-Sebastià A, Paolone G, de Ribot Porta J, Mora J, Espona J, *et al*. A new classification system for the restoration of root filled teeth. Int Endod J 2018;51:318-334.
5. Sorensen JA, Engelman MJ. Ferrule design and fracture resistance of endodontically treated teeth. J Prosthet Dent 1990;63:529-536.
6. Pereira JR, Neto Tde M, Porto Vde C, Pegoraro LF, do Valle AL. Influence of the remaining coronal structure on the resistance of teeth with intraradicular retainer. Braz Dent J 2005;16:197-201.
7. Gegauff AG. Effect of crown lengthening and ferrule placement on static load failure of cemented cast post-cores and crowns. J Prosthet Dent 2000;84:169-179.
8. Kimmel SS. Restoration of endodontically treated tooth containing wide or flared canal. N Y State Dent J 2000;66:36-40.
9. Heydecke G, Butz F, Strub JR. Fracture strength and survival rate of endodontically treated maxillary incisors with approximal cavities after restoration with different post and core systems: an in-vitro study. J Dent 2001;29:427-433.
10. Gutmann JL. The dentin-root complex: anatomic and biologic considerations in restoring endodontically treated teeth. J Prosthet Dent 1992;67:458-467.
11. Soares CJ, Valdivia AD, da Silva GR, Santana FR, Menezes Mde S. Longitudinal clinical evaluation of post systems: a literature review. Braz Dent J 2012;23:135-740.
12. Haralur SB, Al Ahmari MA, AlQarni SA, Althobati MK. The effect of intraradicular multiple fiber and cast posts on the fracture resistance of endodontically treated teeth with wide root canals. Biomed Res Int 2018;2018:1671498.
13. Wang X, Shu X, Zhang Y, Yang B, Jian Y, Zhao K. Evaluation of fiber posts vs metal posts for restoring severely damaged endodontically treated teeth: a systematic review and meta-analysis. Quintessence Int 2019;50:8-20.
14. Sarkis-Onofre R, Amaral Pinheiro H, Poletto-Neto V, Bergoli CD, Cenci MS, Pereira-Cenci T. Randomized controlled trial comparing glass fiber posts and cast metal posts. J Dent 2020;96:103334.
15. Martelli H Jr, Pellizzer EP, Rosa BT, Lopes MB, Gonini A Jr. Fracture resistance of structurally compromised root filled bovine teeth restored with accessory glass fibre posts. Int Endod J 2008;41:685-692.
16. Bonfante G, Kaizer OB, Pegoraro LF, do Valle AL. Fracture strength of teeth with flared root canals restored with glass fibre posts. Int Dent J 2007;57:153-160.
17. Saupe WA, Gluskin AH, Radke RA Jr. A comparative study of fracture resistance between morphologic dowel and cores and a resin-reinforced dowel system in the intraradicular restoration of structurally compromised roots. Quintessence Int 1996;27:483-491.
18. Newman MP, Yaman P, Dennison J, Rafter M, Billy E. Fracture resistance of endodontically treated teeth restored with composite posts. J Prosthet Dent 2003;89:360-367.
19. Boschian Pest L, Cavalli G, Bertani P, Gagliani M. Adhesive post-endodontic restorations with fiber posts: push-out tests and SEM observations. Dent Mater 2002;18:596-602.
20. Eskitaşcioğlu G, Belli S, Kalkan M. Evaluation of two post core systems using two different methods (fracture strength test and a finite elemental stress analysis). J Endod 2002;28:629-633.
21. Acharya S, Tandon S. Fibre reinforced composite: post and core material in a pediatric patient: an alternative to usual. J Clin Diagn Res 2014;8:ZD29-ZD31.
22. Bayrak S, Tunc ES, Tuloglu N. Polyethylene fiber-reinforced composite resin used as a short post in severely decayed primary anterior teeth: a case report. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;107:e60-e64.
23. The Cochrane Collaboration. RevMan: Systematic review and meta-analysis tool for researchers worldwide [Internet]. The Cochrane Collaboration; 2023 [cited 2023 Oct 23]. Available from: https://revman.cochrane.org/info
24. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ 2003;327:557-560.
25. Faggion CM Jr. Guidelines for reporting pre-clinical in vitro studies on dental materials. J Evid Based Dent Pract 2012;12:182-189.
26. Braga MR, Messias DC, Macedo LM, Silva-Sousa YC, Gabriel AE. Rehabilitation of weakened premolars with a new polyfiber post and adhesive materials. Indian J Dent Res 2015;26:400-405.
27. Batra R, Sisodiya M, Kumari P, Kaur S, Patil PB, Bhagat SK. Fracture resistance to treated teeth using known endodontics techniques in Indian patients. Bioinformation 2022;18:184-187.
28. Khurana D, Prasad AB, Raisingani D, Srivastava H, Mital P, Somani N. Comparison of Ribbond and Everstick post in reinforcing the re-attached maxillary incisors having two oblique fracture patterns: an in vitro study. Int J Clin Pediatr Dent 2021;14:689-692.
29. Kumar BS, Spoorti P, Reddy J, Bhandi S, Gopal SS, Ittigi J.

https://doi.org/10.5395/rde.2025.50.e5

Evaluation of fracture resistance of reattached vertical fragments bonded with fiber-reinforced composites: an in vitro study. J Contemp Dent Pract 2013;14:573-577.
30. Jindal S, Jindal R, Mahajan S, Dua R, Jain N, Sharma S. In vitro evaluation of the effect of post system and length on the fracture resistance of endodontically treated human anterior teeth. Clin Oral Investig 2012;16:1627-1633.
31. Ozcan M, Valandro LF. Fracture strength of endodontically-treated teeth restored with post and cores and composite cores only. Oper Dent 2009;34:429-436.
32. Ozcopur B, Akman S, Eskitascioglu G, Belli S. The effect of different posts on fracture strength of roots with vertical fracture and re-attached fragments. J Oral Rehabil 2010;37:615-623.
33. Sirimai S, Riis DN, Morgano SM. An in vitro study of the fracture resistance and the incidence ofvertical root fracture of pulpless teeth restored with six post-and-coresystems. J Prosthet Dent 1999;81:262-269.
34. Thakur A, Ramarao S. A comparative evaluation of fracture resistance of endodontically treated premolar teeth reinforced with different prefabricated and custom-made fiber-reinforced post system with two different post lengths: an in vitro study. J Conserv Dent 2019;22:376-380.
35. Aggarwal V, Singla M, Miglani S, Kohli S. Comparative evaluation of fracture resistance of structurally compromised canals restored with different dowel methods. J Prosthodont 2012;21:312-316.
36. Ramesh P, Mathew S, Murthy SB, George JV, Hegde S, Premkumar R. Efficacy of Ribbond and a fibre post on the fracture resistance of reattached maxillary central incisors with two fracture patterns: a comparative in vitro study. Dent Traumatol 2016;32:110-115.
37. Ozsevik AS, Yildirim C, Aydin U, Culha E, Surmelioglu D. Effect of fibre-reinforced composite on the fracture resistance of endodontically treated teeth. Aust Endod J 2016;42:82-87.
38. Jotkowitz A, Samet N. Rethinking ferrule: a new approach to an old dilemma. Br Dent J 2010;209:25-33.
39. Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature, Part II (Evaluation of fatigue behavior, interfaces, and in vivo studies). Quintessence Int. 2008;39: 117-129.
40. Deliperi S, Bardwell DN. Reconstruction of nonvital teeth using direct fiber-reinforced composite resin: a pilot clinical study. J Adhes Dent 2009;11:71-78.
41. Belli S, Eskitascioglu G. Biomechanical properties and clinical use of a polyethylene fibre post-core material. Int Dent S Afr 2006;8:20-26.
42. Tekçe N, Pala K, Tuncer S, Demirci M, Serim ME. Influence of polymerisation method and type of fibre on fracture strength of endodontically treated teeth. Aust Endod J 2017;43:115-122.
43. Belli S, Eraslan O, Eskitascioglu G, Karbhari V. Monoblocks in root canals: a finite elemental stress analysis study. Int Endod J 2011;44:817-826.
44. Hegde J, Bashetty K. An in vitro evaluation of fracture strength of endodontically treated teeth with simulated flared root canals restored with different post and core systems. J Conserv Dent 2012;15:223-227.
45. Yoldas O, Akova T, Uysal H. An experimental analysis of stresses in simulated flared root canals subjected to various post-core applications. J Oral Rehabil 2005;32:427-432.
46. da Silveira Teixeira C, Santos Felippe MC, Silva-Sousa YT, de Sousa-Neto MD. Interfacial evaluation of experimentally weakened roots restored with adhesive materials and fibre posts: an SEM analysis. J Dent 2008;36:672-682.
47. Deepa VL, Reddy SN, Garapati VC, Sudhamashetty SR, Yadla P. Fracture fragment reattachment using projectors and anatomic everStick Post: an ultraconservative approach. J Int Soc Prev Community Dent 2017;7(Suppl 1):S52-S54.
48. Erkut S, Gulsahi K, Caglar A, Imirzalioglu P, Karbhari VM, Ozmen I. Microleakage in overflared root canals restored with different fiber reinforced dowels. Oper Dent 2008;33:96-105.
49. Ribbond Inc. Ribbond vs. glass fiber reinforcements [Internet]. Ribbond Inc; c2025 [cited 2023 Oct 17]. Available from: https://ribbond.com/pdf/Ribbond_vs_Glass_Fiber_Reinforcement.pdf
50. Piovesan EM, Demarco FF, Cenci MS, Pereira-Cenci T. Survival rates of endodontically treated teeth restored with fiber-reinforced custom posts and cores: a 97-month study. Int J Prosthodont 2007;20:633-639.
51. Mamoun J. Post and core build-ups in crown and bridge abutments: bio-mechanical advantages and disadvantages. J Adv Prosthodont 2017;9:232-237.
52. Nilavarasan N, Hemalatha R, Vijayakumar R, Hariharan VS. Comparison of compressive strength among three different intracanal post materials in primary anterior teeth: An in vitro study. Eur J Dent 2016;10:464-468.