

Evaluation of Clinical Performance of Cast Metal vs. Glass Fiber Posts in the Restoration of Endodontically Treated Teeth

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ABSTRACT

BACKGROUND

Endodontically treated teeth are usually associated with insufficient coronal and radicular tooth structure and hence, are restored with both cast metal and fiber posts. However, there are limitations in both treatment options. Glass fiber posts have known to show better performance than cast metal posts due to similarity in elastic modulus with dentin. The purpose of this study was to compare and evaluate the performance of glass fiber and cast metal posts in endodontically treated teeth that required intraradicular retention.

METHODS

40 endodontically treated teeth were selected in patients and divided into two groups, glass fiber, and cast metal respectively. The participants were randomly allocated to both groups by using their registration number with an allocation ratio of 1:1. Participants were recalled at 3 and 6 months after cementation (baseline) for follow up. Radiographs were taken and evaluation was done according to FDI criteria. The intergroup comparison for the difference of mean scores between the two independent groups was done using the unpaired / independent t test.

RESULTS

Of the 40 endodontically treated teeth, 20 were restored with fiber posts and 20 were restored with cast metal posts. In total, 8 incisors, 6 canines, 21 premolars, and 5 molar teeth were included. The 6-month clinical survival of fiber posts was 100 % while that of cast metal posts was 95 %. The results were found to be non-significant (P = 0.159, 0.231, 0.805 at baseline, 3 months, and 6 months respectively).

CONCLUSIONS

The overall performance of the glass fiber posts was better than that of cast metal posts within the 6 months' study period. However, no statistically significant differences were seen. Hence, in short follow up periods, both showed similar results and performed equally well.

KEY WORDS

Glass Fiber Posts Cast Metal Post Post and Core Technique Endodontically Treated Teeth

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BACKGROUND

Endodontically treated teeth are usually associated with insufficient coronal and radicular tooth structure due to various reasons including dental caries, trauma, endodontic access preparation, etc.¹ The success of post endodontic restorations is highly dependent on the amount of residual coronal dentin. Moreover, it is necessary to preserve at least one coronal wall to successfully restore a root canal treated tooth. In such a situation, gaining support by insertion of a rigid post into the root canal of an endodontically treated tooth, allows the prosthetic core to be constructed and the final prosthesis to be retained.²

Posts are generally categorised as custom fabricated and prefabricated. Materials used for prefabricated posts have been metal alloys in the form of stainless steel, titanium alloys, gold plated brass and other materials such as ceramic and fiber reinforced polymers. Custom fabricated cast gold post and core and other base metal alloys have also been used since a long time to restore teeth with excessive loss of structure.¹

Cast metal posts have been the majorly used method of intraradicular retention since a long time. Owing to the high modulus of elasticity in comparison with that of human dentine, metal posts increase stress concentration in the luting cement, leading to its failure with an added chance of root fracture as well.² The impact of lateral forces also causes vibration and debonding as a result of rigidity in these posts. The focusing of these forces in unpredictable "critical points" along with a tendency for metal corrosion can eventually lead to failure of the prosthesis.³ The stress concentration over a smaller area is another cause of root fracture.⁴ This has led to a dire need for search of a material that has a favourable modulus of elasticity mimicking dentin.³

Hence, a uniformity in stress distribution leads to a significant reduction in interfacial stress and chances of failure. This phenomenon has been coined "monobloc.", a characteristic of fiber posts.⁵

Fiber posts came into practice in the early 1990s, and provided an efficient means to restore the teeth ahead of cast alloy-based posts and cores, as well as metal and ceramic posts.⁶ Fiber-reinforced posts bond with most luting agents like resin and composite core materials. A better bond is known to reduce the wedging effect of the post. Moreover, there is a minimal tendency of fracture owing to reduced dentinal trimming since a shorter and thinner post can also be used. The significance of shape in case of fiber-reinforced posts may also be negated in comparison with a metal post (parallel versus tapered). Fiber-reinforced posts are free of metal allergies or corrosion effects as they are metal-free.⁷ In addition, optical transillumination offers light activation of photopolymerizable adhesive materials within the canal. Moreover, they offer better aesthetics beneath all ceramic restorations due to the translucency.⁸

However, it was found out that the low elastic modulus of certain fiber post brands is responsible for debonding at the restoration interface even though they do not lead to fractures.⁹ With post debonding being the major cause of failure, the other causes include secondary caries, and restorable cervical fractures.¹⁰

Various fiber posts are made of highly cross-linked epoxy resin that is believed to cause difficulties in bonding with

methacrylate-based resin cements.¹¹ Water sorption resulting from prolonged storage can also lead to change in physical properties like flexural strength and elastic modulus (leading to expansion), dynamic functional loading, and changes in temperature.¹²

Hence, the purpose of this study was to compare and evaluate the performance of glass fiber and cast metal posts in endodontically treated teeth that required intraradicular retention. The hypothesis proposed that the clinical outcome of endodontically treated teeth would not differ according to the type of post used.

METHODS

This prospective, parallel group randomised clinical trial was conducted in the Department of Prosthodontics, Crown and Bridge from April 2018 to April 2019. Sample size was calculated with ± 0.5 of standard deviation with a minimum expected difference of 0.52 and 0.05 of significance at 90 % statistical power. A total of 40 endodontically treated teeth were selected in 32 patients irrespective of their socio-economic status, religion, age and sex and divided into two groups, Glass Fiber posts, and Cast Metal posts respectively with follow up at 3 months and 6 months. The study was approved by the Institute's dental ethics committee (Ref No. DJD / IEC / 2018 / A - 24). All possible treatment options were thoroughly discussed with the patients and a written consent from the patients was taken.

Inclusion Criteria

1. Presence of one or more endodontically treated anterior or posterior teeth (ferrule height > 1 mm) requiring intraradicular retention
2. Teeth with complete root formation
3. No sinus / periapical pathology

Exclusion Criteria

1. Untreated periodontitis (pocket depth > 3 mm)
2. Patients with serious medical conditions whereby a normal treatment and follow up couldn't be guaranteed
3. Patients with known allergies to products that were planned to be used in the study.

Clinical and radiographic examination of each tooth was carried out prior to canal preparation, for decision making in order to proceed for post placement. The participants were randomly allocated to both groups based on previously generated random number sequence (block random sample design) with an allocation ratio of 1:1. Allocation to the groups was done by a person who was independent of the research, so as to prevent bias.

For teeth restored with glass fiber posts (Figure 1, 2), an appropriate size of glass fiber post (RelyX, 3M ESPE) was selected for each canal on the basis of preoperative radiographs and clinical judgement. Then, Canal preparation was carried out with peeso reamer (Mani, Japan), removing 2 / 3 of the gutta - percha filling in the canals.



Figure 1.
Pre-Operative
(Glass Fiber Group)



Figure 2.
Post-Operative
(Glass Fiber Group)



Figure 3.
Pre-Operative
(Cast Metal Group)



Figure 4.
Post-Operative
(Cast Metal Group)

Canals were then prepared with the drills compatible with the fiber post system (RelyX, 3M ESPE). Post alignment was analysed using a periapical radiograph. The canals were cleaned with sodium hypochlorite solution (Vishal Dentocare Pvt Ltd), rinsed off with normal saline (Cipla) and dried with paper points (Dentsply Maillefer). The post was luted with self-adhesive resin cement (RelyX U200; 3M ESPE). Digital pressure was applied for 30 seconds, curing light was shown

for 20 seconds and excess cement was removed. A core of resin modified glass ionomer cement (Vitremar, 3M ESPE) was built over the post and followed by tooth preparation for porcelain fused to metal (PFM) crown.

For teeth restored with cast metal posts (Figure 1, 2)), post space was prepared in the same manner as in Group 1. Cast metal post (Ni - Cr) and core impression was made directly with pattern resin (GC). After it was casted and tried in the tooth, the custom-made post and core was then cemented in the tooth with self-adhesive resin cement (RelyX U200; 3M ESPE). An impression (Zetaplus, Zhermack) of the prepared tooth was made while that of the opposing arch made in irreversible hydrocolloid (Tropicalgin, Zhermack). The PFM crown was cemented in place after fabrication with glass ionomer cement (GC Gold label 1, GC America Inc.) Baseline clinical parameters and radiographs were recorded. These were also repeated at 3 months and 6 months' interval.

Clinical and radiographic examinations were carried out 3 and 6 months after cementation (baseline). Periapical radiographs were taken, and evaluation was done according to Federation Dentaire International (FDI) Criteria.¹³ Scoring was done from 1 to 5 on certain Functional Criteria (Fracture of restorative material and restoration retention, Radiographic examination, Patient satisfaction with restoration; and Biologic Criteria (Recurrence of initial pathology, Effect of the restoration on the periodontium). Score 1 when the quality of the restoration was excellent. Score 2 indicated highly acceptable restoration, although one or more criteria deviated from score 1. Score 3 meant sufficiently acceptable but with minor shortcomings. Score 4 was unacceptable but repairable, whereas a score 5 had to be replaced.

Statistical Analysis

The data for the present study was analysed using the SPSS statistical software 19.0 Version (IBM Inc., Chicago, USA). The descriptive statistics included mean and standard deviation. The level of the significance for the present study was fixed at 5 %. The intergroup comparison for the difference of mean scores between two independent groups was done using the unpaired / independent t test.

RESULTS

40 root canal treated teeth in 32 patients were selected, wherein 20 each were treated with the cast metal posts and glass fiber posts including 8 incisors, 6 canines, 21 premolars, and 5 molar teeth.

None of the teeth had periodontal problems and no endodontic-related pain was reported. One failure was observed in the cast metal group and was identified to be debonding at post cement junction. The 6-month clinical survival of fiber posts was 100 % while that of cast metal posts was 95 %.

At baseline the mean functional score for fiber and cast metal group was 1.60 ± 0.598 and 1.90 ± 0.718 respectively (P = 0.159). The mean biological score for fiber and cast metal group was 1.0 (P = 1.000). The overall score at baseline for fiber group and cast metal group was 1.60 ± 0.598 and 1.90 ± 0.718 respectively (P = 0.159).

Criteria	Group	Baseline		3 Months		6 months	
		Mean Score	P Value	Mean Score	P Value	Mean Score	P Value
Functional	Fiber	1.60 ± 0.598	0.159	1.75 ± 0.638	0.012	2.25 ± 0.550	0.819
	Cast metal	1.90 ± 0.718		2.25 ± 0.550		2.30 ± 0.801	
Biological	Fiber	1.00	1.000	2.00 ± 0.648	0.324	2.45 ± 0.510	0.735
	Cast metal	1.00		2.20 ± 0.615		2.35 ± 0.489	
Overall score	Fiber	1.60 ± 0.598	0.159	2.25 ± 0.550	0.231	2.65 ± 0.489	0.805
	Cast metal	1.90 ± 0.718		2.45 ± 0.510		2.60 ± 0.753	

Table 1. Inter Group Comparison of Functional and Biological Criteria and Overall Scores

After 3 months the mean functional score for fiber group and cast metal group was 1.75 ± 0.638 and 2.25 ± 0.550 respectively ($P = 0.012$). The mean biological score for fiber group and cast metal group was 2.00 ± 0.648 and 2.20 ± 0.615 respectively ($P = 0.324$). The overall score after 3 months for fiber group and cast metal group was 2.25 ± 0.550 and 2.45 ± 0.510 respectively ($P = 0.231$).

After 6 months the mean functional score for fiber group and cast metal group was 2.25 ± 0.550 and 2.30 ± 0.801 respectively ($P = 0.819$). The mean biological score for fiber group and cast metal group was 2.45 ± 0.510 and 2.35 ± 0.489 respectively ($P = 0.735$). The overall score after 6 months for fiber group and cast metal group was 2.65 ± 0.489 and 2.60 ± 0.753 respectively ($P = 0.805$). The results were found to be non - significant.

DISCUSSION

Post debonding, fractures, radiographic changes and overall survival were analysed in glass fiber and cast metal post groups at baseline, 3 months, and 6 months, indicating that the overall clinical survival of both the groups was similar and the results were not significant.

In this study, 40 posts were cemented that included 20 each in both the groups. The clinical survival of fiber posts was 100 % while that of cast metal posts was 95 %. Out of the 40 cases, 1 failure from group II (Cast Metal) was noted in the form of post debonding at post cement junction. This could be attributed to the fact that the elastic modulus mismatch,¹⁴ a significant cause in itself could lead to debonding at the interface. Metal posts exhibit stiffness and the resistance to distortion under loading might have concentrated a greater magnitude of shear stress at the post cement interface.

This was in accordance with an in vitro study conducted by Ona et al. (2013),¹⁵ who concluded that the difference in elastic modulus among the tooth and post and core restoration could be an essential reason determining debonding of the restoration.

Verri et al. (2017)¹⁶ also found that the elastic modulus of the glass fiber posts was similar to that of dentin, resulting in a better stress distribution as compared to metal posts.

In this study, both groups were luted with self-adhesive resin cement, which was highly advantageous because of a relative ease of working and ability to withstand detrimental effects of moisture. Moreover, it does not require acid etching or an adhesive step.^{17,18,19,20}

At baseline, the overall score in both the groups came below score 2 and hence the restorations were considered excellent. After 3 months and 6 months of follow up, the overall score in both the groups was below score 3 rendering the prostheses as highly acceptable. Considering the overall scores for both the groups, no statistically significant difference was found in the performance of both the groups. This was in accordance with a study² by Onofre et al. wherein after 3 years of follow up, both glass fiber and cast metal posts, regardless of tooth location exhibited similar survival. A systematic review²¹ by Heydecke et al. compared the clinical and in vitro performance of cast metal and prefabricated posts and found that no particular post was superior. Cloet et al.⁷ in his 5 year follow-up also concluded that both glass fiber composite with cast post and cores performed equally well.

A study⁶ by Zicari et al. compared the clinical performance of cast metal and glass fiber posts and concluded that the success rate at 3 years came out to be 91.7 % in all groups. He stated that longer follow-up times were needed to detect possible significant differences. Piovesan et al.²² in his study found a survival rate of 90.2 % for fiber-reinforced custom posts after 97 months. Gomez-Polo et al.²³ on the other hand reported a survival rate of 82.6 % at 10 years for cast metal posts. Ma H et al.²⁴ in their study concluded that the abutment teeth, have a significant survival rate whether restored by glass fiber, cast metal, or without post. A systematic review by Marchionatti et al.²⁵ analysed various studies that showed no difference in the performance of various fiber and metal posts.

A longer follow up period could possibly detect differences in performances between the two groups. A larger sample size would also prove to be a critical factor in determining a conclusive difference between the two groups.

CONCLUSIONS

In conclusion, after 6 months of follow up, both glass fiber and cast metal posts showed highly acceptable and similar survival rates.

- No significant differences were observed with respect to the fracture, radiographic changes, and periodontal changes. Hence, the null hypothesis wasn't rejected.
- The overall performance of the glass fiber post was better than that of cast metal post group after 6 months follow up but it was not statistically significant. A longer follow up of the restorations along with a larger sample size will be required for further assessment.

Clinical Significance

Endodontically treated teeth often present the need to be restored with both cast metal and fiber posts. However, there are limitations in both treatment options. Glass fiber posts have been known to show better performance than cast metal posts due to similarity in elastic modulus with dentin. However, in short follow up periods, both show similar results and perform equally well. Hence, selection of the better option should be based on a longer follow up time.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.

Financial or other competing interests: None.

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