Research Article

Comparative Evaluation of 3D-Printed & Glass Fiber Post & Core Systems: An In-Vivo Study

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Abstract

Introduction: The successful rehabilitation of endodontically treated teeth depends on an appropriate post-and-core system that enhances restoration retention, supports the remaining tooth structure, and contributes to the longevity of the final restoration. Conventional glass fiber post and core systems are widely used; however, advancements in digital dentistry have introduced 3-D printed post and core systems that offer customization and improved adaptation. Aim: To evaluate and compare the clinical and radiographic performance of 3D-printed post and core systems with glass fiber post and core systems in endodontically treated primary anterior teeth. Materials and Methods: This study included healthy children between the ages of 3-5 years with pulpally involved primary anterior teeth, more than two-thirds of the root length remaining, and at least 1 mm of supragingival tooth structure. Total number of participants are 42 and randomly allocated into two groups. Group A 3-D printed post and core (n = 21) and Group B – glass fiber post and core (n = 21). Clinical and radiographic evaluations were carried out at 3,6,9 and 12 months. A p-value < 0.05 was considered statistically significant. Results: At the 12-month follow-up, the 3D-printed post-and-core group demonstrated a comparatively higher clinical success rate (81%) than the glass fibre post-and-core group (61.9%). Similarly, the radiographic success rate was higher in the 3D-printed group (100%) compared to the glass fibre group (89%). However, the difference between the two groups was not statistically significant (p = 0.500). Conclusion: Both 3D-printed and glass fiber post and core systems demonstrated satisfactory clinical and radiographic performance over the 12-month follow-up. however, the 3D-printed post and core showed a comparatively higher survival rate, indicating superior stability and retension.

Keywords: 3D-printed post and core, Glass fiber post, Early childhood caries, Primary anterior teeth

1. Introduction

One of the most common chronic disease of childhood is dental caries. Early childhood caries remains a significant oral health concern in children, often resulting in extensive coronal destruction and posing challenges to the successful restoration of primary teeth. According to the AAPD guidelines, due to the unique & rampant nature of ECC, immediate therapeutic intervention is necessary to prevent further destruction & subsequent health problems[1]. It is difficult to restore severely damaged teeth, especially when the coronal structure is insufficient to provide retention & resistance for crown restoration[2]. To enhance the rentention & resistance of crown restorations, endodontic posts & cores composed of various materials with different physical & mechanical properties are used. Materials used for these posts & core include, Glass fiber & Custom-made Cast posts & cores. Glass fiber posts have become popular because of their favorable esthetic properties, dentin-like modulus of elasticity, and ability to distribute functional stresses more uniformly. Nevertheless, their prefabricated design may limit adaptation to the unique morphology of primary root canals[3].

The advent of digital dentistry and additive manufacturing technologies has enabled the fabrication of customized post and core restorations using three-dimensional (3D) printing[4]. These restorations are designed through Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) workflows and can be customized to individual canal anatomy, potentially improving adaptation, retention, and overall clinical performance.

2. Materials And Methods

This study included healthy children aged 3-5 years post & core in primary anterior teeth. Ethical approval was obtained for the study, and the accompanying parents or guardians received a comprehensive explanation of the study

objectives, methodology, and associated risks and benefits.

2.1 Inclusion Criteria

This study included healthy children between the ages of 3-5 years with pulpally involved primary anterior teeth, more than two-thirds of the root length remaining, and at least 1 mm of supragingival tooth structure.

2.2 Exclusion Criteria

Children with non-restorable teeth, perforation, pathological mobility, or severe bone loss were excluded from the study.

2.3 Sample Size Calculation

Sample size was calculated using G*Power software (version 3.0). A total of 42 participants (21 per group) was required for a t-test, with a 5% significance level, 95% power, and an effect size of 1.32.

2.4 Randomization

Simple randomization was performed using the lottery method. Forty-two identical slips (21 each for Group A: 3D-printed post-and-core and Group B: glass fiber post-and-core) were mixed in an opaque container. Each participant or guardian drew one slip to determine group allocation.

3. Methodology

This in-vivo study aimed to assess and compare the clinical effectiveness of 3D-printed and glass fibre post-and-core systems in endodontically treated teeth using a standardized treatment protocol. Following pulpectomy and obturation with calcium hydroxide-iodoform paste. After obturation, post space was prepared by removing the obturating material from the coronal one-third of the root canal, leaving 3–4 mm of apical seal intact. Post space preparation was done using hand pluggers. Children in Group A were given a 3D Printed post & core. The post space impression was taken with light body putty followed by heavy body for the preparation of single-unit DMLS Post & Core with ceramic coating. The impression of the post & core was scanned with a laboratory scanner. The obtained data was transferred to a 3D printer in STL format, and the post & core structure will be prepared. Then, the prepared post space was cleaned with saline and air-dried. Then, the Monoblock 3D printed post & core structure was inserted into the canal using GIC. A postoperative radiograph was taken to confirm proper positioning of the post and maintenance of the apical seal. Children in Group B were given a Glass fiber post & core . A prefabricated glass fibre post of appropriate diameter was selected to closely match the canal dimensions. The post length was adjusted so that it extended only into the coronal one-third of the root canal. The post was cleaned with alcohol. The prepared post space was be cleaned with saline and air-dried. The glass fibre post was then inserted slowly into position to full depth. The tooth was restored using a composite strip crown to achieve optimal esthetics and function.

3.1 Clinical And Radiographic Assessment Of The Post And Core

Clinical evaluation was based on tooth loss and post-and-core restoration debonding, whereas radiographic evaluation included periapical radiolucency, post fracture, and pathological root resorption.

3.2 Statistical Analysis

The data for the present study was entered in the Microsoft Excel 2007 and analyzed using the SPSS statistical software 23.0 Version. The descriptive statistics included mean, standard deviation frequency and percentage. The level of the significance for the present study was fixed at 5%. The intergroup comparison for the continous variables will be done using the using the Fisher's Exact Test and for the continuous variables Chi-square test was used.

4. Results

At 12 months follow-up in the 3D-printed post group, debonding occurred in 4 tooth (19%). In the glass fiber post group, debonding occurred in 8 tooth (38.1.0%).

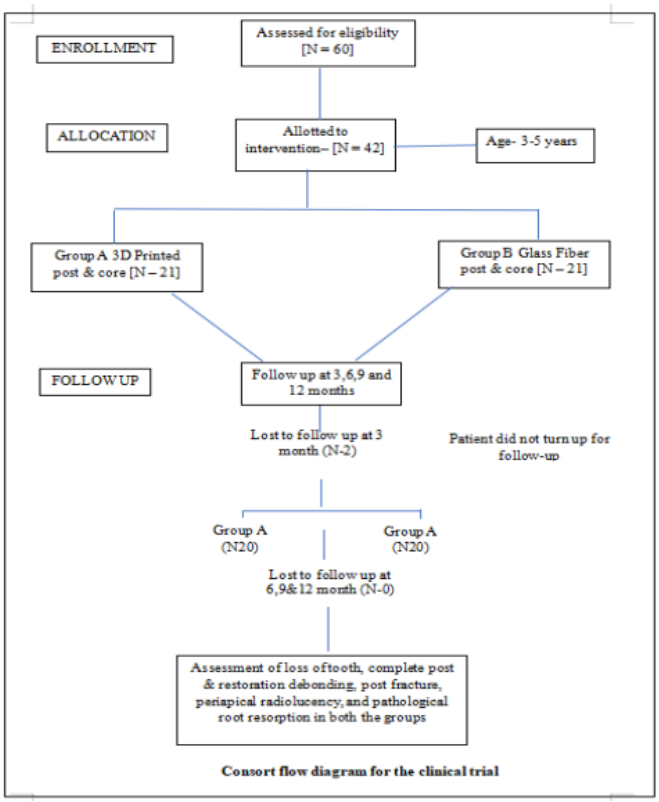
Although the incidence was higher in the glass fiber group, the difference was not statistically significant (p=0.500). (Table 1) Radiographic assessment in the glass fiber post group, periapical radiolucency occurred in 4 tooth (19%) at 9& 12 months follow-up and no post fracture, or pathological root resorption in either group at 12 months. (Table 2)

Table 1: Comparative evaluation of clinical performance between 3-D printed post & core and Glass fibre post & core restorations at different time intervals.

Clinical parameters	Group	3months	6 months	9months	12months	Total
Tooth loss	Group A	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-
	Group B	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-
	P value	-	-	-	-	-
Post restoration debonding	Group A	0 (0%)	1 (4.8%)	2 (9.6%)	1 (4.8%)	4 (19%)
	Group B	2 (9.5%)	2 (9.5%)	2 (9.5%)	2 (9.5%)	8(38.1%)
	P value	0.500	0.500	0.500	0.500	

Table 2. Comparative evaluation of radiographic parameters between 3-D printed post & core and Glass fiber post & core restorations at different time intervals.

Radiographicparameters	Group	3months	6 months	9months	12months	Total
Post Fracture	Group A	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-
	Group B	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-
	P value	-	-	-	-	-
Pathological root resorption	Group A	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-
	Group B	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-
	P value	-	-	-	-	-
Periapical Radiolucency	Group A	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Group B	0 (0%)	0 (0%)	2 (9.6%)	2 (9.6%)	4 (19%)
	P value	-	-	0.500	0.500	



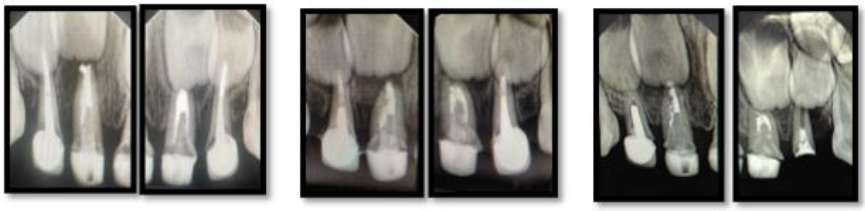
Consort flow diagram for the clinical trial



3 Months follow-up

Glass fiber post i.r.t 51,61

3D printed post & core i.r.t 52,62



6 Months Follow-up **9 Months Follow-up** **12 Months Follow-up**

5. Discussion

The restoration of severely carious primary anterior teeth following endodontic treatment is a significant challenge. Severe damage to the crown portion of a tooth can reduce the retention and durability of the final restoration. Post-and-core systems are used to provide extra support and retention when not enough tooth structure remains to hold a conventional restoration. The selection of an appropriate post system is particularly important in primary teeth because of their anatomical characteristics, limited remaining lifespan, and susceptibility to traumatic injury.5 The present study compared the clinical and radiographic performance of 3D-printed and glass fibre post-and-core systems in endodontically treated primary anterior teeth over a 12-month follow-up period.

Glass-fiber posts are widely used in pediatric population because they possess mechanical properties such as elasticity and fracture resistance, which are similar to that of natural dentin. Their translucent nature also ensures better aesthetic outcomes, in anterior teeth. Sabbagh et al. (2020) reported clinical success rate of 88.2% for glass fibre posts help rehabilitate severely damaged primary incisors, supporting their clinical usefulness in paediatric restorative treatment. Similarly, Eshghi et al.(2009) found elastic modulus of fiber posts being closer to dentin, resulting in improved stress distribution and reduced catastrophic failures. However, glass-fiber posts also have certain limitations, including the need for manual adaptation, possible debonding due to inadequate bonding or retention, and difficulty achieving a precise fit in irregular root canals. These limitations have encouraged the development of advanced digital techniques for post fabrication. 3D printing with CAD/CAM technologies allows clinicians to make improvements to post designs, tailoring them to the anatomical and functional needs of each patient. Almarshadi R et al (2025) observed that 3D-printed post and core systems has higher accuracy and precise adaptation. Digital scanning and design processes facilitate production of posts that confirm closely to the internal shape of the prepared canal, reducing the need for manual adjustment. Mangold et al.(2011) observed that CAD/CAM-fabricated and 3-D printed posts demonstrate favorable clinical and radiographic outcomes primarily due to their precise adaptation to the root canal anatomy and superior material homogeneity. Unlike prefabricated posts, which require canal enlargement to achieve proper fit, 3-D printed posts are designed based on the individual morphology of the prepared canal. This customized adaptation minimizes interfacial gaps between the post, luting cement, and dentinal walls, thereby reducing microleakage and improving retention.

In this study the clinical performance was assessed by tooth loss, and post restoration debonding parameters. Physiological root resorption is a natural process preceding exfoliation; however, restorative interventions involving intracanal posts may influence the normal resorption pattern and can lead to loss of the tooth following post and core restoration. Ram et al. (2005) emphasized that posts placed in primary teeth should not exceed one-third of the root length to prevent interference with natural resorption and to minimize the risk of mobility and premature tooth loss. Similarly, Mortada and King (2004) reported that excessive intracanal preparation and deeper post placement can compromise the remaining dentinal thickness, predisposing the tooth to mobility and early failure.

In the present study post and core restoration debonding were obsereved due to fall and masticatory forces. The traumatic incidents such as falls were predominantly characterized by post debonding, especially in teeth restored with glass fiber posts. This failure may be attributed to the sudden application of high-magnitude, non-axial forces that can exceed the adhesive strength at the interface between the post, resin cement, and radicular dentin. Previous studies conducted by Sharaf et al. (2002) and Fokkinga et al. (2004) discussed the influence of traumatic forces and stress distribution on the post–dentin interface, which may contribute to debonding even in the absence of prolonged functional overloading. Masticatory forces may contribute to the debonding of post-and-core restorations by subjecting them to repeated functional loading during eating. These forces may weaken the bond between the post, luting cement, and root dentin, particularly when the remaining coronal tooth structure is insufficient. Sabbagh et al. (2020) observed post debonding during eating in some cases, indicating that masticatory forces may contribute to restoration failure. In the present study, the lower incidence of debonding in the 3D-printed post-and-core group may be explained by the customized design and improved anatomical adaptation achievable through digital technology and additive manufacturing. Similar findings were reported by Ram et al.(2022) they concluded that customized CAD/CAM and additively manufactured post systems exhibited improved retention and reduced debonding compared to prefabricated fiber posts due to superior canal adaptation and stress distribution. Other factors of post and core restoration debonding are inadequate bonding between the post, cement, and root dentin, which may result from poor moisture control, improper cementation technique, insufficient post length or diameter and degradation of the luting cement over time.

A radiographic assessment in the present study was conducted in both the groups at 12 months follow-up intervals and the parameters considered were periapical radiolucency, post fracture, and pathological root resorption. Post fracture and pathological root resorption, was not observed in both 3D Printed & Glass fiber post & core group. The absence of post fracture may be attributed to the ability of both post systems to withstand functional stresses. Glass-fiber posts possess elastic properties similar to dentin, which may facilitate stress distribution, while the customized design of 3D-printed posts may contribute to improved adaptation within the root canal. Oge S. C et al., (2024) found comparable performance to the customized geometry of the 3D-printed posts, which allows for better adaptation to the root canal anatomy. Improved adaptation reduces stress concentration within the post–cement–dentin complex and promotes more uniform stress distribution along the root. As a result, the risk of post fracture or catastrophic failure is minimized. However, Ram et al.(2022) concluded that CAD/CAM customized post systems demonstrate high fracture resistance due to improved fit and reduced cement thickness. The absence of pathological root resorption may be associated with the maintenance of periapical health. However, higher incidence of periapical radiolucency was observed in the glass fibre post-and-core group compared with the 3D-printed post-and-core group. The development of periapical radiolucency may be influenced by several factors, including the adequacy of pulpectomy, quality of root canal obturation, maintenance of the apical seal, and integrity of the coronal restoration. An effective coronal seal is essential to prevent bacterial penetration and subsequent reinfection of the root canal system. Proper post-space preparation, preservation of sufficient apical filling material, and effective luting cementation may further help minimize interfacial gaps and reduce the possibility of microleakage. Vafaei et al. (2020), compared glass fibre posts with metal posts in severely decayed primary anterior teeth and found periapical radiolucency in the glass fibre post group, which was also associated with internal root resorption.

The present study highlights that both **3D-printed post-and-core and glass fiber post-and-core systems** are viable restorative option. Digital technology is changing pediatric dentistry by making dental care more accurate, comfortable, and personalized for children. Tools such as 3D printing help dentists improve treatments without completely replacing traditional methods. Despite its strengths, the study had certain limitations. A larger sample size would provide more statistically robust conclusions and improve the generalizability of the results. Future studies are required to assess their performance over time. Additionally, the study did not conduct a cost-benefit analysis

comparing the economic feasibility of 3D-printed versus glass fiber post & core.

6. Conclusion

Both 3D-printed post and core systems and glass fiber post and core systems demonstrated satisfactory clinical and radiographic performance in endodontically treated primary anterior teeth. However, 3D-printed post and core restorations exhibited a higher survival rate and lower incidence of debonding compared to glass fiber posts. These findings suggest that customized 3D-printed post and core systems may represent a promising and effective alternative for the restoration of severely damaged primary anterior teeth.

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