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ORIGINAL RESEARCH

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Clinical evaluation of resorbable polylactic acid (PLA) intracanal posts for primary incisor restoration. Randomized controlled clinical trial

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Abstract

This randomized, controlled clinical trial compares the clinical performance of glass-fibre and resorbable polylactic acid (PLA) intracanal posts used to restore carious primary incisors in young patients. The study sample includes 180 primary upper central incisors of 90 children aged 3 to 4 years. All patients were randomly divided into two equal groups of 45 children who received PLA and glass-fibre (GFP) intracanal posts. The clinical assessment of incisor restorations was carried out immediately upon completion and at months 3, 6 and 12 according to the following criteria: anatomical form, marginal adaptation, surface roughness, marginal pigmentation, colour match, secondary caries and contact point. The Gingival Index (GI), the Bleeding Index (Cowell modification; mBI), and bite force (BF) were measured. At the 3-month follow-up, the occlusal BF of patients who received PLA posts was higher than the baseline; the GI and mBI scores were lower, by contrast ($p < 0.05$). This tendency was even more pronounced 6 and 12 months after the restoration. The incidence of side effects or symptoms (apical inflammation, cervical fracture, loosening of the crown) after the PLA posts was significantly lower than after the GFP ($p < 0.05$). No statistically significant differences were present between the two groups with respect to colour matching, anatomical form, marginal adaptation, marginal pigmentation, surface roughness, occlusal contact and secondary caries. Based on the results, applying PLA intracanal posts and cyanoacrylate to residual anterior crowns in young children can improve their gingival health, reduce side effects, and increase the likelihood of successful restoration.

Keywords

Pediatric dentistry; Caries; Coronal restoration; Glass-fibre post; Polylactic acid resorbable root post

1. Introduction

Carious lesions in primary teeth are a common health problem [1–3], with a prevalence of 20% to 80%, according to different studies [4–7]. Treating this disease is difficult for many reasons, ranging from the unique anatomy and physiology of primary teeth to the fact that some dental manipulations cannot be performed on young children [8]. In this regard, restoring the caries-affected crowns in anterior primary teeth is considered one of the central problems in pediatric dentistry.

When two-thirds of the tooth crown is damaged, dentists often resort to indirect restoration, but this method is not flawless [9]. The application of artificial crowns, whether made from metal, ceramic or composite materials, necessitates the removal of a substantial portion of hard dental tissues, triggering the inflammatory response and symptoms of gingivitis [9]. The direct method for restoring damaged tooth crowns with intracanal posts is significantly less susceptible to such faults [10]. The primary indications for intracanal restoration are: (1) 55% to 80% of the coronal part of the tooth is destructed, and (2) the tooth must be endodontically treated beforehand [11, 12]. The recently popular intracanal options use glass and carbon fibres as reinforcement [13, 14]. The glass-fibre systems constitute a standard prescription in anterior teeth restoration. As they have a light translucency similar to a natural tooth [15], these dental implants provide the best aesthetic result. The carbon-fibre alternatives have higher mechanical characteristics and thus serve as an option for chewing teeth restoration.

In China, the cost of tooth repair in children is a crucial determinant of accessibility. Even a slight price reduction can vastly improve access to this procedure, especially for children who have multiple teeth damaged. Hence, it is vital to find cost-effective substitute materials for intracanal posts.

Some studies hold that polylactic acid intracanal posts, or PLA posts for short, show promise for anterior teeth restoration in young children [16, 17]. PLA is a highly crystalline polymer with a high molecular weight. The main degradation route for

PLA is hydrolysis, which takes 12 to 30 months if performed *in vitro*. For comparison, the *in vivo* degradation process requires at least three years [18]. Because of the faster degradation rate, the *in vivo* strategy enables a reliable restoration until signs of physiological root resorption are observed [17].

In regard to biocompatibility, PLA posts perform seemingly well, causing no apparent symptoms of cytotoxicity and cell apoptosis [19]. Another study reported no significant effect on dental follicle cells and I-grade toxicity, suggesting that PLA is non-toxic and safe [20].

With a bending strength of 250–290 MPa and a shear strength of 170–220 MPa [21], PLA posts can provide the mechanical support needed to restore the coronal structure of deciduous teeth [17].

In 2012, researchers proposed two intracanal posts from poly-L-lactic acid (PLLA) and polyglycolic acid (PGA) materials with properties similar to composite resins employed for residual coronal coverage. Subsequently, PLLA and PGA were deemed suitable for use with deciduous tooth posts [22].

The PLA reinforcement can involve the application of cyanoacrylate and fibrin adhesives. These agents can have an instant adhesive effect in the presence of anionic polymerization [23]. Evidence shows that as a fibrin sealant, cyanoacrylate can be relatively effective with biodegradable PLA posts [16].

PLA appears superior to other plastic materials in many respects. Not only biocompatible, highly transparent, and resistant to acids and alkalis [24], PLA has been approved by the US Food and Drug Administration [25]. Therefore, it is an acceptable dental material for primary tooth restoration. At the same time, there is little information about PLA posts applied outside of China. Our clinic has accumulated some experience in reconstructing deciduous teeth with PLA intracanal posts, but no clinical trials compare the effectiveness of PLA-based and glass-fibre systems.

Hypothetically, PLA posts, as a cost-effective alternative to glass-fibre implants, can help improve gingival health, reduce side effects, and increase the likelihood of successful restoration of primary incisors. This study compares the clinical outcomes of glass-fibre and resorbable PLA intracanal posts in the coronal restoration of carious primary anterior teeth.

2. Materials and methods

2.1 Study design

This randomized controlled clinical trial follows the Consolidated Standards of Reporting Trials (CONSORT) [26] and RAPID [27] guidelines. The study ran from January 2019 to January 2021 at the Department of Oral Medicine in the Hebei Eye Hospital (China). The trial complies with the requirements set forth by the World Health Organization (WHO) and the International Committee of Medical Journal Editors (ICMJE).

Between January 2019 and November 2019, some 246 children aged 3 to 4 visited the hospital. These patients were diagnosed with caries and then assessed for eligibility under the following criteria: extensive loss of coronal tooth structure ($\geq$50%), sufficient canal wall thickness (at least 2 millimetres), unsealable root canal, and informed consent. We excluded those with untreated caries, root inflammation, root damage, insufficient canal length and thickness, or canal curvature from further analysis. Some parents refused to allow their children to participate in the experiment; these children were also not included in the study.

Overall, 98 young patients met the eligibility requirements. We then calculated the required sample size using the Power & Sample Size Calculator available at https://www.gigacalculator.com. The input parameters were: alternative H1 for Non-inferiority, $\alpha = 0.05$; $1 - \beta$ (power) = 0.80; effect size = 0.1 (for Gingival Index). The calculation shows that the minimum sample size required per group is 41 patients. Given the possibility of attrition (10% in this case), the total sample size is 90 patients.

Among the population included in the analysis (Fig. 1), 64 were male and 26 were female. All 90 patients had caries on both upper central incisors. Hence, a total of 180 primary upper central incisors were affected.

A specialist (uninformed about the study design) randomly assigned patients to one of two parallel groups using a program available at https://www.gigacalculator.com. Forty-five patients were randomly assigned to receive PLA intracanal posts (PLAP group), and another 45 received glass-fibre posts (GFP group). The sequence for the allocation of patients was concealed in opaque envelopes, which were sequentially numbered and opened just before the operation.

No patients were excluded from the study during the 12-month follow-up period. The data analysis process involved a team of researchers blinded to allocation.

Table 1 presents the demographic and clinical characteristics of the patients.

2.2 Treatment

The restoration of the carious primary incisors consists of the following stages: preoperative assessment and preparation; endodontic treatment (including access and instrumentation/disinfection); preparation of the post space; placement of the intracanal post and crown reconstruction.

2.2.1 Preoperative assessment and preparation

All patients underwent visual and instrumental examination to determine the extent of damage to the coronal tooth structure. Root canals were evaluated using dental X-rays. All therapeutic procedures followed standard protocols, adjusted for the degree of damage. The dentist also assessed oral health and hygiene.

2.2.2 Endodontic treatment

The operative technique involved opening the carious cavity and removing affected tissues using spherical burs. The access cavity was prepared by inclining the bur at the lingual surface. The pulp tissue removal was a complete vital pulpectomy procedure with a 3% hydrogen peroxide solution as an irrigant. The orifice portion of the canal was widened with Gates-Glidden drills.

Root canals were cleaned mechanically with intracanal medicaments for irrigation and disinfection. Specifically, a

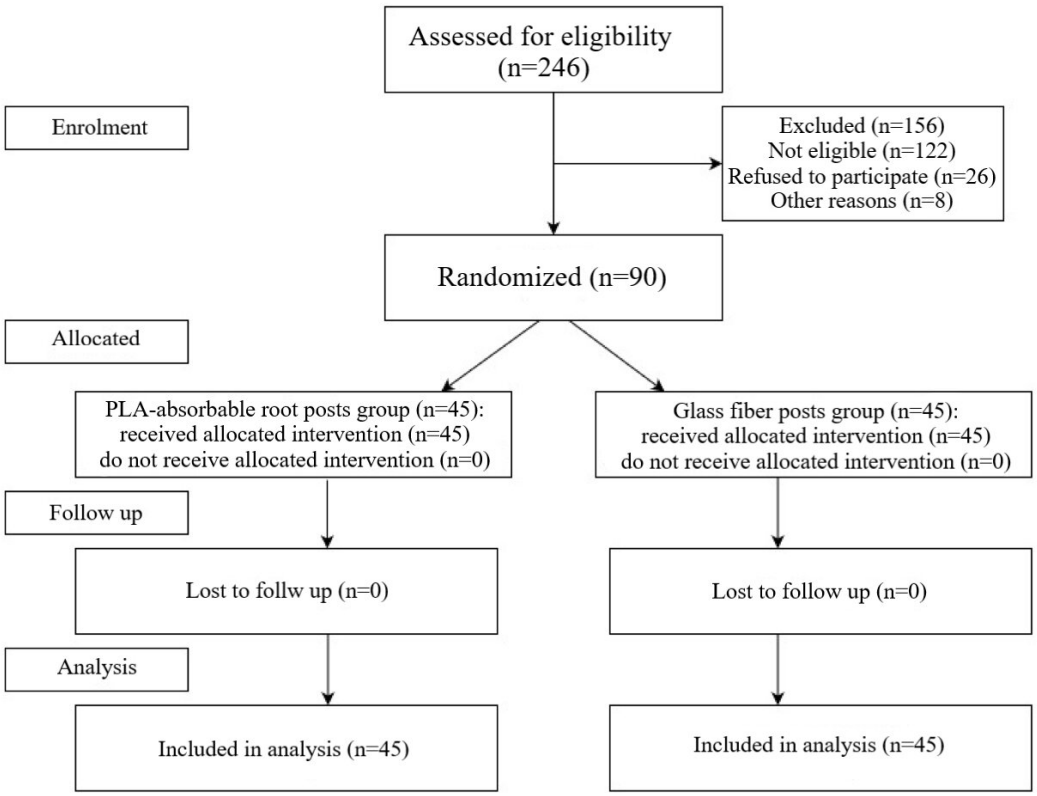

FIGURE 1. Flowchart of patients according to CONSORT guidelines (2010). PLA: resorbable polylactic acid.

TABLE 1. Demographic and clinical characteristics of the patients.

	PLAP group (n = 45)	GFP group (n = 45)
Age		
3 years	18	16
4 years	27	29
Gender		
Male	29	35
Female	16	10
Duration of illness		
Less than 6 months	11	14
More than 6 months	34	31
Caries involvement of upper incisors		
Both central incisors	28	26
Both central and lateral incisors	17	19
Classification of caries by depth of the lesion		
Moderate caries	24	28
Deep caries	21	17
Loss of coronal tooth structure		
50%–60%	14	17
61%–70%	24	23
≥71%	7	5

PLAP: PLA intracanal posts; GFP: glass-fibre posts.

3% sodium hypochlorite solution was injected directly into the root canal using a syringe and left there for 2 to 3 minutes. This procedure was followed by rinsing with a weak hydrogen peroxide solution. Alternative irrigants included iodine-based antiseptics like iodinol or iodate and a 30% aqueous solution of carbamide. The canal was then dried using compressed air. The mechanical cleaning of the root canal, which involves using the K-reamer, was followed by canal obturation with zinc oxide-eugenol paste (without formaldehyde).

Patients with acute or exacerbated chronic inflammation or canal bleeding were assigned for multiple-visit endodontic treatment until these symptoms had fully resolved. There were six such cases in group 1 and nine in group 2.

2.2.3 Post-space preparation

This procedure took place one week after standard endodontic treatment. The first step was to take out the temporary canal filling. Then, the dentist shaped the canals with the K-file using the step-back method. The apical portion of the root canal was instrumented first, and then the coronal part was shaped. The dentist took an initial apical file (IAF) and introduced it into the canal space to a full working length measured by the Woodpex V apex locator (Woodpecker, Guilin, China). After enlarging the root canal four sizes beyond the initial file, the participating dentist administrated the master apical file (MAF) to remove dentin shavings. The coronal portion of the root canal underwent a similar procedure. Each subsequent K-file had a set size of 1 mm shorter than the preceding size to form a conical canal configuration with an apical stop. Periodically, the dentist introduced MAF to full length to keep the canal patent. The intracanal posts used in the study were one size smaller than the MAF. The post length correlated with the canal length.

After the canal shaping, the dental surgeon etched the root space with 37% orthophosphoric acid for 15 to 20 seconds. The canals were then thoroughly rinsed using the syringe needle irrigation method and dried with cotton balls, paper points, and compressed air.

2.2.4 Glass-fiber post placement

The root canals were sealed with dual-curing adhesive resin cement (ExciTE F DSC, Ivoclar Vivadent) [28]. The adhesive agent was applied to canal walls and cured for 10 seconds. Subsequently, the dentist introduced a sealant into the root space along with the canal filler. The next step was to take a GFP (everStick, StickTech Ltd., Turku, Finland) with a diameter of 1.5 mm and cut it to a length of 6 mm. GFP was inserted into the canal to a 3 mm depth so that the remaining portion of the implant could serve as the core structure reinforcement. GFP placement to a depth of 3 mm did not interfere with physiological root resorption. The dentist validated the length of the post with a scored probe before cementation. Before the post-placement procedure, GFP was coated with a dual cement mixture (Variolink II, Ivoclar Vivadent, Liechtenstein); the base and catalyst pastes were mixed as per the manufacturer's instructions. After removing the excess material, the dentist cured the cement for 60 seconds using a polymerization lamp. The fibre-reinforced posts were trapped and manipulated by tweezers.

The crown reconstruction procedure involved the incremental placement of a nanohybrid composite resin (Tetric N-Ceram, Ivoclar Vivadent). The gradual addition of resin reduces the effect of polymerization shrinkage stress and leads to fewer voids. First, the dentist filled the entrance to the canal with a composite, then used the same composite to build a crown (5–6-mm diameter × 6-mm length). Each increment (not thicker than 1.5 mm) was light-cured at 600 mW/cm^2 for 20 seconds using a photopolymerizer (Coltolux LED, Coltène/Whaledent AG, Altstätten, Switzerland). Before applying the new layer of composite substance, the dentist measured the intensity of the curing light with a radiometer (Model 100 Optilux Radiometer, SDS Kerr, USA).

2.2.5 PLA intracanal post placement

The sealant procedure involved a cyanoacrylate adhesive applied to canal walls; the excess material was removed with compressed air. After injecting cyanoacrylate glue into the canal 20 seconds later, the dentist slowly inserted the PLA post (covered with the adhesive agent) into the canal space while applying pressure. The system was cured afterwards using a polymerization lamp. The crown reconstruction procedure was similar to the one implemented in the GFP group (Fig. 2).

Of all patients, 18 were treated under general anaesthesia due to uncooperative behaviour, including seven patients in the PLAP group and 11 in the GFP group, whereas others received local anaesthesia. All teeth were treated by a single experienced dentist.

It would be beneficial to perform the above procedures under a rubber dam, for it helps isolate the operative field and effectively prevents the spread of infections. However, the dentist chose otherwise due to the risk that children aged 3 to 4 years could have an ambivalent response towards the prospect of placing thereof. Instead, the dentist meticulously disinfected the instruments and the operative field to avoid negative consequences.

2.3 Clinical assessment

The incisor restorations were clinically evaluated immediately after the restorative procedure as baseline and subsequently at intervals of 3, 6 and 12 months. The focus was on inspecting the supporting tissues of the restored tooth (periodontium) and assessing inflammatory changes in the marginal gingiva (marginal gingivitis). The follow-up procedure involved evaluating the Gingival Index (GI) and the Bleeding Index (modified by Cowell, mBI). Each upper central incisor (90 per group) was examined separately. The oral hygiene level was measured using the Green-Vermillon Index.

The GI of each restored tooth was obtained by examining the gingival papilla from the medial and distal surfaces of the tooth and the marginal gingiva from the vestibular and lingual tooth surfaces. The bleeding tendency of the gingiva was assessed by running a blunt instrument along the walls of the gingival sulcus. The scoring criteria are as follows: 0—normal gingiva; 0.1–1.0—mild gingivitis; 1.1–2.0—moderate gingivitis; 2.1–3.0—severe gingivitis. The mBI index was measured by probing the gingival papilla. The mBI scoring system is as follows: 0—no bleeding on probing; 1—bleeding

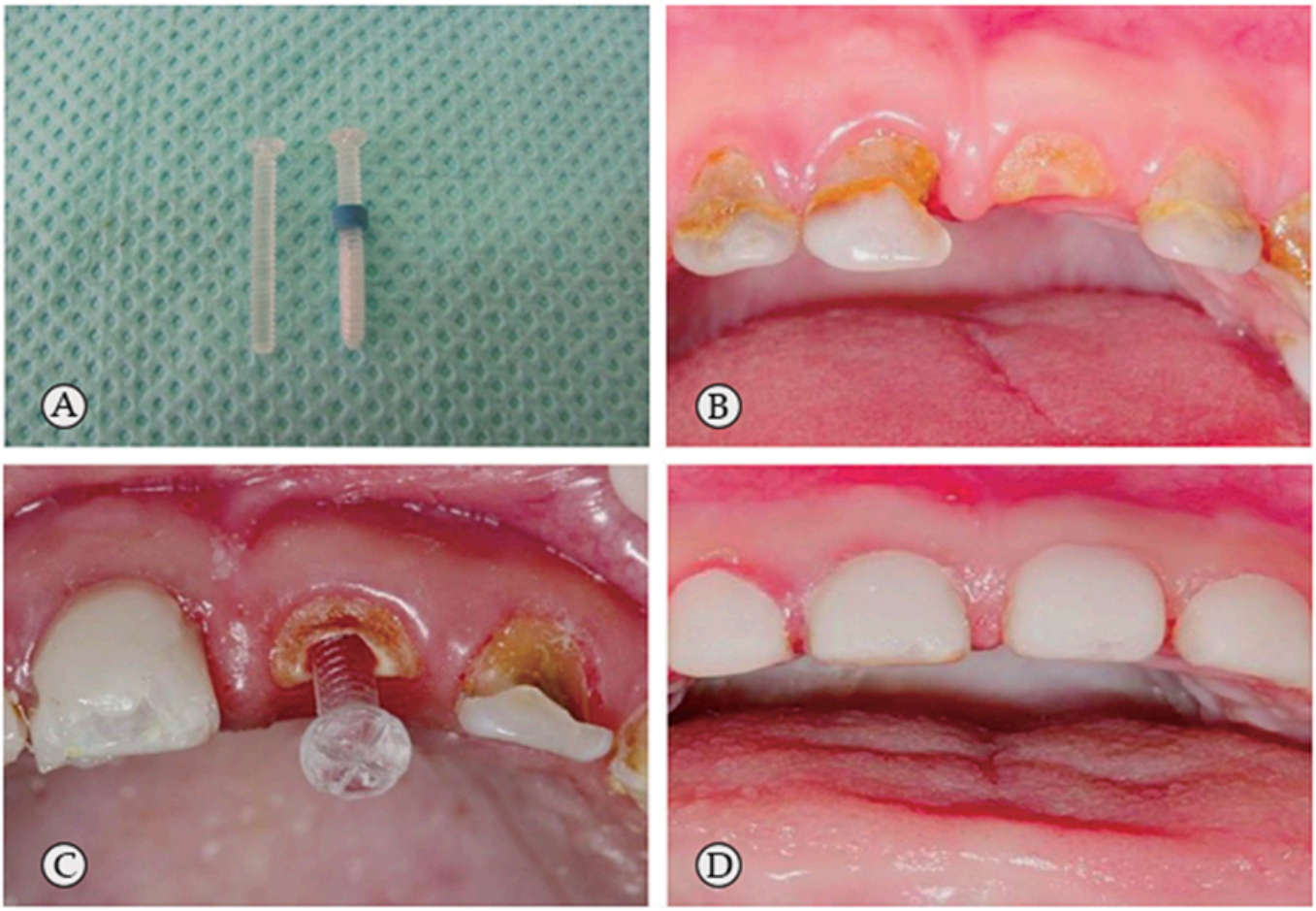

FIGURE 2. A typical case of primary incisor restoration with a PLAP. (A) PLA post; (B) primary incisors affected by caries before crown reconstruction; (C) placement of PLAP; (D) upper primary incisors after crown reconstruction (in this case, the lateral incisors are ignored).

after 30 seconds of probing; 2—immediate bleeding on probe placement or within 30 seconds of probing.

Each patient's bite force was evaluated using the T-Scan II system (Tekscan, USA). The dental surgeon performed the Bite Force assessment procedure in a playful manner to ensure that young patients followed the instructions. The analysis involved taking five measurements at each observation point with a small interval. The lowest and highest values were discarded. The remaining three measurements laid the groundwork for calculating the mean bite force (BF).

Here, we evaluated the clinical effectiveness of intracanal posts by considering whether the restoration was a success or a failure. The operation was considered successful if the child experienced no side effects or symptoms. In this case, the colour of the gums, chewing function, and the state of the periodontium should be within the norm. There must be no signs that the crown fell off or got loosened. The X-ray examination must show no progress in the disease or shadow in the apical region of the tooth. The presence of either of the following symptoms was considered a failure of the treatment: inability to masticate, gum swelling or abnormal colouration, root fracture, deep periodontal pockets, denture loss or loosening, and periapical lesions on X-ray.

Additionally (as a secondary outcome according to CONSORT), the quality of dental tissue restorations was evaluated at 3-, 6- and 12-months using criteria from the United States Public Health Service (USPHS) and Word Dental Federation (FDI) [29]. Based on the FDI guidelines, the primary criteria for evaluating the quality of dental restorations are anatomical form, marginal adaptation, surface texture, marginal discolouration, colour match, interproximal contact and recurrence of caries. We examined parameters separately for each upper central incisor. Here, each criterion was classified as good (Alpha), sufficient (Bravo), unsatisfactory (Charlie), and clinically poor (Delta). Codes Alfa, Bravo, Charlie and Delta were paired with the assigned scores for all parameters of the FDI criteria. The pairings are as follows: Alpha (A)—3 points; Bravo (B)—2 points; Charlie (C)—1 point; Delta (D)—0 points.

The diagnosis of secondary caries was made based on the presence of the following symptoms: bleeding from the gums, teeth (or jaw) that are painful to the touch, inflammation and swelling underneath the filling, red mucosa, bad breath and sensitive enamel.

2.4 Statistical analysis

Data analysis was performed in SPSS 20.0 (IBM, Armonk, NY, USA). Results are presented as means and standard deviations ($M \pm SD$). The normality of the data was checked using

the chi-square (χ^2) test. The comparison between groups was performed using Student's *t*-test with Bonferroni correction. The Student's *t*-test was employed with normally distributed quantitative data. The comparison of qualitative variables was performed using the chi-square test. A *p*-value less than 0.05 was considered statistically significant.

3. Results

Table 2 presents comparative data on the gingival health and occlusal function between groups before and after treatment. As can be seen, there were no statistically significant differences found in GI and BI scores before restoration, and the occlusal BF values were also similar ($p > 0.05$). At three months' post-restoration, the occlusal BF in the PLAP group was higher than the baseline, whilst the GI and mBI scores were lower, by contrast ($p < 0.05$). This tendency was even more pronounced 6 and 12 months after the restoration. The GI and mBI scores of the PLAP group were lower than in the GFP group, but the occlusal BF was higher. This is true for all observation points. These differences are statistically significant ($p < 0.05$).

The incidence of adverse events in the PLAP group was significantly lower than in the comparison group ($p < 0.05$). The GFP group had three cases of apical inflammation, one cervical fracture, and six children with a loose crown. In the PLAP group, there was one incidence of apical inflammation, two loosened crown cases, and no cervical fractures (Table 3). In terms of clinical efficacy, the PLAP group had a significantly higher success rate than the GFP group. This difference was statistically significant at all observation points ($p < 0.05$).

There were no statistically significant differences between the two groups with respect to colour match, anatomical form, marginal adaptation, marginal pigmentation, surface roughness, contact point and secondary caries. In both groups, the gingival status was related to marginal adaptation. Of 45 patients who received GFP, 2 had slight gingival swelling at the 3-month follow-up. In the PLAP group, no such cases were present.

At baseline and after three months of follow-up, all restorations in both groups scored Alpha for colour match, anatomical form, marginal adaptation, marginal pigmentation, surface roughness, and occlusal contact. After 6 and 12 months of follow-up, some restorations downgraded to a Bravo score. However, no statistically significant differences were present between the two groups (Table 4).

4. Discussion

This study compared the clinical outcomes of patients assigned to undergo restoration of the primary upper incisors with GFP and resorbable PLA intracanal posts. In recent years, anterior primary caries and caries-damaged primary teeth restoration have become one of the most urgent problems in pediatric dentistry. A relatively inexpensive and straightforward solution is intracanal reinforcement.

In restorative dentistry, metal anchor pins have long been used to restore tooth crowns. Despite their ability to withstand significant loads related to chewing and provide active mechanical retention, they also have shortcomings. Because metal anchor pins must be screwed in, they create tension within the tooth's root. It can lead to the development of fissures within the canal. In addition, root fractures may occur both during the sealing procedure and when chewing. Another issue is that metal pins produced from specific alloys (nickel-chromium, cobalt-chromium and stainless steel) are prone to corrosion. Studies also report the absence of a strong connection at the metal-cement-dentin interface and insufficient aesthetics in the anterior tooth restorations [11, 12]. Polymeric posts made from synthetic materials such as glass and carbon fibre have emerged as a replacement for metal systems and offer several advantages. GFP exhibits high transverse density, evenly distributes occlusal forces, is biologically inert and provides aesthetic benefits [13, 14]. However, it also has drawbacks. The problem is that the surface of the GFP exhibits low adhesion, resulting in poor bonding with light-cured composite materials. This property reduces their service life. According to some data, the bond between the tooth tissue and the surface of the GFP can fail in 15% of cases, leading to complete debonding of the restoration, necessitating replacement [15]. The extraction of GFP from the canal (if necessary) requires dentists to employ suitable instruments and a microscope [15]. The restorative effect on the residual coronal structure thus depends on the choice of intracanal materials. Modern intracanal posts are designed to provide high retention and fracture resistance, preserve the tooth structure, and reduce the possibility of corrosion [30]. Such intracanal posts also have anti-rotational properties, and their modulus of elasticity is similar to that of dentin. Modern post systems allow an even distribution of occlusal forces along the entire root length and a maximum area of contact with the remaining tissues possible. Hence, they provide excellent aesthetic outcomes. Other advantages of modern dental reinforcements are non-cytotoxicity, radiopacity and ease of use. At the same time, the cost of intracanal post materials can make restorative procedures inaccessible for some segments of the population, especially when addressing caries-related damage to the coronal portion of the tooth. In China, to solve this problem, considerable efforts have been directed towards exploring PLA as a promising substitute for the common intracanal post materials. This exploration pertains to the restoration of caries-affected crowns in primary dentition.

PLA is a highly crystalline, high molecular weight polymer derived from corn or sugar cane starch. Inside the human body, it degrades through the hydrolysis of the ester-bond backbone into lactic acid (which later becomes pyruvate). PLA is excreted from the body as carbon dioxide and water by the tricarboxylic acid cycle [31]. Some researchers studied the degradation time and strength retention of PLA implants *in vivo* and *in vitro*. These studies show that a complete *in vivo* degradation time of a resorbable PLA intracanal post is close to the physiological time of primary teeth absorption [6, 32]. In particular, the experiment with a phosphate buffer used to mimic *in vivo* degradation revealed that the PLA degradation rate was comparable to the absorption rate for primary teeth roots [22]. PLA intracanal posts allow an aesthetic restoration with good full-coronal coverage [22] and provide sufficient

TABLE 2. Comparison of gingival health and occlusal function before and after treatment.

Variables	GFP				PLAP			
	Before restoration	After restoration			Before restoration	After restoration		
		3 months	6 months	12 months		3 months	6 months	12 months
Gingival index (GI)	1.67 ± 0.26	1.12 ± 0.22	1.04 ± 0.23	1.01 ± 0.17	1.63 ± 0.28	0.82 ± 0.14	0.79 ± 0.16	0.74 ± 0.18
Bleeding index (mBI)	2.12 ± 0.18	1.53 ± 0.22	1.44 ± 0.19	1.40 ± 0.21	2.07 ± 0.15	1.17 ± 0.18	1.08 ± 0.15	1.04 ± 0.16
Bite force/Ibs	84.56 ± 5.32	111.34 ± 6.85	113.34 ± 6.43	113.68 ± 6.73	85.22 ± 5.16	142.33 ± 7.31	144.63 ± 7.85	144.87 ± 7.93

Note: GI and mBI were assessed for each upper central incisor (n = 90 per group), and BF was measured for each patient (n = 45 per group).
** Student's t-test p-value indicates statistical significance, $p < 0.05$.*
GFP: glass-fibre posts; PLAP: PLA intracanal posts.

TABLE 3. Comparison of adverse event frequencies between groups.

Groups	Apical inflammation	Cervical fracture	Loosening of the crown	Failure cases, total
GFP	3	1	6	10 (22.2%)
PLAP	1	0	2	3 (6.7%)

Note: Side effects and symptoms were evaluated for each upper central incisor (n = 90 per group).
** Student's t-test p-value indicates statistical significance, $p < 0.05$.*
GFP: glass-fibre posts; PLAP: PLA intracanal posts.

TABLE 4. Comparison of restorations based on the USPHS criteria.

Variables	GFP		PLAP		*p*
	6 months	12 months	6 months	12 months	
Colour match	2.61 ± 0.12	2.56 ± 0.11	2.64 ± 0.13	2.61 ± 0.11	0.025
Anatomical form	2.74 ± 0.08	2.59 ± 0.09	2.69 ± 0.10	2.63 ± 0.09	0.021
Marginal adaptation	2.68 ± 0.07	2.66 ± 0.06	2.71 ± 0.06	2.69 ± 0.07	0.008
Marginal pigmentation	2.52 ± 0.09	2.44 ± 0.10	2.57 ± 0.07	2.47 ± 0.05	0.007
Surface roughness	2.54 ± 0.12	2.48 ± 0.14	2.50 ± 0.12	2.47 ± 0.10	0.004
Occlusal contact	2.78 ± 0.05	2.72 ± 0.06	2.76 ± 0.04	2.72 ± 0.05	0.012

Note: Each upper central incisor was under assessment (n = 90 per group). The significance of between-group differences was determined by the Student's t-test.
GFP: glass-fibre posts; PLAP: PLA intracanal posts.

retention [6].

Both resorbable PLA-based and short glass-fibre posts are essentially foreign bodies, the insertion of which can cause gingival injury. Clinically, the sign of gingival irritation is the inflammation of the gingival sulcus. In this study, PLA intracanal posts were associated with significantly lower inflammation and higher BF values when compared to the glass-fibre ones (Table 2). The present study demonstrates that resorbable PLA posts combined with cyanoacrylate adhesives have a higher success rate in the coronal restoration of anterior central incisors than their glass fibre alternatives used with dual-curing resin cement. In particular, there were just two instances of crown loosening compared to 6 with the glass-fibre posts. Apical inflammation was observed in just one tooth, while the comparison group had three cases like this. When using the resorbable PLA posts, there were no cases of cervical fracture detected. In the GFP group, there was one such case. These findings suggest that PLA posts are as good as GFP. Specifically, the good colour matching of the PLA posts implies that this material has sufficient translucency, which allows aesthetic restoration. The adaptation and staining of the margins depend on the uniform transmission of the load through the crown of the tooth to the adjacent hard tissues. As per this parameter, resorbable PLA posts demonstrate comparable efficacy to those composed of glass fibre. Meanwhile, parameters like the esthetic anatomical form, occlusal contact, and presence of caries depend on the tooth preparation and restoration technique. The surface roughness of coronal

restorations depends on how polished the composite materials are.

The results suggest that resorbable PLA posts combined with cyanoacrylate adhesive can help restore gingival health in children, increase the occlusal bite force, and ensure the safer restoration of anterior deciduous teeth. For high restoration efficiency, PLA posts should be placed one week after conventional root canal treatment unless there is an evident apex anomaly. It is necessary to save as much dental tissue as possible during the treatment. The length of the root canal is directly proportional to the extent of dental tissue preservation. Ultimately, it will result in better restoration. It is necessary to ensure a sufficient width of the root canal and consider the thickness of its walls. Clinical attention should be given to detecting aseptic inflammation in the surrounding tissues caused by lactic acid production during PLA degradation.

Note that this study has its limitations. The follow-up period after the intervention was 12 months. Yet, longer observation periods are needed to evaluate the clinical application of resorbable PLA intracanal posts. This work is currently in progress, and the results will be published in the future. The glass-fibre posts were cemented with a dual-curing adhesive resin cement as the most common agent used with this post type, whilst PLA posts were cemented with cyanoacrylate. In previous studies, this adhesive material performed better with this post type than the alternatives [16]. Yet, more studies are needed to explore these agents in terms of biocompatibility and adhesive ability in a wet environment. Also, children aged 3 to 4 may exhibit low compliance during the follow-up period. Therefore, their parents were informed about dental recommendations. Overall, parental control was crucial for improving compliance. Currently, studies on the clinical application of PLA posts are relevant because such restorative materials can provide an uncomplicated transition to permanent dentition, an average occlusal ratio, and the normal functioning of the maxillofacial region. Because PLA has good biocompatibility and meets biosafety requirements, it can be an effective and more cost-effective alternative to glass-fibre posts.

5. Conclusions

In this study, the GI and mBI scores at the 12-month follow-up were lower in the PLAP group, but the occlusal BF score was higher, by contrast. When using the Ryge criteria, restorations did not differ significantly between the groups at the end of the follow-up period. PLAP had substantially higher success rates compared to GFP.

Based on the present findings, resorbable PLA posts can be used to restore caries-damaged crowns of the primary anterior teeth. When employed in conjunction with cyanoacrylates, PLA intracanal posts exhibit the potential to enhance gingival well-being, diminish the occurrence of adverse effects or manifestations, and notably augment the probability of achieving a successful restoration. Among their advantages are good biocompatibility, no cytotoxic effects, good light transmission, and aesthetic restoration. In addition, they allow the masticatory pressure to be distributed along the dentoalveolar segment, as well as the long-term full-fledged functioning of the dentition. The resorbable PLA intracanal posts are as effective as the glass-fibre alternatives but are less expensive. Hence, PLA can become an alternative to other post types used for the morphological and functional restoration of primary teeth. PLA posts constitute an important direction for further dental research. More in-depth studies are needed.

AVAILABILITY OF DATA AND MATERIALS

Data will be available on request.

AUTHOR CONTRIBUTIONS

HX—Conceptualization and methodology. XFC—Data curation. JRW—Formal analysis. QZ—Project administration and resources. FNQ—Validation and visualization. XLM—Methodology and writing–review & editing.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. The research was approved by the local ethics committees of Hebei Eye Hospital (Protocol No. 58-2019). Informed consent was obtained from parent or guardian of all study participants.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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