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Effect of three fiber post removal technique on the amount of root dentin an *in vitro* study

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Abstract
Aim: Aim of the current research was to differentiate among three distinct methods for removing fiber posts and assess their influence on the quantity of preserved root dentin.
Methods: For 30 removed single-rooted teeth, the teeth were decorated along with endodontic treatment was performed. The roots were cut apically at (11mm from the CEJ) and fibre post spaces were made. Stereomicroscope radiographs of the apical cross section during post space were taken at 20x magnification. Dual cure resin cement was used to secure the fibre post. Following specimen were illustrated in the three (n=10) groups using the fibre post eliminated method: Diamond bur (I), Pesso reamer (II), and Ultrasonic tips (III). The previous section's photographs were shot at the same magnification after the post was removed. Graticule was utilized for assessing the x and y axis space disparities among prior to and following removing photographs. The one-way ANOVA test with the Bonferroni adjustment was used to statistically analyse the data.
Results: The mean amount of root dentin eliminated was highest in diamond bur group when measured on x axis and y axis, while it is lowest for ultrasonic tip at both the axis.
Conclusion: The most forceful approach for removing glass fibre was the diamond bur group.

Keywords: Aesthetics, Fiber post, posts removal, root dentin, ultrasonic tips

Introduction
The restoration of endodontically treated teeth is a crucial phase in the overall treatment plan. Successful treatment outcomes and the reinforcement of weakened teeth can be achieved through the use of intra-radicular posts. These posts serve to stabilize the core within the root portion of the tooth, enabling the replacement of missing tooth structure and ensuring adequate retention as well as conflict for the ending restoration or crown. In recent times, various types of fiber posts have been developed, offering exceptional aesthetic qualities along with favorable physical properties and satisfactory radiographic appearance [1, 2]. These fiber posts exhibit an appropriate elastic modulus and demonstrate strong bonding capabilities with cement. Additionally, they possess the advantage of being relatively simple to remove [3]. When a tooth surface is restored using a fiber post, the forces applied to the tooth are engrossed through the post as well as core, rather than being transmitted to the root formation. As a result, the decline manners by fiber posts tend to be additional favorable compared to metal posts [4, 5]. In modern dental practice, the extraction of fiber posts has become a frequent procedure, particularly whenever a noninvasive retreatment is required attributable to endodontic management deficiency affected by issues such as micro-leakage in the coronal part of the canal or inadequate disinfection of the root canal system. Additionally, fiber post removal may be required as a result of post fracture [5, 6]. Various techniques and bur kits allow for the removal of fiber posts. However, the success of removing an existing fiber post depends on the material used for its fabrication. Often, dentists encounter fiber posts with unknown origins, which poses a challenge as many removal kits are designed specifically for certain post systems. Consequently, these removal kits may be ineffective when dealing with such unfamiliar posts [7]. A universal fiber post removal system has been developed to effectively remove fiber posts of any origin [8, 9].

One such technique utilizes ultrasonic vibration to efficiently fragment various types of cement layers, making the post removal process more manageable [10]. Resin cements, commonly utilized for fixing fiber posts, exhibit higher resistance and have the ability to absorb ultrasonic energy, thereby impeding their fragmentation [11, 12]. During endodontic retreatment, varying amounts of root dentin may be stray, particularly when the tooth is restored using a fiber post [6]. It is also notable that the removal of fiber posts can contribute to additional dentin loss. Hence, primary objective of present research was to distinguish between three different fiber post removal procedures and their impact on the amount of excluded root dentin.

Materials & Methods

This research was carried out for three months, from January 2023 to March 2023, in the Department of Conservative Dentistry and Endodontics, Tertiary Healthcare Center with IEC approval. Thirty single-rooted teeth were designated as well as extracted for orthodontic purposes. These teeth were then randomly categorized into three groups, each comprising 15 teeth, based on the fiber post removal procedure to be used. The teeth in the sample had whole radicular formation and were free from caries as well as cracks, as determined through radiographic evaluation and microscopic examination. Teeth with radicular caries, inner resorption including curved roots were eliminated from the study.

A diamond disk® (Horico, Berlin, Germany) was used to eliminate the tooth crown, and the canal was cleaned and dried with ProTaper®files (DentsplyMaillefer, Ballaigues, Switzerland), beginning with the help of shaping files (S1, Sx, S2) and finishing files (F1, F2, F3). The canal was moistened with the 2.5% NaOCl, along with the smear layer was eliminated with 17% EDTA. The previously constructed canal was covered with root canal sealer AH and above ®sealer (Dentsply Maillefer, Switzerland, Ballaigues) before being occupied with #F3 guttapercha cones as master cones and 0.02 cones as accessory cones (Meta. Korea) using the lateral condensation process.

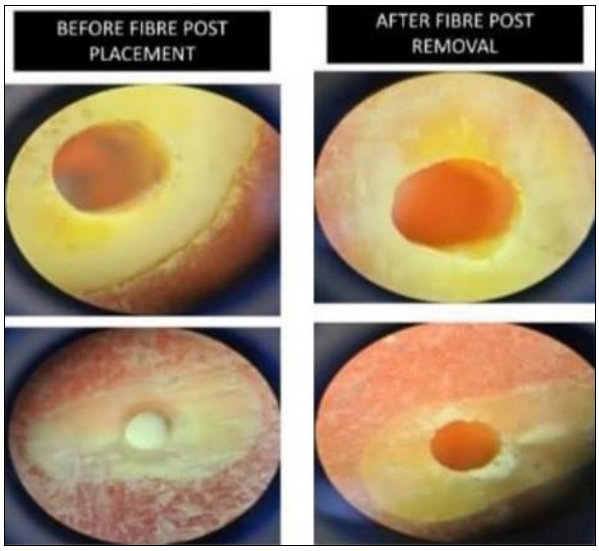
Specimens were equivocating using MDTemp® (Meta. Korea) temporarily filling.

The samples were incubated at room temperature for 7 days in a vial containing 0.9% saline solution in 100% humidity levels. The gutta-percha inside the root canal was eliminated implanting a Largo reamer no. 2, with a rubber stopper positioned at 11 mm of the canal planetary. Subsequently, the canal was prepared to accommodate a No. 3 fiber post (1.6 mm) exhausting the conforming drill (Deukega, Germany). The root apex was trimmed apically to achieve an 11 mm root length. Photographs of the coronal and apical cross-sectional areas were captured and attached on a stereomicroscope ocular eye (MEIJI, Japan, and stereomicroscope) at a magnification of 20x, with the assistance of a graticule at 8x.

During both phases of imaging (Once post space preparation as well as afterward post removal), the distance among the lens as well as the root section was maintained at 20 mm. The photographs were appropriately coded and saved for future matching purposes. The fiber posts were cut at 11 mm length in addition underwent conditioning with alcohol following the manufacturer's suggestions. A Prosil coupling agent from FGM, Brazil, was applied to the post surfaces using a special brush, ensuring complete coverage for 60 seconds. Following this, a gentle current of air was directed at the post for duration of 5 seconds. Prior to smearing the bond agent to fiber post, all posts were treated without coming into contact with the activated area.

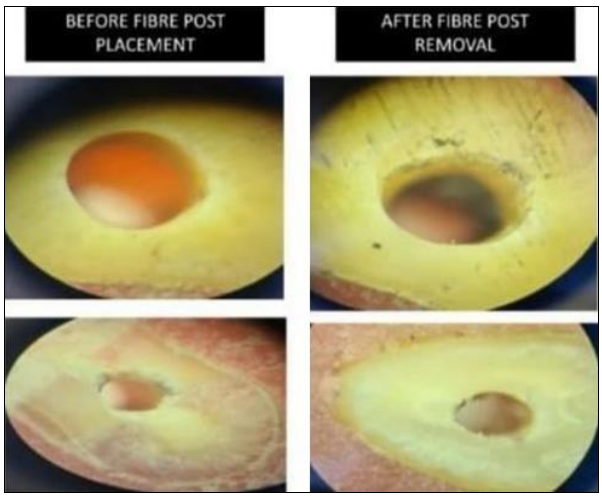
Next, the canals were etched, utilizing the (37% phosphoric acid) (Eco-Etch®, ivoclar vivadent®, Schaan, Liechtenstein) for 15 seconds, afterword full rinsing with the help of water. To prevent the dentin from drying out, paper points were used to blot the canals dry. Subsequently, a one-step dental bond (TetricN-bond®, ivoclar vivadent®, Liechtenstein) was gently applied to the canal walls, and air was casually blustered to ensure comprehensive coverage. Each cut section was then light-cured for 20 seconds to achieve complete bonding. For the next step, a dual-cure resin cement variolink-N® (ivoclar vivadent®, Liechtenstein) was inserted into the canal space with the help of a syringe equipped with a lentulo spiral. Fiber posts were then carefully implanted to their full depth in the post space to confirm optimal adaptation in addition to extreme bonding to the canal. [3, 13] After removing extra cement, light curing for 60 seconds was performed. For 30 days, the specimens were maintained at 37°C to permit the cement to cure previously being casually divided into three distinct categories (n = 15).

The centre of the post was worn away till nearly half of the space was gone utilizing a spherical long neck (0.6 mm) water cooled bur at high speed airoter. (Group 1).



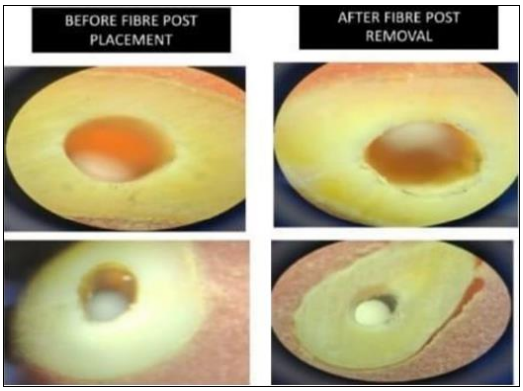
Group 1: (Diamond bur)

Largo Peeso reamer no. 3 was used at short speediness along with no refrigeration to eliminate the post completely from the canal. (Group II)



Group 2: (Peeso reamer)

To facilitate post visualization as well as to disturb the arrangement of post fibres induced by the release of heat, The core of the post was worn out to the center using a scrubbing action with power manner E as well as dry operating method. (Group III)



Group 3: (Ultrasonic tips)

The post removal procedure was deemed complete under the following conditions:

1. The measurement of the depth of pretreatment for the post elimination tool was 11 mm.
2. There were no visible traces of resin cement or fiber post remnants on the canal walls or in the apical region when examined underneath stereomicroscope.

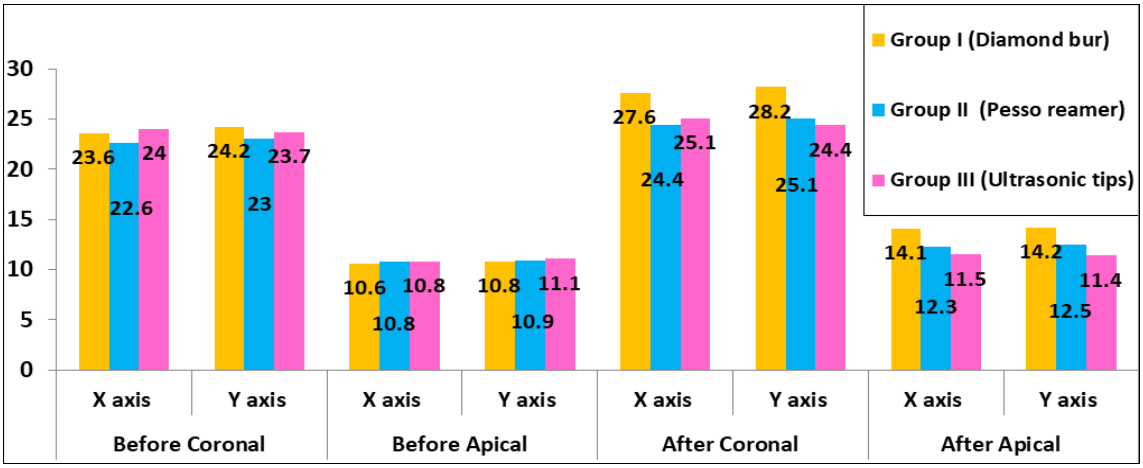
Following successful removal of the posts, debris was thoroughly cleaned, and additional photographs were taken using the previous cross-sectional views. The quantity of eliminated root dentin was then examined based on these photographs, utilizing the graticule at both the x-axis and y-axis.

Results

Group I exhibited the maximum average significance of eliminated root dentin, succeeded by Group II, while the lowermost mean value was observed in Group III. (Table 1, Graph 1).

Table 1: Comparison of mean and SD values of amount of root dentin at coronal and apical cross section in Group I (Diamond bur), Group II (Pesso reamer) and Group III (Ultrasonic tips)

(n=10)	Before Coronal		Before Apical		After Coronal		After Apical	
	X-axis	Y-axis	X-axis	Y-axis	X-axis	Y-axis	X-axis	Y-axis
	average ± Std.	Average ± Std.	Average ± Std.	Average ± Std.	Average ± Std.	Average ± Std.	Average ± Std.	Average ± Std.
Group I (Diamond bur)	23.60±1.07	24.20±1.23	10.60±0.69	10.80±0.92	27.60±1.77	28.20±1.22	14.10±1.29	14.20±0.78
Group II (Pesso reamer)	22.60±0.96	23.0±0.94	10.80±0.78	10.9±0.87	24.40±0.96	25.10±1.10	12.30±0.82	12.50±0.97
Group III (Ultrasonic tips)	24.0±2.31	23.70±1.33	10.80±0.78	11.10±0.87	25.1±2.72	24.40±1.57	11.50±0.71	11.40±0.84



Graph 1: Comparison of mean and SD values of amount of root dentin at coronal and apical cross section in Group I (Diamond bur), Group II (Pesso reamer) and Group III (Ultrasonic tips)

By applying Student's Paired 't' test there is a significant variance in the average standards of amount of root dentin from before to after coronal cross section in Group I (Diamond bur), Group II (Pesso reamer) and Group III (Ultrasonic tips). (Table 2).

Table 2: Comparison of mean and SD values of amount of root dentin from before to after coronal cross section in Group I (Diamond bur), Group II (Pesso reamer) and Group III (Ultrasonic tips)

(n=10)	Before Coronal to After Coronal							
	Before Coronal		After Coronal		X- axis		Y- axis	
	X- axis	Y- axis	X- axis	Y-axis	Student's Paired 't' test value	'p' value and significance	Student's Paired 't' test value	'p' value as well as significance
	Mean± SD	Mean± SD	Mean± SD	Mean ± SD				
Group I (Diamond bur)	23.60±1.07	24.20±1.23	27.60±1.77	28.20±1.22	12	p=0.0001, significant	7.141	p=0.0001, significant
Group II (Pesso reamer)	22.60±0.96	23.0±0.94	24.40±0.96	25.10±1.10	13.416	p=0.0001, significant	4.714	p=0.0001, significant
Group III (Ultrasonic tips)	24.0±2.31	23.70±1.33	25.1±2.72	24.40±1.57	6.708	p=0.0001, significant	4.583	p=0.0001, significant

The application of Student's Paired 't' test stated that the statistically significant modification in the average standards of root dentin asmount before and after the apical cross-section in all three groups: Group I (Diamond bur), Group II (Pesso reamer) as well as Group III (Ultrasonic tips). (Table 3).

Table 3: Comparison of mean and SD values of amount of root dentin from before to after apical cross section in Group I (Diamond bur), Group II (Pesso reamer) and Group III (Ultrasonic tips):

(n=10)	Before Apical to After Apical							
	Before Apical		After Apical		X- axis		Y - axis	
	X-axis	Y-axis	X - axis	Y - axis	Student's Paired 't' test value	'p' value and significance s	Student's Paired 't' test value	'p' value as well as significance
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD				
Group I (Diamond bur)	10.60±0.69	10.80±0.92	14.10±1.29	14.20±0.78	4.583	p=0.0001, significant	11.699	p=0.0001, significant
Group II (Pesso reamer)	10.80±0.78	10.9±0.87	12.30±0.82	12.50±0.97	1.964	p=0.0001, significant	6.708	p=0.0001, significant
Group III (Ultrasonic tips)	10.80±0.78	11.10±0.87	11.50±0.71	11.40±0.84	7.216	p=0.0001, significant	7.236	p=0.0001, significant

Discussion

The extraction of posts from endodontically treated teeth poses a significant challenge during tooth retreatment [11, 12]. When deemed necessary, this process should be performed in a safe and straightforward manner [5, 6].

Ultrasonic vibration is a widely adopted technique for post removal, and it induces the cement coating destruction.[14, 15] The resin cement apply for luting fibre posts, on the other hand, has elements that improve adherence to the intra-radicular dentin, which making it additional impermeable as well as capable of absorbing ultrasonic energy. As a result, it becomes necessary to reinforce ultrasonic vibration by initially using diamond burs and subsequently employing vibration to ensure complete and successful post removal [16-19].

When aiming to achieve maximum removal of filling material and address issues like bacterial presence or broken fiber posts, some degree of dental structure loss is inevitable [6]. This process is necessary to expose fresh dentin and ensure proper bonding with the cement coordination. The distinctive assembly of fiber posts, composed of strained equivalent fibers in a resin conditions, serves as a guide for removal drills and burs. This unique design helps to contain and control the drilling process within the post's structure, minimizing the risk of root perforations [20].

To eliminate any influence arising from variations in tooth type, size of canal preparation, obstruction technique, and fiber post specifications, this study adopted a standardized approach [21]. By doing so, the potential impact of variances in contented, matrix as well as fiber way on post subtraction was minimized.

Considering that the apical third of the tooth root is highly influenced by retreatment processes, an apical root section measuring 11 mm in length was chosen to represent anatomical shape during the study.

The primary reason of glass fibre post disappointment is its independence coming from the root canal dentin [3]. It's very critical to maintain uniform fibre post-bond conditions in order to get maximal bond strength by the root canal dentin. As a result, as Goracci and Ferrari's study demonstrated that the total acid etching approach accompanied by the use of dual-cured resin cement was preferable [3].

On the basis of present research demonstrated that the E4D diamond ultrasonic tip resulted in less dentin removal compared to the diamond bur and Peeso reamer when employed to break up the fiber post construction using vibrations.

However, as the kind of fibre post present within the canal is unknown, preeminent strategy is to use an accessible fibre post elimination kit for making sure harmless as well as efficient removal. This aligns with the findings of Lindemann's study, which investigated the productivity and efficiency of various fiber post eliminations method [7].

Despite the slightly higher average standards for the ultrasonic technique, no significant variance was observed among the effects of the Peeso reamer as well as the ultrasonic tip. The heat created by the ultrasonic vibrations may have contributed to the superior subtraction of tooth tissue as well as adhesion cement nearby the fibre post. The outcomes of our research is similar with study done by Abe *et al*., who found that using ultrasonic heads increased efficacy [22].

The importance of safe post removal cannot be overstated, making it a critical consideration when choosing a post elimination procedure. Additional *in vitro* as well as *in vivo* trials are warranted to assess various fiber post eliminating procedure, different types of fiber posts as well as other ultrasonic tips, focusing on their capability to achieve glass fiber post removal with minimal removal of root dentin.

Conclusion

Based on the results of present research as well as considering the boundaries of the research, it was determined that diamond burs were the destructive method for eliminating glass fiber posts, surpassing the ultrasonic tip E4D as well as Peeso reamer techniques. Further investigations are warranted to explore additional techniques capable of effectively removing glass fiber posts while preserving dental structure.

Conflict of Interest

Not available.

Financial Support

Not available.

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