



## A Comparative Study Of Tensile Forces For Two Types Of Posts (Diamond Burs, Fiber Posts) (An In Vitro Study)

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**Research target:** This study compares the tensile forces for two types of posts (diamond burs, fiber posts).

**Materials and methods:** (40) Single canal mandibular premolars, similar in shape, size, and length, were collected, after cutting the crowns above the (CEJ) by 1 mm and preparing them to receive the posts, the teeth were divided into two groups, each group contains (20) teeth, The teeth of the first group were restored using diamond burs, and the teeth of the second group were restored using fiber reinforced posts.

Then, the tensile forces were examined through a tensile strength test to measure the strength of the posts' attachment with the root dentin using a mechanical testing device, and statistical analyzes were performed.

**Results:** The group that was restored using diamond burs recorded higher tensile strength than the group of posts reinforced with fiber, The arithmetic average of the tensile forces in the group of diamond burs was (567.1 N), while the arithmetic average of the tensile forces in the group of fiber-reinforced posts was (530.8 N).

**Conclusions:** Diamond burs (mineral diamond root posts) (Abdullah's wedge) are better than fiber-reinforced posts in bonding to the root when using double-hardening resin cement.

**key words:** tensile strength, Root posts, diamond burs, fiber reinforced posts.

### The Introduction:

Preserving the vitality of the teeth was and still the most important goal in dental treatments, except that in some cases it is necessary to do endodontic treatment, such as large caries that reach the dental pulp, or when the previously restoration needs to be restored due to recurrent necrosis or due to fracture, or when the pulp is dead due to satisfaction or something else.

Here, endodontic treatment is necessary to preserve the tooth and its function within the dental arch as much as possible. There is no doubt that endodontic treatment makes the tooth weaker, which has previously lost part of its tissue due to necrosis or fracture.

Here, we find that the tooth that received endodontic treatment requires special considerations when planning the final restoration in a way that guarantees survival, resistance, and job performance for the longest possible period.

restoration, especially the restoration of damaged teeth, is a real clinical challenge for the dentist, especially due to the changes in the basic characteristics of the endodontic treated teeth because of pulp tissue and the surrounding dentin structures removal (Shwartz, et al 2004), so restorations in endodontically treated and damaged teeth aim to protect the remaining dental tissues from fracture, and compensation the missing dental tissues (Hargreaves, et al 2016).

therefore, many researchers have suggested using posts to restore endodontically treated and damaged teeth to support and strengthen the remaining tooth tissues, This hypothesis was supported by the ability of the posts to distribute efforts evenly, which improves the tooth's resistance to fracture (Ferrari et al 2007).

However, the attachment of the wedge with the root dentin can fail for several reasons, either related to the wedge, the adhesive cement, or the dentin itself (Vidal et al., 2014).

The posts used to restore endodontic treated teeth varied, where it can be classified according to its function into active and passive, or according to its shape to cylindrical and conical, finally according to the material it is made of (metallic, resinous, Fiber reinforced resin, ceramical).

Recently, Dr. Aziz Abdullah launched a method aimed to use conical diamond burs to restore endodontically treated teeth, Where the metal burs were used as ready-made metal pegs, which are applied in a way similar to the application of traditional ready-made metal posts, and have the following advantages:

1. surface roughness.

2. The fine voids on its surface, which are on the diamond part of the bure, which allow the cement to be embedded within it and thus increase the final stability.
3. The great variety in its shape and dimensions and being accessible to the general practitioner.
4. Its low cost compared to other types of root posts.
5. Easy to use and requires no additional preparation tools.
6. Unthreaded (therefore no torsion torque applied to the root).
7. The possibility of adjusting the coronal part that fixes the restoration of the wedge within the clinic.
8. Provides the practitioner with several restorative options (GIC modified with resin, composite)

These posts suffer from disadvantages, which are:

1. The lack of scientific studies that dealt with it.
2. Increasing the possibility of root perforation during preparation in the event that proper preparation principles are not observed, as is the case in other posts.

#### **Material and methods:**

We collected a sample of 40 human teeth (single canal lower premolar).

#### **Inclusion Criteria:**

1. The teeth should be single-channel mandibular premolars, without cracks, caries and fractures, Similar in shape and size, Free from internal and visible absorption, not endodontically treated.

#### **Exclusion criteria:**

caries or cracks in the teeth, restorations or previous fillings, roots with open apex.

#### **Work method:**

40 teeth were preserved in 0.1% saline solution at 4°C temperature, and the solution was changed weekly until the sample was collected.

The sample was prepared according to previous studies (wang et al 2013, Araujo et al 2014) to standardize the sample, The teeth were cut (1 mm) above the (CEJ) with a low-speed diamond disc with water irrigation to obtain a root length of 15 mm, and we have chosen roots with round canals as shown in Figure (1)

We prepared the access cavity and determined the working length (14 mm), Then we prepared the root canals using the automatic preparation system (SOCO, CHINA) with a scale of (0.4), and we irrigated the canal with sodium hypochlorite 5.25% during the preparation at the end of using each file.

After completing canal preparation and irrigation, the canal was dried using paper cones (Absorbent Paper Point, META Biomed, KOREA).

Then, the root canals were filled with lateral condensation technique using guttapercha cones with a taper of (0.04) and apex size of (25) (Pearl endopia, Pearl Pent, South Korea) and eugenol-free sealer (Adseal, META Biomed South Korea) to exclude the effect of eugenol on the hardening of the resin cement is as shown in Figure (2).

And when we finished the endodontic treatment, we kept the teeth at (100%) humidity and temperature (37°C) for 7 days. The root canals have been emptied from gutta-percha by gates glidden burs (2), retaining (5mm) of gutta-percha in the apical section of the root canal to obtain a space to receive the wedge with a length of (9) mm from the (CEJ), Then the place of the wedge was prepared in the first group, the root facer bur was used to form a space that fixed the wedge to coronal part of the canal.

Then a diamond bur of 9 mm was installed on micromotor handpiece, and the canal was prepared to receive the wedge at a speed of 1500 revolutions per minute with water irrigation.

The preparation of the canal to receive the wedge ends when the wedge moves easily in and out.

Each bur used to prepare only 3 canals.

After the preparation was done, the canal was washed using a physiological saline solution to get rid of the preparation residues.

A diamond bur identical to the preparation bur was inserted into the endodontic canal and rotated manually 360 degrees with light pressure applied to prepare the walls of the endodontic canal to receive the wedge so that each bur is used to prepare only five canals.

The place of the wedge in the second group was also prepared by means of a special bur for the wedgs at a low speed, according to the manufacturer's instructions.



**Figure (1):** The tooth sample after cutting the crowns



**Figure (2):** the tooth sample after root canal filling

The canal was scratched with phosphorous acid 37% (Eco-Etch, Ivoclar Vivadent, Liechtenstein) for 15 seconds. Then the canal was washed with distilled water for (30) seconds, after washing it, the canal was dried using paper cones (Absorbent Paper Point, META Biomed, KOREA). Then, a dual-sclerosing dentin bonding agent (Excite-FDSC, Ivoclar Vivadent, Liechtenstein) was applied to the root canal walls with a brush, followed by applying a light air current to brush the bond for (5) seconds, and the excesses of the bonding material were removed with paper cones. After completing the canal preparation procedures for receiving the post, Diamond posts have been cleaned using alcohol. As for the fiber-reinforced posts, they were cleaned with phosphorous acid (37%), Then Silane bonding agent ((Porcelain Primer, Bisco, USA) was applied and left to dry for a minute, then the bond was applied on the surface of the post. Then, the dual-cured resin cement was mixed according to the manufacturer's instructions 1:1 and transferred to the root canal by means of a bore fixed on a micromotor handpiece as shown in Figure (3). Then the post was inserted into the canal with a slight vibration to avoid the air bubbles formation, and the excesses of resin cement were removed by a Bond brush, and then hardening was done for (40) seconds using the light sclerosing device (Light, Hema Medical, China). The teeth were placed in acrylic molds that fit the supporting arm of the mechanical testing device, as shown in Figure (4).

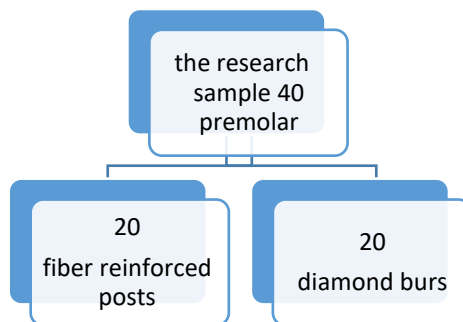


**Figure 3:** Transfer of the dual cured resin cement to the root canal



**Figure 4:** The tooth sample after casting it with acrylic molds

The sample was divided as follows



**Figure (5)** a chart showing the distribution of a sample of 40 premolars in a comparison of tensile strength between two types of posts (diamond posts, fiber reinforced posts).

The tensile strength test was carried out using the mechanical test device located in the materials resistance laboratory in the Faculty of Mechanical and Electrical Engineering at Tishreen University. The teeth were fixed within the acrylic molds on the base of the device, The post was held by a head fixed on the arm of the moving device vertically, and the device settings were set at a speed of (0.5) mm/sec to measure the force needed to separate the post from the root canal estimated in (Newtons) as shown in Figure No. (6)

The results for each unit tested were recorded through the values that the device displays on the corresponding plate.



Figure No. (6) Fixing the teeth within the acrylic molds on the base of the testing device.



Figure No. (7) The head used to fix the post and transmit force.

**Results:**

The research sample included 40 premolars divided equally into two groups (the diamond posts group = 20 samples, the fiber reinforced posts group = 20 samples) where measurements were made for the samples to compare the tensile strength between the two groups.

**Table (1)** The distribution of a sample of 40 premolars in a comparison of tensile strength between two types of posts (diamond posts, fiber reinforced posts).

Posts type	Quantity	percentage
Diamond posts	20	50%
Fiber reinforced posts	20	50%

We note from the previous table that two types of posts have been applied in order to measure tensile strength and compare them by 50% for each of them.

**Table (2)** Descriptive analysis of tensile strength for the two types of posts used.

Posts type	Quantity	SMA	minimum value	highest value	standard deviation
Diamond posts	20	567.1	449	811	107.3
Fiber reinforced posts	20	530.8	408	751	100.5

The table shows the descriptive analysis of the values of the tensile forces for each of the two groups, where the tensile forces had the highest value in the group of diamond posts with an arithmetic mean value of (1.567), while the arithmetic average of the tensile forces in the group of fiber-reinforced posts was with a value of (8.530).

We note from the previous table that the tensile strengths using diamond posts were higher than the tensile forces using fiber-reinforced posts.

**Table (3)** test for normal distribution of data.

Posts type	Statistical value	degree of freedom	significance level	distribution pattern
Diamond posts	0.170	20	0.13	normal distribution
Fiber reinforced posts	0.136	20	0.20	normal distribution

The Kolmogorov-Smirnov test was used to find out the nature of the data distribution, whether it follows a normal distribution or not. The results of the tests showed that all data follow the normal distribution model, where the significance level value was more than 5% for both types of posts, and therefore the parametric test was used to study whether there were significant differences between the two groups.

**Table (4)** Average values of tensile forces according to the types of posts used.

P-value	Fiber reinforced posts	Diamond posts	
0.02	<b>530.8±100.5</b>	<b>567.1±107.3</b>	<b>Mean ± SD</b>
0.02	<b>408 - 751</b>	<b>449 – 811</b>	<b>Min - Max</b>

The Independent T Student test was used to study the difference between the averages of two independent groups, where we found statistically significant differences between the two groups with regard to the average values of tensile forces, as the values were higher in the group of diamond posts.

#### Discussion:

This study dealt with the problem of the separation of the posts from the root canals when used in the restoration of teeth with a large demolition, and indicated that the type of posts used has an effect on the strength of the attachment of the posts with the root canals, where the study was done on two types of posts (diamond posts, and posts reinforced with fibers).

The main objective of the current study was to compare the bonding strength of diamond burs used as posts with the bonding strength of commonly used fiber reinforced posts.

#### Discussion of the sample collection:

The teeth sample were taken from the extracted mandibular premolars for orthodontic reasons as single-rooted teeth; Due to the ease of obtaining them intact from caries and other defects, and in a way that does not contradict the ethics of scientific research, they also have a sufficient mass of dental tissues to fit most root canal systems (Spazzin et al., 2011) and are very similar to the front teeth in terms of root unity and the amount of tissue. Coronary dentition, also a clinical study also found that the premolars are the teeth most prone to fracture (Tamse et al., 1999). Therefore, the premolars were chosen as a sample for research.

The study was not conducted on anterior teeth due to the difficulty of collecting the sample of one type in this quantity. Likewise, the lower premolars are among the teeth that most need treatment with root posts clinically (Ferrari et al., 2000). An effort was made to select the samples so that they have similar characteristics and to make the procedures standard. The lengths of the samples ranged from  $21 \pm 0.5$  mm, and the length of the crown was at least 7 mm.

To eliminate the influence of premolars sizes on the results: the buccal-lingual and mesial-lateral dimensions of the sample were measured. The premolars were divided into several groups, each group containing premolars with similar dimensions.

Then the premolars were distributed to the two research samples to reach the similarity of the groups in terms of the sizes of the premolars included in our study.

#### Preservation of extracted teeth:

We adopted a 0.5% chloramine solution to preserve the collected extracted teeth to conduct this study. As the recommended solution according to ISO standards for preserving extracted teeth prior to use in studies (Salameh et al., 2006) (Manold and Kern, 2011).

This study was carried out using metallic diamond root posts (Abdullah's post), which is a new class of pre-made root posts developed by Dr.aziz Abdullah this is because of its ease of preparation (as preparation is done using a single bur) and the wide options it offers to the medical practitioner in the dental clinic (Diamond metal burs have many sizes, shapes and dimensions that make them suitable for various cases), In addition to its high availability and low cost.

Fiber-reinforced posts were also chosen because they achieved satisfactory success rates during relatively long follow-up periods (Dietschi et al, 2008) (Bolla et al 2007) (cagidaco et al, 2008) (Ferrari 2008).

Many laboratory and clinical studies confirmed the importance of using fiber-reinforced posts in the restoration of endodontically treated teeth (Naumann et al., 2003) (Frazer et al 2008) (Vici et al 2000).

We also chose dual-cured resin cement, as it is the most widely used in scientific studies that dealt with the strength of prefabricated posts' attachment to the rootstock (Rosato et al, 2014).

#### Post surface treatment before gluing:

The surfaces of the fiber-reinforced composite resin posts were treated with the binding agent "silane" before the placement in the root canals.

Likewise, prior to building cores and restoring the crowns around the teeth, where the silant mediates a chemical bond between the inorganic structure of the post and the organicity of the resin increases the wettability of the post surface (Mattison et al., 1984), It also increases the bonding of the posts with the composite resins intended for the construction of the cores and with the resin cements (Boschian Pest et al., 2006).

#### Preparation of root canal dentin:

The dentin was scratched with phosphorous acid 37% for 15 seconds before applying the adhesive, then the adhesive was cured inside the root canal for 20 seconds with a light intensity of 3.6 watts, and a special brush was used to place the adhesive within the canals to deliver it to the dentin walls of the post sheath, according to the recommendation et al., 2002

(Ferrari Ferrari), Its use led to a higher percentage of the area of the resinous dentin insertion area up to the apical third and a higher percentage of resinous elongations (Ami Smidth, 2003).

Based on the conclusion that phosphorous acid treatment of dentin is more effective than the use of self-irritating or self-adhesive primers (Abdul et al., 2006).

This is in terms of its effect on dissolving the thick smear layer resulting from the preparation on the canal walls (Krenchel, 1964). Therefore, acid etching was adopted in this study as a unified method for removing the smear layer resulting from preparation in the two groups.

The adhesive was light cured after applying a gentle air current at the entrance of the canal to ensure that the adhesive was spread within the endodontic root canal and the adhesive layer was homogeneous within the canal (krug et al., 2013b).

#### **Application of resin cement:**

We inserted the cement by means of borates, as it is an effective way to avoid the formation of bubbles within the resin cement, in addition to placing the cement on the post and injecting it into the canal with the special head that is with the resin cement.

#### **Discussion conducting mechanical tests (tensile forces):**

I had faced difficulty at applying the sample to the mechanical tester, which resulted from the absence of the ability to apply small-dimensional samples to the device, after consulting with specialized experts within the Faculty of Electrical and Mechanical Engineering, and consulting "Dr. Aziz Abdullah", the tool called "Tensile Force Vector" was developed. Because of the presence of a moving part within it (the rope), the research needed to answer the question about the reliability of the values that resulted from the tensile strength test. The moving part may lead to the emergence of a non-perpendicular force, meaning that it is an inclined force on the axis of applying the force that removes the post This question has been answered by applying a unified angle to all samples, and therefore "any change in values" will have occurred in a uniform proportion on all test samples, which means that the comparison of the results of the values reached in the study is correct, this means that the main objective of the study, which is the comparison between the tensile strength of two types of posts (diamond posts and fiber reinforced posts) has been achieved, without any effect on the reliability of the result.

Thus, this study investigated the effect of post type on root attachment strength.

Where we noticed through the study that there is a statistically significant difference in the tensile strength between the diamond burs (Abdullah's post) and the fiber-reinforced posts fixed with dual-cured resin cement.

This result can be explained by the fact that the post clearly depends on friction with the walls of the canal in the presence of a suitable adhesive.

It seems that the surface roughness of the diamond burs (Abdullah's post) had a clear effect on increasing the mechanical stability, Where the diamond burs (Abdullah's post) are characterized by the presence of microscopic recesses resulting from the distribution of micro-sized diamond grains on the surface of the diamond burs And this factor may lead to a decrease in failures at the expense of the post surface and cement, and therefore it can be said that the diamond spikes (Abdullah's post) have achieved a better bond with the root canal than the fiber reinforced post.

The failure was visually observed and evaluated and classified into two types:

1. Type 1: When separation occurs at the level of resin bonding with dentin (easier reprocessing).
2. Type 2: when separation occurs at the level of resin bonding with the post walls (reprocessing a group of modified metal posts (diamond burs). Separation occurs at the level of adhesion resin bonding with dentin, and the post comes out with the adhesive resin from the root canal (first style is preferred).

Fiber-reinforced posts group.

Separation occurs at the level of bonding of the adhesive resin with the walls of the post, so the post comes out and the adhesive resin remains attached to the internal walls (second type is unfavorable).

The failure in the tensile test in the modified diamond steel posts group is attributed to these posts having a flat surface Rougher than fiber-reinforced posts and thus more mechanically interlocking the resin cement to the fiber-reinforced post surface.

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