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# EFFICACY OF POST LENGTH AND POST MATERIAL ON THE PULL-OUT BOND STRENGTH OF INDIVIDUALLY FORMABLE GLASS FIBER POST VERSUS CUSTOM MADE METAL POST ON ENDODONTICALLY TREATED MANDIBULAR PREMOLAR TEETH (AN IN VITRO STUDY)

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## *ABSTRACT*

**Aim:** Aim of the present study was to evaluate the efficacy of post length and post material on the pull-out bond strength of individually formable glass fiber post versus custom made metal post on endodontically treated mandibular premolar teeth.

**Materials & Methods:** Sixty-six extracted human mandibular premolars teeth were endodontically treated, they decoronated 2 mm above the cementoenamel junction and randomly divided into two main groups (Group A& B) based on the post materials to be used. Group A: individually formed glass FRC posts (everStick post), Group B: custom made metal post (Ni-Cr). Moreover, samples of each group were divided into 3 subgroups (subgroup 1, 2, 3) (n=22) according to the post length: subgroup I: 14.0 mm; subgroup II: 12.0 mm; subgroup III: 10.0 mm. All of the posts were luted with dual-polymerizing self-adhesive universal resin cement (RelyXUnicem). The samples were subjected to a pull-out bond strength test in a universal testing machine at a crosshead speed of 0.5 mm/min. The results, in newtons, were analyzed with two-way ANOVA and the pair wise Tukey post hoc test ($\alpha$= .05). Two samples from each group were processed for digital microscope observations in order to investigate the mode of failure at the post/cement interface.

**Results:** Two-way ANOVA showed statistically non-significant difference (P>0.05) between cast metal post group (227.77± 42.40 N) and everStick post group (225.15± 23.65N). Moreover, post length with 14mm recorded the highest statistically significant difference (p<0.05) mean value (278.45± 33.81 N) followed by post length 12mm (241.37± 42.74 N) then post length 10mm recorded the lowest statistically significant difference (p<0.05) mean value (159.57± 17.53 N).

**Conclusion:** It can be concluded that the pull out bond strength (debonding force) is directly proportional to post length.

**KEYWORDS :** EverStick post , Cast post , Post length , Pull out test

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## INTRODUCTION

After root canal treatment, restoring teeth to rehabilitate oral functions is a major concern in dentistry. Most of the endodontically-treated teeth are structurally compromised and weaker due to the peripheral destruction caused by the carious process as well as the central destruction that was caused by the endodontic treatment itself. Since the amount of remaining dentin directly determines the strength of the tooth, these teeth are at higher risk of biomechanical failure than the vital teeth[1]. The primary reason for using a post is to retain a core with the objective to restore the missing coronal tooth structure and not to strengthen the tooth. [2]

In the past, cast post and core have been considered the gold standard over many years and are still used by clinicians. It can be used effectively in any location such that oval and larger root canal where a prefabricated post is not advisable[3]. But it has some disadvantages, which may affect the long term success of the restoration, including uneven stress distribution, greater elastic modulus 10 times greater than that of dentin, biological side effects due to corrosion and color reflection of the cast post. [4] These concerns have led to the development of innovative post systems, one of which is theformable glass fiber post. This post is supplied in a soft form that can be adapted and conformed to the morphology of the root canal. Preparation of the root canals is rather conservative when compared to conventional post preparation[5]. Therefore, diminishing the risk of perforation.

Post design, dimensions, surface roughness and length all have been shown to affect post fracture resistance and retention. It was believed that, given at least 4–5 mm of apical seal, the more apical into the canal the post was placed, the higher the retention of the restoration[6]. Nonetheless, the root has been shown to be at risk when the post is too short or too long. The risks of root perforations and root fractures during placement of root canal posts should not be underestimated as well. [7]Nowadays, thanks to the optimization of bonding mechanisms of current adhesive composite cements, guidelines regarding post length may be revised. Since fiber posts are bonded within the root canal, their length could be shortened in light of a less invasive post build-up. [2]

Therefore, the purpose of this in vitro study is to evaluate efficacy of post length and post material on the pull-out bond strength of individually formable glass fiber post versus custom made metal post on endodontically treated mandibular premolar teeth to see if we could accomplish a more conservative intra radicular preparation without sacrificing the bond strength.

The null hypotheses in the present study were as follows: that there would be no statistically significant difference in the debonding force between the different post materials and different post lengths.

## MATERIALS AND METHODS

### Methodology

#### *I. Teeth selection*

Sixty-six freshly extracted human mandibular second premolars, predominantly extracted for periodontal reasons, were selected, with patient's age ranged from (30 - 50) years old. The measurements were taken at the cemento-enamel junction level using digital caliper (Somet, SOMET CZ Company, Czech Republic) with an average similarity in size, shape and root morphology were selected for this study to achieve least variation. The mean of tooth dimensions (SD) were 17± (0.3) mm in root length, 7.8± (0.2) mm in buccal-lingual width and 7.0± (0.2) mm in mesio-distal width of the crown.

#### *II. Teeth disinfection and storage*

To avoid dehydration, they were disinfected in 5.25% sodium hypochlorite and stored in 0.9% standardized saline solution at room temperature.

***III. Teeth preparation***

Each tooth was sectioned horizontally at the level of 2 mm coronal to the most incisal point of the proximal cemento-enamel junction perpendicular to their long axis with Saw Microtome (Leica SP1600: Leica, Germany) under copious water cooling .

***IV. Root canal treatment***

Access opening for endodontic therapy was established for all teeth following the standard procedure; using endodontic hand instruments (K-files sizes 10, 15 and 20) (K-files; DentsplyMaillefer, Ballaigues, Switzerland) and rotary Nickel Titanium files and glyde through (SX-S1–S2–F1–F2–until F3) (Pro Taper, Dentsply – Maillefer) following manufacturer's instructions to achieve final contour of root canals. All canals were then obturatedwith Adseal (Resin Based Root Canal Sealer, META BIOMED Co, Korea)

***V. Mounting of the teeth in sample holder***

A specially designed centralizing device was used to allow the accurate centralization of the tooth in the sample holder.Then, all samples allocated in the group randomly and divided by (www.RANDOM.org) web site into equal groups.

***VI. Post space preparation***

The drill press device (Drill Press, Chengdu Huilingfeng Bit Co., China) was used to prepare a uniform post space for all samples with a size 5 Peeso reamer (1.5mm diameter) (Peso reamer, NORDIN, Switzerland).

***VII. Posts fabrication***

**A. everStick post**

Pre impregnated continuous unidirectional E-glass fiber reinforcement (everStick POST, Stick Tech Ltd, Turku, Finland) was cut to a premeasured length and inserted into the root canal. The post was initially light-polymerized inside the root canal for 20 s. After removing the post from the canal, it was further light-polymerized for a total of 40 s. The surface of the post was activated for the formation of secondary IPN bonding using light-curable resin (Stick®Resin, Stick Tech Ltd, Turku, Finland) and the post was placed under a light shield for 3-5 min to prevent premature polymerization of the activation resin by light. Prior to cementation, the resin layer was thinned by carefully blowing the surface of the post with dry air. The post was light-polymerized for 10 s.

**B. CAST POST**

Cast posts were fabricated from the root canal impressions taken with chemically activated resin (Pattern Resin LS, U.S.A) and plastic posts (Plastic Pin, Reliance, U.S.A) in silicon rings with phosphate bonded investment and were cast in Nickle-Chromoium alloy (I-BOND 02- Interdent d.o.o.,Opekarniškacesta, Slovenia). Cast posts were blasted with aluminum oxide particles and were adjusted to fit the root canals.

***VIII. Posts Cementation***

Both the everStick post and cast post were cemented with self-adhesive resin cement RelyXunicem (3M ESPE AG, Germany) according to the manufacturer instructions

***IX. Testing procedure***

A tensile load with pull out mode of force was applied via universal testing machine (Model LRX-plus; Lloyd Instruments Ltd., Fareham, UK) at a crosshead speed of 0.5 mm/min. The relatively slow crosshead speed was selected in order to produce a force that resulted in debonding of the post along the tooth-cement interface. The load required to debonding was recorded in Newton.

## RESULTS

### Post materials effect

It was found that the endodontically treated mandibular premolar teeth restored with custom metal post group recorded statistically non-significant difference (P>0.05) higher debonding force mean value (227.77± 42.40 N) than everStick post group (225.15± 23.65 N) as indicated by two way ANOVA followed by pair-wise Tukey's post-hoc tests **Figure (1) Table (1).**

### Post length effect

It was found that the endodonically treated mandibular premolar teeth restored with post length 14mm recorded the highest statistically significant difference (p<0.05) mean value (278.45± 33.81 N) followed by post length 12mm (241.37± 42.74 N) then post length 10mm recorded the lowest statistically significant difference (p<0.05) mean value (159.57± 17.53 N) as indicated by two way ANOVA test. Pair-wise Tukey's post-hoc test showed non-significant (p>0.05) difference between 14mm and 12mm subgroups**Figure (2) Table (2).**

TABLE (1): Comparison between total debonding force results (Mean values± SDs) as function of post materials

| Variables | | Mean | SD | Rank | Statistics (p value) |
|---|---|---|---|---|---|
| Post | everStick post | 225.15 | 23.65 | A | 0.8254 ns |
| | Custom metal post | 227.77 | 42.40 | A | |

***Different letter in the same column indicating statistically significant difference (p< 0.05)***

****; significant (p< 0.05)  ns; non-significant (p>0.05)***

TABLE (2): Comparison between total debonding force results (Mean values± SDs) as function of post lengths

| Variables | | Mean | SD | Rank | Statistics (p value) |
|---|---|---|---|---|---|
| Post length | 14 mm | 278.45 | 33.81 | A | <0.0001* |
| | 12 mm | 241.37 | 42.74 | A | |
| | 10 mm | 159.57 | 17.53 | B | |

***Different letter in the same column indicating statistically significant difference (p< 0.05 *; significant (p< 0.05)***

***ns; non-significant (p>0.05)***

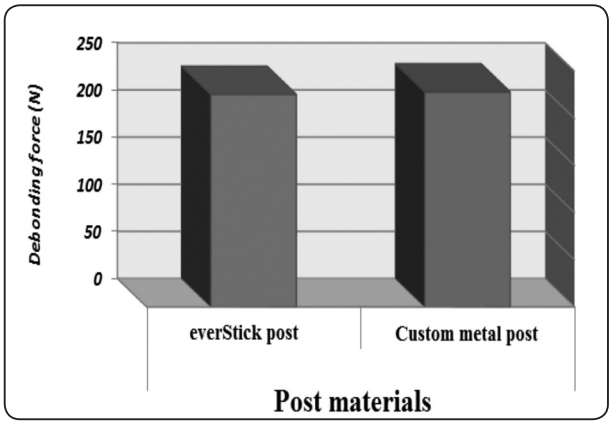


Fig. (1) A column chart of total debonding force mean values as function of post materials

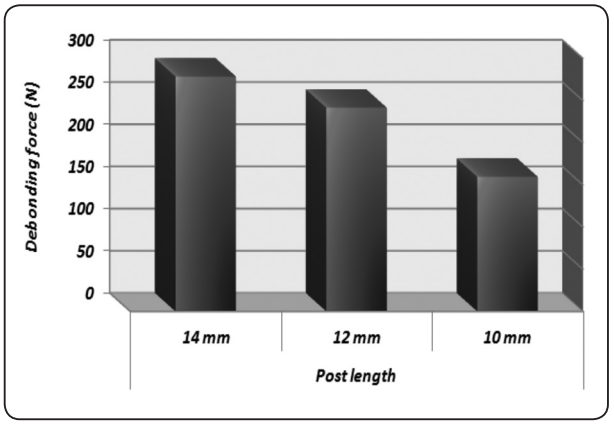


Fig. (2) A column chart of total debonding force mean values as function of post lengths

## DISCUSSION

In the current study, the first hypothesis tested was accepted because the in vitro pull-out (debonding force) did not significantly affect the bond strength for everStick post and custom made metal post. However, the post lengths affect significantly the bond performance, thus, the second hypothesis was rejected. The post length, material and the luting agent are main factors that influence the retention of posts. Some studies[8][9] have suggested that a shorter post length may be used without loss of retention and the optimization of bonding mechanisms of current adhesive composite cements may increase retention. Post length could be shortened in light of a less invasive and more conservative approach. Since there are still some doubts about the effect of post length on its retention [10], this in vitro study was designed to investigate and compare the efficacy of post length and post material on the pull-out bond strength of individually formable glassfiber post versus custom made metal post on endodontically treated mandibular premolar teeth. Pull out test was selected in this study to measure bond strength because it provided the highest values of bond strength than push out and microtensile bond strength test due to stress distribution in all post surfaces and low stress values in the bond interface and the results in shear force are comparable to clinically findings. This may be a consequence of the design as well, where the tensile load was applied farther away from bond interface than the compression load in the push-out test[14]. In the present study, it was shown that the different post materials are influenced by the debonding force. The result obtained in this study showed that no statistically difference between individually formable glass fiber post (everStick post) and custom made metal post (Ni-Cr) in pull out test. A possible explanation for these results may be related to post design which is conformed to canal space. The cement layer was thinner and more uniform which might contribute to similar retention value of cast post compared with everStick post. These results were in accordance with **Braga et al 2006**[15] Concluded that the type of intracanal post (glass-fiber or metallic cast) did not influence the removal resistance and **Ahmed 2008**[16] Concluded that endodontically treated teeth restored with cast post and Easy post (fiber reinforced composite / tapered design) was not statistically significant. On the other hand, they were in contrast to those of **Khamverdi et al 2007**[10] Observed that the retention of fiber posts was significantly more than the cast posts. Irrespective of post materials, it was found that 14mm recorded the highest statistically significant mean value followed by 12mm then 10mm recorded the lowest statistically significant mean value. This is likely explained by frictional retention produced by cement in these areas which contribute to the debonding resistance of the post. Frictional retention is directly proportional to the contact area (the larger the contact surfaces, the better the retention). This explains the results of this study; posts luted deeper provided the highest pull- out bond strengths. In addition to the contact area, closer contact between cement type and dentin is also important in order to improve the frictional retention of the post [11]. These results were in accordance **with Jefferson et al 2011** [11] Concluded that increasing post length significantly increased the tensile strength of prefabricated posts and cast post-and-core used in endodontically treated teeth. In contrast, they were in contrast to **Jefferson et al 2010**[12] Observed that increased post length in teeth restored with prefabricated posts does not significantly increase the fracture resistance of endodontically treated teeth . Although the design of the current study attempted to simulate clinical situations such as tensile force. It is difficult to interpret these results directly for the clinical practice. This is because this study had some limitations; it is an in vitro investigation which could not fully replicate oral conditions. The study also evaluated the mandibular premolar teeth and therefore, these results can be applied only to that group of teeth.

## CONCLUSIONS

Within the limitations of this in vitro study, the following conclusions could be drawn:

1. The pull out bond strength (debonding force) is directly proportional to post length

2. The individually formable glass fiber post cemented with adhesive resin cement had no statically significant difference in debonding force compared to cast post cemented with the same cement.

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