**Research Article**

**Evaluation of Bond Strength and Quality of Fiber Posts Cemented With Two Cements in Asymmetric Dental Root Canal**

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ABSTRACT:

**Background and Objective:** Debonding is one of the most common causes of failures in post fibers used in the root canal interface of dentin-fiberpost. The purpose of this study is to evaluate the interface of the fibers post in the root canal with appropriate and inappropriate compliance with CBCT and its push-out bond strength with two types of resin cement used in the mandibular premolars.

**Materials and Methods:** Forty (40) Mandibular Premolar teeth which were extracted were used due to the orthodontic problems. After endodontic, the teeth were randomly classified into two groups including teeth with post space in compliance with the fiber post and a group of posts space wider than fiber post. Thereafter, each group was sub-divided into two groups according to the used cement: panavia F2.0 (Kuraray Medical Inc., Osaka, Japan), Rebilda DC (Voco, Germany) and finally, four groups were created [P.a:canal with appropriate adaptation + panavia F2.0, P.in:canal with inappropriate adaptation + panavia F2.0, R.a:canal with appropriate adaptation + Rebilda DC, R.in:canal with inappropriate adaptation + Rebilda DC]. Data analysis was carried out using ANOVA, Post hoc Tukey test, Chi-square test (p <0.05).

**Results:** The bond strength was significantly affected by the analyzed root area (p-value = 0.03) and there was a significant difference between two canals with appropriate and inappropriate compliance with the same type of cement (p-value = 0.05). In addition, the bond strength was not affected by cement type (p-value = 0.67) and the area of the voids was higher in P.in groups. Nevertheless, in R.a group, no void was observed.

**Conclusion:** The bond strength was affected by the post space but it was not affected by cementation techniques. As a result of this, applicator of Rebilda cement reduces the voids in the root canal with appropriate compliance.

**Keywords:** Rebilda DC, panavia-Fluoro 2.0, Dental cement, Fiber glass, Cone Beam Computed Tomography, Bond strength.

**I** [INTRUDUCTION]

Reconstruction of endodontically-treated teeth has been studied extensively, but there are challenges on some issues[1]. Metal cast posts may increase the risk of root fracture due to corrosion or wedging effects. For this reason, fibre posts with good mechanical properties made from quartz, carbon, or fiber glass, were produced in recent years[2]. Different adhesive systems used for cement of fiber posts which contains cements light-cure, self-cure, and dual-cure are applied in...
the root canal[3]. The ideal fitness of post is a critical factor that is responsible for the appropriate thickness of cement. Poor fitness led to thick cement, especially in the coronal of the root canal due to the void or bubble increase that lead to the debonding[4]. Debonding can be developed in the fiber posts for different reasons like preparing the post surface, dentin bonding components, cement, and application of adhesives, and also polymerization methods. Different morphology in various regions of the root canal leads to different qualities of the bond in the coronal, middle and apical regions[3]. There is still no agreement on the ideal thickness of cement and also the effect of void on the bond strength of fiber posts [5]. One of the clinical problems for the dentists in the restoration of endodontically treated teeth this unfitness of diameters of post space and that of the post. Although using the drills with appropriate size by the manufacturers create a perfect compliance of post with the wall of the root canal, but the teeth root canals have different shapes and therefore, the thickness of resin cement around posts can vary [6]. Several studies about the defects at the dentin-cement junction are known to be related to how the method was utilized for application of cement[7]. According to the previous studies, the push-out test is preferable so as to evaluate the bond strength than other cases, such as shear-test, since in this test, fracture occurs in parallel at the dentin junction and adhesives cause real shear-test[8]. In several studies, the SEM or analysis of digital images have been utilized for reviewing the junction of dentin-glass fiber post [5]. The purpose of this study was to evaluate the of push-out bond strength of two different types of cements and also observe the CBCT for the three-dimensional assessment of dentin-junction glass fiber post in root canal with appropriate and inappropriate compliance.

**[II] MATERIALS AND METHODS**
In the present research, 40 mandibular premolars teeth were selected (teeth were stored in saline) and then, two mesiodistal and buccolingual views of radiography were utilized for studying the presence of calcification, anatomical anomalies, and treatment of the previous root canal. The samples were mounted from the CEJ areas in cubes with sizes of 15 × 15 × 15 mm made of epoxy resin. The teeth were cut from the CEJ with a high-speed water cooled diamond disc (Buehler Ltd, Lake Bluff, IL, USA). Then access holes for Endodontic were created with tapered diamond fissure bur and the function of teeth with a K 15 file and also by subtracting 1mm from the length of the root to apical foramen was obtained. Rotary protaper files were utilized via the sequence of SX, S1, S2, F1, F2 so as to widen the canal and in order to wash between the cleaning processes, 2 ml 25.5% sodium hypochlorite was utilized. After cleaning, the obturation of root canal was carried out using gutta-percha lateral condensation technique and then sealer AH26 (Dentsply, Maillefer, Ballaigues, Switzerland). In order to ensure complete sealing and prevent drying, teeth were placed in distilled water at 37°C for 24 h. After that, teeth were randomly classified into 2 groups according to the selected glass fiber posts (innopost premier anatomic, innotech, Italy) and the post space was prepared according to the manufacturer’s instruction of using the considered drill. In one of the groups, the space was prepared due to drill, while in the other group the bigger drill was used so as to increase the diameter of post space in order to develop inappropriate compliance. The depth of post space from the cement enamel junction (CEJ) was selected as 10 mm. Then the prepared area was washed with 5 ml normal saline and then it was dried using dry paper. The fiber post was similar in both groups, and then each group was sub-divided into 2 groups based on the used cement. Finally, 4 groups were created from two resin cements panavia F2.0 (Kuraray Medical Inc., Osaka, Japan) and Rebilda DC (Voco, Germany) in order to place the fiber posts in the canal (Table1). The panavia was utilized as a result of the cement manufacturer’s orders. One drop of A and B Primers were mixed together (The mixture was
used within 15 s after mixing) and then canal walls were exposed using a brush to blend smeary. The additions were removed by completely using the air pore and paper points. Thereafter Panavia was prepared on the completely dried pad based on the instructions. After that, the post was dipped in the dough and then it was placed with a gentle vibration to prevent formation of air bubbles in the canal. Thereafter the canal was treated with Halogen light-cure for 3-2 s so as to remove the additional cement. The at the end, it was cured for 20 s from coronal side. In the relationship with the Rebilda DC cement, after inoculation of the root canal walls with primer, Futurabond DC (Voco, Germany) was placed using a good brush, cement, and the applicator in the canal. Thereafter, the posts were placed in the canal according to the manufacturer's instructions. Then each group was cured for 24 h in distilled water maintained at 37°C. The samples were sent for CBCT analysis and CBCT scans were obtained using the Newton5G system (Verona, Italy), with a potential difference of 110 kVp, tube follow of 3.46 mA, duration of 6 × 68.4 and 6 × 6 field of view. The thickness of each voxel size was 0.3 Mm, the thickness of each slice was 0.1 mm, and the spaces of each slice was 0.5. Images were evaluated by NNT viewer software in the axial plane.

Table 1: Composition of the materials use

<table>
<thead>
<tr>
<th>Composition</th>
<th>Manufacturer</th>
<th>Polymerization and conditioning method</th>
<th>Luting cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDP, dimethacrylate, barium glass powder, sodium fluoride, silica, amine, benzoyl peroxide, sodium aromatic sulfinate</td>
<td>Kuraray, Osaka, Japan</td>
<td>Dual curing, self-etch</td>
<td>Panavia F 2.0</td>
</tr>
<tr>
<td>BIS-GMA, UDMA, DDDMA, BHT, dibenzoyl peroxide, silica, barium borosilicate glass ceramic, accelerators</td>
<td>Voco, Cuxhaven, German</td>
<td>Dual curing, self-etch</td>
<td>Rebilada DC</td>
</tr>
<tr>
<td>Futurabond DC: organic acids, BIS-GMA, HEMA, TMPTMA, BHT, ethanol, fluorides, CQ, amine, catalysts</td>
<td>Voco, Cuxhaven, Germany</td>
<td>Adhesive</td>
<td></td>
</tr>
</tbody>
</table>

**Table 1**

**[III] RESULTS**

The bond strength was statistically significant in the coronal, middle, apical and separately between the groups (Coronal: p-value = 0.000, C: p-value = 0.003, apical: p-value = 0.006) (Table 2) in [Figure 1]. While the bond strength wasn’t significantly related to the coronal, middle, and apical areas in the two types of applied cement (p = 0.67). Nevertheless, the bond strength of the two types of canal with appropriate and inappropriate compliance with the same cement was significant (p = 0.05). The bond strength in different parts of root canal was also significant (p = 0.03). In the middle area, the bonding strength
of P.a and P.in was not significant (p=0.36), but the relationship was significant in the R.a and R.in (p=0.007). Nevertheless, in the apical area of P.a and P.in was significant (p=0.032), while in the Rebilda DC cement, it was not significant (p=0.073). In the coronal and medial areas of R.a group, no voids were observed. The area of void observed in the coronal area was higher in the coronal and middle areas of the P.a group. While at the apical area, void surface area was higher using the P.in group. Among all samples, the most types of the fractures were Type1 adhesive failure between dentin & cement (ADC) in [Figure- 2].

### Table 2: Mean push-out bond strength values (MPa) with their standard deviations

<table>
<thead>
<tr>
<th>Luting cement</th>
<th>Apical third (MPa ±SD)</th>
<th>Middle third (MPa±SD)</th>
<th>Cervical third (MPa±SD)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.a</td>
<td>7.1±0.9</td>
<td>9.2±0.9</td>
<td>12.9±8.3</td>
<td>a.P</td>
</tr>
<tr>
<td>P.in</td>
<td>6.4±0.9*</td>
<td>8.6±0.8</td>
<td>11.9±0.9</td>
<td>P.in</td>
</tr>
<tr>
<td>R.a</td>
<td>7.1±0.6</td>
<td>9.9±0.6</td>
<td>13.4±0.7**</td>
<td>a.R</td>
</tr>
<tr>
<td>R.in</td>
<td>6.1±0.8</td>
<td>8.6±0.6</td>
<td>11.7±0.7</td>
<td>R.in</td>
</tr>
<tr>
<td>p-value</td>
<td>0.006</td>
<td>0.003</td>
<td>0.000</td>
<td>P value</td>
</tr>
</tbody>
</table>

Several cases where Tukey’s post-hoc analysis was used showed no significant difference (Alpha = 0.05), (lowest *, the most **).

[Figure-1]: The push-out bond strength in three areas (1) coronal, (2) middle, (3) apical

[Figure-2]: failure type
[IV] DISCUSSION
In this study, bond strength of glass fiber post was evaluated with two types of resin cements and also in canals with appropriate and inappropriate compliance using the push-out test. In this study, it was found that bond strength in the coronal area was more in all groups and then in the middle area, while in the apical area, the strength was less in other parts. This test is based on stress shear at the dentin-cement junction similar to the post-cement junction.

The push-out test is a reliable technique for precise measurement of the bond strength of fiber posts to root dentin compared to modified routine tests of microtensile. For this reason, the push-out method is actually a real shear test[8]. In a study that was carried out by Pereira et al, it was found that the bond strength was different in various areas of the root[9]. Ebrahimi et al concluded that the bonding strength of fiber posts in the coronal area is more affected by their adhesive system polymerization methods[3]. Dua et al. achieved similar results with this research while in the study; it was shown that the bond strength is affected by the type of cement[10]. In the study of Pereira and Foxton, significant differences were not observed in bond strength in different parts of the roots[9]. Nevertheless, in a study carried out by Rengo, it was concluded that difficulty in clearing the apical region of the posts can explain the low bond strength in the apical area[5].

According to a study carried out by Ebrahimi, dual-cure adhesives in the apical portion of the adhesive bond strength than light – cure. It was revealed that due to the reduction of the intensity of light in the apical area, lower degree of conversion is less in optical adhesives[3]. So, the difference had less rooted bond strength in different areas which was because of less dependence of the light equitability of bond strength in different parts of the roots[3].

In this study, the cement dual –cure was used so as to remove the effect of light transmission intensity. So, the reduction of bond strength can be as a result of the reduced density in the apical area of dentinal tubules in the apical area. In a study carried out by Musharraf et al, it was concluded that as a result of the increased density of dentinal tubules in the coronal, apical tubules were more than the bond strength in the coronal area[1].

The two different methods used in cementation in this study showed that the bond strength is not affected by cementation techniques because the differences in the two types of cement bond strength were not significant and/or with the void area in the coronal was more and was ineffective in reducing the bond strength in the coronal area. Nevertheless, according to the study of Watske et al, conventional cementation method creates the voids[7]. Nevertheless, according to a study carried out by Bitter, void cannot be a weakness for the lower strength but can act as stress relaxation[11]. In this research, incompliance of posts reduced bond strength in canals with poor compliance, similar to study of Uezonoglue et al, it was shown that the bond strength decreases with increasing thickness of cement; and they concluded that reduction of shrinkage in the thinner cement causes less stress on the joints. They also showed that by increasing the thickness of the cement, there is the probability of creating more voids that could weaken the cement and eventually debonding[6]. While Peretz et al believe that by increasing the thickness of the cement, bond strength will not reduce[12].

Also, unlike our study, in a study carried out by Perdigao et al, it was concluded that the diameter of space which increases the thickness of the cement posts doesn’t affect the push-out on bond strength[8]. The study of Frank revealed that in contrast to the present study, the posts in the root canals with inappropriate compliance had higher resistance in contrast to the dislodgment rather than the canals with appropriate canals[13]. In this study, similar types of fiber post in all groups were used because, according to study carried out by Bitter, differences were found in the post types which can be effective in the push-out bond strength[11]. In this study, the greatest type of failure is type 1 adhesive failure between dentin &
cement (ADC) which is similar to Bitter study. Dua also carried out a study which revealed that most of the failure of the type of adhesive was between cement and dentin[10].

The purpose of this research is to evaluate the voids in the cement space of CBCT. The advantages of CBCT is that it is a non-destructive method for samples, and in fact, there is the possibility of sample analysis without losing any information while in the traditional methods, the parts of the dental tissue or material during cutting and preparation for testing are lost and only a limited number of samples can be used for observation[5]. In this research, it was revealed that in the root canal with appropriate compliance, the voids were less but there were bubbles, which can be due to the variety of root form, despite the fact that the use of appropriate drills in compliance with post is appropriate. In addition, the root canals with Rebilda DC cement had less voids. This could be as a result of the use of applicator for cementation of posts in the root canal which prevents trapping of air bubbles. According to Watzke, defects at the cement junction depend on the cementing methods and application of applicator aid which caused more homogeneity of the cement in the root canal[7]. It is noteworthy that using the application in dual-cure cements in root canals is not due to its faster setting before correct arrival of the post[14]. On the other hand, Ferrari et al reported that using microbrush in root canal creates a uniform bond in the canal[15]. Rengo et al concluded that the volume of voids in the coronal area regardless of the post position is greater and based on that, void size in the coronal was greater. The bond strength is greater in the coronal area which is due to the effect of the voids as stress absorber and it was also reported that it is because of the volume of large voids in the coronal area which is also due to high cement volume[5]. Dua study also showed that the use of spiral Lentoral reduces the voids of cement[10]. In a study carried out by Bitter et al, it was also shown that though the voids was higher in Rebilda DC cement, but it was not lower in bond strength compared to other cements, because void could compensate for the damaging effect of C-factor in stress relaxation[11].

[V] CONCLUSION

Bond strength is affected by the post space but will not be affected by cementation techniques. The applicator of Rebilda DC cement reduces voids in root canal with appropriate adaptation. The presence of void in the coronal area had no effect on reducing bond strength.

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