The effect of dowel length on the retention of two different endodontic posts

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ABSTRACT
Background: Several factors govern the retentiveness of endodontic posts, the shape of the post and its length are among the essential factors. This in vitro study formulated to compare the retentive values of stainless steel, parallel sided, serrated posts (Euro post) to fiber reinforced, tapered, smooth posts (Easy post) at two embedment depths (5 and 10 mm).

Materials and Methods: Thirty-two intact human mandibular second premolars were selected for this study. These samples were endodontically treated, and randomly divided into four study groups of eight teeth each:

- **Group I**: Teeth restored with Easy post at embedment depth 10 mm.
- **Group II**: Teeth restored with Easy post at embedment depth 5 mm.
- **Group III**: Teeth restored with Euro post at embedment depth 5 mm.
- **Group IV**: Teeth restored with Euro post at embedment depth 10 mm.

Ten failure loads were measured in the absence of crowns using an inston test machine at cross head speed of 5 mm/min. Values were recorded in Newton. Mean values and standard deviations were analyzed with one way ANOVA test and the least significant difference test.

Results: Retentive failure loads were recorded for all test specimens; the means and standard deviation for each group were as follows: Group I: 65.75 ±23.6; Group II: 64.25 ±22.2; Group III: 189.5 ±25.9; and Group IV: 221.1 ±27.

Conclusion: Endodontically treated teeth restored with Euro post (stainless steel/parallel sided/serrated posts) showed significantly greater retentive values than Easy post (fiber reinforced composite/tapered/smooth posts), also there was no significant difference in retentive values achieved with both systems at 5 mm and 10 mm post length.

Key words: Euro post, fiber reinforced posts, post length, retention.

INTRODUCTION
Endodontically treated teeth regularly receive posts and cores to provide predictable replacement for lost tooth structure and to facilitate crown support and retention. Prefabricated and cast metal posts are traditionally used; they are as well as the novel all ceramic posts rigid in nature. The rigidity may pose a risk for root fracture. Recently, fiber reinforced composite root canal posts have been introduced as an alternative to more conventional materials (1). The bio-mechanical properties of fiber reinforced composite posts have been reported to be close to those of dentin. Fiber reinforced composite posts exhibit high fatigue and tensile strength, its chemical nature is compatible with the BIS-GMA resins in the adhesive resin cements which effectively transmit stresses between the post and the root structure (2). The introduction of new resinous cement provides dentistry with the opportunity to improve the success rate of post endodontic restorations (3). Numerous studied of retentive properties have been conducted relative to the shape, diameter, length and surface configuration of the posts. Most invitro post and core experiments have been accomplished by evaluating the tensile force to remove the posts from the root canals, this rarely occurs clinically.

As a result of the test specimens’ geometry in the pullout test, a major portion of retention was created not only by the adhesive bonding agent but also through micro retention from the surface roughness and macro retention from the frictional fit between two surfaces (4).

MATERIALS AND METHODS
Thirty-two lower second premolars recently extracted of comparable sizes and shapes were selected for experimentation. All teeth were cleaned from soft tissue debris and stored in physiologic saline solution at room temperature from the time of extraction to the time of testing. Access opening for endodontic therapy was established for all teeth with a fissure carbide bur (No.21 R/12; Komet, Germany) rotating at high speed under constant water spray the pulpal tissue was removed with a barbed broach (Produits Dentaire S.A Vevey, Switzerland), and a No.10 file was inserted until its tip just appeared at the apex. The working length was recorded as 1 mm shorter than that length. Instrumentation of the canal was continued up to size 45 K-file (Dentsply, Switzerland), with the use of step back technique (filing action) under full sodium hypochlorite irrigation (NaOCl 0.25%), then dried with paper points. Zinc oxide based sealer cement (Dorifill, Dorident, Austria) was mixed according to manufacturer’s instructions, and a size 40 file was used to carry the sealer inside the canal and coat the walls of the canal. The canal was then obturated with gutta percha in conjunction with endodontic sealer using lateral cold condensation.
The coronal portion of the teeth were removed at the level of 1mm coronal to the cementoenamel junction with a diamond disk (Komet, Germany) and a full water spray coolant, ending with root length of 14mm. Then the samples were randomly divided into four groups of eight teeth each:

**Group I:** teeth restored with fiber reinforced, tapered, smooth posts (Easy post) at embedment depth 10mm.

**Group II:** teeth restored with fiber reinforced, tapered, smooth posts (Easy post) at embedment depth 5mm.

**Group III:** teeth restored with prefabricated stainless steel, parallel sided, serrated posts (Euro post) at embedment depth 10mm.

**Group IV:** teeth restored with prefabricated stainless steel, parallel sided, serrated posts (Euro post) at embedment depth 5mm.

The most similar sizes available among the post systems used in the study were chosen. Each post in group I (Easy post) was marketed at a distance 14mm from its apical end while posts in group II were marketed at a distance 9 mm. A line was drawn around the post at this level, and all these posts were sectioned horizontally with a water cooled diamond fissure bur. This would standardize the post lengths with established similarity between post diameters of the different designs, all post designs used in this study had shown 1.8 mm diameter at the coronal and middle level, considering that the apical part varies according to post design which was left for comparison. The gutta percha was removed from the root canals of teeth with peeso drills (Dentsply, Switzerland), to a depth 10 mm measured from the coronal end of the root in group I and III, and to a depth 5mm in group II and IV then the post spaces were prepared with the special preparation drills of each system. Easy post (Fiber reinforced posts, tapered design, C 0602, Dentsply, Switzerland) were used in group I and II, posts No. 2 (C 0600, Dentsply, Switzerland) were selected. The special preparation drill of the system(C 0601 No.2) was used to prepare the post spaces under full water irrigation.

Euro post (stainless steel /parallel sided/serrated posts), (Set ref 5320 Anthogyr, France) were used in group III and IV, posts No.3 (long) (3L 5312 Anthogyr, France) were selected for group III, while posts No.3 (short) (3S 5312 Anthogyr, France) were selected for teeth in group IV. The special drill of the system (No.5313 Anthogyr, France) was used to prepare post spaces under full water irrigation. All teeth were marked 3mm below their coronal level and a line was drawn around the root at this level with right angle to the long axis of the tooth, then teeth were embedded in individual blocks of acrylic resin to the depth identified by the circumferential line. All posts were first tried inside the canals with out cement to the full prepared length, then cementing using VariolinkII (Dual cure adhesive resin cement, Ivoclar Vivadent Ag Fl-94 Schan/Liechtenstein). Following manufacturer's directions, one drop of 37% phosphoric acid gel (Alpha-Dent, Dental Technologies, USA) was applied to post spaces for 15 seconds then thoroughly rinsed with water for 30 seconds, dried with paper point and air blower. One drop of each base and catalyst of the bonding resin (Alpha-Dent, Dental Technologies, USA) was dispensed on a mixing dish and mixed for 4 seconds then applied homogenously on dentin on post spaces as well as on the surface of the posts and allowed to set for 60 seconds, then carefully dried with a faint air jet. The excess bonding in the root canal was removed with paper points. According to manufacture's instructions equal parts of Variolink II resin cement paste were applied on a mixing pad and were gently mixed for 20 seconds with a plastic spatula until creamy consistency with a uniform color was obtained (the working time is 3.5minutes), the mixed cement was inserted in the prepared canal with a lentulo spiral (Produits Dentaires, S.A. Vevey Switzerland) and the post was uniformly coated with the cement and fully seated in to the canal to the prepared length(with finger pressure for posts in groups I and II, and screwing action for posts in group III and IV) . Excess cement was removed immediately after the post was seated by using a disposable brush. The light curing device was applied at the margin to initiate curing mechanism of the adhesive resin cement. Then the samples were stored in normal saline until the time of testing. The tensile forces required to dislodge the posts from their canals were measured by a Zwick (Universal testing machine), the mounted teeth were grasped by the lower jaw of the testing machine. The posts were held by a special holder specially made for this purpose that assure loading along the long axis of the teeth, this holder was mounted in to the upper jaw of the testing machine. A constantly increasing tensile force was applied at a cross head speed of 5mm/min until the post was displaced from the root canal which determined by a sudden release of load on the post as seen on recording graph. Peak tensile force (in Newton) required to remove posts were recorded on a strip chart.
RESULTS
Retentive failure was recorded as point of deflection on Instron recording sheet. Mean failure loads (in Newton) and standard deviation (±SD) were calculated for all tested groups (Table 1), and illustrated graphically in Figure 1.

Table 1: The data of tensile forces (in Newton) for all test specimens with Mean and Standard deviation of each group.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SD</th>
</tr>
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<tbody>
<tr>
<td>Group I</td>
<td>65.75 ± 23.6</td>
</tr>
<tr>
<td>Group II</td>
<td>64.25 ± 22.2</td>
</tr>
<tr>
<td>Group III</td>
<td>189.5 ± 25.9</td>
</tr>
<tr>
<td>Group IV</td>
<td>221.1 ± 27.0</td>
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Figure 1: Bar chart graph to compare the mean retentive values for the experimental groups.

At an embedment depth of 5mm Euro post (stainless steel, parallel sided, serrated posts) (group IV) tended to be the most retentive post among tested groups with mean retentive force of 221.1±27N. The next more retentive configuration was Euro post (group III) at embedment depth of 10mm, which was retained at 189.5 ±25.9N. Easy post (fiber reinforced, tapered, smooth posts) at embedment depth of 10mm (group I) exhibited mean retentive ability of 65.75±23.6 N while Easy post at embedment depth of 5mm (group II) was the least retentive posts at 64.25 ±22.2 N.

Statistical analysis of data using analysis of variance "ANOVA" revealed that there was a statistically highly significant difference (p< 0.001) between the mean retentive values among the four groups tested as shown in Table 2.

Further investigation using LSD (Least Significant differences) test showed that there was a statistically highly significant difference (P< 0.001) between group I and group IV, also between group II and group IV. There was statistically significant difference (P< 0.05) between group I and group III, also between group II and group III, while there was no significant difference (P>0.05) between group I and group II, also between group III and group IV (Table 3).

Table 2: Analysis of variance (ANOVA) test for the four groups.

<table>
<thead>
<tr>
<th></th>
<th>F-value</th>
<th>P-value</th>
</tr>
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<tbody>
<tr>
<td>Between groups</td>
<td>29.40</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table 3: Least significant difference LSD test to compare the mean retentive values for the experimental groups.

<table>
<thead>
<tr>
<th></th>
<th>P-value</th>
<th>Sig</th>
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<tbody>
<tr>
<td>Group I &amp; Group II</td>
<td>0.90</td>
<td>NS</td>
</tr>
<tr>
<td>Group I &amp; Group III</td>
<td>0.0014</td>
<td>S</td>
</tr>
<tr>
<td>Group I &amp; Group IV</td>
<td>0.000</td>
<td>HS</td>
</tr>
<tr>
<td>Group II &amp; Group III</td>
<td>0.0012</td>
<td>S</td>
</tr>
<tr>
<td>Group II &amp; Group IV</td>
<td>0.000</td>
<td>HS</td>
</tr>
<tr>
<td>Group III &amp; Group IV</td>
<td>0.28</td>
<td>NS</td>
</tr>
</tbody>
</table>

DISCUSSION
The retention of a post in the root canal is critical for the successful restoration of endodontically treated teeth. The retention of various types of posts has been the subject of much experimentation; numerous studies of retentive properties have been conducted relative to the form, shape, diameter, length and surface configuration of the posts. Although every effort has been made to select specimens of comparable characteristics and to standardize the experimental procedure accurately, a range of retention values with in each group couldn't be avoided. The variability of the physical properties of human teeth may be a reason for such data range, dentin is a heterogeneous tissue, its structure, and degree of calcification can vary from tooth to another. Under the condition of the present study the results showed that endodontically treated teeth restored with Euro post (Stainless steel /parallel sided /serrated posts) recorded significantly higher retentive values than those restored with Easy post (fiber reinforced /tapered /smooth posts). Dowel design is very important variable affecting both retention and protection potential for the dowel. Dowels that are tapered and cemented in their channels are least retentive and act as wedges causing coronal stress concentrations. Parallel sided, serrated dowels act as intermediate retainers and distribute stress evenly through remaining root structure. Surface configuration of the dowel is another important variable in retention; the marked increase of
retentive values was also attributed to the serrated surface of the Euro post. The superior retentive abilities of parallel sided design of the post over tapered design in resisting tensile, shear, and torque forces, and the serrations at the surface of the post as well as the use of adhesive resin cement for luting the post, all these factors will greatly improved the retention of the post inside the root canal. This finding is in agreements with that obtained by Colley et al (5), Johnson and Sakamura (6), Love and Purton (7), Purton et al (8), and Cohen et al (9), but disagrees with the findings of Stockton and Williams (10) who revealed that the serrated C-post (parallel design) required significantly more tensile force to dislodge them than Para post (Plus post). The serrations at the surface of the fiber post would significantly increase the retention of the post inside the canal, also with the findings of Drummond (11) who found that there was no significance difference in the retention of the fiber post versus stainless steel Para post. All the tapered dowels could easily be removed after the cement seal was broken, and they came out cleanly with no cement attached. The bond between the cement and the dowel was the failure site, while in the parallel sided design posts could not be removed from the tooth after the fracture of the cement bond. Tensile forces greater than the forces required to break the cement bond were required to remove the parallel-sided dowels, once removed. The parallel sided dowels were coated with cement as were the dentinal walls of the prepared canals, thus failure site with in the cement. The serrations on the parallel sided dowels served as a mechanical locking device for the cement and prevent failure of the cement dowel bond.

Post length has a pronounced effect on post retention. In this study although the retentive values of group I (Easy post 10mm depth) were higher than that of group II (Easy post 5mm depth) but still its statistically not significant, this may be due to the fact that an increase in the bonded post surface area 50% most likely influenced the increased in the retentive strength. There was no significant difference in the retentive values of group III (Euro post 10mm depth) and group IV (Euro post 5mm depth) this may due to that nearly the same number of retentive spirals engaged the canal wall. The results of this study are in agreement with that of Rovatti et al (12), Purton and Payne (13) and Borer et al (14), but disagree with that of Standlee et al (15), who claimed that the more deeply the dowel were placed in their dentin canals the more retentive they became. The result of Johnson and Sakamura (6) who stated that an increase in length of the dowel from 7 to 11mm lead to increase in the retention by 30%.

Increasing the post depth must be well with in the constraints of root length, canal morphology, root diameter in the apical area, and the maintenance of an endodontic apical seal. However, the influence of post length on retention should not be over emphasized and the temptation to compromise the apical seal of a root filling by increasing post length should be resisted. Each tooth must be evaluated on an individual basis by the dentist before its restored with a post.

REFERENCES