Comparison of fit among different types of post restorations luted with conventional cement

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ABSTRACT

Background: with the advent of new postmaterial in dentistry, it has become important to measure fitness of post restoration along the horizontal plane of the root space.This study aimed to measure and compare, the cement film thickness of conventional zinc phosphate cement in micrometer between the post and root dentin along horizontal plane at different post space regions (coronal, middle and apical) of four types of posts, by using stereomicroscopy.
Material and methods: Thirty-two extracted human maxillary canines, mandibular canines and maxillary central incisors (n=32) were instrumented with ProTaper system files (hand use) and obturated with gutta-percha for ProTaper and AH26® root canal sealer. After 24hrs of incubation at 37ºC, post space was prepared using FRC Postec® plus drills no.3 and ER Cera reamer size 70, creating 10 mm deep post space. The prepared samples were then randomly divided into four main groups (8 samples each) according to the type of post used (Group A: fabricated cast metal post), (Group B: fabricated zirconia post), (Group C: prefabricated glass fiber reinforced composite post), (Group D: prefabricated zirconia post). After cementation and incubation period of 24hrs, each root was sectioned horizontally into 3 discs (2mm in thickness) at the coronal, middle and apical regions of the root space. The cement thickness between post and root dentine was measured (in µm) by using a stereomicroscope.
Results: The results of this study showed that the lowest mean of cement thickness was in group C (35.28µm), followed by group A (78.12µm) and group D (81.9µm), and all three groups demonstrated acceptable cement thickness, while group B produced unacceptable cement thickness (127.34µm). One way ANOVA test revealed a statistically highly significant difference for the cement thickness among four post types used within each region of the root.
Conclusions: the root region and type of post system have an effect on cement thickness along post space.
Keywords: Cast metal post, zirconia post, fiber post, root region. (J Bagh Coll Dentistry 2013; 25(3):14-18).

INTRODUCTION

In most of endodontically treated teeth, the amount of coronal tooth structure remaining is often limited as a result of trauma, caries, prior restoration and endodontic access procedures.The choice of an appropriate restoration for endodontically treated anterior teeth is guided by the strength and esthetics [1]. Historically, cast posts were more commonly used than prefabricated posts, but over many decades, cast posts have become much less popular. When there is wide, noncircular (oval canal), or extremely tapered canals, cylindrical prefabricated posts may not achieve adequate adaptation [2].However, the fabricated cast metal posts have fit adaptation, high retention and thin cement layer, but the base metal alloy has corrosion and allergic reactions [3]. Moreover, the increasing demand for more esthetically and biocompatible restorations has led to the development of tooth-colored, translucent, metal-free post- systems [4].

The type of zirconia used for dental post is composed of YTZP (yttrium tetragonal zirconium polycrystals).The physical and mechanical properties of zirconia posts could increase the strength of the tooth [5]. An alternative to cast post and zirconia, fiber posts have been introduced in the early 1990s to restore endodontically treated teeth with an excessive loss of dentinal structure, because their elastic modulus is claimed to be similar to that of the dentin; therefore, displayed higher survival rates when compared with teeth restored with zirconia posts [6], have good mechanical and biocompatibility properties[7]. Like all prefabricated posts, prefabricatedfiber posts are designed so that a circular post is produced, and therefore an unnecessary amount of dentin has to be removed [2].The cement must have homogeneous biomechanical unit to allow more uniform stress distribution, better preserves the weakened tooth structure, reduces microleakage at the dentin–cement interface, and reduces secondary caries and re-infection of the periapical area [8]. The thin layer will flow into the internal surface irregularities between post and tooth structure, resulting in greater retention [9].

MATERIALS AND METHODS

Sample selection: Thirty-two freshly extracted human teeth (maxillary canines, mandibular canines and maxillary central incisors). The teeth were straight root, no caries, no fractures, cracks or external resorption by examination with 10X magnifying eye lens and light cure device.

Samples preparation: The length of the root was marker (15 mm) and sectioned parallel to the cemento-enamel junction. Plastic test tube was used as a mold to hold ofspecimens. The rootswere placed with the aid of simple dental

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surveyor (J.M.Ney, U.S.A.) the long axisof the roots parallel to that of plastic tubes.

Endodontic treatment: Root canal instrumentation was performed using ProTaper hand files (Dentsply, Switzerland) in crown down technique. Irrigation performed using of 2.5% NaOCl after every change of file size throughout thecleaning and shaping of the root canals, dried with paper points and filled with gutta-percha for ProTaper F3 (Dentsply, Switzerland) and AH26® root canal sealar (Dentsply, Germany). The excess gutta-percha at the canal orifice was removed.The accessopening were sealed with temporary fillingmaterial, and stored at 37ºC, 100% humidity in an incubator (Memmert, Germany) for 24hr.

Sample grouping: After that the roots were randomly assigned into four groups (n=8each), depending on the type of post used (Group **A:** fabricated cast metal post(Hi-Chromsoft-7, Japan), Group **B:** fabricated zirconia post (Zirconzahn, Italy), Group **C:** prefabricated glass fiber reinforced composite post (Ivoclar Vivadent, France), and Group **D:** prefabricated zirconia post (komet, Germany)), and then each group was subdivided into three groups (n=8 each), according to the root region (coronal, middle and apical).

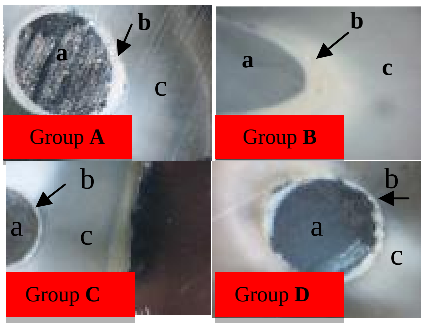

Fig.1. Digital images in middle region a) Post b) Cement c) Root structure

Root space preparation: After 24hrs,the gutta-percha was removed by Pesso drills No.1, ingroups **A, B,** and **C**the canal walls prepared with FRC Postec®Plus drills No.3 (Ivoclar Vivadent, France).In group **D** the canal walls were prepared with Cera post reamer size 70 (komet, Germany).The preparation was performed under copious water coolingwith handpiece attached to modify dental surveyor (Cendres & metaux, Switzerland) to creating (10 mm) deep post space measured from the coronal end of the root.keeping 5 mm of gutta-percha apically.

Construction of fabricated cast metal post and core: It was casted from a direct wax pattern, blue inlay wax type II (Degussa, Germany) fabricated in the root samples, phosphate bonded investment(Yeti dental, Germany)was vacuum mixed,then the wax patterns were coated with the investment material using the brush technique and allowing the investment to set for 1 hour. After that the ring was placed in a cold furnace (Combilabor, Germany) and the temperature was set for 480 °C soaked for 15 minutes. The temperature was then raised to 650 °C and held for another 15 minutes before raising it to 950 °C and holding for another 15 minutes.The ring was removed from furnace at the time of nickel based alloy melted in electrical centrifugal casting machine (Dentaurum, Germany). Then the cast post was tried to fit by using a disclosing agent, if a pressure spot was detected it was adjusted with carbide bur to obtain a passive fit [10].

Construction of fabricated zirconia post and core: Eight metal posts and core were constructed using the same procedure as in cast metal group and fixed in in the holding plate of the copy milling machine(Zirconzahn, Italy). The milled structure is 30% larger than the metal pattern as zirconia undergoes shrinkage of 30% after sintering of milled restorations. The copy was then sintered in furnace (Zirkonofen 600, Italy)prior to the sintering process (8-hours):From room temperature to 1500°C è 4-hours,hold time at 1500°C for 2- hours, andcooling-down phase up to room temperature 2-hours.After that it adjusted by using a disclosing agent. If a pressure spot was detected it was adjusted with diamond bur to obtain a passive fit [1].

Post cementation: The De Tray zinc phosphate cement (Dentsply, Germeny) was mixed and a constant load of (4.5Kg) was applied for (10 minutes), using a custom-made loading apparatus. After setting the roots were stored in distilled water for 24 hours at 37°C in an incubator.

Preparation of the specimens for sectioning: The roots were removed from moldand the apical end of the roots was fixed in the plastic piston of the syringe with a composite resin material by using a simple dental surveyor and loading the syringe with cold acrylic.The sectioning of the root was made by using a diamond disc (komet, Germany) mounted on special custom cutting machine (12000 rpm).The cuts were made under heavy flow of water (19-25°C) to minimize the smearing [11]. From each specimen, 3 discs (coronal, middle, and apical) were obtained, each (2 mm) in thickness.

Measurement of film thickness: The cement thickness measured at four indentations at the midpoint of buccal, mesial, lingual and distal surfaces by a stereomicroscope (Hamilton, Italy) are shown in (Figure 1). The microscope was calibrated to 2.5 mm (2500µm) at magnification 40X. All readings were recorded and converted to (µm) by a magnification factor, depending on two readings of two persons and taking the mean of the two readings to assure accuracy. To overcome errors in readings, measurements repeated 4 times [12].

Statistical analysis: All statistical analysis was performed using commercially available software (SPSS for Windows) version 15.

RESULTS

1. The measurement of cement thickness of four groups at three regions:

The mean of cement thickness at different root regions are shown in (Figure 2), in both fabricated posts the apical regions have higher mean, followed by middle regions, while the lowest value seen at the coronal region and in both prefabricated posts the coronal regions have higher mean, while middle region of group C had the lowest than apical region, while the middle region of group D had highest mean than apical region. The highest mean could be seen at the apical region of group B, while the lowest value seen at the middle region of group C.

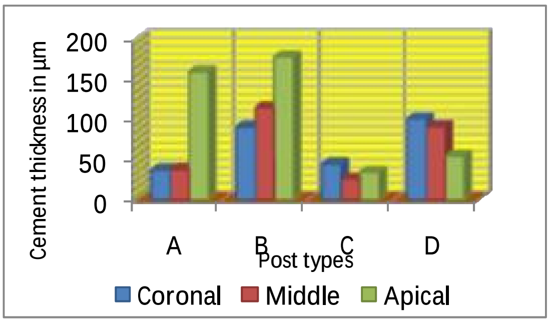

Fig. 2. Bar-chart graph showing the mean values of cement thickness of different groups and subgroups

In the first analysis, one-way ANOVA test revealed that the cement thickness was significantly affected by the different regions of the post space, a very highly significant difference (P<0.001) within each regions of root at same type of the post used.

In the second analysis, one-way ANOVA test revealed that the cement thickness was significantly affected by the different regions of the post space, a very highly significant difference (P<0.001) among different regions of root within the four post types used.

2. The measurement of cement thickness of four groups:

The mean of cement thickness at all root regions are shown in (Figure 3), the highest mean was seen in group B, followed by group D and group A, while the lowest value was seen at group C.

One-way ANOVA test revealed that the cement thickness was significantly affected by the post types used, a very highly significant difference (P<0.001) in mean of cement thickness values among the four post types.

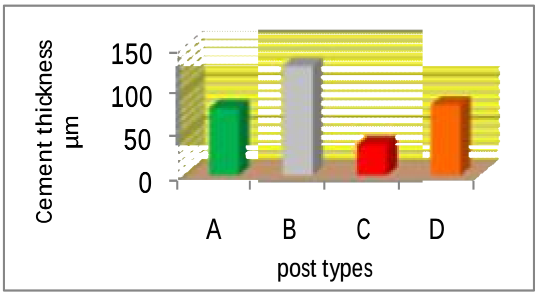

Fig. 3. Bar-chart group showing to the mean values of cement thicknessfor total values of four groups

DISCUSSION

Contemporary post types can be divided into two subgroups according to the technique approach used to prepare the root prior to cementation. The first group, prefabricated posts are usually used for the direct technique where the post insertion and core build-up are performed at the same appointment. In the second group, fabricated posts are usually used for the indirect technique, where the post space prepared, preserving as much dentin as possible and taking an impression of the prepared canal, the dental laboratory technician fabricates the post and core; these steps require at least two visits [10].There are two main reasons for the failure of teeth restored with post are firstly poor marginal adaptation between post and dentine of root structure which clinically leads to a higher incidence of coronal bacterial leakage or secondary caries and the second reason is fracture of the remaining dental hard tissue. Adequate adaptation of restorations improves longevity and reduces the risk of restoration misfit associated with periodontal disease [13]. One of the main criteria to evaluate the adequacy of a restoration is marginal fit. The success of post restorative procedures depends in part, on the thickness of the cement used to create a link between the post and root canal dentin. The fit is typically measured by the cement thickness between post and dentin of root structure. The method of horizontal cement thickness between structures was used. In this study four types of posts were used: two fabricated posts and two prefabricated posts. The fitness was analyzed for different post systems in canals with oval shape of natural human maxillary central incisor, maxillary canine and mandibular canine roots.

The maximum film thickness of zinc phosphate cement between two flat surfaces is 25 µm according to (ADA specification No. 96), and the current ISO 9917 standard requires a film thickness at the time of seating inferior to 25 µm for water-based luting cements. In this in vitro study, the prefabricated glass fiber reinforced composite system mean of cement thickness was (35.28µm), followed by the fabricated cast metal systems (78.12µm), and followed by the prefabricated zirconia system (81.9µm), and all three groups demonstrated acceptable cement thickness while the fabricated zirconia system produced unacceptable cement thickness (127.34µm) according to previous researches [14-16] that suggested that 120 µm should be the highest limit for clinically acceptable cement thickness.The four systems showed a large variation in cement thickness values:

Fabricated cast metal post and fabricated zirconia post: A standardized construction technique could not be obtained because of the difference in their procedure, materials and equipment during post fabrication technique. The cement thickness demonstrated the higher values for the apical region and the lowest values for the coronal regions of the post space. The construction technique in apical region of post required adjustment because of on passive fitted of post and when adjusted may reduction dimension in the end related to the direction of view to the operative site.

The fabricated cast metal post was a combination of two techniques, the lost-wax and casting techniques; therefore, it may undergo minor dimensional changes caused by the use of a separating medium before waxing of the post and the minor shrinkage during solidification of the wax, but the expansion of the investment and dimensional changes of the metal may be adequate to compensate for the metal casting shrinkage and obtaining a desirable cement thickness (78.12µm).The results disagree with Yüksel and Zaimoğlu [17] who suggested that the mean of cement thickness of casting copings (96.5 µm), this value was higher than those obtained in this study, and the difference may be related to the difference in material used.

Thefabricated zirconia post produced unacceptable cement thickness (127.34µm), which may be due to:

1. The cement thickness might be influenced by the separating medium that was used during the fabrication of copying metal post.
2. The copying metal post may undergo dimensional changes after melting and casting metal alloy.
3. The machining of zirconia blank may be inadequate to compensate for the shrinkage occurring after sintering of blank.
4. Dependence on the skill of the laboratory technician.
5. The no passive fit of the milled zirconia posts. Repeated adjustments were necessary, as was subsequent post sintering, to passive fit of the posts into the canal.

The results agree with Dietschi et al. [18], who investigated the marginal adaptation of different post types to root dentin, it was reported that the fabricated zirconia post presented the highest cement thickness proportion compared to other post types. The results disagree with Adriana et al. [19] who suggested that the mean of cement thickness of restoration fabricated by using the copy milling machine of Zirkonzahn was (22.8 µm) with using cement, and the difference may be related to type of cement and load apply for cementation.

Prefabricated glass fiber reinforced composite post and prefabricated zirconia post: In these groups, all steps that might have caused the dimensional changes are not found. The shape of drill used to prepare root space is coincident with the post design according to manufacturer's instructions to provide better canal adaptation and thus the lower values for (the middle region in prefabricated glass post and the apical region in prefabricated zirconia post), and the highest values for (the coronal regions of root space).The lower thickness in prefabricated glass fiber post (35.28µm) was probably because of technological development and new material, the taper shape and passive design of posts which conforming to the original shape of the root space and obtaining a good fit. The results agree with Schmagea et al. [20] who suggested that the mean of cement thickness of greater taper prefabricated post was ranging between 33 and 48 mm with using zinc phosphate cement.

The shape and passive design of prefabricated zirconia posts manufacture for canal adaptation and obtaining a desirable thickness (81.9µm).This coincides with Stricker and Göhring [21] who reported that prefabricated glass fiber and ceramic post had a positive effect on marginal adaptation.

Comparison between fabricated groups: The different in manufacturing processes may affect on the cement thickness results [22].The lower in the fabricatedcast metal system was due to fewer laboratory steps: (convert of wax to metal), while in fabricated zirconia system (convert of wax to metal and then convert of metal to zirconia). The expansion and contraction properties of the various materials used in the fabrication of coping metal post, combined with the complex fabrication steps of the milling process; the sintering process inadequate to compensated 30% shrinkage of pre-sintered zirconia pattern and difficult to obtain an acceptable fit of a fabricated zirconia system.

Comparison between prefabricated groups: The shape of drill used for preparation of root space different according to manufacture instruction, is greater taper in prefabricated glass fiber reinforced composite post to obtain thinner cement thickness at middle of root canal space and taper drills shape in prefabricated zirconia post to obtain thinner cement thickness at increasing root canal depth.

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