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\- 포스트 공간 전처리 방법에 따른 접착력의 비교 -

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포스트 공간 전처리 방법에 따른 접착력의 비교

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근관 치료 후 적절한 수복을 통해 저작과 심미 기능을 회복시켜 주는 것은 필수적이다. 특히 우식이나 치관 파절 등으로 치질 손상이 심해 코어의 부가적인 유지력이 필요한 경우 치근에 포스트를 위치시켜 코어와 전장관의 유지를 향상 시킬 수 있다.

최근에는 치질과 탄성 계수가 비슷하며 술식 과정이 편리한 fiber 포스트와 자가 접착 레진 시멘트가 소개되어 많이 이용되고 있다.

이에 자가 접착 레진 시멘트를 이용한 포스트 접착시 포스트 공간 전처리 방법에 따라 접착력의 차이가 있는지 비교 분석 하였다.

ProTaper (Dentsply Maillefer, Ballaigues, Switzerland) 전동 파일과 거타퍼챠 콘과 AH Plus 실러 (Dentsply Maillefer, Konstanz, Germany) 를 이용하여 단근관 소구치의 근관치료 후 포스트 공간을 형성 하고 전처리를 하지 않는 그룹, 17% EDTA로 1분간 처리한 그룹, 32% 인산으로 20초간 처리한 그룹으로 나누었다. Luxapost (DMG, Hamburg, Germany)와 G-CEM LinkAce (GC, Tokyo, Japan)를 이용하여 포스트 접착 후 각 치아를 6등분으로 주수하에 절단하여 치아에서 포스트가 탈락할 때까지의 push out bond strength를 측정 하였다.

상부와 중앙 부위에서는 세 그룹 간에 유의한 차이가 없었으며 하부 부위에서는 전처리를 하지 않은 그룹이 EDTA로 처리한 그룹과 인산으로 처리한 그룹보다 유의하게 접착력이 높았다. EDTA와 인산으로 처리한 그룹 간에는 유

의한 차이가 없었다.

자가 접착 레진 시멘트를 이용한 포스트 접착 시 전처리를 하지 않고 수세 및 건조만 한 경우가 apical 부위에서 접착력이 우수하므로 임상 적용시 고려해야 할 것으로 사료된다.

Ⅰ. Introduction

Severely damaged endodontically treated tooth is commonly restored with fiber post retained restoration. Currently, fiber post was introduced as alternative of metal casting post. Because the procedure of metal casting post is complicated and dependent on laboratory procedure. Metal post also result mismatch of modulus of elasticity between stainless steel post (200 GPa) and dentin (20 GPa). It can cause root fracture and post retained core failure under overload stress [1]. However, fiber post can resist fracture because the modulus of elasticity on fiber post is similar dentin's value. Moreover, the color of fiber post is translucent which guaranteed better esthetic and polymerization result [2]. And bonding procedure of fiber post needs less chairside time than a casting post and core [3]. Accordingly, many fiber post were widely replaced metal casting post in dental practice.

Although a homogeneous unit (post-cement-dentin) is ideal, there are some difficulty for luting to the root dentin. After post room preparation and cleaning, smear layer and unfavorable humidity environment inhibit adhesion between post and root dentin. High polymerization stress could generate adhesive failure and curing light can not reach to apical part of post room, it makes unpolymerized cement debond from root dentin [4, 5]. For this reason, traditionally dual-cured resin cements were used for luting post to dentin. But as adhesive system improves toward simple procedure, cements are also changed to more simple. Especially, self-adhesive resin cements are widely used because it is no need to process any pretreatment and used in a one step and improved bond strength like dual-cured resin cements [6].

According to manufacturers' manual, using self-adhesive resin cement do not need any pretreatment. But after post room preparation and cleaning, the post room's environment is changed humid and full of excessive smear layer over root dentin. Moreover, there is limitation of demineralization and hybridization of dentin because self-adhesive resin cements are mildly acidic [7]. Although, 17% ethylene diamine tetracetic acid (EDTA) or 32% phosphoric acid can be used to demineralize intertubular dentin, collagen fibrils in dentinal tubule is essential for the adhesion between the hydroxyapatite and self-etching adhesive resin cements [8]. Therefore, the effect of post room pretreatment with self-adhesive resin cement is controversial.

The aim of this study was to compare push out bond strength of fiber post luted with self-adhesive resin cement according to pretreatment.

II. Materials and methods

1. Specimen preparation

Twenty one single-rooted human premolar extracted for orthodontic treatment were used under the approval of the Institutional Review Board (CUDHIRB 1503 008). Exclusion criteria were the presence of resorption, fracture and caries. The crown was removed to prepare a uniform length of 17mm from the apex using diamond bur. Access cavities were prepared and a size 10 k-file was used to establish apical patency. Working length of root canal was determined to 1mm shorten from root apex. After confirming patency, root canals were prepared with ProTaper rotary SX, S1, S2, F1 and F2 file (Dentsply Maillefer, Ballaigues, Switzerland) using crown down technique and irrigated with 5.25% sodium hypochlorite. The canals were dried with paper point(B&L BIOTECH, Bala Cynwyd, USA) and obturated with gutta-percha cones with AH plus sealer (Dentsply Maillefer, Konstanz, Germany) using continuous wave compaction technique. The post room was immediately prepared to a depth of 12mm with LuxaPost drill (∅1.25mm, DMG, Hamburg, Germany) and rinsed with air-water syringe, and then the canals were dried with paper points. Prepared canals were examined using dental operative microscope at x20 magnification (Carl Zeiss, Jena, Germany) to confirm residual gutta percha and sealer existence. Then the specimens were randomly divided by three groups of 7 teeth each;

-Group 1) No pretreatment.
-Group 2) Pretreatment with 17% EDTA (MD-Cleanser, META BIOMED, Cheongju, Korea) for 60 seconds then rinsed with water using syringe and gently dried with paper points.
-Group 3) Pretreatment with 32% phosphoric acid (Uni-Etch, Bisco, Schaumberg, USA) for 20 seconds then rinsed with water using syringe and

gently dried with paper points.

2. Cementation procedures

G-CEM LinkAce (GC, Tokyo, Japan) self-adhesive resin cement was mixed by automixing tip and applied directly to post room through a elongation application tip. Composition of G-CEM LinkAce was described in Table 1. After application, translucent LuxaPost (∅1.25mm, DMG, Hamburg, Germany) was seated immediately and light cured (Normal mode, B&L Lite, B&L biotech, Ansan, Korea) with blinded under CEJ for 2 cycles of 20 seconds. The specimens were stored in water 37℃ for 1 week.

Table 1. Composition of G-CEM LinkAce.

Material	Manufactures	Composition
G-CEM LinkAce	GC (Tokyo, Japan)	Paste A : Fluoro-alumino-silicate glass, Urethane dimethacrylate(UDMA), Initiator, Inhibitor, dimethacrylate, Silicon dioxide, Paste B : Initiator, Inhibitor, Silicon dioxide, UDMA, dimethacrlylate,

3. Push out bond strength test

The specimens were inserted to acrylic resin blocks vertically. The specimens were fixed and transversally sectioned using water-cooled low-speed diamond saw (R&B, Daejeon, Korea) to produce six 1 mm thick post-dentin slices (Fig. 1). First coronal slice of spare post and cement was cut into 0.5mm and removed to make flat aspect because it cause misinterpretation of result. Six slices were obtained from each tooth and divided into coronal 2 slices, middle 2 slices and apical 2 slices. Each slice was marked sign on apical side and measured thickness by a digital caliper and positioned upward to push out apical-coronal direction in a universal testing machine (AG - 10KNX, Shimadzu, Japan) at a cross head speed of 0.5mm/min. The reason specimens were located apical- coronal direction is to push out toward the larger part. The pluger tip positioned to touch only post area without pressing the surrouding root dentin. The push out strength value were measured at post separated from specimen in Newton (N). A digital micrometer with 0.01mm accuracy was used to measure the thickness of the slice and the coronal and apical diameter of the fiber post. The value was converted into MPa by dividing the strength that made failure (N) by the post interface area (A) using the following formula of a conical frustum [9].

Debonding stress(MPa) = Load(N)/A

$$A = \Pi (R_1 + R_2)\sqrt{(R_1 - R_2)^2 + h^2}$$

R_1 : Coronal diameter of post

R_2 : Apical diameter of post

h : Thickness of slice

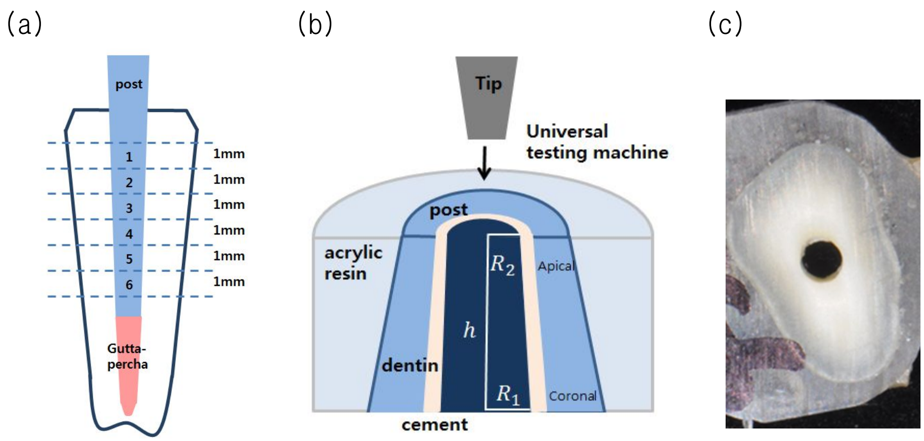

Figure 1. Schematic description of (a) the specimen preparation, (b) push out bond strength test and (c) the image of specimen after push out test.

4. Statistical analysis

The bond strength data were analyzed using Kruskal-Wallis test and Mann-Whitney test. All statistical analyses were performed at P=0.05.

III. Results

The push out bond strength of specimens are shown in Table 3 and Fig. 2. The push out bond strength of coronal displayed the highest value and the apical showed the lowest value on each specimen regardless of pretreatment. On anlaysis of each part among 3 groups using Kruskal-Wallis test, there was no significant difference in each coronal part and middle part. However, on apical part, there was significant difference between no pretreatment group and pretreatment with EDTA for 60 seconds group and between no pretreatment group and preptreatment with phosphoric acid with 20 seconds group using Mann-Whitnety test ($p<0.05$). Meanwhile, there was no significantly difference between pretreatment with EDTA for 60 seconds group and pretreatment with phosphoric acid for 20 seconds group in apical part.

Table 3. Push out bond strength between the fiber post and radicular dentin according to pretreatment. (unit=MPa)

	Coronal	Middle	Apical
No pretreatment	6.86±3.70	3.75±2.17	$2.96±1.93^{a}$
Pretreatment with EDTA for 60s	6.73±1.89	3.79±3.27	$1.08±0.50^{b}$
Pretreatment with phosphoric acid for 20s	6.96±2.24	4.78±3.44	$0.97±0.70^{b}$

The data were expressed mean±standard deviation. Groups with columns represent statistically significant differences among pretreatment groups ($p<0.05$).

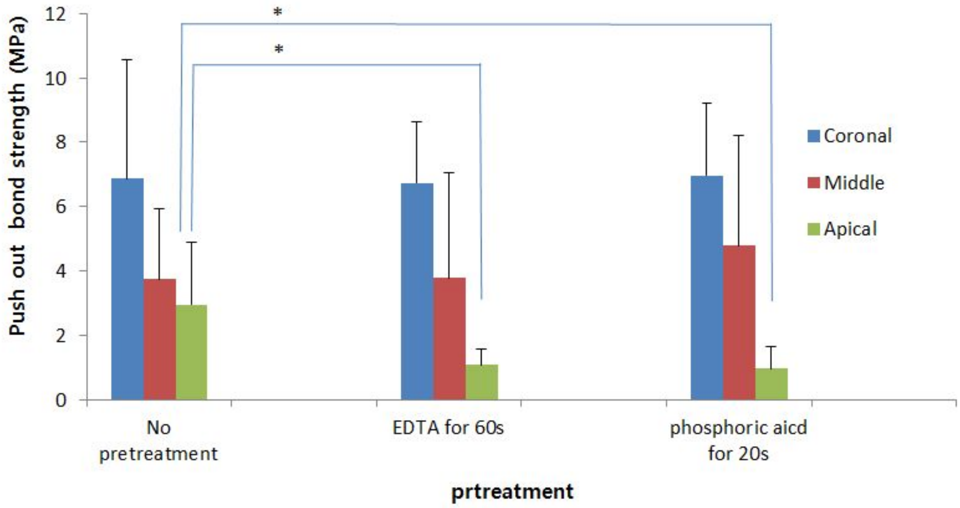

Figure 2. Diagram of the push out bond strength on each group. Asterisk represent significant difference among pretreatment groups (*:$P<0.05$).

Ⅳ. Discussion

In the present study, post room surface was treated by EDTA or phosphoric acid to modify or remove the smear layer for higher bond strength between cement and dentin to form a uniform hybrid layer [10]. The specimens were cut to a uniform 17mm because the CEJ of each tooth and size of post room is different and it makes experimental standard more complicated. Post rooms were prepared to 5mm from apex to make apical sealing ensure. After canal obturation, post room was immediately prepared because polymerization of sealer to make apical seal between dentin and sealer can be fractured by heat and vibration of post preparation bur. Cemented post was cured 40 seconds with blinded over CEJ to reproduce clinical situation that curing light do not reach to the apical area. The specimens were immersed in distilled water for 24 hours expecting umpolymerized resin cement to be self-cured.

The push out bond strength test is 3-point bending test using universal testing machine. This technique was used to measure regional bond strength between post-cement-dentin at post separated from specimen. Some studies carried out microtensile bond strength test for comparing bond strength between cement and dentin. However, there is a difficulty of making specimens and high incidence of pre-testing failure while preparing the specimens. However, push out test has low incidence of pre-testing failure and more similar to the clinical situation and demonstrated a more homogenous stress distribution by FEA (finite element analysis) and less variability compared to microtensile bond strength test [10]. There is also experimental limitation on push out test. It is needed that push out force [N] was converted to [Mpa] by dividing adhesion area. In apical part, the gap between post surface and post room surface can be ignorable mathematically, but in coronal part, the gap between post surface and post room surface cannot be ignore and make error in results.

There was no significant difference in each coronal part and middle part. In clinical procedure, it is impossible to wait for self-cure mode for 30 minutes so that coronal part was cured for 40 seconds. It could make self-adhesive resin cement polymerization on coronal and middle part that had no difference among the 3 groups. Adhesion dimension of coronal part is also obviously wider than that of apical part that affects push out bond strength. Overall retention of post is influenced by the amount of surface texture on cementation area [11]. Difficulty in getting the curing light to apical part have been proved by evaluating the depth of the light-initiated polymerization of fiber reinforced composite into the root canal [12]. To overcome this limitation, light-guiding attachment is introduced to penetrate light to apical part when using bonding agent [13]. Although many self-curing initiator was added to compensate for shortage of curing light penetration, dual-cured resin cement displayed higher bond strength at accompanied by light curing [11-14].

The efficiency of adhesive system is directly related to dentin and collagen integrity [15]. The selection of adhesive system is fundamental in post cementation because root dentin is unfavorable environment for adhesion. Moisture in root dentin and insufficient curing light penetration to apical portion disturb adhesion between cement and root dentin. This problem can be compensated by using dual-curing resin cement or self-adhesive resin cement. Self-adhesive resin cements were introduced to overcome complicated cement applications, receptivity to moisture and postoperative sensitivity of conventional resin cements. These cements relief the need for an additional pretreatment to the dentin surface in manufacturer's manual [3, 16]. Especially, G-CEM LinkAce (GC, Tokyo, Japan) was introduced that had the highest bond strength in unfavorable environment using self-cured mode [17].

EDTA is a mild calcium-chelating agent that removes the hydroxyapatite of dental hard tissue selectively without destructing the collagen matrix structure [18-20]. When dentin surface was pretreated with 17% EDTA for 60 seconds, 30% of the smear layer plugs remained with partially removed smear layer and no change on morphologic was observed [18, 20].

When smear layer was removed and dentinal tubule was opened, slight erosion of the peritubular dentin inhibits adhesion of cement to root dentin. Over-etching of dentin surface also had negative effects on bond strength of dentin-bonding system [14]. A layer of denatured collagen and residual smear layer may form on the dentin surface and prevent the collagen network from being exposed [21]. Phosphoric acid removes the smear layer, demineralize the dentin surface, open dentinal tubules, and increase the microporosity of the intertubular dentin [22]. Overwet phenomenon that dentinal tubule fluid can flow out and contaminate post room surface and disturb adhesion hydrophobic resin tag when smear layer removed by phosphoric acid was occur. This factor decrease bond strength in post room.

Ⅴ. Conclusion

Within the limitation of this study, it can be concluded that pretreatment with EDTA or phosphoric acid have negative effect in apical part on push out bond strength of fiber post luted with self-adhesive resin cement.

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