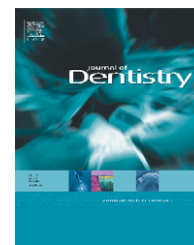


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Effect of types of luting agent on push-out bond strength of zirconium oxide posts

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ABSTRACT

Objective: The aim of this study was to investigate the effect of different luting agents on the bond strength of zirconium oxide posts in root canals after artificial ageing.

Material and methods: Thirty single-rooted extracted teeth were collected. Post spaces were prepared. Custom milled zirconium oxide posts (Cercon, Degudent) were fabricated. Specimens were divided into 3 groups ($n = 10$), according to the luting agents used: group RA, conventional resin luting agent (RelyX ARC); group RU, self-adhesive resin luting agent (RelyX Unicem); and group Z, zinc phosphate luting agent (DeTrey). Specimens were subjected to thermocycling and water storage at 37 °C. Specimens were horizontally sectioned into three sections and subjected to a push-out test with 0.5 mm/min crosshead speed. The failure mode was assessed by scanning electron microscopy. Data were analysed by using 2-way ANOVA.

Results: The following bond strength values were obtained: group RA – 8.89 MPa, group RU – 10.30 MPa and group Z – 9.31 MPa. There was no significant difference in bond strength among the groups ($P = 0.500$). Adhesive failure mode at the cement/post bonded interface was seen in 100%, 66.67% and 83.3% of examined sections in groups RA, RU and Z, respectively. There was no significant difference in bond strength among different root regions ($P = 0.367$).

Conclusion: The type of luting agent had no significant effect on the push-out bond strength of zirconium oxide posts after artificial ageing.

Clinical significance: Conventional luting agents, such as zinc phosphate cement, seem to provide comparable retention to resin luting agents for cementing custom milled zirconium oxide posts.

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1. Introduction

Ceramic restorations are currently a standard option for aesthetic dentistry. Among the available ceramic systems, zirconium oxide ceramics have very favourable mechanical

properties.¹ When using tooth-coloured zirconium oxide posts, metal-free, highly aesthetic restorations can be achieved. Although there is a lack of long-term clinical studies, short-term studies of zirconium oxide posts have reported favourable results.^{2,3} Nevertheless, several in vitro studies have reported that zirconium oxide posts possess

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lower retentive values when compared with other types of posts.^{4–7}

The effect of luting agents on the retention of zirconium oxide posts *in vitro* has been investigated.^{4,5,8–11} Conventional cementation of zirconium oxide posts with glass ionomer or resin-modified glass ionomer luting agents has been reported to produce lower retentive values when compared with adhesive resin luting agents.^{8,9,11} Zinc phosphate cement provided comparable retentive value when compared with other conventional resin luting agents, but was less retentive than a phosphate monomer-containing chemically adhesive resin luting agent.⁵

Resin luting agents can be classified into conventional resins and chemically adhesive resin luting agents that contain functional monomers that are capable of adhering to tooth tissue and restorative materials.¹² It has been reported that zirconium oxide posts cemented with conventional resin are less retentive than those cemented with chemically adhesive resin luting agents.^{4,5,12,13} The retentive strength of chemically adhesive resin luting agents differ according to the chemical composition of their functional monomers.¹⁴ 10-Methacryloyloxydecyl dihydrogen phosphate (10-MDP)¹⁴ and 4-methacryloyloxyethyl trimellitate anhydride (4-META) are among the most effective and highly adhesive functional monomers.¹⁵ Self-adhesive resin luting agents are the latest type of resin luting agents introduced to the market. They offer the advantages of easier clinical application while retaining the retentive abilities of resin luting agents. The first marketed self-adhesive luting agent was RelyX Unicem.¹⁶ It contains acidic phosphate ester functional monomers which demonstrate chemical bonding ability to tooth structure.¹⁷ This composition showed adequate bond strength to zirconium oxide surfaces.¹⁸ Bitter et al. evaluated the bond strength of zirconium oxide posts cemented with RelyX Unicem resin luting agent.¹¹ Their results indicated that the bond strength of self-adhesive resin luting agent (RelyX Unicem) was comparable to other chemically adhesive resin luting agents.¹¹

For a laboratory study to produce clinically relevant data, artificial ageing methods, including water storage and thermocycling, should be included in the study design.¹⁹ It has been reported that artificial ageing resulted in reduction in bond strength between zirconia and luting agents.^{20,21} In the literature, reports on the effects of luting agents on retention of zirconium oxide posts after artificial clinical ageing are lacking. Therefore, the aim of this study was to investigate the effect of three types of luting agents (zinc phosphate, conventional resin and self-adhesive resin luting agents) on the bond strength of zirconium oxide posts in root canals after simulated artificial ageing. The null hypothesis tested was that there is no significant difference in bond strength of zirconium oxide posts cemented with the three different luting agents.

2. Materials and methods

2.1. Specimen preparation

Preliminary power analysis was performed to determine the sample size. By using a standard deviation reported in a

previous study¹¹ and by considering 3 MPa as the statistically significant difference relevant for this study, at least 30 specimens were required in each group to achieve 85% power for finding statistically significant differences at the 5% level of significance. Thirty extracted human permanent single-rooted teeth, free of caries, restorations, fracture or cracks on visual inspection were collected. The crowns were sectioned approximately 1 mm above the midfacial cemento-enamel junction (CEJ) perpendicular to the long axis of the tooth with a diamond disc (K6974, GEHR Brasseler GmbH and Co.KG, Lemgo, Germany), resulting in a flat tooth surface. Root canals were instrumented with hand files (K-files, SybronEndo Corporation, West Collins, Orange, CA) and irrigated with 2.5% sodium hypochlorite (NaOCl). Canals were not obturated. Eight-mm-deep post spaces were prepared with Gates Glidden drills (Pulpdent Corporation; Watertown, MA) sequentially from size 4 to size 6. ParaPost drill size 6 (ParaPost Black P-42-6, ParaPost XP; Coltene/Whaledent Inc., Mahwah, NJ) was finally used to prepare a post space with parallel walls to a depth of 8 mm and a width of 1.5 mm.

2.2. Post fabrication

Details of the materials used in this study are presented in Table 1. Five black smooth plastic ParaPost impression posts (P-743-6, ParaPost XP; Coltene/Whaledent Inc.) were fitted passively in 5 root canals. The projecting ends of the plastic posts were cut to leave 6 mm of the post's length projecting outside the canal, which assisted in mounting the specimens into the acrylic resin block. The plastic posts were scanned with a laser scanner (Cercon Eye scanner; DeguDent, Dentsply, Hanau-Wolfgang, Germany). Partially sintered Cercon yttria-stabilized zirconia ceramic blanks size #30 (Cercon Base; DeguDent, Dentsply) were milled by computer aided machining (CAM) (Cercon Zirconia Milling System #5; DeguDent, Dentsply) then sintered (Cercon heat; DeguDent, Dentsply) at 1140 °C for 6 h and 40 min.

2.3. Post cementation

The posts were then seated in the root canals for try-in, and the fit was adjusted by using a silicone disclosing medium (Fit Test C and B, VOCO GmbH, Cuxhaven, Germany) to determine binding areas. Binding areas were removed with a round diamond rotary instrument (801/014, Diaswiss SA, Nyon, Switzerland) in a high-speed handpiece with copious water irrigation. Specimens were randomly divided into 3 groups ($n=10$) according to the luting agents used: group RA, conventional resin luting agent (RelyX ARC; 3M ESPE, Seefeld, Germany); group RU, self-adhesive resin luting agent (RelyX Unicem; 3M ESPE, Seefeld, Germany); and group Z, zinc phosphate luting agent (DeTrey Zinc; Dentsply DeTrey GmbH, Konstanz, Germany).

Luting agents were mixed according to the manufacturer's instructions. RelyX ARC cement is a dual-polymerized conventional resin luting agent. For group RA, root canals were etched with 35% phosphoric acid etchant (Scotchbond Etchant; 3M ESPE, St. Paul, MN) for 15 s. Canals were washed with water by using an irrigating syringe (Kalmed dental products, Inc., Marietta, GA) for 10 s, and then dried with a

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