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Influence of surface pretreatment of fiber posts on cement delamination

Leontine A. Jongsma, Cornelis J. Kleverlaan, Albert J. Feilzer*

Department of Dental Materials Sciences, Academic Centre for Dentistry Amsterdam (ACTA), University of Amsterdam and VU University Amsterdam, Louwesweg 1, 1066 EA Amsterdam, The Netherlands

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ABSTRACT

Objectives. To evaluate the influence of post surface pretreatment on the delamination strength of different cements from a prefabricated FRC post tested in a three-point bending test.

Methods. Three cements were tested; RelyX Unicem, DC Core Automix, and Panavia F2.0. Per cement, 40 posts (D.T. Light Post Illusion size 3) were divided into four groups; no pretreatment (control), sandblasting, silanization, and sandblasting followed by silanization. A cement layer was applied to the posts using a standardized poly-oxy-methacrylate mold. The specimens were subjected to a three-point bending test recording the initial and catastrophic failure loads. Two-way ANOVA and Tukey post-hoc tests were used to analyze the differences between the variables.

Results. At the initial failure load, all specimens demonstrated delamination of the cement layer, therefore initial failure load was defined as delamination strength. With RelyX Unicem, none of the pretreatments showed significant differences. When using Panavia F2.0, silanization (735 ± 51 MPa) resulted in higher initial failure values than sandblasting (600 ± 118 MPa). When DC Core Automix was used, silanization (732 ± 144 MPa) produced significantly higher initial failure values than the no pretreatment group (518 ± 115 MPa) and the combined sandblasting and silanization group (560 ± 223 MPa). Two failure types were observed; cohesive and adhesive failure. In the silanization groups, more cohesive failures were observed for all cements tested.

Significance. Especially when non self-adhesive cements are used, silanization of fiber posts has a beneficial effect on cement delamination strength and failure type.

1. Introduction

In recent years, there has been a clear shift from metal alloy posts to the use of fiber posts. These posts offer a number of mechanical and clinical advantages. Their elastic modulus is closer to that of dentin compared to metal posts [1], which reduces the risk of root fracture. Indeed, clinically, root fracture is less apparent in endodontic teeth restored with glass fiber posts than in teeth restored with metallic posts [2]. A major problem with all types of posts is reliable cementation. This applies to glass fiber posts especially, because they are supposed to be cemented adhesively. An observation that illustrates this problem is the fact that debonding is the most common mode of failure of the fiber-reinforced composite post restoration [3,4]. Endodontic failure [5,6] and secondary

* *Corresponding author*. Tel.: +31 20 5188697; fax: +31 20 6692726.
E-mail address: L.Jongsma@acta.nl (L.A. Jongsma).
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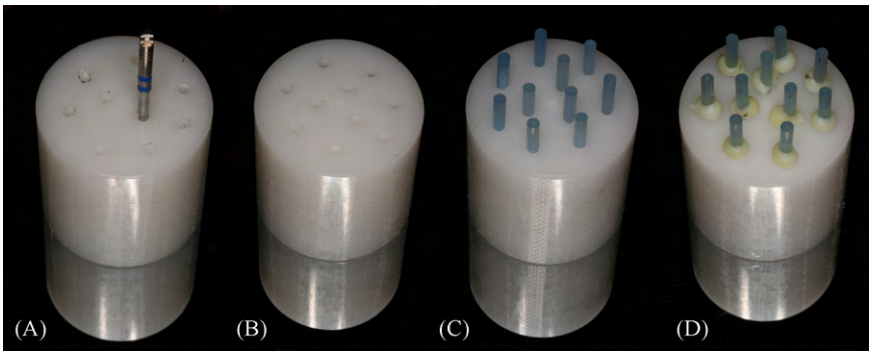

Fig. 1 – Fabrication of the test specimen. (A) Preparing the post space preparations in a poly-oxy-methacrylate block. (B) POM mold with preparation of ten post spaces. (C) The fiber posts are fitted in the post spaces of the mold. (D) Cement is applied in the post spaces, posts are placed and samples are removed after setting of the cement.

caries [7] are also a common mode of failure, which can be a direct effect of microleakage due to failure of the adhesive bond. There are many factors that affect the retention of post systems, for example post design, type of luting agent, cementation procedure, preparation, shape, and condition of the post space among others [8]. Another factor affecting the success of the total adhesive system is the adhesion between cement and post. This bond has to withstand stresses induced by the normal masticatory function, which can eventually result in debonding of the post-core restoration.

Different pretreatment methods have been proposed to improve the retention of fiber posts. Silanization is often used to improve adhesion of cementation to a fiber post. This has the benefit of being a fast chair-side procedure. Several studies show that the microtensile bond strengths between post and cement can be improved by silanizing the post [9,10]. However, there is no consensus on this subject. One study using a push-out bond strength test set-up, reported that the use of a silane coupling agent in combination with sandblasting did not increase the bond strengths when resin cements were used, although it was commented that this could be due to the limited adherence of the luting cement to the root canal walls [11]. Another study, by the same research group, reported that the use of a silane coupling agent alone did not increase the bond strengths when resin cements were used [12]. Another method of potentially creating extra retention is sandblasting. Sandblasting results in roughening of the post surface, leading to an increase in micromechanical retention [13]. Although some studies show that sandblasting the surface of fiber-reinforced composite posts significantly improved the retention of posts adhesively luted with a dual-cured resin cement [14], the effectiveness of sandblasting is still debatable [13,15]. The main problem with this method is the lack of selectivity. The matrix and fibers are both affected by the sandblasting, which could lead to damage of the post structure [13].

Retention of posts has been widely investigated, but these studies usually involve extracted teeth in order to provide clinically relevant results. The post retention is often measured by means of (micro) push-out strength measurements [13] or by microtensile bond strength testing [13]. Although push-out and microtensile bond strength tests relate to how posts behave in the clinical situation, only the strength of the weakest part of the restoration is determined. Failure can occur either on the cement–dentin interface, or on the cement–post interface, or cohesively within the cement, post or dentin. Moreover, the failure is not likely to take place at the cement–post interface, knowing that the bond between post and cement is usually stronger than the bond between cement and dentin. Therefore these tests are not the best way to evaluate the bond strength between post and cement.

Currently, there is no test that reflects the clinical situation exactly. In order to gain a better understanding of bond strengths of composite cements to the post surface, it is beneficial to address this problem from different perspectives. In this light, the adhesion of cements to the post surface has been investigated using a new testing methodology developed by the authors which involves a three-point bending test. The purpose of this study was to evaluate the influence of different cements and post surface pretreatment methods on the delamination strength of the cement from the post surface.

2. Materials and methods

In a poly-oxy-methacrylate (POM) block, standardized post spaces were prepared. An initial hole was drilled in the block using a 1 mm parallel carbide bur in the lathe cut machine (MF 70, Proxxon, Germany), and then the D.T. Light Post special burs (RTD, St. Egreve, France) were used to finish the post space preparation to the desired size and depth, which was a post space corresponding with a number three sized post to full preparation depth. In this way, a non-bonding mold was created as can be seen in Fig. 1. Using this mold, a thin, uniform and in dimensions clinically relevant cement layer could be applied to the fiber posts. Per cement, 40 fiber posts (DT light Post Illusion size 3, RTD, St. Egrève, France), were divided into four groups and pretreated in different manners. The first group (control) was cleaned with ethanol 80% and dried with compressed air, no post surface pretreatments were carried out. In the second group, the posts were sandblasted (Danville Engineering) perpendicular to their long axis for 2 s with 50 μm aluminum oxide particles with a pressure of 4000 HPa (4 Bar) at a distance of 5 cm and cleaned with ethanol. In the third group,