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Evaluation of the Effects of Hydroxytyrosol on the Pull Out Bond Strength of Fiber Reinforced Post to Sodium Hypochlorite (NaOCl) Treated Root Dentin - An *invitro* Study

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Abstract: ***Aim**: To evaluate the effects of Hydroxytyrosol on the pull out bond strength of fiber reinforced post to Sodium Hypochlorite (NaOCl) treated root dentin. **Materials and method**: Forty single-rooted extracted human teeth were randomly divided into two groups based on the final irrigation protocol: Group 1 (15% Hydroxytyrosol) and Group 2 (saline). The canals were cleaned, shaped, irrigated thoroughly using 5.25% Sodium hypochlorite and obturated with gutta-percha and AH Plus sealer. Post space was then prepared and the post spaces were flushed with the respective solutions. Fiber posts were luted in the post spaces of all the specimens using dual cure resin luting cement. All the prepared specimens were then mounted upright on acrylic resin blocks. After 24 hours, pull out bond strength test was carried out using universal testing machine. The data were statistically analyzed using Mann Whitney U test ($P < 0.05$). **Results**: 5.25% NaOCl significantly decreased the bond strength of fiber post to dentin ($P < 0.05$). 15% hydroxytyrosol was capable of reversing the compromised pull out bond stregth of fiber post to NaOCl-treated root dentin. **Conclusion**: Rinsing the post space with Hydroxytyrosol prior to bonding increased the pull out bond strength of fiber reinforced post to NaOCl treated intraradicular dentin.*

Keywords: Antioxidants, Hydroxytyrosol, free radicals, fiber reinforced post

1. Introduction

When restoring an endodontically treated tooth with excessive loss of tooth structure, a post may be needed to enhance the retention of the core build-up material and to distribute occlusal stresses along the remaining tooth structure. The use of fiber-reinforced composite-resin posts (FRC posts) has become popular in the past few years. The probable reason for this is the dentin-like modulus of elasticity of the FRC post which allows better distribution of forces along the length of the root. Another advantage of fiber posts is that it can be used in teeth with short roots or with roots presenting with a high degree of curvature. [1]

Whilst vertical root fracture have been reported to be the most severe cause of failure of endodontically treated teeth that were restored with rigid metallic posts, loss of retention has been reported to be the most recurrent cause of failure when using fiber posts. The most common reason for clinical failure of fiber posts is the debonding of these posts from dentin which may be due to improper adhesion, which may arise from multistep procedures required for post bonding and can hinder with the ability of the luting materials to retain the post. [2]

Sodium hypochlorite (NaOCl) is widely used for the irrigation of post space prior to the luting procedure. It is effective in dissolving the organic component of the smear layer produced during post space preparation. However, remnants of this strong oxidizing agent or its oxidative by-products such as hypochlorous acid and hypochlorite ions are reported to inhibit the free radical polymerization of methacrylate resins. This eventually compromises the bond strength of the luting cement to root dentin. [3]

Studies have shown that pretreatment of the post space with antioxidants or neutralizing agents before adhesive bonding of resin cements is capable of reversing the NaOCl-induced reduction in bond strength.[4] Hydroxytyrosol is a phenylalanoid, a type of phenolic phytochemical with antioxidant properties. In nature, hydroxytyrosol is found in olive leaf and olive oil, in the form of its elenolic acid ester oleuropein. [5] This study aimed to analyze the effect of natural antioxidant hydroxytyrosol, on the reversal of NaOCl-induced reduced bond strength of a methacrylate luting cement used in the cementation of fiber reinforced post to dentin.

2. Materials and Methodology

2.1. Preparation and grouping of sample

Forty eight extracted human single rooted teeth with single canal were used in the study. After extraction, teeth were immediately placed under running water to remove blood, followed by curettage to remove soft tissue and subsequently stored in 0.1% thymol solution at room temperature. Teeth were decoronated with a diamond disk under water spray to standardize the root length to 14.5mm.

Working length was determined by subtracting 1mm from the length at which the tip of ISO size#10 K-file was visible at apical foramen. The apical end was sealed with wax, to prevent extrusion of irrigant through the apical foramen during root canal preparation and final rinse. All canals were prepared using rotary endodontic system up to 40 apical size using Protaper Universal rotary system. During instrumentation, all canals were irrigated using 5.25% sodium hypochlorite solution, with help of a #26 gauge hypodermic needle and a syringe and a final rinse was done with saline and was dried using paper points. All prepared canals were obturated with gutta-percha along with AH Plus sealer. The obturated roots were kept in an incubator for 48 hours at 37°C and 100% humidity. After 48 hours, post space of length 10mm was prepared upto size 2 peaso reamer in all the obturated canals.

2.2. Division of experimental group:

Post space prepared teeth were randomly divided into two groups each containing twenty specimens. In group 1, post space was treated using 15% hydroxytyrosol and in group 2 saline was used.
Group 1 (n=20): Post spaces treated with 15% hydroxytyrosol
Group 2 (n=20): Post spaces treated with saline

2.3. Methodology

The post spaces of all the specimens were flushed with 5.25% sodium hypochlorite followed by saline and then dried with paper points. In group 1, post spaces were pretreated with 15% hydroxytyrosol for 5 minutes. The post space was then finally flushed with distilled water and dried with paper points completely. Fiber posts were luted in the post spaces of all the specimens using a self-adhesive, dual cure resin luting cement (Ivoclar Vivadent Multilink Speed). All the prepared specimens were then mounted upright on acrylic resin blocks. After 24 hours, pull out bond strength test was carried out using universal testing machine (Mecmesin- MultiTest 10i) (Fig 1)

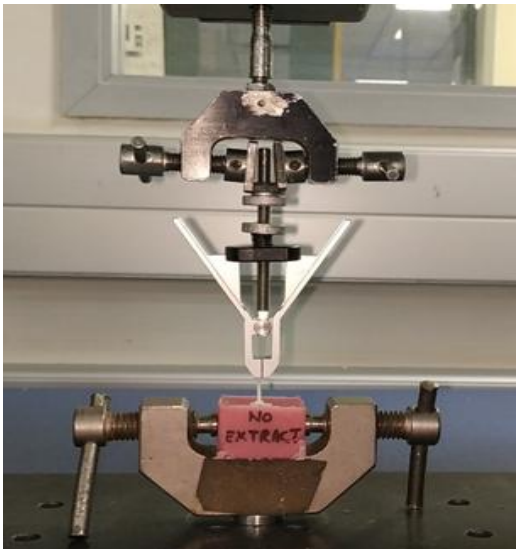


Figure 1: Pull out bond strength test carried out using the Universal Testing Machine

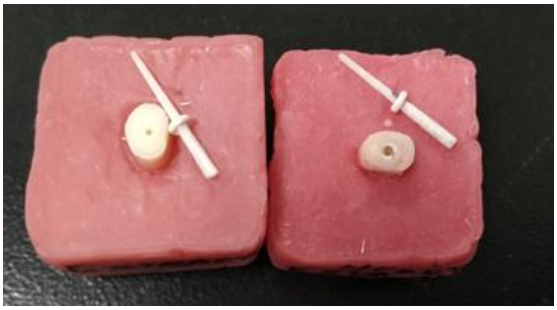


Figure 2: Fiber post failure seen after the pull out bond strength test

3. Statistical Analysis

Statistical Package for Social Sciences [SPSS] for Windows, Version 22.0. Released in 2013. Armonk, NY: IBM Corp., was used to perform statistical analyses.

Mann Whitney U Test was used to compare the mean Pull out Bond Strength (in Newton) between Group 1 (15% hydroxytyrosol) and Group 2 (saline). The level of significance [P-Value] was set at $P<0.05$.

4. Results

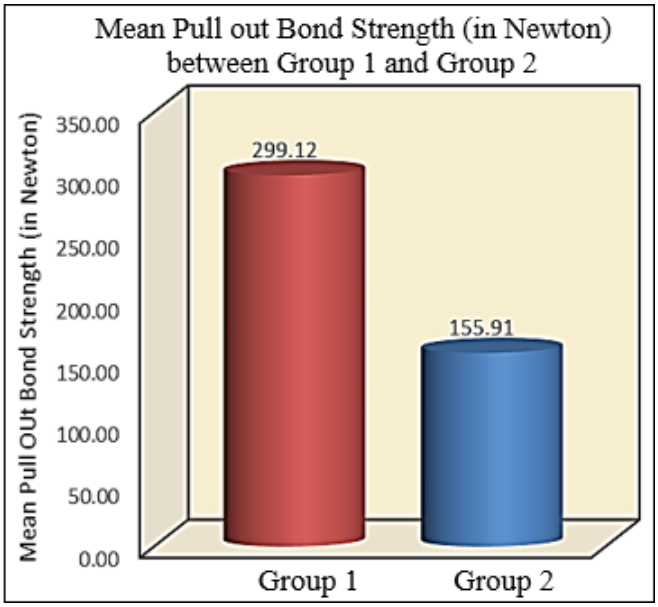
Table 1 represents the mean pull out bond strength (in Newton) between Group 1 and Group 2 group using Mann Whitney U Test.

Comparison of mean Pull out Bond Strength (in Newton) between Group 1 and Group 2 using Mann Whitney U Test

Group	N	Mean	SD	Mean Diff	Z	P-Value
Group 1 (15% Hydroxytyrosol)	20	299.12	26.84	143.21	-5.410	<0.001*
Group 2 (Saline)	20	155.91	17.85			

* Statistically Significant

The test results demonstrate that the group treated with 15% hydroxytyrosol showed significantly higher mean pull out bonds strength [299.12 ± 26.84] as compared to the group treated with saline [155.91 ± 17.85] with a mean difference of 143.21 Newton. This difference in the mean pull out bond strength (in Newton) between the two groups was statistically significant at P<0.001.



5. Discussion

In light of the results of this study, pretreatment with hydroxytyrosol increased the pull out bond strength of fiber reinforced composite post to NaOCl treated intraradicular dentin.

The use of NaOCl decreased the bond strength of resin cement to dentin. The use of NaOCl during post space preparation removes the organic debris from the canal. In due course, it also causes degradation of root dentin collagen. On contact with organic matter in the root canal, NaOCl breaks down into chloramines and protein-derived radical intermediates. Daumer et al. observed that these breakdown products are capable of having an adverse effect on the pyridinoline cross-links occurring in type I collagen. [6] Thus, irrigation with NaOCl results in a structurally compromised collagen in the root dentin. Collagen is essential for adhesion of resin cement, as the latter has been shown to chemically bond to the amino groups of dentin. This adhesion mechanism is hindered when NaOCl is used as a final rinse of the post space before the cementation of the fiber post in the canal. Another logical reason is that the oxygen bubbles formed following the use of NaOCl prevent the penetration of the resin cement into the fine apertures of dentinal tubules. These could be the reasons behind the significantly lower bond strength in Group 2.

Studies have shown that pretreatment of the root canal with antioxidants or neutralizing agents before adhesive bonding of resin is capable of reversing the NaOCl-induced reduction in bond strength. A study done by Manimaran et al. showed that 5% Grape seed extract could significantly improve the bond strength of resin cement to NaOCl-treated root dentin. The reason being that Proanthocyanidins present in grape seed extract have excellent radical scavenging and antioxidant potential. The multiple electron donor sites of PAs donate hydrogen atoms, thereby binding free radical molecules which improves the bonding of resin cement to the dentin. [7]

Another such antioxidant which has gained popularity in the medical field is Hydroxytyrosol (HXT). HXT is a phenolic compound drawn from the olive tree and its leaves as a by-product obtained from the manufacturing of olive oil. It is considered the most powerful antioxidant compound after gallic acid and one of the most powerful antioxidant compounds between phenolic compounds from olive tree followed by oleuropein, caffeic and tyrosol. Due to its molecular structure, its regular consumption has several beneficial effects such as antioxidant, anti-inflammatory, anticancer, and as a protector of skin and eyes, etc. [5]

In the present study, pretreatment with 15% hydroxytyrosol significantly increased the pull-out bond strength. This should be attributed to the anti-oxidation ability of Hydroxytyrosol. Hydroxytyrosol treatment after the NaOCl irrigation could neutralize the residual NaOCl and oxygen through redox reaction and therefore restore the compromised bond strength of dentin after deproteinization with 5.25% NaOCl.

Ethanol and acetone are commonly used as solvents in the extraction of Hydroxytyrosol from olive leaf extract. In dentistry, they find the use as dentin-cleaning agents and water chasers in bonding agents. Sarac et al. observed that these solvents could effectively be used to remove water from the dentin surface and facilitate better penetration of resin into the dentin. [6] This could have also enhanced the action of HXT on the root dentin.

Many experimental tests have been described for the evaluation of the bond strength between root dentin and posts, such as the pull-out test, the micro-tensile test and the push-out test. The pulling out of the whole post from restored roots necessitates high loads and results in testing large adhesive interfaces. With the present experimental set-up, the pull-out test design was chosen for evaluating the retention of fiber posts. The clinical significance of this test is based on the fact that debonding is the most usual failure mode of fiber post and that axial loading is considered predominant with clinical restorations. Furthermore, a pull-out bond strength test evaluate the bond strength along the whole post space which is more clinically significant unlike push out bond strength test which evaluates bond strength in segments. [8]

6. Conclusion

Within the limits of this study, pretreatment of post space with Hydroxytyrosol increased the pull out bond strength of fiber reinforced post to NaOCl treated intraradicular dentin.

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