Original Article

Effect of 2% Chlorhexidine on Shear Bond Strength of Composite Resins to Dentin

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Abstract

Background and Aim: Intracanal medicaments can affect the bond strength of composite to dentin. The aim of this study was to evaluate the effect of 2% chlorhexidine (CHX) gel as an intracanal medicament on shear bond strength of three different composite resins to dentin.
Materials and Methods: In this in-vitro study, 60 intact extracted human premolars were utilized. Each tooth was sectioned vertically and dentin of the buccal surface was exposed. Then, specimens were divided into six groups of 10 teeth. In groups 1-3, dentin was exposed to CHX and in groups 4-6, dentin was exposed to saline. All prepared surfaces were rinsed with distilled water and dentin bonding agent specific for each composite was applied on the dentin surfaces. Z100, Z350 and P90 composites were applied to the treated surfaces and cured. The shear bond strength was recorded in Newtons and converted to MPa. Data were analyzed using the Kruskal-Wallis and Dunn tests.
Results: The lowest mean shear bond strength was reported for normal saline and Z100 composite group (18.47 MPa) and the highest for CHX and Z350 group (42.26 MPa). No statistically significant difference in bond strength values was found between normal saline and CHX groups ($P>0.05$). There was a significant difference in bond strength values of different composite resins in normal saline ($P<0.05$) and also in CHX groups ($P<0.05$).
Conclusion: Application of 2% chlorhexidine gel slightly but not significantly increases the mean shear bond strength of composite to dentin. The type of composite influences the shear bond strength to dentin.
Key Words: Chlorhexidine, Composite resins, Root canal therapy

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Introduction

Tooth-colored restorative materials and composites are commonly used for reinforcement and reconstruction of endodontically treated teeth. Structure and chemical composition of dentin can affect the micromechanical retention of resin and its bond to dentin when tooth colored restorative materials or transparent intracanal posts are used [1]. Irrigating solutions, intracanal medicaments and endodontic sealers can all affect the structure of dentin during root canal treatment [2]. Use of these materials can affect the structure and chemical composition of coronal and radicular dentin and may compromise the bond of composites and tooth-colored restorative materials to dentin [3].Type of composite used can also affect the bond strength. Chlorhexidine is among the most commonly used root canal irrigants and intracanal medicaments. It has bacteriostatic and bactericidal effects, which are dose-dependent. It also has antifungal and antiviral properties and has a strong antimicrobial activity against obligate an-aerobes. Due to the afore-mentioned favorable properties, CHX has extensive applications as an intracanal medicament and root canal irrigant in endodontics [4]. The effect of CHX on dentin may be explained by the chemical reactions that occur between CHX and calcium in dentin as well as the chemical bond of CHX and dentin [5]. Also, CHX reacts with collagen fibrils in dentin. Matrix metalloproteinases are present in coronal dentin. They decrease the hybrid layer produced by dentin bonding systems [6]. It appears that CHX inhibits the activity of dentin matrix metalloproteinases and subsequently prevents the reduction in bond strength. Consequently, it prolongs the bond of dentin to tooth-colored restorative materials [7]. Also, considering the wettability of CHX and its strong bond to tooth structure, it appears that CHX increases the bond of adhesive resins to tooth structure.

In an in vitro study by Breschi et al, in 2009 on the effect of concentration of CHX on the bond strength of etch and rinse bonding agents during 12 months, it was shown that CHX significantly enhanced the bond strength. Since no bacterial growth was noted, it was concluded that CHX inhibited the intrinsic factors degrading the adhesive interface [8].

Ercan et al, in their study in 2009 concluded that sodium hypochlorite, hydrogen peroxide and 2% CHX as root canal irrigants decreased the bond strength of composite to dentin when a self-etch system was used but they did not have any adverse effect on the bond to dentin when etch and rinse system was used. Moreover, they found that 1% CHX gel had no effect on bond strength irrespective of the use of self-etch or etch and rinse bonding agents [9].

Murthy et al, in 2013 evaluated the effect of three antibacterial agents on shear bond strength and concluded that Citrisil and CHX increased the bond strength while Alpron had no effect on bond strength [10]. Mohammed in 2008 evaluated the effect of acetic acid and CHX on bond strength of compomer restorations and found that 2% CHX and acetic acid as an irrigant increased the bond strength [11].

Physical properties of dentin can affect its bond strength to tooth-colored restorative materials. Also, materials used for endodontic treatment of teeth may have adverse effects on physical properties of dentin and subsequently on the longevity of restorations. Moreover, different composites have variable bond strengths to dentin. Thus, this study aimed to compare the effect of 2% CHX on bond strength of three types of composite resinsto dentin.

Materials and Methods

This in vitro, experimental study was conducted on 60 human premolar teeth extracted within the past six months. The collected teeth were immersed in 0.2% thymol solution (Merck, Darmstadt, Germany) for disinfection for 48 hours. The teeth were then rinsed and stored in saline until the experiment. The teeth were then mounted in cylinders containing autopolymerizing acrylic resin (Acropars, Tehran, Iran). To prevent the adverse effect of heat generated during acrylic polymerization, as soon as the resin gained its primary consistency, the cylindrical molds were placed in a container containing saline. Cylindrical samples were removed from the molds. To expose dentin, buccal enamel was removed by a fissure bur (Tizkavan, Tehran, Iran) and high-speed handpiece (NSK, Tokyo, Japan) under water and air spray until a large flat surface of dentin was exposed. The area of this surface was almost the same in all samples. Using a surveyor, vertical position of this surface relative to the ground was ensured.

Next, the samples were divided into six groups of 10. Each sample was coded and separately stored in small containers containing saline. In the first three groups, dentin in the buccal surface of teeth was covered with a cotton pellet dipped in saline. In the second three groups, dentin surface was covered with 2% CHX gel (Ultradent, South Jordan, USA,). The samples wee then covered in cellophane to prevent moisture loss and each sample was placed in a separate container. Dentin was exposed to the understudy materials for 10 days. During this time period, the samples were stored at 37°C. The samples were removed from the incubator every three days and CHX gel was refreshed and the samples were placed again in the incubator. After 10 days, exposed dentin surface was rinsed with saline for five seconds. In groups one and four (exposed to saline and CHX), primer of P90 composite (3M ESPE, St. Paul, MN, USA) was gently applied on the dentin surface by an applicator and was then spread on the surface by gentle dry air spray and light cured for 10 seconds using a light curing unit (LED Turbo South Jordan, USA). Next, the bonding agent of P90 composite was gently applied on the dentin surface by an applicator. The bonding agent was then gently spread on the surface by air spray and light cured for 20 seconds. Next, transparent plastic molds with an internal diameter of 2mm and height of 3mm were placed on the surface and filled with A2 shade of P90 composite. Excess material was removed by a scalpel and the composite was light cured for 20 seconds from four directions (at the sides and from the top for a total of 80 seconds). Plastic mold was gently cut by a scalpel and separated from the composite.

Dentin in groups two and five (exposed to saline and CHX) was etched with 37% phosphoric acid (Ultra-etch, South Jordan, USA) and rinsed with water for 15 seconds. Then, itwas air dried with gentle air spray for five seconds in such a way that dentin surface remained moist. One layer of Single bond (3MESPE, St. Paul, MN, USA) was then gently applied by an applicator on the dentin surface and spread with gentle air spray and light cured for 20 seconds. Next, Z100 composite was applied as explained earlier.

In groups three and six (exposed to saline and CHX), Z350 (3M ESPE, St. Paul, MN, USA) composite was used as described for Z100. The samples were then transferred to a laboratory and subjected to shear bond strength testing in an Instron machine (HC10 Dartec, Stourbridge, England). Shear load was applied vertically by a blade with 0.5mm thickness at a crosshead speed of 1mm/min to samples at theclosest possible location to the tooth-restoration interface. By dividing the load at fracture in N by the bonding surface area in mm^2, bond strength in MPa was calculated. The data were analyzed using the Kruskal Wallis test and Dunn test.

Results

The results showed that the highest mean shear bond strength belonged to the group with CHX and Z350 composite (42.26±13.02 MPa) while the lowest value was noted in the saline and Z100 composite (18.47±11.46 MPa). Bond strength of each composite was compared between the saline and CHX groups using the Dunn test. The results showed that despite the higher mean bond strength of all three composites in the CHX compared to the saline group, this difference was not statistically significant ($P>0.05$) (Table 1).

The bond strength of the three composites in the CHX and saline groups was compared using the Kruskal Wallis test. The results showed that significant differences existed among the three composites in both CHX and saline groups ($P<0.05$). It means that the mean bond strength of at least two composites was different in the two groups of CHX and saline (Table 2).

For pairwise comparison of composites in each group, the Dunn test was used. In the saline group, the mean bond strength of P90 and Z100 and also Z100 and Z350 composites was significantly different ($P<0.05$). Also, Z100 had the lowest and Z350 had the highest mean bond strength. In the CHX group, the bond strength of P90 and Z350 was significantly different ($P<0.05$). Also, Z350 had the highest and P90 had the lowest bond strength.

Discussion

Irrigating solutions, intracanal medicaments and endodontic sealers are among the factors that can change the structure of dentin during endodontic treatment [2]. These materials can affect the structure and chemical composition of coronal and radi cular dentin and can affect the retention of composites and tooth colored restorative materials [3]. The results of this study showed that application of 2% CHX gel did not affect the shear bond strength of composite to dentin and

Table 1. Comparison of the mean bond strength of the three composite between the saline and CHX groups

Composite	Material	Mean± standard deviation	P value
P90	Saline	23.98±5.61	0.704
	Chlorhexidine	25.31±9.41	
Z100	Saline	18.47±11.46	0.217
	Chlorhexidine	27.38±19.07	
Z350	Saline	34.49±14.24	0.219
	Chlorhexidine	42.26±13.02	

Table 2. Comparison of the mean shear bond strength of the three composites in the saline and CHX groups

Group	Type of composite	Mean± standard deviation	P value
Saline	P90	23.98±5.61	0.006
	Z100	18.47±11.46	
	Z350	34.49±14.24	
Chlorhexidine	P90	25.31±9.41	0.016
	Z100	27.38±19.07	
	Z350	42.26±13.02	

application of CHX even slightly increased the bond strength. The effect of CHX on dentin may be due to chemical interactions between CHX and calcium in dentin and is also related to the chemical bond of CHX and dentin [5]. It appears that CHX inhibits the activity of dentin matrix metalloproteinases and subsequently prevents the reduction in bond strength. Consequently, it prolongs the bond of dentin to tooth-colored restorative materials. Also, considering the wettability of CHX and its strong bond to tooth structure, it appears that CHX increases the bond of adhesive resins to tooth structure [7].

In the saline group, a significant difference existed between Z100 composite and Z350 and P90 composites and Z100 had significantly lower bond strength than the other two. Z100 composite is a hybrid composite with 0.01-3.5μ filler size and 66% filler volume percentage. Z350 is a nanohybrid composite with a mean filler cluster size of 0.6-10μ (combination of 20nm silica and 4-11nm zirconia particles) and 63.3% filler volume percentage. Both these composites were bonded to dentin using a fifth generation bonding agent. The only difference between these two composites is in the size and orientation of their fillers, which may affect their bond strength. These factors were probably responsible for lower bond strength of Z100. Smaller size of fillers, their presence in the form of cluster and higher percentage of matrix positively affect the bond strength. Moreover, the difference in bond strength of P90 and Z100 may be due to the different type of bonding agent in Z100 and P90 (fifth generation bonding agent for Z100 and sixth generation bonding agent for P90) and difference in the type of resin matrix (Z100 resin matrix includes UDMA, bis-GMA, bis-EMA and TEGDMA while the resin matrix of P90 is silorane-based).

In the CHX group, Z350 showed significantl higher shear bond strength than P90. Considering the difference in their bonding agent and resin matrix, the effect of CHX on dentin probably affected the bond strength of Z350 more than that of P90 and increased it.

Castro et al, in 2003 evaluated the effect of 2% CHX on bond strength of composite to dentin. They used three bonding systems namely Prime and Bond NT, Single bond and Clearfil SE bond and concluded that 2% CHX before or after acid etching of dentin did not interfere with the bond of resin to dentin [7]. Also, Ercan et al, in 2009 [9] evaluated the effect of different endodontic irrigants on bond strength of root dentin and concluded that sodium hypochlorite and hydrogen peroxide decreased the bond strength while CHX increased the bond strength [11].

Sharma et al, in their study on shear bond strength

of composite after cavity disinfection concluded that IPI and CHX had a negative effect on self-etch bonding systems [12]. Reddy et al, in 2013 evaluated the effect of different disinfectants on shear bond strength of composite resin to dentin following etching and concluded that the highest bond strength belonged to the CHX and the lowest to 3% hydrogen peroxide [13]; these findings were in line with our results.
Campos et al. showed that application of CHX decreased the bond strength in different self-etch systems, which was in line with our findings [6]. Such a controversy in the results may be due to the difference in the type of bonding agents and tooth colored restorative materials used in the study by Campos et al, and in the current study.
Regarding the most efficient material causing the least changes in bond strength of composite to dentin, it can be stated that CHX gel not only has wide-spectrum bacteriostatic and bactericidal effects, it forms a strong bond with hydroxyapatite crystals and provides a substantive reservoir of CHX after completion of treatment. On the other hand, different composites, due to the use of different bonding agents, different resin bases and variable size of filler particles, provide different bond strength values to dentin.

Conclusion

The results of this study showed that application of 2% CHX gel did not interfere with shear bond strength of composite to dentin; instead, it even slightly increased the bond strength of composite. Also, the shear bond strength of the three composites was variable in the two groups of saline and CHX.

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