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Comparative Evaluation of Shear Bond Strength of Enamel and Dentin with Two Different Aesthetic Materials – An In Vitro Study.

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Abstract

Aim: To evaluate the shear bond strength of 2 different aesthetic materials on enamel and dentin.

Materials and Methods: 40 extracted human molar teeth were taken, cleaned, and stored. Buccal surfaces of 20 teeth were flattened using a straight fissured bur at a depth of 1.5 millimetres (mm) until dentin was exposed. The remaining 20 samples were ground to a depth of 0.5 mm to observe enamel surfaces. Acrylic blocks were made using cold-cured acrylic resin, and samples were placed in the blocks. Out of 20 enamel-exposed samples and 20 dentin-exposed samples, 10 samples were restored with Cention and the other 10 with Zirconium Oxide, respectively. All specimens were shifted to a universal testing machine individually and subjected to shear bond strength (SBS) testing.

Results: Statistical analysis was done for all four groups using descriptive statistics and an unpaired t-test ($p<0.05$). Bulk fill dual-cured Cention showed better Shear bond strength than zirconia-reinforced Glass ionomer cement.

Conclusion: Among all four groups, the groups with Cention showed better Shear bond strength to both enamel and dentin than Zircon Omer.

Keywords: Cention, Zircon Omer, Shear Bond Strength, Dentin, Enamel

Introduction

The most common cause of tooth loss is dental caries, which impairs the structure and function of the particular tooth. This lost tooth structure is restored with restorative materials that regain aesthetic, functional, and biological properties. Recent developments in restorative dentistry are a result of the requirement for restorative materials with improved adhesion and strength to endure the stress of masticatory forces [1].

One of the most crucial mechanical characteristics of a restorative material that rebuilds the tooth structure in the posterior area is bond strength. Bond strength is the amount of force needed to separate a bonded restoration from the tooth surface, with failure taking place at or around the adhesive contact [2].

An early failure of the restoration will occur if the restorative material has inadequate mechanical qualities, which will have a negative impact on the longevity of the tooth structure and the restoration [3].

The basis for aesthetics is laid by position, contour, texture, and color. Wilson and Kent (1972) introduced the first aesthetic restorative material, i.e., glass ionomer cement (GIC). This material bonds directly to teeth and also has remineralizing capacity because of its fluoride content. Since GIC has some disadvantages like a lack of hardness, low fracture resistance, low abrasion resistance, and moisture sensitivity, many advances have been made, like resin-modified GIC, Composites, Cention, Zircon Omer, Amalgomer, Giomer, Compomer, etc., to improve the mechanical properties [4].

Recently, a novel material called zirconia-reinforced glass ionomer cement was introduced, which is also called "white amalgam. It contains zirconium oxide, glass powder, tartaric acid (1–10%), polyacrylic acid (20–50%), and deionized water as its liquid. Zirconia was employed at the beginning of the 1990s for implant abutments, strong framework cores for crowns, and fixed partial dentures (FPDs) [5].

A novel bulk-fill direct posterior restorative material called Cention is a self-cured resin-based restorative material with a light-curing option [6]. The liquid consists of organic monomers: urethane Di methacrylate (UDMA), tricyclode cane – dim ethanol Di methacrylate (DCP), tetra methyl -xylylene - urethane Di methacrylate (Aromatic aliphatic-UDMA), and polyethylene glycol 400 Di meth acrylate (PEG-400 DMA). Self-cure composition: includes inorganic fillers such as barium aluminium silicate, ytterbium trifluoride, is filler calcium barium aluminium fluorosilicate, and calcium fluorosilicate. Liquid hydroperoxide, thiocarbamide. The light cure composition includes Ivo cerin and Acyl Phosphine Oxide [7].

There are many in vitro studies and clinical trials conducted on the compressive and flexural strengths of these materials, but very few studies on shear bond strength. So, in the present study, the shear bond strengths of Cention and Zircon Omer on enamel and dentin were compared to evaluate the bond strengths. The aim of the study was to evaluate the shear bond strength of enamel and dentin with Cention and zirconium oxide.

Materials & Methods

Sample collection

Inclusion criteria: Forty caries-free upper and lower permanent human molars that are extracted for periodontal reasons were collected, cleaned, and then stored in distilled water until used for the study.

Exclusion criteria: Teeth with previous restorations, visible cracks, decay, fracture, abrasion, or structural deformities.

Sample preparation

Buccal surfaces of 20 teeth are flattened using a straight fissured bur at a depth of 1.5 mm until dentin is exposed (Figures 1a, b). The remaining 20 samples were ground ed on buccal surfaces to a depth of 0.5 mm to observe enamel surfaces (Figure 1c). Later teeth were mounted on self-curing acrylic blocks by using metal moulds to embed the root portion and expose the buccal surfaces only.

40 teeth were divided into 2 Groups (I and II) of 20 specimens based on enamel and dentin samples. These 20 samples were further divided into 2 subgroups. Out of 20 enamel samples,10 specimens were restored with Zircon Omer (Shofu Dental, Tokyo, Japan) (IA - Enamel restored using Zircon Omer), and the remaining 10 with Cention (Ivoclar Vivadent AG Liechtenstein) (IB - Enamel restored using Cention). Out of 20 dentin samples, 10 specimens were restored with Zircon Omer (IIA - Dentin restored using Zircon Omer) and the remaining 10 with Cention (IIB - Dentin restored using Cention) respectively.

These cements were mixed according to the Manufacturer's instructions & were placed onto buccal sur faces by using a straw (4 x 4 square millimetres) (mm^2) (Figure-2 a, b).

Experimental procedure

The Universal Testing Machine (EiE Instruments Pvt. Ltd., India) was used to evaluate the shear bond strength. whereby the crosshead speed was 0.5 Millimetre per minute (mm/ min) and the load applied was 1 Kilo New ton (KN) for all the samples.

The shear bond strengths of all the samples were obtained and checked for statistical analysis (Figure 2c).

Results

Statistical analysis was done for evaluating the bond strength. Data were analysed using SPSS Version 20.0 with descriptive statistics and an unpaired t-test. Table 1 shows the mean and standard deviation of shear bond strength values for different experimental groups.

Groups	Min	Max	Mean	SD	SE	95% CI for Mean	
						Lower Bound	Upper Bound
Group IA	4.90	5.30	5.11	0.13	0.04	5.02	5.20
Group IB	6.90	10.10	9.10	1.24	0.39	7.53	10.10
Group IIA	5.80	6.40	6.08	0.20	0.06	5.94	6.22
Group IIB	6.70	9.80	8.03	0.71	0.23	7.94	9.80

Table 1: Descriptive statistics

- Group IA- Enamel restored using Zircon Omer, Group IB - Enamel restored using Cention,
- Group IIA- Dentin restored using Zircon Omer, Group IIB - Dentin restored using Cention

Cention showed better shear bond strength to enamel and dentin than Zircon Omer (Tables 2 and 3).

Group I	n	Mean	SD	t-value	P-value
IA. Zircon Omer	10	5.11	0.13	-26.192	$<0.001^*$
IB. Cention	10	9.10	1.24		

Independent t test, *p<0.05(significant)

Table 2: Comparison of mean enamel shear bond strength among Group IA - Enamel restored using Zircon Omer and Group IB - Enamel restored using Cention,

Group II	n	Mean	SD	t-value	P-value
IIA. Zircon Omer	10	6.08	0.20	-35.795	$<0.001^*$
IIB. Cention	10	8.03	0.71		

Independent t test, *p<0.05(significant)

Table 3: Comparison of mean dentin shear bond strength among Group IIA- Dentin restored using Zircon

Omer and Group IIB - Dentin restored using Zircon Omer

In a comparison of enamel and dentin, Cention showed more shear bond strength to enamel than dentin, whereas Zircon Omer showed more shear bond strength to dentin than enamel (Figure 3).

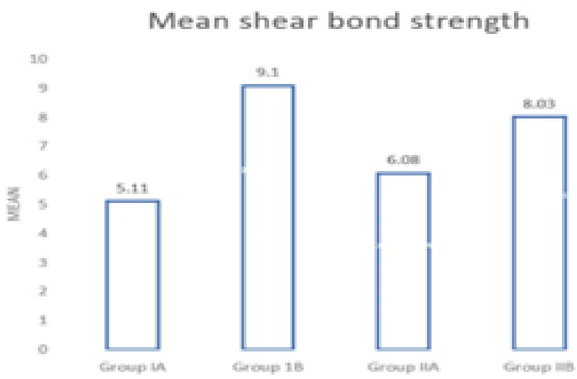

Figure 1: Mean shear bond strength of all groups.

- Group IA- Enamel restored using Zircon Omer
- Group IB - Enamel restored using Cention
- Group IIA- Dentin restored using Zircon Omer
- Group IIB - Dentin restored using Zircon Omer.

Discussion

In the oral cavity, restorations undergo stress from masticatory forces that produce different reactions that lead to deformation, which can ultimately compromise their durability over time [8]. The choice of restorative material is mostly dependent on its manipulation and mechanical qualities. The bond strength of restorative materials is crucial among other mechanical parameters since it often replaces a significant portion of tooth structure and should provide enough strength to with stand intraoral masticatory stresses [9].

The clinical success of restorative materials hinges on their ability to adhere well to tooth surfaces and withstand a variety of dislodging forces operating within the oral cavity. The resistance to forces that move restorative material beyond tooth structure is how shear bond strength is defined. Since shearing forces near the tooth-restoration interface tend to dislodge materials the most, it is thought to be of greater clinical significance. Therefore, high shear bond strength shows better bonding of the restorative material to the tooth [10–12].

Many aesthetic materials, like composite resin, resin-modified glass ionomer cement, Cention, zircon Omer, etc., were introduced. In this study, Zircon Omer was compared with a resin material named Cention because there are many in vitro studies conducted individually on these materials and all showed better results. Though there are various mechanical properties like compressive strength and flexural strength, this study was done on bond strength as there are few studies on this mechanical property [13].

In the present study, Cention showed the highest shear bond strength. The existence of a stable self-cure initiator and a highly cross-linked polymer structure may be the likely cause. Moreover, barium aluminium silicate and calcium aluminium silicate glass filler particles give the Cention strength, making it a more suitable and durable material for the stress-bearing posterior region [10].

Due to the homogeneous nature of enamel, which is primarily made up of hydroxyapatite crystals, and the resin present in the liquid being easily absorbed by capillary attraction, creating micro tags that extend into the enamel prism cores and aid in micro mechanical adhesion, Cention demonstrated better bonding to enamel [3].

The improved bonding of Cention to dentin is likely due to the fact that monomers, initiators, catalysts, and other additives in Cention combine to produce the reactive component of a resin-based restorative. Due to the inter connections (cross-links) formed during poly merization, the mixture of UDMA, DCP, an aromatic aliphatic-UDMA, and PEG-400 DMA exhibits high mechanical capabilities and good long-term stability. The major element of the monomer matrix is UDMA. It produces high mechanical qualities and displays a modest degree of viscosity [10].

Zircon Omer showed less shear bond strength than Cention due to the difference in their bonding mechani SMS. In the case of Cention, bonding to the tooth occurs by micro mechanical adhesion, whereas in Zircon Omer, bonding occurs by chemical adhesion as it is a GIC modification [4]. Zircon Omer showed less bonding to enamel than Cention due to variations in their compositions [14–17].

Due to changes in dentin's surface chemistry and morphology brought on by the acidity of the liquid, Zircon Omer demonstrated greater bonding to dentin than enamel. This can have an impact on bonding. In locations with perpendicular tubule orientation compared to those with parallel tubule orientation, a much thicker hybrid layer was observed [10].

When compared to enamel, bonding to dentin presents different challenges due to the different substrates. Dentin, in contrast, is heterogeneous and made up of collagen and hydroxyapatite. Depending on whether the dentin is close to the DEJ or close to the pulp, the amount of mineral content varies quite a bit. Generally, dentin has a substantially higher water content than enamel, which presents another difficulty for adhesive bonding [3].

Because zirconia powder has various grain sizes and additives, such as yttrium oxide and alumina, that are dispersed uniformly across the entire material or at high concentrations near grain borders, zirconia powder demonstrated superior bond strength. The resulting porosity and the material's translucency are both influenced by the grain size. Zirconia's grain size possesses a special property known as transformation toughening, which boosts endurance and high resistance to masticatory stresses while also delivering high strength, toughness, hardness, and corrosion resistance [18–20].

Although all experimental steps of this study were performed in a judicious manner and strictly following the protocol, in vitro and in situ studies have limitations. So, their results cannot be accurate for clinical conditions.

Conclusion

Cention showed better shear bond strength than Zircon Omer to enamel surfaces and dentin surfaces. Self-cured resin-based restorative material, Cention showed better shear bond strength to enamel surfaces than dentin sur faces, whereas Zirconia - reinforced glass ionomer cement, Zircon Omer showed better shear bond strength to dentin surfaces than enamel surfaces. Further, in vivo studies are needed to confirm these results.

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