ABSTRACT

Introduction
The use of glass ionomer cements (GIC) as a restorative material was limited to areas of low masticatory forces due to their low mechanical properties which were also affected by the powder/liquid mixing ratio of this material. Bond strength is important for the clinical success of adhesive material. The shear bond strength (SBS) is the maximum force that an adhesive joint can tolerate before fracture which is tested by SBS tests. The high bond strength helps the adhesive to resist stresses caused by resin contraction and forces for a longer time and thus prevents the problems of bond failure such as recurrent caries, tooth sensitivity and restoration failure. GIC as a restorative material has the capacity to release fluoride and shows good bonding ability. The use of GIC in anterior applications appears to be satisfactory, but they have limitations for use in permanent posterior teeth, particularly with regard to large restorations. Zirconia-reinforced GI (Zirconomer, Shofu Inc, Japan) is a new class of restorative material containing reinforced glass ionomer with special zirconia fillers that promises the strength and durability of amalgam with the protective benefits of glass ionomer while eliminating the hazards of mercury. Amalgomer CR (Advanced Health Care, Tonbridge, Kent, UK), a novel ceramic-reinforced GIC, was introduced, which combines the benefits of GIC with the high strength of ceramics. In the present study, shear bond strength to the dentin with Zirconomer, Amalgomer CR and Fuji type IX GIC (GC Tokyo) are compared.

Aim
To evaluate the shear bond strength of three different aesthetic materials to dentin.

Methodology
Thirty extracted human molar teeth were taken, cleaned, stored and the occlusal surfaces of the teeth were flattened with a straight fissured bur at a depth of three millimetres until dentin was exposed. Acrylic blocks were prepared by cold cure acrylic resin and the samples were embedded into the blocks and conditioning of dentin was done using dentin conditioner (GC Corporation Tokyo, Japan). Out of 30 dentin-exposed samples, 10 samples were restored with Zirconomer, the other 10 with Amalgomer CR and the remaining 10 with GIC respectively. All the specimens were transferred to the universal testing machine individually and subjected to shear bond strength analysis.

Result
Statistical analysis was done for all three groups by using descriptive statistics that include one-way ANOVA and Tukey’s multiple post hoc procedures for intergroup comparison.

Conclusion
Zirconomer showed better shear bond strength than Amalgomer CR and GIC.

Keywords
Zirconomer, Amalgomer CR, glass ionomer cement, shear bond strength.
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. The need for restorative material with better adhesion and strength to withstand the stress of masticatory forces led to recent advances in restorative dentistry.

Bond strength is one of the most important mechanical properties of a restorative material which restores the tooth structure in the posterior region. Bond strength is defined as the amount of force required to break the connection between a bonded restoration and tooth surface with failure occurring in/near the adhesive interface. Restorative material with poor mechanical properties will adversely affect the longevity of the tooth structure and the restoration, and a premature failure of restoration will. The base for aesthetics is laid by position, contour, texture and colour. In the 1960s composites were used as an alternative to silicate cements and unreinforced methyl methacrylate direct filling resins for the restoration of anterior teeth (Bowen, 1962,1965a) and, in 1972, Wilson and Kent introduced an aesthetic restorative material – glass ionomer cement (GIC). In 1962, Bowen developed the Bis-GMA monomer in an attempt to improve the physical properties of acrylic resins, as their monomers only allowed linear chain polymers to be formed. These early chemically cured composites required the base paste to be mixed with the catalyst, leading to problems with the proportions, mixing process and colour stability. In 1970, composite materials polymerised by electromagnetic radiation appeared, doing away with mixing and its drawbacks. GIC material bonds directly to teeth by chemical adhesion and also has a remineralising capacity because of fluoride content. Since GIC has some disadvantages including lack of hardness and fracture resistance, low abrasion resistance and moisture sensitivity, many new aesthetic restorative materials were introduced with improved mechanical properties.

Recently, a novel material called zirconia-reinforced glass ionomer cement was introduced which is also called “white amalgam” or “Zirconomer” and contains zirconium oxide, glass powder, tartaric acid (1-10%), polyacrylic acid (20-50%) and deionised water as its liquid. In the early 1990s, zirconia was used in endodontic posts, implant abutments and hard framework cores for crowns and fixed partial dentures (FPDs). Amalgomer CR, a novel ceramic-reinforced GIC, was introduced in the 2000s. This tooth-coloured cement combines the benefits of glass ionomer cement with the high strength of ceramics. The mechanism of bonding of Zirconomer and Amalgomer CR with the dentin is chemical in nature, thus lacking the reinforcement of bond with micromechanical interlocking.

There are many in vitro studies and clinical trials conducted on the compressive and flexural strength of these materials but very few studies were done on shear bond strength. So, in the present study, the shear bond strength of dentin with Zirconomer (Shofu, Japan), Amalgomer CR and glass ionomer cements (GC Corp)

MATERIALS AND METHODS
Sample collection

Inclusion criteria
Thirty caries-free upper and lower permanent human molars that were 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
Teeth were mounted on self-cure acrylic blocks by using metal molds to embed the root portion and to expose the crown portion only. Then 3mm of the coronal tooth structure was removed using a diamond abrasive to expose the occlusal dentine. Teeth were randomly divided into three groups of 10 specimens each and restored as follows:

Group 1: Zirconomer (Zirconomer improved-Zirconia reinforced glass ionomer cement, Shofu, Japan) (n=10),
Group 2: Amalgomer CR (n=10) and Group 3: Glass Ionomer Cement (GC Corporation, Tokyo, Japan) (n=10).

Conditioning of dentin was done to all the samples using a dentin conditioner (GC Corporation Tokyo, Japan) that contained 10% polyacrylic acid for 10 seconds. The surface was rinsed thoroughly with water and then blotted with a cotton pellet to remove excess water. Powder and liquid were hand mixed until putty-like consistency in a ratio of 1:1 according to the manufacturer’s instructions (Figure 1b,c).16 and cements were placed onto the occlusal surface using a straw as a template which was cut into dimensions (4mm x 4mm2) (Figure 1d).19

Experimental procedure
A universal testing machine was used to evaluate the shear bond strength, whereby the crosshead speed was 0.5mm/minute and the load applied was 1kilonewton for all the samples. The shear bond strength of all samples was obtained and checked for statistical analysis (Figure 1e).

RESULTS
Data were analysed using SPSS Version 20.0 with descriptive statistics that include one-way ANOVA and Tukey’s multiple post hoc procedures for intergroup comparison. Statistical analysis was done for evaluating the bond strength. Table 1 shows the mean and standard deviation of shear bond strength values of different experimental groups. Group 1 showed the highest shear bond strength followed by Groups 2 and 3 (Graph 1). In Table 2, the shear bond strength of Zirconomer to dentin showed a statistically significant difference with Amalgomer CR and GIC (p<0.001).

Table 1: Descriptives: Mean and SD for all groups

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<th>Group 1</th>
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<tr>
<td>Group 1</td>
<td>-</td>
<td>0.003 (S)</td>
<td>0.000 (S)</td>
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<tr>
<td>Group 2</td>
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P-value is <0.001*

DISCUSSION
In the oral cavity, restorations undergo stress from masticatory forces producing different reactions that lead to deformation, which can ultimately compromise their
The durability over time. The selection of restorative material is mainly based on mechanical properties and manipulation.

Among various mechanical properties, the bond strength of restorative materials is important because it usually replaces a large bulk of tooth structure and should give enough strength to resist the intraoral masticatory forces.

The clinical success of restorative materials depends on good adhesion with tooth surfaces and resistance to various dislodging forces acting within the oral cavity. The shear bond strength is described as the resistance to forces that slides restorative material past tooth structure. It is assumed to have greater clinical importance because the most dislodging forces at the tooth restoration interface have a shearing effect. Therefore, high shear bond strength shows better bonding of the restorative material to the tooth. Many aesthetic materials like Zirconomer, Amalgomer CR and so on were introduced for better mechanical properties.

In the present study, Zirconomer showed better SBS than Amalgomer CR and GIC. Zirconomer possibly exhibited superior bond strength as the powder has various grain sizes and other ingredients such as yttrium oxide and alumina that are evenly dispersed throughout the substance. The material’s porosity and translucency are influenced by the different grain sizes. This is in correspondence with the study done by Chalissery et al. It showed improved resistance to erosion and abrasion, which is attributable to the cement’s strength being derived from the ongoing development of aluminium salt bridges. Zirconia is recognised as being a good material for strengthening and toughening in several contexts due to the special character of phase shift from tetragonal phase to monoclinic phase under stress. This transformation produces a 4% change of volume which generates local compressive stress, which then offsets crack opening tension and so inhibits crack propagation and increases the incorporating material’s fracture resistance.

In the present study, Amalgomer CR showed better SBS than GIC but less SBS than Zirconomer. According to S Srinivasa Murthy et al., micronisation of the main glass components in the Amalgomer CR powder caused an increase in tensile strength, flexural strength and fracture toughness than those of conventional GICs and these properties could have made Amalgomer CR more resistant to shear stress.

GIC showed less SBS than Zirconomer and Amalgomer CR because of its inferior mechanical properties such as low fracture toughness, tensile strength and brittleness when compared to other restorative materials and so it is better to avoid GIC in stress-bearing areas. The bond strength tests for GICs cannot always express the interface bond strength as they report cohesive failures within the material, limiting the results to material strength. The composition of GIC consists of powder: silica, alumina, aluminium fluoride, calcium fluoride, sodium fluoride and aluminium phosphate. Liquid: polyacrylic acid. The powder/liquid (P/L) ratio is one of the factors indicated in altering the mechanical properties of GICs; the higher amount of powder, the higher the mechanical properties. The reason for less SBS than Zirconomer and Amalgomer CR is a modification of the powder composition.

Table 2: P-value Tukey’s post hoc test for pair-wise comparison

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<th>Group 1 Zirconomer</th>
<th>Group 2 Amalgomer</th>
<th>Group 3 GIC</th>
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<td>6.08</td>
<td>5.28</td>
<td>4.25</td>
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Figure 1(a) Flattening of occlusal surface (b) Conditioning the tooth with a micro brush (c) After conditioning (d) Restoring the samples with cements by using a straw (e) Shear bond strength testing under a universal testing machine.
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