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ScienceDirect

Tanta Dental Journal 10 (2013) 58–66

www.elsevier.com/locate/tdj

Micro-shear bond strength of different composites and glass-ionomers used to reinforce root dentin

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Abstract

Purpose: Comparison of microshear bonding strength of reinforcing root dentin materials (microhybrid composite, nano-composite, conventional glass ionomer, nano-glass ionomer).

Materials & methods: A total of 20 roots of similar-sized undamaged one rooted lower premolars were used, 40 root halves were embedded in the acrylic block and were randomly divided into four equal groups (10 each) according to the reinforcing materials. Group I: microhybrid composite, group II: nano-composite, group III: conventional glass ionomer was used and group IV: light cured nano-ionomer was used. Teeth were sliced and loaded to a testing machine. A shearing load with tensile mode of force was applied via materials. The mode of failure was observed under stereomicroscope. The results were statistically analyzed using one way ANOVA and *t*-test.

Results: Nano-composite group recorded the highest μ-shear bond strength mean value (23.52 ± 3.997 MPa) followed by μ-Hybrid composite group (16.88 ± 3.356 MPa) then nano glass-ionomer group (8.77 ± 1.341 MPa) while conventional glass-ionomer group showed the lowest μ-shear bond strength mean value (4.062 ± 0.9623 MPa). The difference was statistically significant between all groups ($P < 0.05$). The failure modes indicated that high bond strength showed cohesive or mixed modes, while low bond strength groups tended to exhibit adhesive, cohesive or mixed modes.

Conclusion: Nano-composite recorded the highest microshear bond strength close to that required to resist the polymerization contraction stress.

Keywords: Composite resin; Glass ionomer; Microshear bond strength; Mode of failure; Reinforcing materials

1. Introduction

The restoration of endodontically treated teeth commonly presents a challenge to dentists, especially in cases of extensive crown-root destruction [1,2]. Excessive root canal flaring can result in a large, conical and insufficiently retentive post [3,4]. On the other hand, the use of posts with a smaller diameter than that of the post-space leads to the formation of voids that, even if filled with cement, represent potentially weakened areas [3].

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Peer Review under the responsibility of the Faculty of Dentistry, Tanta University

Production and hosting by Elsevier

 http://dx.doi.org/10.1016/j.tdj.2013.08.004

A recent technique has been proposed for restoring a compromised endodontically treated teeth involves the use of reinforcing materials to replace lost root dentin and possibly strengthen the root [5,6]. The thickness of dentin remaining after tooth preparation is the most relevant factor in determining tooth strength [7,8]. It is necessary to retain as much tooth tissue as possible during restorative procedures, as roots with little remaining dentin for structural support are less able to withstand functional and impact stresses [8]. In certain situations, the destruction of the tooth structure extends to the internal region of the root as a result of dental caries, fractures, removal of previously placed posts, previous endodontic treatment, internal reabsorption or idiopathic causes [9,10].

A thin peripheral dentinal wall may be prone to fracture after cementation of a cast post and core as a cast post has been shown to improve the retention of the restoration rather strengthen the root [11]. Especially if a cast post is cemented into a flared canal, the post may exert a wedging effect on the canal walls [12].

The structure of dentin is an important factor that should be taken into account in terms of bonding [13]. Bonding of adhesive restorations can be influenced by the anatomical and histological characteristics of the root canal, including the orientation of the dentin tubules. Dentinal tubules in the root are straighter, less divergent [14], and not as numerous as in the crown [15]. Moreover, as the number of dentinal tubules decreases from the cervical to the apical part of the root [16], dentin bonding.

To avoid extraction of weakened roots, filling of the radicular defects with restorative materials has been suggested [10,17]Several materials have been used to fill radicular defects with the aim of increasing the resistance of the weakened roots, such as different types of glass-ionomer cements and composite resins and hybrids of glass-ionomers cement and composite resin [10,17,18].

In a recent extensive discussion about a framework for definitions presented to the European Commission, the nanoscale was defined as being of the order of 100 nm or less. Similarly, nanomaterial has been defined as any form of a material that is composed of discrete functional parts, many of which have one or more dimensions of the order of 100 nm or less.

There are two major characteristics conferring the special properties of any nanosized material, nanophase materials have unique surface properties, such as an increased number of grain boundaries and defects at the surface, a huge surface area and an altered electronic structure, when compared to conventional micron-sized materials [19,20]. Finally, nanosized and nanocrystalline materials have different mechanical and optical properties compared to larger grained materials of the same chemical composition [21].

Therefore, nanotechnology is of great interest glass ionomer. The manufacturer calls the new restorative cement a ‘nano-ionomer’ because the formulation is ‘based on bonded nanofiller technology [22], which allows a highly packed filler composition (69%), of which approximately two-thirds are nano-fillers [23].

To test the bond strength of these materials the ideal bond-strength test should be in the first place easy (meaning low technique-sensitivity) and relatively fast [24].

The microshear bond strength (μ-SBS) test was introduced as an alternative to the microtensile bond test. Advantages of the microshear bond test include less demanding specimen collection and easier control of the bond test area by means of microbore (polyvinyl chloride) tubes. Shimida et al., 2002 [25] modified the microshear bond test by replacing the blade with a looped orthodontic wire.

2. Materials & methods

Twenty similar-sized one-rooted lower premolars with fully developed apices and were extracted for orthodontic purpose the patient’s age was ranging from (20–35) years. All teeth were radiographed; any tooth with root caries, internal calcification or resorption was excluded. Teeth were cleaned from any attached soft or hard tissue and stored in 10% natural buffered formalin [26]. Crown was sectioned transversally at the cemento-enamel junction (CEJ) with double-faced diamond disc at low speed. The twenty roots were then split longitudinally in a buccolingual direction giving a total 40 halves. The inner surface of each root was ground until it was smooth and flat using 1000-grit silicon carbide paper. The cut surface was pretreated with 1% NaOCL and 17% EDTA solutions for 5 min to remove the smear layer [27].

Each prepared root- half was placed onto a glass cover slab (inner surface of root half touches the flat surface). To imbed the root half in an acrylic block a plastic tube with a diameter of 2 cm and a height of 2 cm was painted with separating medium and the opening of the tube was placed over the tooth specimen and filled with acrylic material around the outer surface of the root. After acrylic setting, the tubes were removed from the samples producing 40 root halves embedded in the 40 acrylic blocks with a diameter of 2 cm and a height of 2 cm. The entire specimen unit