Transverse and Pressure Resistance of Composite Shear Bond Strength on Dentine

Tlačna i posmična otpornost sveze kompozita i dentina

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Summary

Transverse and tensile resistance of a dentin-bonded composite resin restoration was tested. The composite resins (Fluorocore, Coradent and Coracore) were retained routinely by a dentin adhesive (Syntac) on dentin samples. The specimens were mounted on a mechanical testing device, and each of the 23 specimens was loaded perpendicularly to its long axis. The transverse force was applied at a crosshead speed of 0.5 mm/min until failure occurred. The next 22 specimens were loaded in parallel with their long axis in the same conditions. All the three materials showed a satisfactory compressive shear bond strength, but transverse resistance was inadequate and restorative pins had to be used.

Key words: *shear bond strength, dentin adhesive, composite, dentin*

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Introduction

With the increasing use of dental composite resins in larger cavities, there is a special interest in bonding to dentin as well as to enamel. The acid etch technique, accompanied by a bonding agent, has become a routine procedure for composite resin restorations, but generally, dentin has a lower bond strength with composites than enamel (1,2). An important parameter for the efficacy and lifetime of a bond is bond strength (3). Bond strength can be measured in various ways, by application of tensile, shear or torsion stress (4).

Dental pins are used to retain amalgam and composite in teeth which are extensively broken down, a use which includes the retention of pores upon which crowns will be placed (5).

The purpose of this study was to examine the transverse and pressure shear bond strength resistance of three composite resins retained on dentin without the use of dental pins.

Materials and Methods

Dentin samples

Fourty-five extracted sound human lower premolar teeth were used. After one-month preservation in a 10% formaldehyde aqueous solution, the teeth were cleaned mechanically

and ultrasonically. The teeth were split transversally in the cervical portion utilizing a thin diamond disc. Only roots were used in the study. The roots were stored at 37°C in saline solution, except during the periods required for the completion of experimental procedures. The prepared specimens were randomly assigned to three groups of 15 roots each. The root specimens were embedded in cold-curing acrylic resin in a uniform cylinder. The cervical portions of the roots protruding from the acrylic cylinders were prepared with a high-speed diamond drill (ISO Diamant, Germany) with water cooling, to form a dentin cylinder with a diameter of 5 mm x 0.4 mm. The root canals were filled with phosphate cement. After 24 hours, 2 mm deep recesses were made by a diamond drill of a 2 mm diameter inside the filled root canals. After that, the dentin surface was cleansed by Ahidron.

Composite resins

Composite materials, Coradent (Vivadent, Lichtenstein), Coreform (Kerr. Sybron, Michigan) and Fluorocore (3M, St. Louis) were used. The composite resins and dentin adhesive bonding were applied according to the manufacturers' instructions, as follows: all specimens were dried. Then, the entire dentin surfaces of each specimen in all groups were etched for 30 sec with 37% orthophosphoric acid, rinsed thoroughly for 30 sec and dried. The dentin surface was coated with a bonding agent and then light-cured for 20 sec. Finally, a 4 mm thick composite layer was placed. The blue light was only applied for the Flurocore composite resin. The retainer and matrix were removed after 20 min and the specimens placed back in the saline solution for 24 at 37°.

Transverse bond strength procedure

The transverse strength was determined using an Instr-on testing machine. Each of the 23 composite specimens was loaded perpendicularly to its long axis. The load was placed on the composite 1 mm from the dentin-composite junction. The transverse force was applied at a crosshead speed of 0.5 mm/min until failure occurred. The force required to dislodge the bond between the dentins and composite resin was recorded as a peak load in N. Prior to placing the composite container, the dimension of each prepared surface was calculated by the

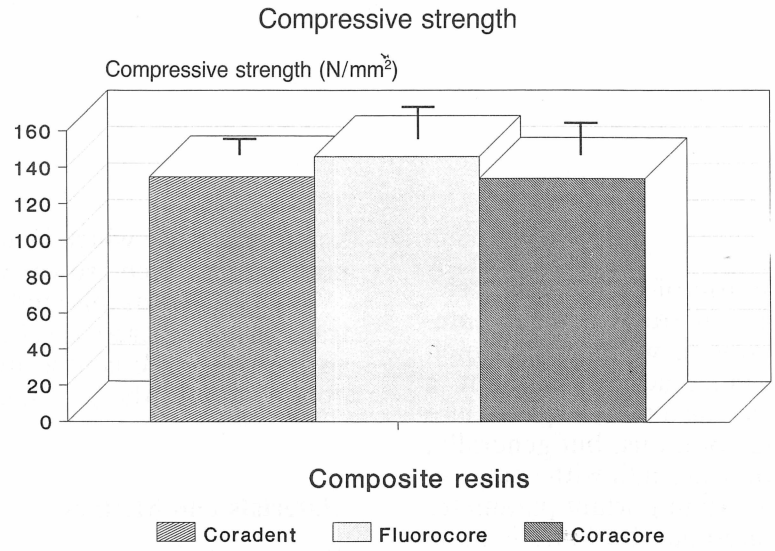

Figure 1. *Relationship between mean values (standard deviations) of compressive failure force (N/mm²) for shear bond strength for the composite resins tested*

Slika 1. *Srednje vrijednosti (standardne devijacije) tlačnih sila izražene u N/mm² koje su izazvale kidanje sveze ili kompozitne nadgradnje*

formula for the ellipse surface area (AxBxII). The mean shear bond strengths with standard deviations were calculated for each group. Statistical analysis was done by Student's t-test.

Tensile bond strength procedure

For the compressive resistance test, the specimens were placed in a mechanical testing device. Each of 22 specimens was loaded directly in parallel to its long axis until failure occurred.

Results

The compressive bond strength mean value for Coradent was x = 135.007 N/mm^2 (s = 10.332), for Fluorocore x = 146.897 N/mm^2 (s = 25.190) and for Coracore x = 134.273 N/mm^2 (s = 24.990) (Fig. 1). No statistically significant difference among the samples was obtained ($p > 0,05$).

The transverse bond strength mean value for Coradent was x = 2.92 N/mm^2 (s = 0.134), for Fluorocore x = 3.33 N/mm^2 (s = 0.131) and for Coracore x = 3.86 N/mm^2 (s = 0.196) (Fig. 2). Statistically significant differences were found between Coradent and Fluorocore ($p < 0,05$) and Fluorocore and Coracore ($p < 0,01$). No statistically significant difference among the samples was obtained at Alpha = 0,01.

Discussion

The nature of a bond between two materials is either mechanical, chemical or a combination of the two. Development of intermolecular bonds may play a role in the bonding mechanism. Access to Ca^{++} or collagen in the surface may be obtained by the dentin surface pretreatment with a Ca-chelator or acid, which remove the smear layer covering a prepared dentin surface (6). A bond to dentin can be useful both for retention of restorative materials and for prevention of microleakage. Microleakage can occur through cracks, splits or gaps along the interface, but for retention the stress situation is more complex. The difficulties with the tensile tests are largely related to the problem of a correct alignment of the two substrates bonded together by the adhesive (7). Another factor which influences the measured bond strength is the quality of the dentin to which the bonding material is applied. Some bonding materials (Scotchbond) have a higher bond strength to dentin just beneath the dentin-enamel junction than to dentin near the pulp (8). Storage conditions seem to have a marked influence on the dentin adhesive tested.

Acid-etching of dentin in a situation without enamel gave a significantly higher transverse resistance (9). A combination of the results, as

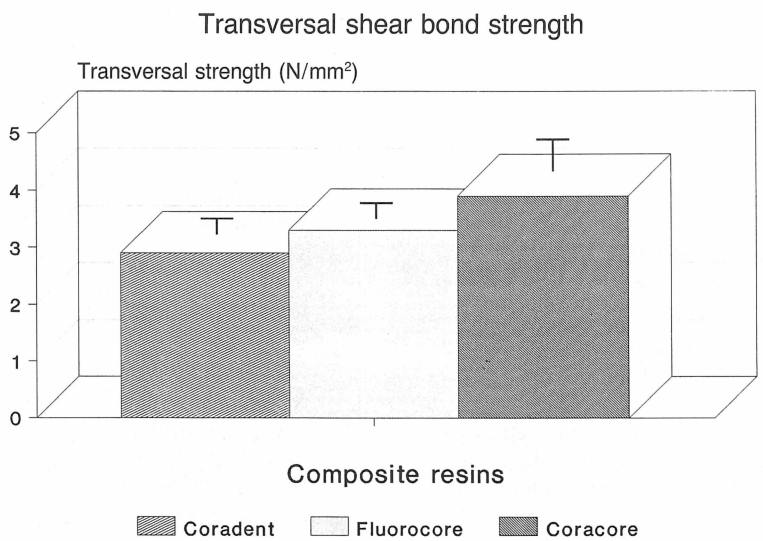

Figure 2. *Mean values (standard deviations) of transversal shear bond strength values for tested composite resins and dentin adhesive*

Slika 2. *Srednje vrijednosti (standardne devijacije) posmičnih sila koje su izazvale kidanje sveze kompozitne nadgradnje i dentinskog adheziva te dentinskog uzorka*

shown in Table 2, gives a mean shear bond strength of N/mm^2. These values are in the same range as those of other *in vitro* tests (10, 11).

According to the results of this study, Coradent, Fluorocore, and Coracore should not be used without the pins for restoration of extensively broken lower teeth.

TLAČNA I POSMIČNA OTPORNOST SVEZE KOMPOZITA I DENTINA

Sažetak

Ispitivana je mehanička otpornost triju kompozitnih materijala i sveze dentinskoga adheziva Syntaca s dentinom. Kompozitne smole (Fluorocore, Coradent i Coracore) rabljene su za izradbu nadgradnje na korijenskom dentinu pretkutnjaka. Kompozitne nadogradnje (22) tlačene su okomito i paralelno (23) s uzdužnom osi zuba dok nije puknula nadgradnja, sveza ili dentin. Sva tri materijala pokazala su klinički dovoljnu tlačnu, ali ne i posmičnu otpornost. Za opsežnije kompozitne nadgradnje vitalnih zuba potrebno je uporabiti i parapulpalne kolčiće.

Ključne riječi: *otpornost sveze, dentin, adhezija, kompoziti*

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