ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 2, Issue – 5, September – October - 2019, Page No. : 134 - 139

Comparative Analysis of Microshear and Microtensile Bond Strength of Different Microhybrid Composites.

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Type of Publication: Original Research Paper

Conflicts of Interest: Nil

Abstract

Background: Modern dental adhesives have shifted from multistep bonding process towards self-etch single bottle systems. In these progression variations in the bond strength has been observed.

Objectives: This study was carried out to comparatively evaluate microshear & microtensile bond strength of different microhybrid composites using either etch & rinse or self-etch technique.

Materials & method: Sixty freshly extracted mandibular molars were selected and randomly divided into two groups. Each group comprised of thirty samples which were further subdivided into two subgroups, where subgroup A was treated with etch & rinse and subgroup B with self-etch technique. Each subgroup was further subdivided into 3 sections and restored with Spectrum, Filtek Z250 and with Te-econom plus respectively. The samples were subjected to universal testing machine at 0.5mm/min until fracture occurred. Collected data was statistically analysed.

Results: Irrespective of etching technique used microtensile bond strength was found to be highest with Filtek Z250 followed by Te-ecomom plus and Spectrum while microshear bond strength was found to be highest with Te-ecomom plus followed by Spectrum and Filtek Z250.

Conclusion: Use of etch & rinse bonding agents result in higher bond strength compared to self-etch adhesives.

Keywords: Bond strength, microhybrid composites, self-etch, etch & rinse.

Introduction

With increasing demands for esthetics, resin-based composites have emerged as the favourite direct restorative materials in anterior as well as posterior teeth because of their aesthetic quality and improved handling properties.[1] Composites tend to adhere to the tooth structure not only because of external adhesive technique but also through the adherence inherent within the material.[2]

A stable bond between the tooth structure and composite material determines the longetivity of composite

restorations which is limited because of factors such as polymerization shrinkage, marginal breakdown, post operative sensitivity, marginal leakage etc.

With advancements in material science bonding systems have evolved and progressed from multi step bonding procedures such as two or three bottle systems to single step bonding such as one bottle system. Composite restorations are usually as retentive as the adhesive used.[3] Shear and tensile bond strength of Composites assumes nearly the same importance as compressive strength but these are not dependent on material itself but rather depend on employed adhesive technique and the medium used.[4,5,6.]

Hence this study was concieved and conducted to comparative evaluate three contemporary composites in respect to the two different bonding techniques being used currently.

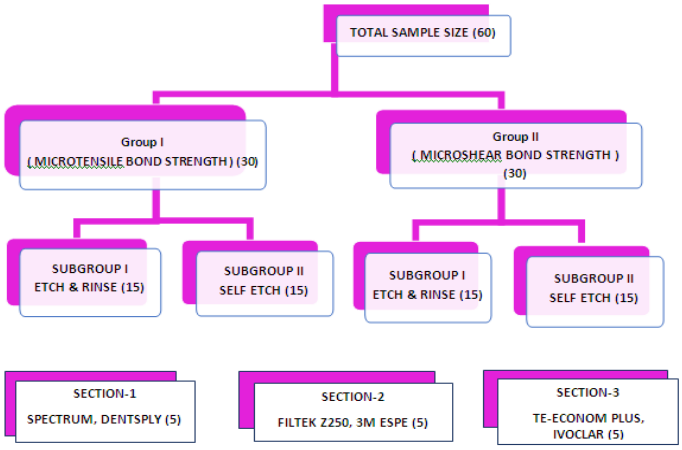
Material & methodology

For this study approval was granted by institutional ethical committee, Teerthanker Mahaveer ethical committee.

Freshly extracted human mandibular molar were collected and used for this study. Teeth were cleaned under running water then scaled ultrasonically and were disinfected. All the collected teeth were examined clinically and radiographically and were selected based on inclusion and exclusion criteria as mentioned in table 1.

Inclusion criteria	Exclusion criteria
Human Permanent Mandibular molars	Carious or decayed tooth
	Fractured tooth
	Endodontically treated teeth
	Restored teeth
	Teeth with loss of tooth structure
	Teeth with resorption

Selected teeth were equally divided into 2 groups which were further subdivided into 2 subgroups and each subgroup was further subdivided into 3 sections. (Table No. 2)



All the selected teeth were first flattened using diamond disc at slow speed. Samples were randomly grouped and numbered on the basis of different composites and adhesives used for the μTBS and μSBS test. The flattened surfaces were treated with respective adhesives in each group and light cured for 15 seconds.

In all the samples tested for microtensile bond strength, Composite build-ups were constructed on flattened tooth structures in four 1mm thick increments and individually light polymerized for 40 seconds each. Samples were stored in distilled water for 24 hours. Samples are sectioned longitudinally using diamond disk to produce rectangular slabs approximately 1mm in width. Specimens were fixed to a jig used in a universal testing machine (Instron) and stressed at the rate of 0.5mm/min.

In all the samples tested for microshear bond strength, a plastic tube of approximately 2mm internal diameter and height of 2mm was placed on the flattened tooth surface. Resin composite was condensed into the tube; a clear cellophane sheet was placed over the resin composite, pressed gently and light cured for 40 seconds. The plastic tubes were removed with a sharp blade and the specimens

were fixed to universal testing machine for µSBS testing. A shear force was applied at a crosshead speed 0.5mm/min until failure occurred. Collected data was tabulated and evaluated statistically.

Null hypothesis for this study was that there would be no difference in microshear and microtensile bond strength of three different composite systems when used with either etch & rinse or self etch technique do no result in different bond strength.

Results

Irrespective of etching technique used microtensile bond strength was found to be highest with Filtek Z250 ranging from 82.4 to 75.6 MPa followed by Te-econom plus ranging from 64.7 to 55.4 MPa and Spectrum ranging from 62.3 to 53.4 MPa while microshear bond strength was found to be highest with Te-ecomom plus ranging from 25.80 to 23.47 MPa followed by Spectrum ranging from 23.76 to 22.58 MPa and Filtek Z250 ranging from 20.27 to 16.53 MPa).

Mean Microshear Bond Strength

Microhybrid Composite	Etch & Rinse Technique(Mpa)	Self Etch Technique(Mpa)
Spectrum	23.12 (±0.12)	13.44 (±1.24)
Filtek Z250	18.76 (± 1.26)	11.37 (± 0.79)
Te-Econom Plus	24.39 (±0.67)	18.08 (±1.63)

Mean Microtensile Bond Strength

Microhybrid Composite	Etch & Rinse Technique (Mpa)	Self Etch Technique (Mpa)
Spectrum	57.36 (±2.71)	41.38 (±2.10)
Filtek Z250	79.6 (±1.04)	61.9 (±1.21)
Te-Econom Plus	59.8 (±2.7)	44.8 (±1.51)

Comparison between Two Different Etching Techniques

Microhybrid Composite	Etch & Rinse Technique		Self Etch Technique	
	µtbs (Mpa)	µsbs (Mpa)	µtbs (Mpa)	µsbs (Mpa)
Spectrum	57.36	23.12	41.38	13.44
Filtek Z250	79.60	18.76	61.90	11.37
Te Econom Plus	59.8	24.39	44.8	18.08

Discussion

Restorative dentistry has gradually shifted towards adhesive materials, as a result shear and tensile bond strength have gained importance.[7] Composites are the most widely used adhesive restorative material. In different studies shear and tensile bond strength of these restorations has been evaluated which varies as per commercial product.

Shear bond strength is the amount of force required to fracture the adhesion between a bonded restoration and the tooth surface with the failure occurring in or near the adhesive interface by applying unaligned forces pushing the two substrates in opposite directions.

Out of the tested composites, Te econom plus was found to possess the highest microshear bond strength followed by Spectrum and Filtek Z250. Although exact compositional details are not available, maufacturer claims better physical properties due to their patented technology.

Tensile bond strength is the amount of force required to fracture the adhesion between a bonded restoration and the tooth surface with the failure occurring in or near the adhesive interface by applying aligned forces pulling the two substrates in opposite directions.

Microtensile bond strength was found to be highest with Filtek Z250 followed by Te econom plus and Spectrum.

The reason for Filtek Z250 displaying highest tensile bond strength is that it has high molecular weight resins as a result fewer double bonds per unit of weight are present resulting in less shrinkage, reduced aging and softer resin matrix. They are less sensitive to changes in atmospheric moisture. Andrea et al. (2010) found that Filtek Z250 achieved highest bond strength values. The reason they assigned was due to differences in the resin composition since filler consistency has been maximized displaying better physical properties.[4]

For the adhesive restorations both etch & rinse and self etch techniques are being used extensively with the later being promoted more due to convenience and wider research. In our study both the microtensile and microshear bond strength was found to be higher with etch & rinse technique irrespective of the different composites used. The reason for this finding could be assigned to higher demineralisation & monomer infiltration in the remaining enamel along with dentin with etch & rinse technique. Moreover compared to self etch restorations the smear layer removal is achieved.[8]

Similar findings were achieved in a study by Sarr et al. (2018) who found higher bond strength with etch & rinse adhesive than self etch adhesive. The reason they assigned for this finding was that the etch and rinse adhesive resists water aging thus improving the initial bond strength and durability of the resin dentin bond.[9]

Peumans M et al. (2007) reported that self etch adhesive scored lowest bond strength of all the adhesives tested as they also showed pretesting failures.[10] Villela-Rosa et al. (2011) showed that two step etch and rinse adhesives have higher dentin bond strengths than self etch adhesives due to insufficient etching effects of self etch adhesives and the poor penetration of its monomers to the dentinal tubules.[11] Armstrong et al. (2003) reported that two step etch and rinse adhesives has a higher dentin bond strength than two step self etch adhesives.[12]

According to Taneja et al (2018) self etching adhesives depends on acidic monomers to concomitantly demineralize and infiltrate dentin and the mineral content of tooth must neutralize this acidity to allow complete polymerization of the adhesive layer while with the total etch adhesives the application of the etchant removes the smear layer. Since there is remaining acidity and incapacity to remove the smear layer , the self etch adhesives have lower bond strength.[13]

On contrary, Thanaratikul B et al (2016) found that the microshear bond strength (μSBS) when using a universal adhesive in either etch and rinse or self-etch mode compared with those of similarly used adhesives showed similar μSBS in both techniques but slightly higher values with self etch technique. Nakornchai et al.(2005) reported that self etch group had a higher bond strength to dentin than that of the etch & rinse group as not all hydroxyapatite is removed from interaction zone, much calcium ions are available for additional chemical interaction with specific adhesive functional monomers.[14]

The null hypothesis for this study was rejected since microshear and microtensile bond strength was found to be variable with different composites and etch & rinse technique provided higher bond strength than self etch. With contemporary composites adequate shear and tensile bond strength can be achieved which tends to resist nearly all the occlusal forces and prevailing factors. The etch and rinse technique tends to provide better bond strength but with gradual development in self etch technique these adhesives are fast catching up to achieve near similar bond strength.

Conclusion

Etch and rinse technique tends to provide higher microtensile and microshear bond strength for Composites

restorations hence usage of etch and rinse technique should be preferred over self etch.

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