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Analysis of shear bond strength of two different types of bonding agents on different types of tooth substrates in different periods of time

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Introduction

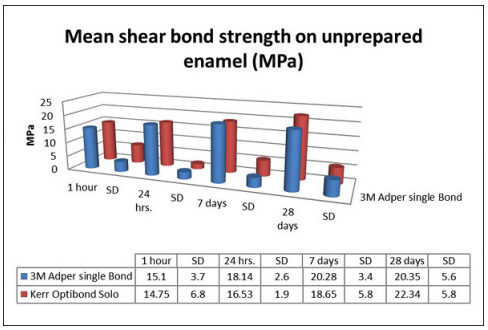
The importance of high tensile strength in the adhesion of resin materials to enamel, and particularly to dentin, for the creation of well-sealed and long lasting restorations has often been detailed. However, most of these tests are done after a 24 hours or longer periods. These studies though important in indicating the ability of the bonding resin to adhere to tooth substrate; do not discourse the strength immediately after the bonding resin is cured. Early bond strength can be considered very significant because this is the period when high stresses are placed on the bond among the cavity wall, bonding resin and resin composite. If the bond strength is not strong enough during the first hour after cure, it may rupture, causing gap formation. Investigations of the repair of composites have shown that bond strength can be significantly reduced at an interface involving an aged composite.

Objectives

The aim of this in vitro study was to investigate the early shear bond strength of two bonding systems on three different tooth substrates and compare the results with other test times and then estimate the obtained results by using SEM, AFM and 2D optical analyser to evaluate the significance of these methods.

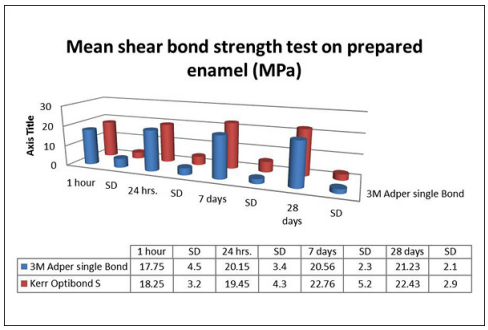
Material and Methods

240 human premolars teeth have been collected for this study. All the specimens' teeth were free of any carious lesion. Three human tooth substrates were used. The first substrate was clean, unprepared enamel. Relatively flat coronal areas were cleaned with a fluoride free pumice flour slurry and rubber cup for 10 seconds and rinsed for another 10 seconds. No other preparations were performed prior to etching. The second and third substrates were prepared enamel and dentin. These specimens were prepared using a model trimmer with coarse and fine silicon carbide wheels and rinsed for 10 seconds. These specimens were also cleaned with fluoride free pumice flour slurry and rubber cup for 10 seconds and rinsed with an air water syringe for another 10 seconds. the embedding moulds used to hold the specimens were made of methylmethacrylate resins. the moulds dimension were 1 inch in height and 1 inch in width. Care was taken to remove any air pocket around the edges of the specimen holes to prevent leakage of the embedding resin. each tooth substrate was positioned within its specimen hole using a small amount of sticky wax, if necessary, to secure uncut specimens. 80 specimens were prepared for the sound enamel in a fact of 20 specimens for each test period, respectivley, one-hour, 24 hours, 7 days and 28 days. 80 specimens were prepared for the prepared enamel and 80 specimens for the dentin in the same distribution as the group for the sound enamel. A cubical specimens of commercial denatl composite were prepared with dimensions of 4 mm. All the test surfaces have been etched with (Actino Etch, 37% Phosphoric Acid Etching Gel, Dental Etchant 1 x 5mL, UK) and then, the composite cubes have attached to the different tooth substrates mounted into the test moulds by the use of test bonding agents.
Two bonding agents have been used in the study. 3M ADPER Single Bond 2 adhesives (10%, 5 nm, colloidal filler) (3M, ESPE, USA). OptiBond Solo adhesive system (15% filled with 0.4 micron barium glass) (Kerr USA). During the storage period, all the specimens were kept in a solution of artificial saliva in a temperature simulating that of human body with an average of 36° C. and the storage solution was replaced every 1-2 days. The ready specimens were subjected to failure by Schimadzu Precision Universal Tester AG-X series (Schimadzu corp. Japan) with a cross head speed of 0.1 mm/second. After testing the specimens, the they were removed from the moulds and sectioned by the use of IsoMet 5000 (Buehler, USA) and then tested under scan electron microscopy to check for the bonding embeddement of the bonding agent into the dentinal tissues. The same specimens were evaluated under Atomic Force Microscopy AFM (nanoWizard II KPK, Germany) and by 2D optical surface texture analyzer (non-contact type) (Alicon, Austria). The results oobtained by these different methods were compared and analysed.
Statistical analysis: A one-way analysis of variance (ANOVA) was used to determine if there were significant differences in shear bond strength between materials bonded to different surfaces. Tukey\'s multiple comparison test was used to determine the nature of the differences. Benferroni test was used to confirm significance.



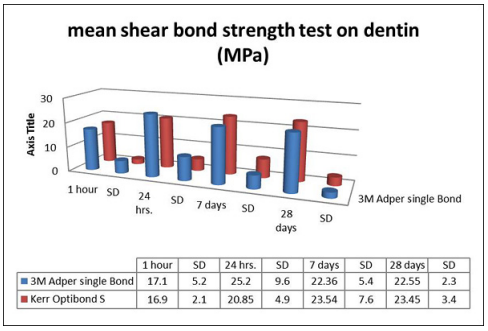
	1 hour	SD	24 hrs.	SD	7 days	SD	28 days	SD
3M Adper single Bond	15.1	3.7	18.14	2.6	20.28	3.4	20.35	5.6
Kerr Optibond Solo	14.75	6.8	16.53	1.9	18.65	5.8	22.34	5.8

Fig. 1: Mean shear bond strength of composite filling on unprepared enamel. (Unit= Mega Pascal)



	1 hour	SD	24 hrs.	SD	7 days	SD	28 days	SD
3M Adper single Bond	17.75	4.5	20.15	3.4	20.56	2.3	21.23	2.1
Kerr Optibond S	18.25	3.2	19.45	4.3	22.76	5.2	22.43	2.9

Fig. 2: Mean shear bond strength of composite filling on prepared enamel. (Unit= Mega Pascal)



	1 hour	SD	24 hrs.	SD	7 days	SD	28 days	SD
3M Adper single Bond	17.1	5.2	25.2	9.6	22.36	5.4	22.55	2.3
Kerr Optibond S	16.9	2.1	20.85	4.9	23.54	7.6	23.45	3.4

Fig. 3: Mean shear bond strength of composite filling on dentin. (Unit= Mega Pascal)

Results

The results showed no significant difference in shear bond strength between 1-hour and 24 hours for all groups. The collected results revealed an increase in shear bond strength from 1-hour to 24 hours, 7 days and 28 days respectively but with no significant difference among these test periods. There was no significant difference between the test groups in spite of the fact that 3M ADPER Single Bond 2 has shown higher numerical values after 24 hours. (See Figures 1-3)
The estimation of the specimens by the use of different methods revealed that the use of SEM is more reliable than the other mothods used in this study in estimating the hybrid layer and the depth of the polymerised bonding agents into the etched dentin or enamel Figures (4-6).

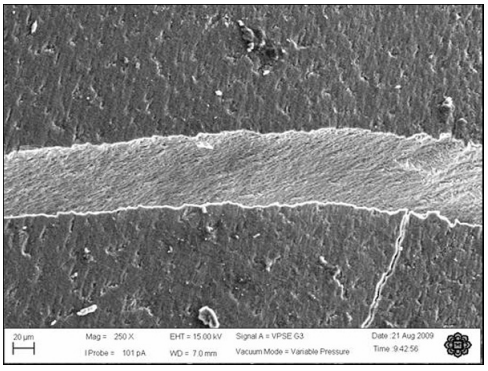


Fig. 4: SEM image showing the hybrid layer between the composite and the dentin.

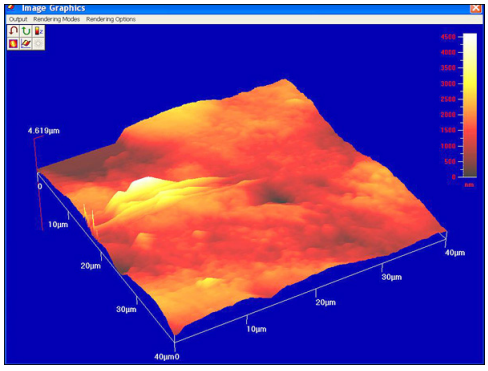


Fig. 5: Atomic Force Microscopy image of the hybrid layer between the coposite and the dentin.

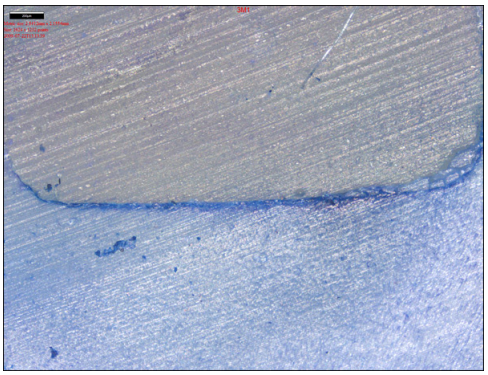


Fig. 6: 2D optical analyzer image showing the hybrid layer between the composite and the dentin.

Conclusions

The bonding systems that were used in the current study have formed an immediate bond to enamel and dentin which was durable to the other test periods. SEM images showed evidence of micromechanical bonding at the interface between the dental composite and the tooth substrates. SEM, 2D Optical analyzer and AFM showed that the fillers of the bonding agents used as adhesives were penetrated the dentinal tubules creating a true structural bond.

This Poster was submitted by Assist. Prof. Dr. Ammar A. Mustafa.

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