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Original Article

Dentistry Section

Microtensile Bond Strength of Embrace Wetbond Hydrophilic Sealant in Different Moisture Contamination: An In-Vitro Study

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ABSTRACT

Aim: Contamination of etched enamel with saliva has been shown to result in sealant failure. Recently, a hydrophilic sealant has been introduced. In absence of documented literature, this in vitro study was undertaken to ascertain the efficacy of Embrace Wet Bond without reduction of microtensile bond strength in the different moisture contamination.

Materials and Methods: A 5mm block of sealant were built over prepared occlusal surface of 40 non-carious therapeutically extracted third molars which were sectioned into 1mm thick stick and tested using Zwick micro tensile tester. Obtained data were subjected to descriptive analysis, one-way ANOVA and Scheffe's post-hoc tests.

Results: Mean microtensile bond strength of Embrace sealant was not significantly lowered in different moisture contamination groups except Group 3 (air drying), which showed very highly significant ($p<0.001$) decrease in μTBS as compared to Group 1 (non-contaminated).

Conclusion: Mean μTBS of Embrace sealant remains largely unchanged even in presence of moisture. Owing to its hydrophilic property, this sealant can be a great help in cases where maintaining isolation is difficult.

Keywords: Fissure sealant, Moisture tolerant, Restorative material, Retention

INTRODUCTION

Revolutionary change in clinical practice of dentistry was marked by classic study of Buonocore in 1955.Based on Buonocore's work, first pit and fissure sealant along with curing initiator was introduced named Nuva-Seal in February 1971. Soon after this, ultraviolet based sealant was launched named Caulk Nuva Lite [1].

Sealants have been proven to be highly effective in caries reduction especially if it remains undefiled. Salivary contamination following etching is the main cause responsible for its failure. Isolation of teeth is difficult in partially erupted molars and in young children [2,3].

Resin – based restorative materials are most customarily used in our modern dentistry. Notwithstanding its high retentiveness, its use clinically is limited because of inherent sensitivity of Bis-GMA being hydrophobic [4]. The use of hydrophilic adhesive in lieu of sealant around saliva contaminated enamel may improve retention clinically [5,6].

Recently there has been a significant advancement in resin-based sealants with the development of moisture-tolerant chemistry. Embrace™ WetBond™ (Pulpdent, Watertown, MA) is an example is a unique resin-based sealant that contains no BisGMA and no Bisphenol A and uses hydrophilic resin chemistry. However further research is needed to prove its efficacy [4].

As an indicator of sealant retention ability, the strength of its bond to enamel can be measured in vitro by different techniques, of which microadhesion is least explored. There has been evidence that microtensile strength test correlate better with clinical retention in irregular surfaces and regional differences can also be taken into account [7].

However, there is sparse literature available regarding effect of salivary contamination on microtensile bond strength of sealants and introduction of new materials makes continuing research on this subject even more necessary. Hence, this study was undertaken to evaluate the influence of different moisture contamination on microtensile bond strength of this newer Embrace wetbond sealant.

MATERIALS AND METHODS

The present *in vitro* study was conducted in Department of Materials Engineering, Indian Institute of Sciences in Bangalore after institutional ethical clearance.

Forty non carious, stain free therapeutically extracted third molars were disinfected and stored in distilled water until use. Teeth were randomly divided into four groups of ten each which were subjected to different treatment as follows:

Group 1 (Non-contaminated): All the teeth were etched with 37% phosphoric acid (Swisstec etchant gel) for 15 sec no saliva contamination. This was followed by thorough rinsing with distilled water for 10 sec and drying with gentle stream of oil-free compressed air for 5 sec.

Group 2 (Air – thinning): After etching was done as in Group 1, artificial saliva (Wet Mouth, ICPA health products) was applied for 5 second and air thinned for 1 sec.

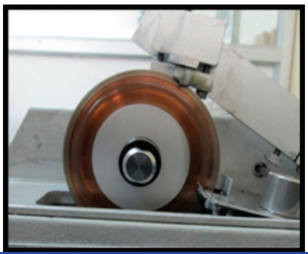
Group 3 (Air-drying): After etching was done as in Group 1, artificial saliva was applied for 5 sec and then completely with air-stream for 5 sec.

Group 4 (Re-etching): After etching was done as in Group 1, artificial saliva was applied for 5 sec and then completely with air-stream for 5 sec, re-etching for 15 sec, rinsed with distilled water for 10 sec and thoroughly dried for 5 sec.

On the bonding surface thus obtained a block of 5mm of sealant was progressively built up with each increment measuring 2mm taking care of uniform thickness by applying the sealant from periphery to centre and utmost care was taken to avoid formation of void. Each increment was light cured (Dentsply QHL 75 Curing Light) for 20 sec as per manufacturer's instructions. The block height was confirmed using digital vernier caliper. The samples were stored for 24 h in distilled water at 37°C [Table/Fig-1].

All the samples obtained were sectioned longitudinally perpendicular to the adhesive interface with low-speed isomet saw (Buehler Lake Bluff, Illinois, USA) to form rectangular beams of 1mm thickness, measured with digital vernier calliper [Table/Fig-2].

[Table/Fig-1]: Prepared samples before sectioning



[Table/Fig-2]: Sectioning of the sample into 1mm thickness using isomet low speed saw

[Table/Fig-3]: Mounting jig for testing

Each specimen was then bonded to the customised rubber jig using cyanoacrylate based adhesive on to the Zwick microtensile tester. The specimens were tested for microtensile bond strength using a 100 N load at a cross-head speed of 1 mm/min [Table/Fig-3].

The data were analysed using one-way ANOVA test at the 95% confidence level. Failure modes were classified as cohesive (in enamel or in the sealant), adhesive (between the enamel and the sealant) or mixed (cohesive and adhesive).

RESULTS

[Table/Fig-4] summarises the results of Mean microtensile bond strength of Embrace Wetbond Pit and Fissure Sealant in Different Moisture Contamination. One way ANOVA revealed significant difference p-value (<0.001) in values of microtensile bond strength of in different moisture contamination groups [Table/Fig-5].

Intragroup Comparison of mean microtensile bond Strength between non-contaminated and air drying grouprevealed highly

GROUPS	N	Mean	SD	Min.	Max.
Non-contaminated	10	21.720	1.964	17.00	24.00
Air Thinning	10	20.205	1.818	17.80	22.80
Air Drying	10	18.020	1.533	15.80	21.20
Re-etching	10	21.720	2.057	18.40	24.60

[Table/Fig-4]: Comparison of mean microtensile bond strength of embrace wet bond in different moisture contamination

	Sum of Squares	df	Mean Square	F	Significance 'p'
Between Groups	91.86	3	30.621	8.908	<0.001***
Within Groups	123.750	36	3.438		

[Table/Fig-5]: One-Way ANOVA of Mean Microtensile Bond Strength of Embrace Wetbond Sealant in different moisture contamination
***p< 0.001-Very highly Significant

significant difference (p=<0.001) [Table/Fig-6]. When evaluated for failure modes in different moisture contamination groups, higher frequency of cohesive failure was observed with air drying and re-etching group [Table/Fig-7].

	Mean Difference	t-Value	'p'
Non –Contaminated / Air Thinning Group	1.515	1.790	0.090
Non- Contaminated / Air Drying Group	3.700	4.695	<0.001***
Non. Contaminated / Re-etching Group	0.00	0.00	1.000

[Table/Fig-6]: Intragroup comparison of mean microtensile bond strength embrace wet bond sealant in different moisture contamination
***p< 0.001-Very highly Significant

Failure modes	Non-contaminated	Air Thinning	Air- Drying	Re-etching
Adhesive	2 (20%)	3 (30%)	4 (40%)	2 (20%)
Cohesive	4 (40%)	3 (30%)	4 (40%)	5 (50%)
Mixed	4 (40%)	4 (40%)	3 (30%)	3 (30%)

[Table/Fig-7]: Frequency of Failure Modes of EmbraceWetbond sealant In Different Moisture Contamination

DISCUSSION

Prevention is the main objective of modern dentistry, mainly in Paediatric dentistry, since 88% of the carious lesions in children are located in pits and fissures [8]. In order to obtain long-term success with sealants, the first and perhaps the most important condition is the maintenance of a satisfactory retention of the material to enamel. Nevertheless, any contamination of the substrate harms the sealant retention capacity. The main cause of sealant failure is the saliva contamination after enamel acid etching [2,3,9].

Salivary contamination predominately affects the strength and retention through:

a) Change in surface characteristics because of formation of organic adherent film covering the etched surface.

b) Presence of moisture which inhibits close contact of materials to the recipient conditioned surface.

Conventional tensile and shear bond strength tests limit the location of the bond and require prior flattening of the enamel surface. Thus, these tests cannot be used to evaluate the interaction of materials with the intact enamel surfaces. Fortunately, such problems may be avoided with the recent development of microtensile bond strength test. Since the microtensile test permits measurement of bond strengths of relatively small surface areas of $1mm^2$, this method has been widely used for testing irregular surface. Apart from the above mentioned advantages, this test was used in the present study to evaluate the microtensile bond strength of the materials under different moisture contamination with the advantage of producing multiple specimens at each tooth [7,10].

In the present study, block of sealant of 5mm was incrementally built on the occlusal surface of the molars. Although this procedure does not correspond to clinical situation, it was performed to allow the production of resin-enamel sticks according to microtensile bond strength test protocol [10,11].

Among the different variants of the microtensile techniques, the non- trimming method producing 1mm thick beams was chosen, as previous investigation had shown that such shape and size were the most appropriate for microtensile bond strength testing on specimens from enamel [12].

To simulate an inadvertent contamination of etched enamel that can occur clinically when children swallow during attempts to apply sealants and in partially erupted teeth, artificial saliva was used as in other studies with enamel contamination [13].

There was decrease in µTBS values between non-contaminated (21.72±1.96 MPa) and decontamination by air thinning (20.20 ± 1.81MPa) but the difference in values were not statistically significant (p>0.05). This observation could be explained on the basis of hydrophilic nature which allow them to function to some degree in the presence of saliva contamination by displacing or diffusing through moisture and then they infiltrate and polymerise.

Farideh Darabi et al., while evaluating effect of different decontamination procedures from a saliva-contaminated cured bonding system (single bond), concluded that with blot drying or air thinning there was significant lower bond strength in comparison with other groups (p<0.05). Contradictory to results obtained in the present study, Jiang et al., had shown in their study of effects of saliva contamination on µTBS of self etching adhesives that simple water spraying of the saliva contaminated enamel surfaces could completely restore the bond strength [14,15].

In group 3 when air drying was done, there was significant decrease in µTBS. The mean microtensile bond strength values without any contamination was higher (21.72 ± 1.96 MPa) than when air drying was done for decontamintation (18.02 ± 1.53 MPa). This observation could be result of collapse of water filled collagen fibers and adsorption of dried protein film as result of air drying which inhibited penetration of hydrophilic sealant.

In group 4, when re-etching was done to decontaminate the surface, it could significantly increase the µTBS but couldn't restore it to non-contaminated values. The mean microtensile bond strength values of sealant without any contamination was similar (21.72 ± 1.96 MPa) to mean microtensile bond strength with reconditioning group (21.72 ± 2.05MPa) Results obtained in this study is in consensus with various other studies which reported that reconditioning of saliva contaminated with phosphoric acid is the best method for obviating the negative effects of saliva [16,17].

However, conversely Ghavam and Pour showed that there was no significant difference when the contaminated dentine was either washed or washed and re-etched. Fritz et al., showed that re-etching is not necessary when contamination with the saliva occurs [18,19].

Shichi et al concluded that the cohesive strength of adhesives that include solvents was lower than that of adhesives composed by hydrophobic monomers only. In the present study, higher frequency of cohesive fractures was observed suggestive of lower cohesive strength being composed of hydrophilic monomers [20].

Embrace Wetbond pit and fissure sealant was launched by Pulpdent in 2002 and being composed of uncured hydrophilic monomers it was claimed to adhere even in presence of moisture. However there have been no investigational studies to evaluate the strength values.

In the present study, the good performance of Embrace Wetbond even with salivary contamination is in agreement with findings of clinical and microleakage studies [16,17].

LIMITATIONS

Anatomic differences between first and third molars and differenced in viscosity and constituents between artificial and human saliva. The lack of reported studies using the same methodology and materials tested in the present study is a limitation in stating a reliable comparison with outcomes of previous investigations. This being the pioneer study evaluating the microtensile bond strength of Embrace Wetbond further in- vitro and clinical studies are needed to validate the results and recommend it in the clinical set up.

CONCLUSION

Within the limitations of the study it can be concluded that saliva contamination adversely affected the microtensile bond strength of the embrace wetbond sealant. Among the various decontamination procedures employed reconditioning could improve the microtensile bond strength of sealants as compared to air thinning and air drying. Embrace Wet Bond could chemically adhere even in presence of humidity without significant reduction of microtensile bond strength. This suggests in the clinical scenario where there is risk of contamination, one may consider the use of Embrace Wetbond fissure sealant.

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