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RESEARCH ARTICLE

Influence of Cavity Disinfectant on Biological Seal Obtained

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Abstract

Background – The aim of this study is to assess the effect of chlorhexidine based cavity disinfectant on bond strength and adaptability of teeth restored with bulkfill composite ver- sus ACTIVA bioactive restorative material.

Methodology- Total of sixty freshly extracted human mandibular molars were taken. Class I cavities were prepared with 4mm in depth and divided into four groups and restored as follows- GROUP I A - Filtek bulkfill with chlorhexidine (CHX), GROUP II A - Filtek bulkfill without chlorhexidine (CHX), GROUP III B - ACTIVA with chlorhexidine (CHX), GROUP IV B - ACTIVA without chlorhexidine (CHX). All the samples were sectioned bucco-lingually, tested for immediate bond strength under universal testing machine and under scanning electron microscope (SEM) for gap formation at tooth restoration junction. The data was statistically analyzed using One way ANOVA.

Results- ACTIVA with chlorhexidine shows less gap formation and maximum immediate bond strength as compared to all the groups, whereas, bulkfill without chlorhexidine shows acceptable adaptation but lowest value of immediate bond strength.

Conclusion- All bulkfill composites are clinically acceptable but a new bioactive material i.e. ACTIVA gives comparably better results. (2018, Vol. 02; Issue 02: Page 1 - 8)

Key words: Bioactive “smart material”, Bulk fill composite, Chlorhexidine, Gap formation, Immediate bond strength.

Introduction

The primary goal of restorative dentistry is restoration of oral function, esthetics and replacement of lost tooth structure along with the preservation of oral health. There have been constant changes and improve- ments in the health science. Restorative dentistry is not an exception; hence today dentists are searching for a restorative material which will chemically bond to the tooth structure to form a perfect seal ca- pable of withstanding moist environment and temperature fluctuations (1).

Polymerization shrinkage appears to be the most significant problem with the light cured composite restorations, as it has the

potential to initiate gap formation at the tooth composite interface, which can lead to microleakage, secondary caries, and eventually degradation and failure of the bond (2). Improvements in today's compo- sites demonstrate enhanced wear and pol- ishability characteristics, but polymeriza- tion shrinkage is still a cause of concern (3).

Advanced composite technology i.e. bulk- fill composites have been introduced with the rational of reducing clinical steps by a filling the cavity in a "single" increment, thereby simplifying the existing incremen- tal technique. This also ensures reduced porosity and uniform consistency restora- tion, with reduce clinical time and cost for the patient (4).

Various artificial substitutes have been in- troduced which will not replace but refill the lost tooth structure. Unlike traditional materials that are hydrophobic, repel wa- ter and are designed to be passive, ACTIVA is moisture friendly and plays a dynamic role in the mouth. ACTIVA is a new cate- gory of strong, esthetic, smart bioactive composite and base/liner resins that re- lease and recharge calcium, phosphate and fluoride ions and are more bioactive than glass ionomers. ACTIVA BioACTIVE products are the first dental resins that mimic the physical and chemical proper- ties of teeth. They contain bioactive ionic resin matrix, shock absorbing rubberized resin component and reactive ionic glass fillers (5).

Today, the application of disinfectants af-
ter cavity preparation and before tooth restoration is gaining acceptance as it eliminates potential risks due to bacterial activity (6).

The ideal dentin disinfectant should com- bine the possession of a potent antimicro- bial action and should not interfere with the bonding efficacy of the subsequently applied adhesive system. It should also enhance the bond durability through the inhibition of the matrix derived enzyme (matrix-metalloprotease) (7).

Chlorhexidine (CHX) has proven biocom- patibility and good anti-bacterial action both in vivo and in vitro. CHX has been found to have matrix metalloproteinases (MMP) inhibitor and anti-enzyme proper- ties (against MMP-2, -8, and -9) even at low concentrations. Several in vitro and in vivo resin-dentin bonding studies have confirmed the ability of 2% CHX to protect dentin collagen degradation (8).

Therefore, the study was designed to find out the success of achieving predictable biological seal in class I cavities by restor- ing them using bulkfill composite and bi- oactive filling material with or without cav- ity disinfection protocol, as it is proved that cavity disinfectant increases bond strength. Further, the effect of 2% chlor- hexidine based cavity disinfectant was also checked with the respective materi- als.

Materials and method

This study was performed at Institute of Dental Studies and Technologies in De- partment of Conservative Dentistry and Endodontics. Total of sixty caries free, freshly extracted human mandibular mo- lars were taken from department of oral surgery. These sixty teeth were prepared with Class I cavities to the depth of 4mm were prepared in each tooth as manufac- turer's claim for bulkfill composites using

a diamond bur in high speed handpiece with copious air-water spray.

The specimens were randomly divided into two groups i.e. Filtek Bulkfill (3M ESPE, U.S.A) and Bioactive restorative material

i.e. ACTIVA (Pulpdent, U.S.A) with thirty teeth in each group.

The specimens into two groups were fur- ther subdivided as follows:

GROUP A - Filtek Bulkfill further subdi- vided into:

GROUP I A - Filtek Bulkfill with prior CHX disinfection

GROUP II A - Filtek Bulkfill without CHX disinfection

The teeth were hybridized using self etch bond i.e. 3M ESPE Scotch Bond Universal. GROUP B - ACTIVA further subdivided into:

GROUP III B - ACTIVA with prior CHX dis- infection

GROUP IV B - ACTIVA without CHX disin- fection

2% Chlorhexidine (BISCO, U.S.A) in solu- tion form used as a disinfectant was ap- plied for 10 seconds in Group I and III with the help of micro-brush. The dentin sur- faces of these teeth were then rinsed and dried with air for 10secs.

Ten samples from each group were sec- tioned bucco-lingually, the surface area was measured using digital calliper and then tested for immediate bond strength under universal testing machine at a crosshead speed of 1.0 mm/minute at tooth restoration junction. The shear bond strength values was recorded in Newtons

(N) and calculated in Mpa taking into ac- count the cross-sectional area.

The remaining five sectioned samples of each group were observed under scanning electron microscope for gap formation at tooth restoration junction. The obtained results were statistically analyzed using SPSS version 18.0 (IBM, U.S.A) with One way ANOVA.

Results

The results showed that ACTIVA with CHX demonstrated maximum bond strength than bulkfill composite group. Table 1 summarizes (Mean, Standard Deviation, Median, Maximum and Minimum score of bond strength in Newtons) for all the groups.

Table 2 represents pair wise comparison in bond strength for different pair of groups by independent “t” test. The signif- icant difference between the groups at

0.05 level of significance .i.e. ($P < 0.05$) was obtained between all the groups.

The stereomicroscopic images (Fig 1A-1D) showed that ACTIVA with chlorhexidine has least gap formation whereas on the other hand Filtek bulkfill without chlor- hexidine shows maximum gap formation. ACTIVA with chlorhexidine shows less gap formation and better immediate bond strength as compared to ACTIVA without chlorhexidine. Bulkfill with chlorhexidine shows good adaptation and immediate bond strength whereas, bulkfill without chlorhexidine shows acceptable adapta- tion but immediate bond strength was slightly lower as compared to other groups, although it showed clinically ac- ceptable results.

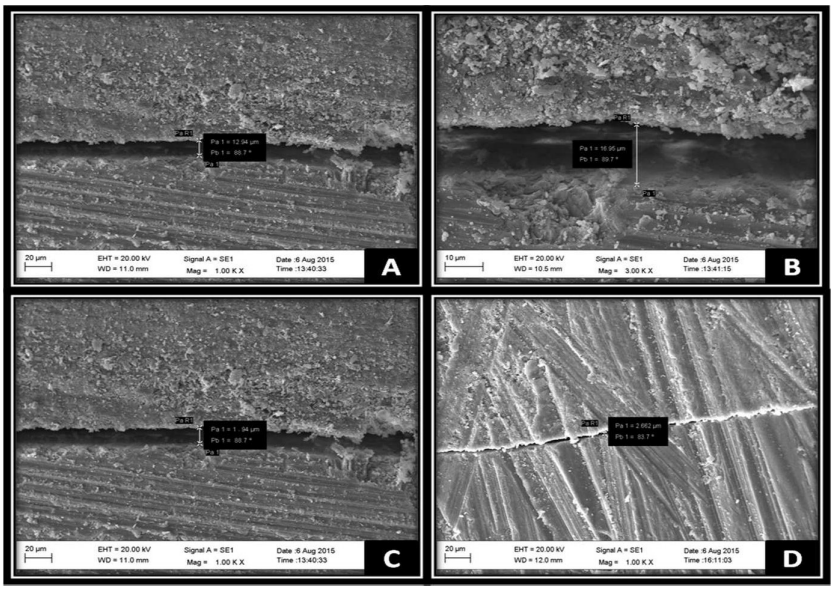

Fig 1: Scanning electron microscope images for all the groups showing gap formation as follows: Fig. 1A Filtek Bulkfill with CHX, Fig. 1B Filtek Bulkfill without CHX, Fig. 1C AC- TIVA with CHX, Fig. 1D ACTIVA without CHX.

Table 1: Mean, Standard Deviation, Median, Maximum and Minimum score of bond strength (N) for the four groups.

Bond strength	Group I A Bulk fill with CHX	Group II A Bulk fill without CHX	Group III B ACTIVA with CHX	Group IV B ACTIVA without CHX
	23.4	22.4	30.8	26.8
	23.8	21.6	28.8	26.9
	23.4	22.5	29.9	25.9
	23.6	21.6	28.6	25.7
	23.8	22.7	30.6	26.7
	23.7	22.3	28.9	25.7
	22.6	22.4	29.6	26.5
	23.5	22.6	30.6	26.5
	22.8	22.7	29.5	25.8
	23.5	22.8	29.8	26.8
Mean	23.41	22.36*	29.71**	26.33
Stand. Deviation	0.404007701	0.42998708	0.788035532	0.496767328
Median	23.5	22.45	29.7	26.5
Max.	23.8	22.8	30.8	26.9
Min.	22.6	21.6	28.6	25.7

(*=Least, **=Maximum)

F= 357.836151, P value < 0.05

Table 2: Pair wise comparsion for bond strength between different pair of groups by inde- pendent 't" test.

S.no.	Pair of groups	Probable values of independent 't" test	P- value/ Significance
1.	Group I A & Group II A	.0002*	P<.05 (Significant)
2.	Group I A & Group III B	.0000*	P<.05 (Significant)
3.	Group I A & Group IV B	.0003*	P<.05 (Significant)
4.	Group II A & Group III B	.0001*	P<.05 (Significant)
5.	Group II A & Group IV B	.0000*	P<.05 (Significant)
6.	Group III B & Group IV B	.0004*	P<.05 (Significant)

*Shows a significant difference between the groups at .05 level of significance .i.e. P <.05

Discussion

The development of bulk fill composites has begun to "change the game" for direct restorative dentistry (9). Bulk-fill Resin composites have been proven in several studies to enable restoration in thick lay- ers, up to 4 mm, maintaining the mechan- ical properties and the degree of conver- sion within the whole increment. Besides, decreased polymerization shrinkage, re- duced cusp deflection in standardized class I and II cavities, good bond strengths regardless of the filling technique and the cavity configuration, and improved self-levelling ability for low-viscosity materials are reported (10).

In the present study, ACTIVA gives better results as compared to bulkfill whether used with or without cavity disinfectant because of its physical and chemical prop- erties. The first bioactive "smart" material responds to changes in oral environment, with shock absorbing ionic resin matrix and bioactive fillers, mimics physical and chemical properties of teeth and releases, recharges calcium, phosphate and fluo- ride. ACTIVA has unique properties of in- timate adaption to tooth structure, excep- tional marginal integrity, seals against bacterial leakage as it forms a strong resin-hydroxyapatite complex, antimicro- bial properties; rubberized resin compo- nent provides unparalleled toughness and resilience (5).

The bond strength between a resin adhe- sive and the dentin substructure will de- grade over time because of following fac- tors which includes continuous occlusal loading (cyclic loading) through chewing and swallowing, moisture contamination from inadequate isolation, and improper use of the adhesive materials (technique sensitivity). A more recently discussed contributor to bond degradation is a fam- ily of cell-derived proteolytic (protein breakdown) enzymes referred to as dentin matrix metalloproteinases. MMPs and are dormant enzymes located throughout the dentin which can be activated by the acid- ity of the total-etch and self-etch dentin adhesives. Once activated, the enzymes can degrade the collagen fibrils that are left exposed and unprotected by resin in the hybrid layer (11).

Chlorhexidine is a broad spectrum anti- septic, and its use has been generalized over the past two decades for chemical control of bacterial plaque; the disinfec- tion of therapeutic cavities has been adopted as a positive control for studies on bacterial growth or antibacterial activity (2).

In accordance with results of the present study, 2% CHX contributes to long term stability of hybrid layer and bond strength. 2% CHX is used in adhesive den- tistry as an inhibitor of MMPs, which in- turn leads to the protection of the integrity of the hybrid layer collagen after applica- tion of etch and rinse adhesive (12).

According to Chang YE et al. in vitro bond strength of specimens tested after thermo-cycling for 10,000 cycles resulted in a sig-nificant bond strength reduction in the control group ($p<0.05$), but it showed less reduction in groups treated with chlorhex- idine (13).

Sharma V et al. concluded that the use of cavity disinfectants with resin composite restorations appears to be material spe- cific, with regard to interaction with the ability of various dentin bonding systems to seal dentin.

These results are supported by a study conducted by Verma R et al who con- cluded that surface pre-treatment with ei- ther 2% CHX or 30% phosphoric acid had no significant effect on the immediate shear bond strength of both the etch-and- rinse simplified adhesives. However, it sig- nificantly reduced the fall in bond strength of both the adhesives after 6 months of water storage as compared to the groups without surface pre-treatment (8).

In contrary to results of the current study, Gurgan S et al. proved that 2% chlorhex- idine cavity disinfectant application, be- fore or after acid etching, decreases the shear bond strength of composite resin to dentin, whereas rinsing off the cavity dis- infectant before bonding does not affect the bond strength.

The application sequence of the disinfect- ant is another factor to consider. Some cli- nicians prefer to apply the disinfectant af- ter cavity preparation, prior to the acid etching, whereas others prefer to apply af- ter the etching. Some clinicians also prefer to rinse off the disinfectant before the bonding procedure and others do not (14). Ercan et al. concluded that CHX solution as a cavity disinfectant, should preferred with an etch-and-rinse bonding system (15).

Scanning electron microscope examina- tion by Meiers and Kresin showed that CHX modified the appearance of the smear layer by removal of the loose smear debris. This could have enhanced the pen- etration of the acidic monomers of the self-etch adhesive. Furthermore, it could have enhanced the chemical bonding capacity of the MDP monomer. Lastly, this could be attributed to the possible stabilizing effect exerted on the smear layer turning it from a semi-permeable, loosely bound layer to a firmly bond layer, thus minimizing the convective and evaporative water fluxes from the underlying dentin, thus enhanc-ing the bonding capacity of the self-etch adhesive.

Pilo *et al*., who reported that pre-treating the dentin surface with CHX improved the bond strength of self-etch adhesive sys- tems. Soares et al. and Brackett *et al*. re- ported that using CHX with etch-and- rinse adhesives either enhance or not af- fect the bonding mechanism. This may be possible as in their studies CHX was ap- plied after the etching step (7).

In support of our study it was proved that the application of CHX to acid-etched hu- man dentin can save the collagen fibrils in

the hybrid layer when etch-and-rinse den- tin bonding is used (16).

Other factors that might have influenced bond strength are “C factor” in class I cav- ity is maximum and weakens the bond strength and deep dentin has a higher wa- ter content than does superficial dentin due to the larger diameter and number of tubules per unit area. This water may di- lute the organic solvents of some bonding systems, causing monomers to leave the soluble phase and form resin globules in water (17).

The application of 2% Chlorhexidine to the phosphoric acid etch surface after rinsing off the acid is the only procedure that has been clinically tested to prevent bond strength degradation so far (18).

Conclusion

Under the limitation of this in-vitro study, all bulkfill composites are clinically ac- ceptable and provide good clinical ease, but a new bioactive material i.e. ACTIVA gives comparably better results. More clin- ical and in-vitro studies need to be con- ducted and more extensive research work needs to be carried out to establish better materials as posterior restoratives over long term perspective.

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