Effect of D-Solv Gel caries removal on Bonding of Self-etching Adhesive to Caries-affected Dentin

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Abstract—

Aim: *To evaluate the effect of D-Solv Gel, chemomechanical caries removal method on bonding of self-etching adhesives to caries-affected dentin, in comparison to the standard rotary-instrument caries removal method.*

Materials and Methodology: *Twenty extracted carious human molars exhibiting frank cavitation intodentin were used. Ten teeth were randomly divided into two groups, according to the caries excavation methods :(i) D-Solv Gel and (ii) a round steel bur. After caries removal, eachgroup underwent self-etching adhesive application and resin composite buildup. Bonded specimens were sectioned into beams for shear bond strength testing under universal testing machine.*

Results: *Results of the one-way ANOVA revealed that the shear bond strengths were not affected by the factor "caries excavation method" ($p > 0.05$).The method of caries removal had no effect on the bond strengths of one-step self-etching adhesive to residual dentin following caries excavation ($p > 0.05$).*

Conclusion: *The chemomechanical caries excavation methods did not affect bonding of self-etching adhesives to caries-affected dentin, in comparison to rotary caries excavation method.*

Keywords—D-Solv Gel, Chemomechanical caries removal, Single Bond Universal, Self-etch adhesive

I. INTRODUCTION

For almost the whole of the last century, both teaching and practice of operative dentistry have been influenced to a very great extent by Dr. G.V. Black. His contribution to this field are numerous and were supported by many based on the scientific knowledge available in his time. His classification of cavities is followed to this day and most of the principles of cavity preparation taught by him are still in use.

It was believed that once caries had begun, it would continue to progress until the entire tooth is lost. The concept of remineralization of early dental caries was unknown. Also the few materials that were available then were all non-adhesive and mainly dependend upon macro-retention. Therefore most of the cavity outlines proposed by Black relied on the concept of "extension for prevention". This resulted in a "mechanistic" or "surgical" approach to treatment planning, instead of a "biologic" or "therapeutic" one.

Over the last few decades, there have been extensive research in the fields of cariology to introduce the concept of "prevention of extension" or minimally invasive approaches. Also clinical observations on the mode and patterns of failure of various restorative materials using conventional and conservative methods of cavity preparation are being carried out. All this has encouraged the researchers and clinicians to question existing concepts and to adapt more conservative, less destructive methods and approaches to treating dental caries. This has started a new era in the practice of dentistry where emphasis is on minimally invasive treatments, rather than blindly following the traditional "drill and fill" approach.

Drawbacks of conventional methods:

- ✓ Contamination and cross-infection.
- ✓ The need for presterilization cleaning.
- ✓ Removal of infected and unaffected tissues.
- ✓ Noise, vibration and discomfort experienced with burs.

Rationale behind new developments:

- ✓ Removal of only infected dentin.
- ✓ Reduce patient anxiety.
- ✓ Provide favorable surface features for bonding.
- ✓ Reduce contamination and cross- infection.
- ✓ Reduce need for anesthesia.
- ✓ Easier recognition between infected and uninfected dentin.
- ✓ Provide equal or superior efficiency comparedto conventional methods.
- ✓ Reduce cost.

Minimally invasive caries excavation techniques, including laser ablation, air abrasion, sonic abrasion, and chemomechanical caries removal, are characterized by a common feature of selective removal of caries infected tissue, leaving the caries-affected tissues intact.[5]Also increasing popularity of adhesion in dentistry, has reduced the need for preparing wide cavities with undercuts and unnecessary extensions.

The chemomechanical caries removal method was introduced by Goldman[4] in 1967, with the first chemomechanical caries removal agent being GK-101, which was developed to GK101E (Caridex National Patent Dental Products; New Brunswick, NJ, USA) in 1984.

D-solv gel is a sodium-hypochlorite-based (NaOCl) agent which comes in a pack of dual syringe. Syringe 1 consists of sodium hypochlorite. Syringe 2 consists of a combination of amino acids. There are three amino acids, leucine, lysine and glutamic acid.

When introduced into the cavity, these three different amino acids react with sodium hypocholrite to form three differently charged chloramines. These chloramines react with the denatured collagen and release the electrostatic force between the denatured collagen and thus the denatured collagen can be easily scraped off using a spoon excavator.

The D-solv was introduced by Dr.Tom's International on 7th August, 2014 and the concept was developed by SreeChithiraTirunal Institute of Medical Science & Technology, Thiruvananthapuram.

Bonding to caries-affected dentin is one of the most controversial topics in adhesive dentistry. Caries-affected dentin is characterized by a marked reduction in mineral content, loss of crystallinity, and alteration of the organic matrix.[6]This complex substrate poses a great challenge to achieving reliable bonding.

Previous studies have reported higher bond strengths of etch-and-rinse adhesives than self-etching adhesives to caries-affected dentin.[7,8] Current study deals with the use of self etching adhesive and assessment of bond strength to dentin in rotary vs D-solv gel caries removal.

II. AIM

To evaluate the effect of D-Solv Gel, chemomechanical caries removal method on bonding of self-etching adhesives to caries-affected dentin, in comparison to the conventional rotary-instrument caries removal method.

The null hypothesis is that chemomechanical caries removal has no effect on bonding of self-etching adhesives to caries-affected dentin compared to conventional rotary caries removal.

III. MATERIALS AND METHODS

Twenty permanent posterior teeth exhibiting frank moderate cavitation extending to the dentin were used. The teeth were stored in distilled water for a period of less than one month following extraction. These teeth were used for shear bond strength testing.

3.1 Tooth Preparation:

All the teeth were sectioned till the cementoenamel junction and were embeded in acrylic resin. The teeth were then randomly divided into two groups (n = 10) according to the caries excavation method.

- ✓ Group one: D-solv gel caries removal

✓ Group two: Rotary caries removal.

The two groups were then painted with two different nail varnishes on the acrylic resin to indicate two different groups. Group one was painted pink and group two was painted red. Both the groups were numbered.

3.1.1 Group 1: The carious cavity was treated with D-solv gel.

The piston of the dual syringe was pressed and 2-3 drops of D-solv gel from each of the syringe was allowed to fall into one of the depressions provided in the inner tray of the box. The gels are mixed using an applicator (fig.1) and applied to the carious dentin. The gel was left for 30 s prior to excavating the dentin using a spoon excavator. Scraping is done in a rotating movement. Once the gel became cloudy, it was rinsed off with distilled water for 20 s and the process was repeated until successive applications of the gel failed to become cloudy and surface feel hard.

FIG 1D SOLV CARIES REMOVAL AGENT

3.1.2 Group 2: Rotary assisted caries removal

Caries removal was performed with a lowspeed handpiece (NSK) at using a round bur (no.2).Caries infected dentin was removed and affected dentin was left untouched.

All the specimens were then grounded to get a flat surface for ease of bonding. But care was taken to leave the deepest part of caries affected dentin untouched. (fig.2)

TABLE 1
SHEAR BOND STRENGTH VALUES FOR GROUP 1 AND 2

D - SOLV GEL	ROTARY
12.89	14.82
1.61	5.15
6.32	8.18
12.86	6.44
11.35	7.09
12.96	6.44
9.16	10.12
14.96	11.09
1.84	13.92
8.77	6.06

TABLE 1
MEAN VALUES OF SHEAR BOND STRENGTH FOR GROUP 1 AND 2

Group1	9.272
Group2	8.931

FIG. 2 SPECIMENS MOUNTED ON ACRYLIC BLOCKS WITH DEEP DENTINE EXPOSED.

3.2 Bonding Procedures:

After caries removal, each group underwent self-etch adhesive application. A one-step self-etching adhesive, Single Bond Universal (3M ESPE) was used. The adhesive was applied following the manufacturer's instructions, followed by light curing of the adhesive for 10 s using a LED light-curing unit(DY400-4, Denjoy, 8.75V) with a light intensity output of 670 mW/cm2.The bonded surface was covered with a resin composite (Herculiteprecis, Kerr Corporation, CA, U.S.A). The resin composite was applied in 2mm thick increments and light cured for 20s at the same light intensity (fig 3).The teeth were stored in distilled water at 37°C for 24 h.

FIG. 3 COMPOSITE RESIN PLACED OVER THE DENTINE

3.3 Shear bond strength testing:

All bonded teeth were subjected to shear stress in a universal testing machine at a crosshead speed 1 mm/min. The values of shear bond strength for all twenty specimens were recorded.

3.4 Statistical analysis:

The bond strength data were analyzed using Microsoft excel 2013.The bond strength data were analyzed using one-way ANOVA to examine the effect of one variable (caries excavation method) and the interaction of this on the shear bond strength. A significance level of 5% was employed for this analysis.

IV. RESULTS

Results of the one-way ANOVA revealed that the shear bond strengths were not affected by the factor "caries excavation method" ($p > 0.05$).The method of caries removal had no effect on the bond strengths of one-step self-etching adhesive to residual dentin following caries excavation ($p > 0.05$)

V. DISCUSSION

Previous studies which evaluated the bond strength of residual caries-affected dentin following enzyme-based chemomechanical caries removal used demineralized dentin to avoid the effect of caries lesion size, shape, depth, and surface irregularities on the results of the bond strength test.[9,10]However, results obtained from demineralized dentin should be interpreted with caution, because natural carious dentin contains a wide variety of pathogenic materials, organic acids, hydrolytic enzymes, and whitlockite occluding the dentinal tubules.[11] Kinney et al reported that artificial loss of mineral content led to collapse of the collagen fibers, which might affect resin hybridization into dentin and bond strength results.[1]

The shear bond strength test used in the current study considered the tooth as the test unit and the flattest portion of the residual caries-affected dentin was selected. The present results showed that there was no significant difference in bond strength among the two caries excavation methods. The null hypothesis that chemomechanical caries removal has no effect on bonding of self-etching adhesives to caries-affected dentin could not be rejected.

Previous studies which evaluated the morphological changes of dentin following chemomechanical caries removal reported that the excavated surface following chemomechanical caries excavation was irregular and partially covered with a smear layer with most of the dentinal tubules being patent or partially occluded.[12,13]These morphological characteristics may increase the dentinal surface area for micromechanical retention of adhesive resin following caries removal.

Conversely, many studies reported that the excavated surface following caries removal using burs was relatively smooth, and covered with a smear layer with occlusion of tubules.[12,14,15]Some studies reported that the smear layer might act as a natural barrier preventing resin infiltration into dentin.[13,16]However, Lohbauer et al reported that hybridization of self-etching adhesive resin with dentin mainly depended on bonding of hydrophilic monomers to the exposed collagen scaffold, and that the resin tags did not influence bond strength. [2]

Abdebayo et al mentioned that application of adhesive resin with a scrubbing motion enhanced resin penetration into dentin.[3]Therefore, the thin smear layer following caries excavation and the scrubbing motion used in self-etching adhesive application may explain the nonsignificant difference in bond strength between the rotary and chemomechanical caries excavated groups observed in the current study.

In addition to micromechanical bonding, self-etching adhesive contained the functional monomer group MDP (10-methacryloyloxdecyl dihydrogen phosphate), which can chemically bind to hydroxyapatite.[14]This chemical bonding mechanism may increase the bond strength of residual caries-affected dentin in all groups. The results of this study are in agreement with the majority of previous studies, which reported that the caries excavation method did not affect bond strength to residual caries-affected dentin[17,9,13,18].

VI. CONCLUSION

Under the conditions of the present study, the chemomechanical caries excavation methods did not affect bonding of self-etching adhesives to caries-affected dentin, in comparison to rotary caries excavation method.

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