Shear Bond Strength of Self Etch and Total-Etch Adhesive System to Caries Affected Dentinal Surface after Chemomechanical Caries Removal: An In Vitro Study

Mohit Kumar¹, Shubhra Malik Juneja²

¹Professor, Conservative Dentistry & Endodontics, Narayan Swami Hospital & Dental College, Dehradun, Uttarakhand, India; ²Associate Professor, Department of Conservative Dentistry, Santosh Dental College, Ghaziabad, Uttar Pradesh, India.

ABSTRACT

Introduction: Dental caries brings about the destruction of teeth.¹ The conventional method for caries removal which utilizes high-speed handpiece is quick but there may be undesirable removal of the tooth.² The main aim should be to conserve tooth structure.

Aim: The present study aimed to evaluate the shear bond strength of self etch and total-etch adhesive system to caries affected dentinal surface after chemomechanical caries removal.

Materials and Method: Forty extracted non-restored human maxillary and mandibular molars having carious lesion on occlusal surfaces were selected. They have divided into two main groups i.e. group I: Caries removal by conventional method and group II: Caries removal by chemomechanical method (using Carie Care) which was further subdivided into two subgroups of 10 teeth each according to the type of adhesive used: Subgroup IA: Restored using the total-etch technique, Subgroup IB: Restored using self etch technique, Subgroup IIA: Restored using the total-etch technique, Subgroup IIB: Restored using self etch technique. A standardised cylindrical mould was used to prepare composite cylinders on the occlusal surface of each specimen. Shear bond strength testing was conducted in a universal testing machine at a cross-head speed of 0.5 mm/min until failure. The values thus obtained were tabulated and subjected to statistical analysis.

Result: Chemomechanical group showed slightly higher shear bond strength values than the conventional group in both totals etch and self etch subgroups, the difference between them was not statistically significant. Also, total-etch adhesive showed better bond strength than self etch adhesives.

Conclusion: No significant difference was found between bond strength of chemomechanical and conventional caries removal.

Key Words: Shear bond strength, Chemomechanical caries removal, Self etch adhesive, Total-etch adhesive, Carie Care, Papain

INTRODUCTION

Dental caries brings about the destruction of teeth.¹ The conventional method for caries removal which utilizes a high-speed handpiece is quick but there may be undesirable removal of the tooth.² The main aim should be to conserve tooth structure. A substitute to the conventional method is the chemomechanical caries removal method which utilizes chemical agents that soften carious dentin and aid in its excavation.³ Among the various methods of chemomechanical caries removal, some systems had some disadvantages such as short shelf life, the demand of specific instruments, and were expensive so papacarie, papain enzyme-based prod-

uct was introduced in Brazil.⁴ A chemomechanical system similar to it has been created in India i.e. Carie- Care. Latex of leaves and fruits of Carica Papaya tree is used to get papain.^{5,6} The carious tissues are devoid of antiprotease alpha-1-anti-trypsin, which impedes protein digestion in healthy collagen-based tissues.⁷ Also there is chlorination of incompletely degraded collagen by the action of chloramines. This disrupts the collagen structure and destroys hydrogen bonds which facilitate tissue removal.⁵ Following caries removal, morphological alterations in the dentinal surface by the chemical agent used for caries removal may play a role in its binding with resins.^{8,9} This study was done to assess the shear bond strength of self-etch and total-etch adhesive sys-

Corresponding Author:

Dr. Mohit Kumar, Professor, Conservative Dentistry & Endodontics, Narayan Swami Hospital & Dental College, Dehradun, Uttarakhand, India.
Mob: 9910113023; Email: mohit_cusp@yahoo.co.in

ISSN: 2231-2196 (Print)

ISSN: 0975-5241 (Online)

Received: 19.11.2020

Revised: 08.01.2021

Accepted: 02.03.2021

Published: 05.07.2021

tem to caries affected dentinal surface after chemomechanical caries removal.

MATERIALS AND METHOD

Forty extracted non-restored human maxillary and mandibular molars having carious lesion on occlusal surfaces extending midway between dentin enamel junction and pulp seen in radiograph were selected. Each tooth was embedded in self-cure resin just below cemento-enamel junction in standardized moulds. The enamel and dentin from each tooth were removed by abrading the occlusal surface with 600 grit silicon carbide papers until a flat surface was developed near the excavated carious lesion. Samples were divided into two main groups of 20 teeth each according to the type of caries removal method.

Group I: Caries removal by the conventional method

Group II: Caries removal by chemomechanical method (using Carie Care)

It consists of papaya extract (papain) 100 mg, clove oil 2 mg, coloured gel (blue), chloramines, sodium chloride, and sodium methylparaben.

Each group was further subdivided into two subgroups of 10 teeth each according to the type of adhesive used.

Subgroup IA: Restored using the total-etch technique

Subgroup IB: Restored using self etch technique

Subgroup IIA: Restored using the total-etch technique

Subgroup IIB: Restored using self etch technique

Group I was treated with the conventional method, caries was removed using diamond points in a slow-speed hand-piece.

In group II chemomechanical caries excavation was done using Carie Care gel. The carie-Care gel was applied to the carious surface and left undisturbed for 1 min. When the gel turned cloudy, it was removed with a spoon excavator and then the fresh gel was applied.

This was repeated till the gel turned clear; caries removal was complete when the dentin was hard on probing.

Groups IA and Group IIA: Dentin surfaces were etched with 37% phosphoric acid 15 s, rinsed with distilled water, and the excess was removed with absorbent paper.

Total etch adhesive was applied to all prepared areas of specimens with applicator tip and light-cured together with the adhesive for 20 seconds.

Standardised cylindrical mould was placed on the occlusal surface of each specimen and composite resin was placed in two increments to have a final build-up of 3mm in diameter and 4 mm in height. Each increment was light-cured for 20 seconds using quartz halogen activation light.

The teeth with composite build-ups were stored in water in the incubator at 37°C for 7 days.

Group IB and Group II B: Cavity surfaces were treated with self etch adhesive according to manufacturer's instructions followed by restoration as done in group I.

The teeth with composite build-ups were stored in water in the incubator at 37°C for 7 days before testing.

For shear bond strength testing, the loading was conducted in a universal testing machine at a cross-head speed of 0.5 mm/min until failure. The force was applied at the interface between dentin and adhesive. The force necessary for separating the sample was divided by the cross-sectional bonding area to obtain SBS in MPa.

The SBS values were calculated for each specimen using the formula:

$$\text{Shear bond strength (MPa)} = \frac{\text{Shear force (N)}}{\text{Cross-sectional area (mm}^2\text{)}}$$

The values thus obtained were tabulated and subjected to statistical analysis using an unpaired or independent t-test to compare the mean shear bond strength between the groups.

RESULT

Table 1: Intergroup comparison revealed that the chemomechanical group showed slightly higher shear bond strength values than the conventional group in both totals etch and self-etch subgroups, the difference between them was not statistically significant.

Group	Mean±S.D.(MPa)	p- value
I A	18.05±1.29	0.117
II A	18.95±1.15	
I B	10.69±1.48	0.800
IIB	10.86±1.48	

SD, standard deviation; MPa, MegaPascal

Table 2: Intragroup comparison revealed that the highest shear bond strength value was seen in the total-etch group as compared to self etch in both conventional and chemomechanical method.

Group	Mean $\pm$ S.D. (MPa)	p-value
I A	18.05 $\pm$ 1.29	< 0.001
I B	10.69 $\pm$ 1.48	
IIA	18.95 $\pm$ 1.15	< 0.001
IIB	10.86 $\pm$ 1.48	

SD, standard deviation; MPa, MegaPascal

DISCUSSION

Chemomechanical caries removal has been developed as a substitute to the conventional method of removing caries and it works on the principle to chemically modify the carious tooth to soften it; which eases its removal. In Chemo mechanical method, chlorination of slightly deteriorated collagen in carious dentine occurs that disrupts hydrogen bonding which aids in caries removal.^{10,11}

Enamel predominantly contains inorganic material thus bonding to enamel is easy as compared to dentin.¹² Dentine bonding system provides a retentive phase between the hydrophobic resin restoration and relatively hydrophilic dentine along with enamel. Previous studies have compared the effect of various adhesives on the bond strength of dentin but few studies have evaluated the effect of the chemomechanical method on caries affected dentine. Therefore, the present study was done to evaluate the shear bond strength of adhesive systems (total-etch and self-etch) to caries-affected dentine that is treated with the chemomechanical and conventional method.

In the present study, Group I was treated by the conventional method, in which caries was removed using diamond points. In group II chemomechanical caries excavation was done using Carie Care gel. Group I and II were further divided into I A, IB and II A, II B depending upon the type of adhesive used for bonding. In Groups IA and Group IIA total-etch adhesive (Single bond 2), was applied while in Group IB and Group II B cavity surfaces was treated with self etch adhesive (single bond universal) followed by restoration and shear bond strength was calculated which helps to evaluate the adhesion of dental adhesives.¹³

Intergroup comparison revealed that the chemomechanical group showed slightly more shear bond strength values than the conventional group in both totals etch and self etch subgroups, the difference was not statistically significant. This might be since papain based chemomechanical caries removal removes the smear layer because of the proteolytic property thus patent dentinal tubules are left behind.^{14,15} This enhances bonding by helping in the infiltration of adhesive

resin into intertubular dentine and patent dentinal tubules.⁶ A rough dentine surface having micro-irregularities is generated with the chemomechanical method which improves the adhesion of restorative materials.^{16,17}

Adebayo et al.¹⁸ also reported that when the adhesive resin is used with a scrubbing action resin penetration into dentin was improved. This may be the reason for the non-significant difference between the chemomechanical and conventional caries excavated groups in the present study.

Bernasconi et al.¹⁹ showed that Papacarie results in superficial destruction of collagen fibrils and hybrid layer formation at the dentin resin interface may be the reason for better bond strength.

Schutzbank et al.²⁰ showed that surface irregularities improved micromechanical interlocking after using the chemomechanical method. However, Zawaideh et al.²¹ showed that chemomechanical method did not affect the bond strength. Similar results were shown by Cehreli et al.²² and Chittum et al.²³ where there was no difference in the mode of caries removal to bond strength.

The intragroup comparison showed that the highest shear bond strength value was seen in the total-etch group as compared to self etch in both conventional and chemomechanical method. In total-etch adhesives, when phosphoric acid is applied before the adhesive results in smear layer removal and demineralizes the dentin which causes exposure of collagen fibrils. This collagen might yield reactive groups that would be able to chemically interact with bonding primers.²⁴⁻²⁷

In the total-etch system, complete removal of the chemomechanical agent after acid-etching and water rinsing is expected believed to take place. But in the self-etching system, the absence of the rinsing step results in remnants of the gel on the dentin surface and might interfere with the bonding mechanism.²⁸

Our study demonstrates that the caries removal method did not lead to significant differences in the shear bond strength. Total etch adhesive system led to higher bond strength as compared to self etch adhesive system. Further investigations simulating the clinical conditions should be carried out to validate the findings of the present study.

CONCLUSION

Within the limitations of this study, the chemomechanical group showed slightly higher shear bond strength values than the conventional group in both total-etch and self etch subgroups, the difference between them was not statistically significant. Also, total-etch adhesive showed better bond strength than self etch adhesives.

ACKNOWLEDGEMENT

Authors acknowledge the immense help received from the scholars whose articles are cited and included in references of this manuscript. The authors are also grateful to authors/editors/publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

Source of Funding: Nil

Conflict of Interest: Nil

Author's Contribution: Dr Mohit Kumar (Study design, Preparation of manuscript)

Dr Shubhra Malik (Sample preparation and Conduct of Study)

REFERENCES

- Karaarslan ES, Yildiz E, Cebe MA, Yegin Z, Ozturk B. Evaluation of micro-tensile bond strength of caries-affected dentine after three different caries removal techniques. *J Dent*. 2012; 40(10):793-801.
- Khattab NMA, Omar OM. Papain-based gel for chemo-mechanical caries removal: influence on microleakage and micro shear bond strength of esthetic restorative materials. *J Am Sci*. 2012;8(3):391-9.
- Mohammed TI, Salih SA. The effect of chemomechanical caries removal and different bonding systems on shear bond strength of carious dentin (In vitro study). *Mustansiria Dent J*. 2011;8(2):115-26.
- Viral PM, Nagarathna C, Shakuntala BS. Chemomechanical caries removal in primary molars: Evaluation of marginal leakage and shear bond strength in bonded restorations-An in vitro study. *J Clin Pediatr Dent*. 2013;37(3):269-74.
- Ramamoorthi S, Nivedhitha MS, Vanajassun PP. Effect of two different chemomechanical caries removal agents on dentin microhardness: An in vitro study. *J Conserv Dent*. 2013;16(5):429-33.
- Hamama HHH, Yiu CKY, Burrow MF, King NM. Chemical, morphological and microhardness changes of dentine after chemomechanical caries removal. *Aust Dent J*. 2013;58(3):283-92.
- Hamama HHH, Yiu CKY, Burrow MF. Effect of chemomechanical caries removal on the bonding of self-etching adhesives to caries-affected dentin. *J Adhes Dent*. 2014;16(6):507-16.
- Dinesh DS. Comparative evaluation of shear bond strength of a self etch adhesive system and total-etch adhesive system to normal human permanent dentin with and without carisolv treatment. *Pak Oral Dental J*. 2011;31(2):443-6.
- Aggarwal V, Singla M, Yadav S, Yadav H. The effect of caries excavation methods on the bond strength of etch-and-rinse and self-etch adhesives to caries affected dentine. *Aust Dent J*. 2013;58(4):454-60.
- Hamama H, Yiu C, Burrow M. Current update of chemomechanical caries removal methods. *Aust Dent J*. 2014;59(4):446-56.
- Venkataraghavan K et al. Chemomechanical Caries Removal: A Review & Study of an Indigenously Developed Agent (Carie Care™ Gel) In Children. *J Int Oral Health*. 2013;5(4):84-90.
- Santos RA, Lima EA, Pontes MMA, Nascimento ABL, Montes MAJR, Braz R. Bond strength to dentin of total-etch and self-etch adhesive systems. *Rev Gaúch Odontol, Porto Alegre*. 2014;62(4):365-70.
- Hegde MN, Bhandary S. An evaluation and comparison of shear bond strength of composite resin to dentin, using newer bonding agents. *J Conserv Dent*. 2008;11:71-5.
- Amaral FLB, Martao Florio F, Ambrosano GMB, Basting RT. Morphology and micro tensile bond strength of adhesive systems to in situ-formed caries-affected dentin after the use of a papain-based chemomechanical gel method. *Am J Dent*. 2011;24(1):13-9.
- Ahmed AA, Godoy FG, Kunzelmann KH. Self-limiting caries therapy with proteolytic agents. *Am J Dent*. 2008;21:303-312.
- Banerjee A, Kellow S, Mannocci F, Cook RJ, Watson TF. An in vitro evaluation of microtensile bond strengths of two adhesive bonding agents to residual dentine after caries removal using three excavation techniques. *J Dent*. 2010;38:480-489.
- Hossain M, Nakamura Y, Tamaki Y, Yamada Y, Jayawardena JA, Matsumoto K et al. Dentinal composition and Knoop hardness measurements of cavity floor following carious dentin removal with Carisolv. *Oper Dent*. 2003;28:346-351.
- Adebayo OA, Burrow MF, Tyas MJ, Palamara J. Effect of tooth surface preparation on the bonding of self-etching primer adhesives. *Oper Dent*. 2012;37(2):137-49.
- Bertassoni LE, Marshall GW. Papain-gel Degrades Intact Non-mineralized Type I Collagen Fibrils. *J Scan* 2009;31(6):253-8.
- Schutzbank SG, Galaini J, Kronman J, Goldman M, Clark REA. Comparative in vitro study of GK-101 and GK-101E in caries removal. *J Dent Res*. 1978; 57:861-4.
- Zawaideh F, Palamara JE, Messer LB. Bonding of resin composite to caries affected dentin after Carisolv treatment. *Pediatr Dent*. 2011;33(3):213-20.
- Cehreli ZC, Yazici AR, Akca T, Ozgünlaltay G. A morphological and micro-tensile bond strength evaluation of a single-bottle adhesive to caries-affected human dentine after four different caries removal techniques. *J Dent*. 2003;31(6):429-35.
- Chittem J, Sajjan GS, Varma KM. Comparative evaluation of micro shear bond strength of caries affected dentinal surface treated with conventional method and chemomechanical method. *J Conserv Dent*. 2015;18(5):369-73.
- De Goes MF, Pachane GCF, Garcia-Godoy F. Resin bond strength with different methods to remove excess water from the dentin. *Am J Dent*. 1997;10(6):298-301.
- Nakabayashi N, Sami Y. Bonding to intact dentin. *J Dent Res*. 1996;75(9):1706-15.
- Prati C, Chersoni S, Mongiorgi R, Pashley DH. Resin-infiltrated dentin layer formation of new bonding systems. *Oper Dent*. 1998;23(4):185-94.
- Inokoshi S, Hosoda H. Interfacial structure between dentin and seven dentin bonding systems revealed using argon ion beam etching. *Oper Dent*. 1993;18:121-5.
- Piva E, Ogliari FA, de Moraes RR et al. Papain-based gel for biochemical caries removal: influence on microtensile bond strength to dentin. *Braz Oral Res*. 2008;22(4):364-70.