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Original Research

Evaluation Of Micro Tensile Bond Strength of Self Etch Universal Adhesive On the Caries Affected Human Dentin After Using Diamond Abrasives, Carbide Burs, Smart Burs And A Chemo mechanical Agent - Brix3000 As Caries Removal Approaches

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ABSTRACT:
Background: This study was conducted to evaluate and compare in vitro, the bond strength of a universal adhesive on differently prepared carious human dentin using a Universal testing machine. **Material and methods**: Freshly extracted human molar teeth from the Department of Oral and Maxillofacial Surgery, GDC, Srinagar, were used as the study sample. The total number of extracted teeth used for the study were Forty Eight. **Results**: As per table no.1, mean value tensile bond strength of group 2(carbide bur group) showed highest micro followed by group 4(Brix 3000 group), group 3 (smart bur bur) and least mean value recorded for group 1 (Diamond bur group). **Conclusion**: micro tensile bond strength, self-etch adhesive, caries, diamond abrasives, carbide burs, caries removal.
Keywords: Tensile Bond, Strength

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INTRODUCTION

Dental caries is an infectious disease that damages the structure of teeth. Currently its one of the most common diseases throughout the world. (1) Disease prevention is ultimate goal in restorative dentistry. (2) Ideally, caries removal should be accomplished with minimal patient discomfort during and after restorative procedure. (3) Fusayama`s research demonstrated that carious dentin consists of two distinct layers: an outer layer of bacterially infected dentin and an inner layer of affected dentin (4). The superficial layer of carious infected dentin is grossly denatured and is a poor substrate for adhesion of restorative materials. (5) The underlying layer of partially demineralised caries affected dentin contains dentinal tubules that are usually filled with white lockite crystals, rendering it highly impermeable to dentinal fluid transudation or the creation of rapid fluid shifts that may stimulate the underlying A delta nerve fibres and cause post operative sensitivity.(6) Since the caries affected dentin contains intact under natured collagen fibrils and is amenable to remineralization(7) ,there is a general consensus for this layer to be preserved during caries excavation(8) .

Caries is generally removed by rotary burs at slow speed. The conventional method of caries removal include spoon excavator, stainless steel round burs, diamond burs, tungsten carbide burs in slow speed. Diamond and carbide burs are most commonly used for cavity cutting. Carbide burs are better for cutting as they produce lower heat and have more blade edges. Diamond rotary instruments have higher hardness and excellent cutting effectiveness. (9) Since diamond and tungsten carbide burs are indiscriminate in their removal of carious lesions. They can remove caries infected and caries affected dentin simultaneously, with possible extension into the underlying sound dentin. This indiscriminate cutting action may even lead to iatrogenic pulpal exposures and associated sequelae. Besides this, greater heat generation and vibration results in patient discomfort, thus

necessitating the application of local analgesia during treatment. (10) Thus keeping this into consideration, Minimally Invasive Dentistry (MIC) is apparently the safer approach in management of dental caries. One such approach is a self-limiting concept in mechanical caries removal has been brought to fruition by the introduction of a polymer bur. (11) The paddle shaped bur has a unique flute design and is constructed from medical grade polyether ketone-ketone (PEKK) (12). Hardness of smart burs is 50KHN which is higher than that of infected dentin(15-20KHN) but less than that of healthy dentin (68KHN), which allow selective removal of infected dentin, leaving behind the affected dentin intact. These burs are used exclusively at low speed (500-800RPM), the bur quickly dulls and vibrates when it encounters the more highly calcified caries affected dentin. (13) Another such minimal invasive concept of caries removal is via chemical method. In 2003, an agent extracted from papaya peel called as papacarie was introduced. One of its components was papain, an enzyme similar to human pepsin. This enzyme breaks down denatured collagen fibres, allowing easy removal with handpiece. However, it too had some drawbacks like higher cytotoxicity and more time consuming.

More recently in 2016 (in Latin America), a new product, papain-based agent, Brix 3000 was introduced in the market. According to manufacturers, due to encapsulation and higher concentration, this product is able to remove compromised tissue more easily and without causing damage or pulp cytogenicity. (14)(15) Preparing dentin with different techniques creates quantitatively and qualitatively different smear layer. (16)(17) Smear layer formed by smart burs is thicker than that might affect the penetration of bonding agent, whereas no or little smear layer is expected to be formed from chemo mechanical agents. Therefore, information on effects of preparation method on resin dentin adhesion is highly clinically relevant. The strength of adhesion to dentin depends upon both the adhesive systems used and type of dentin remaining after excavation. Traditionally, total etch adhesives systems were used. However, this apparently results in creation of deeper layer of demineralized dentin after acid conditioning with 35% phosphoric acid. On the other hand, Self-etch adhesives which are being used increasingly nowadays, do not require a separate acid-etch step and do not remove the smear layer. (18)(19)They are composed of aqueous mixtures of acidic functional monomers , generally phosphoric acid esters with a ph relatively higher than phosphoric acid etching gels.(20) Self etch adhesive systems are less aggressive and partially demineralise the smear layer and incorporate its remnants into hybrid layer. A smear layer that is not completely resolved or removed, partly integrates into hybrid layer. (21)

The current self-etch adhesive systems are classified based on the number of clinical application steps: one step or two step adhesives.(22) Two step self-etch adhesives include the use of hydrophilic etching primers , which combine acidic monomers that simultaneously etch and prime tooth structure(23)(24) and after solvent evaporation , a layer of hydrophobic bonding agent seal the dentin.(25) One step self-etch adhesive systems are all in one adhesives which combine the etching , priming and bonding (26) , thus containing acidic functional monomers , water and organic solvents into a single solution.(27) The bonding of self-etch adhesives has been intensely investigated and two fold bonding mechanisms; micromechanical interlocking and chemical bonding were described , which seem to be advantageous in terms of restoration durability. The micromechanical bonding contributes to provide strength against mechanical stress, while the chemical interaction reduces the hydrolytic degradation, keeping the marginal seal for a longer duration. (26)

In this ongoing quest for clinical step reduction , in 2010 there came into the picture a one-step self-etch adhesive systems called as “Universal or Multimode Adhesives” , which can be applied in etched or unetched enamel or dentin .These bonding agents are also indicated to be used as silane for glass ceramics and primers for metal alloys and poly crystalline ceramics.(28)(29) Nowadays, these self- etch universal bonding agents has become very popular , because of their simplification of bonding procedures, reduced risk of post operative sensitivity, reduced technique sensitivity, also a substantial amount of hydroxyapatite remain available within a submicron hybrid layer, encapsulating and protecting collagen. (18)

Although etching aggressiveness of self-etching systems can be used to predict the depth of demineralization of tooth structure and ultra structure and thickness of hybrid layer, it can be co related to bond strength obtained on enamel and dentin. Several laboratory tests are commonly used to evaluate the bonding performance of adhesives such as micro tensile and micro shear. (30)(31) The micro-tensile bond strength test is currently considered as a versatile and standard bond strength testing method. The big advantage of micro-tensile bond strength test is that the research can focus on clinically relevant substrate with 3-D surfaces. (32)

A myriad of research work has been published till date comparing the bond strength of different adhesives and after using different excavation protocols. However, there is a paucity of studies comparing the bond strength of newly introduced universal adhesive on dentin prepared with different methods, especially minimally invasive techniques. And to our knowledge no study about bond strength of universal adhesive on dentin prepared with Brix 3000 has been done yet. Thus, keeping in view these aforementioned facts, we aim our study to compare the micro tensile bond strength of newly introduced universal adhesive in a self-etch mode after preparing the dentin with both conventional as well as minimally invasive techniques.

MATERIALS AND METHOD

The present study was done in the Department of Conservative Dentistry and Endodontics, Government Dental College, Srinagar and in the Department of Mechanical engineering, Institute of Technology, University of Kashmir, Zakura Campus, Srinagar.

Source of data:

Freshly extracted human molar teeth from the Department of Oral and Maxillofacial Surgery, GDC, Srinagar, were used as the study sample.

The total number of extracted teeth used for the study were Fourty Eight.

Study samples were selected on the basis of following:

Inclusion criteria:

1.Permanent molars with simple occlusal caries extending into dentin, with cavity opening diameter ≥ 2mm.
2.Teeth extracted due to poor periodontal health.

Exclusion criteria:

1. Grossly decayed teeth
2. Teeth with multiple carious lesions.
3. Teeth with developmental anomalies
4. Teeth involving pulpal and periapical pathology
5. Teeth with crown fractures.
6. Hypoplastic and hypomineralised teeth.
7. Presence of white spots.
8. Teeth with restorations

ARMAMENTARIUM

1.Diamond disc for sectioning
2.Contra angled handpiece (NSK, Japan)
3.Round diamond abrasive (DS White diamond burs Br Series)
4.Smart burs (SS White smart bur)
5.Brix3000 (Latin America)
6.Spoon excavator (GDC)
7.Tungstan carbide bur (SS White carbide bur Hp series)
8.Digital calliper (Mitutoyo, Japan)
9.Ivoclar tetric N-bond universal
10.Ivoclar tetric N- ceram
11.Cyanoacrylate glue (Loctite super glue)
12.Microtensile testing machine (Indosaw)

METHODOLOGY:

SAMPLE PREPARATION:

The selected teeth were stored in normal saline in a for no longer than four weeks after extraction as per ISO/ TS11405. Any soft tissue or calculi debris was removed using an ultrasonic scaler. Enamel and superficial dentin of the crown were flattened perpendicular to the long axis of the tooth with a diamond disc under water cooling, therefore exposing a flat dentin surface. After that specimens were washed with water.

EXPERIMENTAL GROUPS: The teeth were randomly divided into four groups according to caries removal technique used.

GROUP 1:

Consisted of 12 teeth, in which carious lesion was removed using high speed handpiece (320,000-350,000 rpm) under cooling system with a round diamond abrasive (DSWhite diamond burs Br Series). A new bur was used for every pair of specimen. The cavity was rinsed with water and wiped with sterile cotton pellet.

GROUP 2:

Consisted of 12 teeth in which caries was removed using a high speed handpiece (320,000-350,000 rpm) under cooling system with Tungstan carbide bur (SS White carbide bur Hp series). A new bur was used for every pair of specimen. The cavity was rinsed with water and wiped with sterile cotton pellet.

GROUP 3:

Consisted of 12 teeth in which caries was removed using water cooled slow speed handpiece (500-800rpm) with SmartPrep SS White smart bur in a light, discrete strokes that were directed from center of the lesion outward. A new bur was used for every specimen.

GROUP 4:

Consisted of 12 teeth in which caries was removed using a chemo mechanical technique.in which a newly introduced papain based agent (Brix 3000) was used. The carious tooth surface was covered with Brix 3000 gel for 2 minutes and then the carious dentin was gently scraped away with a spoon excavator in a gentle scrapping motion to remove the softened carious lesion. Finally the gel was removed with water soaked cotton pellet. Gel was applied again until all the carious lesion was removed as confirmed by the tactile method of carious detection.

After caries removal in all the groups , Tetric N bond Universal adhesive was applied and light cured as per the manufacturers instructions. After application of adhesive , Tetric N Ceram composite resin was applied incrementally with 1.5mm layers and built up to the height of 6mm.

MICROTENSILE TEST:

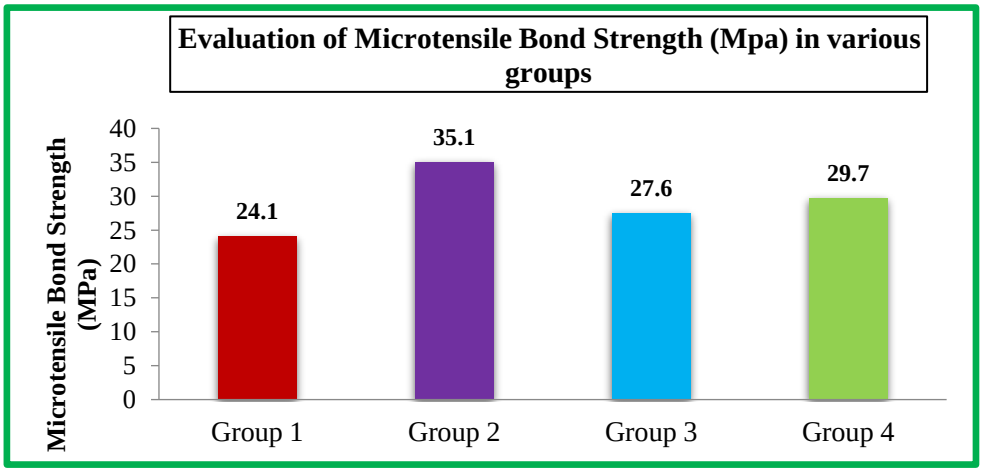
After immersion in water at 37 degrees for 24 hours, the restored teeth were vertically sectioned both mesio-distally and bucco-lingually along the long axis of tooth using slow speed diamond disc. From 2-3 vertical sections approximately 1mm in thickness were made .These slices were trimmed and shaped by means of super fine diamond burs into a gentle curve along the adhesive interface to form a square cross section of approximately 1mm wide at its narrowest portion (trimming technique). The surface area for bonding was measured by measuring the width of the narrowest portion with digital callipers. These specimens were then attached one by one to the micro tensile testing attachment of universal testing machine (Indosaw) using cyanoacrylate glue (Loctite super glue) for tensile testing at a crosshead speed of 1mm per minute , and underwent tensile force until fracture. The bond strength was recorded in MPa.

Results

Table 1: Evaluation of Microtensile Bond Strength (Mpa) in various groups

Group	Mean	SD	Range	95% CI
Group 1	24.1	2.513	19.4-28.9	22.5-25.7
Group 2	35.1	2.455	30.2-38.3	33.5-36.6
Group 3	27.6	3.546	23.3-32.5	25.4-29.9
Group 4	29.7	2.532	24.7-32.5	28.1-31.3

As per table no.1, mean value tensile bond strength of group 2(carbide bur group) showed highest micro followed by group 4(Brix 3000 group), group 3 (smart bur bur) and least mean value recorded for group 1 (Diamond bur group).

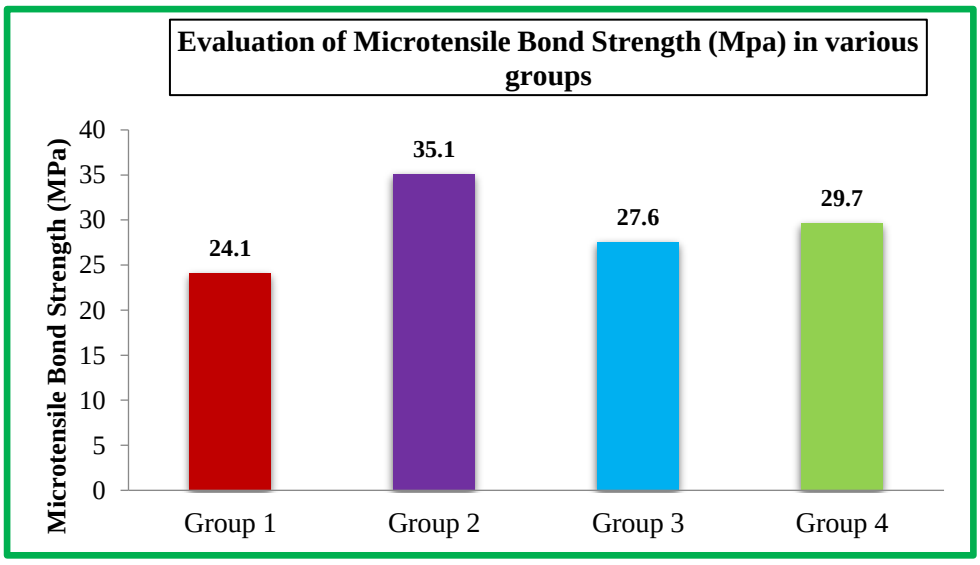


Graphical representation of Micro tensile bond strength in MPa in four groups.

Table 2: Intergroup comparison based on Micro tensile Bond Strength (Mpa) among various groups

Group comparison	Mean difference	P-value	Significance
1 vs 2	-11.0	<0.001	Significant
1 vs 3	-3.6	0.003	Significant
1 vs 4	-5.6	<0.001	Significant
2 vs 3	7.4	<0.001	Significant
2 vs 4	5.4	<0.001	Significant
3 vs 4	-2.0	0.085	Not significant

Table no. 2 represents the significant difference in micro tensile bond strength values between diamond bur group and other three groups, with diamond having the least value recorded. while as there was no statistical significant difference between smart bur and Brix 3000 group.



Graphical representation of Micro tensile bond strength in MPa in four groups.

DISCUSSION

Dentin is a biological composite that envelops collagen. Dentin is different from enamel as it is intrinsically humid and less hard than enamel, with low energy surfaces and low intermolecular forces. Enamel, by virtue of its high inorganic content, acts as a good substrate for bonding. In contrast, dentine has less mineralized tooth structure with the presence of dentinal fluid.[33,34] Altogether, making dentin a challenging substrate for resin bonding.

Over the years , many resin adhesive systems and types have been developed to achieve a durable bond to dental tissues. Dental adhesives have evolved from no etch to total etch (4th and 5th generation) to self etch (6th, 7th and

8th generation) systems. Each generation has attempted to reduce the number of clinical steps , to provide faster application techniques and to offer improved chemistry to facilitate stronger bonding.
The self etch adhesive do not require the separate acid conditioning step. A self-etching adhesive is composed of non-rinse acidic monomers that have an affinity for hydroxyapatite (e.g. 10-methacryloyloxydecyl dihydrogen phosphate or phenyp-p).[22] which condition and prime enamel and dentin simultaneously. This system dissolves a smear layer and partially demineralizes the underlying dentin surface[35]. The simplified self-etch adhesives do not completely decalcify the substrate unlike the traditional total etch. They bond by an ionic interaction, termed as 'adhesion-decalcification' concept by Van Meerbeek et al.[22] The bonding of self etch adhesives occurs by two fold bonding mechanisms i.e.,micro mechanical interlocking and chemical bonding , which seem to be advantageous in terms of restoration durability. Depending upon the acid dissociation constants (pka values), the etching aggressiveness of self etch adhesives systems can be classified into:"strong"(ph<1), "intermediately strong" (ph=1.5) ,"mild" (ph=2) and "ultra-mild" (ph≥2.5).[18] Even though adhesive systems have been significantly improved, the bonded interface remains the weakest area of resinous restorations[36] . The hydrophilic nature of self-etch adhesive systems is considered to be responsible for the poor clinical performance, these systems are more prone to water sorption, hydrolytic breakdown and loss of the structural integrity at the resin-dentin bonding interface[37]
In 2010, voco America introduced 8th generation bonding agent under the name voco futurabond DC. In these new agents, the addition of nano fillers with the average particle size of 12 nm increases the penetration of resin monomers and increases the hybrid layer thickness which in turn improves the mechanical properties of bonding systems.[38] Such One step self etch adhesive systems called as "Uni versal or Multimode Adhesives" , can be applied in etched or unetched enamel or dentin. In addition,to the monomers that are capable of producing chemical and micromechanical bond adhesion to the dental substrates such as methacryloyloxydecyl dihydrogen phosphate (MDP), the matrix of universal adhesive contains monomers of hydrophilic (hydroxyethyl methacrylate, HEMA), hydrophobic (decandiol dimethacrylite, DDMA) and intermediate (bis-GMA) nature. This combination enables the formation of bridge over the gap between the hydrophilic tooth substrate and hydrophobic resin restorative[39]
For evaluating the bond strength of different adhesive systems, normal dentin as a substrate has been used in majority of studies. These substrates are not necessarily representative of the dentine encountered during many restorative procedures in a clinic. In an actual clinical scenario, the clinician often encounters caries affected dentine, which is mineralized and does not warrant excavation.[40] In response to the carious process, there is deposition of minerals in the dentinal tubules, which may affect the infiltration of resin monomers. Moreover, different caries excavation methods may affect the quality of remaining dentine. The way dentin surface is prepared has an important role on the bond strength and in the stability and reliability of this bond.
Several studies have reported that dentin surface roughness and smear layer thickness vary with the coarseness level of the burs and abrasive papers. Preparing the dentin surface with various instruments (e.g. diamond bur, carbide bur, stainless steel bur, air-driven abrasive particles) creates quantitatively and qualitatively different smear layers.[16][17] Dentin prepared with a diamond bur creates a significantly thicker smear layer than that with the carbide bur.[62] Similar results have been reported in other studies.[41][42] This might be due to the fact that the carbide bur used blades to cut rather than the abrasive cutting of the diamond bur. Blade cutting produces a new surface, and therefore creates less debris[43] the dentin prepared with a diamond bur created a thicker smear layer than that prepared with the carbide bur, thicker smear layers reflected an increased number of close dentinal tubules after self etching primer treatment and also produced fewer and shorter resin tags.[44]
As a safer alternative to traditional dental burs, smart bur was introduced. One study[45] reported normal dentin hardness ranging from about 54 to 65 Knoop Hardness Number {KHN) with softer values closer to the dentino enamel junction and the hardest values located about two millimeters from the dentino enamel junction. Sound dentin had a hardness range of 51 to 62 KHN, varying by depth, while the range of hardness of primary dentin was 30 to 55 KHN. The most superficial layers of carious permanent dentin are less than 20 KHN, and this softness gradually decreases with increasing depth of the lesion until the hardness of unaffected dentin under the lesion is reached at about 60 KHN .[46] For acute dentin caries in fissures, the hardness of the dentin at the bacterial infection front averaged 6.9 KHN with a range of 4.4 to 11.2 in one study,[47] For chronic lesions, the average was 39.2 KHN with a range of 16.0 to 61.0 IŒN, and for smooth surface lesions, the average was 30.7 with a range of 11.7 to 56.5 KHN. While it appears that there is a range of hardness values for the microbial front among various lesion types, excavation of carious dentin to a KHN range of 5 to 20 would completely remove infected dentin in many lesions and adequately disinfect most chronic lesions. By constructing a mechanical device for dentin caries removal of material much softer than carbide steel, and by providing cutting elements that abrade or deflect upon encountering dentin above a given hardness, cutting efficiency can be controlled so that only the softened and infected carious dentin can be removed. Hardness of smart burs is 50KHN which is higher than that of infected dentin(15-20KHN) but less than that of healthy dentin (68KHN), which allow selective removal of infected dentin, leaving behind the affected dentin intact. These burs are used

exclusively at low speed (500-800RPM), the bur quickly dulls and vibrates when it encounters the more highly calcified caries affected dentin.[13]

The dentin surface prepared by a polymer bur is found to be hard but discolored/pigmented.[48] Use of a polymer/ smart bur does have an affect on dentinal topography. The scanning electron microscope show different topographic characteristics of the dentin surface in smart bur and conventional carbide bur prepared dentin. The dentin surface prepared with smart bur shows irregular globular surface almost completely covered by smear layer. However dentin surface prepared with conventional carbide bur show an irregular surface with almost complete removal of smear layer.[49] Patent dentinal tubules are occasionally present in polymer bur prepared dentin when observed under TEM.[48]. Clinically, a greater amount of residual caries below the compact smear layer on the cavity walls has been described when using polymer burs compared to that obtained with carbide burs by Meller et al., 2007. Tubules, within dentin surfaces following caries removal with polymer burs, were found to be collapsed with the specific smear plugs, and collagen fibrils were grossly deranged into microfibrillar components as per Silva et al., 2006[48]

Another safer option for caries removal is by using a chemo mechanical agent mainly papain based gels. Papain similar to human pepsin makes it easy to clean necrotic tissues and secretions and reduces tissue repair time in addition to not affecting sound tissues close to lesion. It does not harm healthy tissue and accelerates tissue healing. It acts only on carious tissue, which lacks the plasmatic protease inhibitor alpha-1-antitrypsin; its proteolytic action is inhibited on healthy tissue, which contains this substance.

Various studies that have been previously done for evaluating the morphological changes of dentin following chemo mechanical agent, has reported that excavated surface following papain based agent was rough and characterised by total absence of smear layer with mostly patent dentinal tubules.[50] Caries removal with these agents does not produce smear layer, resulting in greater opening of the dentinal tubules, which optimizes the penetration of the adhesive systems[51]. However, its speculated that the papain based gel could interfere with the micromorphology of collagen fibrils thus leading to cleavage of polypeptide chains and hydrolysis of collagen cross linkages. These cross linkages give stability to collagen fibrils, which become weaker and thus more prone to be removed when exposed to the gel.[52] As the self-etching system lacks the rinsing step and thus the smear layer is not removed but only partially demineralized, remnants of the gel could be stagnated on the dentin surface, and could potentially interfere with the bonding mechanism. In fact, under SEM examination of gel-excavated dentin, Banerjee et al.2 (2000) described the presence of surface globules, which could be linked to remnants of the gel that had not been washed away.

Thus, different caries excavation methods can differently influence the dentinal topographic characteristics like surface roughness , thickness of smear layer formed, patency of dentinal tubules , which in turn have an impact the bonding with self etch adhesives.[53] Thus keeping in view these facts that preparation of dentin has an impact on the bond strength of resin adhesive, so here is an attempt of trying out the various caries removal approaches in this study like diamond abrasive , carbide bur , smart bur and a newly introduced papain based chemo mechanical agent, Brix3000 . Brix3000 contains a high concentration of papain (3000U/mg) by Brix medical science Argentina. Caries treatment involve an enzymatic activity, in which papain is bioencapsulated by EBE technology (Encapsulated Buffer Emulsion), that immobilises and confers the stability, which increases enzymatic activity of final product.(14)(15) Each 100 ml topical gel contains: Papain 30,000 U / mg 10 g, Excipients (Propylene Glycol, Citric Pectin, Triethanolamine, Sorbitan Monolaurate, Disodium Phosphate, Monopotasic Phosphate, Toluidine Blue, Distilled Water q.s. 100 ml).

After excavation using these different tools, we sought to figure out their influence on the bond strength of currently in demand eight generation universal adhesive. There are a numerous studies available in the literature regarding the comparison of bond strength of various self etch adhesives using different excavation protocols but that about these newly introduced universal adhesives is only limited to few. Hence using scarcely investigated, universal adhesive , namely**, Tetric N bond Universal** by Ivoclar with the ph of 2.5- 3 (ultra mild). Its composed of BisGMA (25-50%), water and ethanol , 2-hydroxyethyl methacrylate (HEMA) , phosphonic acid methacrylate(MDP) , diphenyltrimethylbenzoyl phosphonic oxide The high content of HEMA seems to improve the performance of the Tetric N-Bond when applied in the self-etch mode by improving the penetration of the bonding system into the self-etched dentin structure.[54]

When the components at bonding area , such as filling material , bonding resin , hybrid layer and underlying dentin are bonded and connected strongly enough to each other the bond strength is determined by the mechanical strength of component. The weakest part should be fractured during the test. In this context , evaluation of mechanical strength of interfacial components is considered to correlate with the bond strength.[55] The microtensile test offers versatility that cannot be achieved by conventional methods like micro shear bond tests. Its labor intensive than conventional testing, but holds great potential for providing insight into the strength of adhesion of restorative materials to clinically relevant sites and substrates.[56] Thus keeping in view these facts, we chose micro tensile testing method using Universal Testing Machine for evaluating the bond strength of aforementioned adhesive on carious teeth that were grouped on the basis of excavation method ie.,

Group 1: Diamond abrasive;

Group 2: Carbide bur
Group 3: Smart bur
Group 4: Brix 3000
Upon obtaining the data in all the groups, micro tensile bond strength found in different groups could be arranged in the following descending order:
Group 2(carbide Bur)> **Group 4**(Brix 3000)> **Group 3**(Smart bur)> **Group 1**(Diamond abrasive) , as given in Table 1.
As in agreement with the previous studies ,such as the study by Barros et al[57], in 2005, on the effect of the type of bur and conditioner on dentin surface, showed that surfaces prepared with carbide burs had less smear plugs than those prepared with diamond burs and results showed that carbide burs leave a surface that is more conducive to bonding than diamond bur. Also in another study by Walter et al[58], surface preparation using a carbide bur generally yielded higher bond strengths than preparation using either a diamond rotary instrument or SiC abrasive paper. Likewise, in another study by Yiu CK et al[59], higher bond strengths was achieved with SE bond when applied on dentin surfaces prepared with tungsten carbide burs as compared with diamond burs. As per Ogata et al[60], when cutting dentin, selecting the adequate bur type is important for improved bonding of adhesive systems using self-etching primer to dentin. With carbide cutting bur yielded highest bond strength and diamond abrasive cutting yielded lowest bond strength. As per N Silva et al[49] the polymer bur surface exhibited significantly lower bond strengths than the carbide bur . As per N Toledano et al[61] ,bond strength of carbide bur was higher than smart bur group as polymer burs created a thick smear layer that was not infiltrated by tested self-etching agents . As per study done by Evandro Piva et al (2008)[62] ,papain based gel excavated samples had significantly lower bond strength as compared to conventional carbide bur excavated samples , which could be speculated that the papain-based gel could interfere with the micromorphology of the collagen fibrils.
These studies are in agreement with the findings of this study, showing that the outcome of our study was in favour with the carbide bur i.e, the bond strength testing was recorded significantly higher in carbide bur group than other groups. Which may clearly be elucidated from previous studies that because of homogeneously less debris covered and relatively smooth dentin substrate created by carbide burs. Followed by brix group and smart bur group in which smear layer formed is believed to be negligible in former and surface completely covered with smear layer with occluded dentinal tubules in later. And as far as diamond bur group is concerned, its bond strength was recorded to be least as compared to others, which is ascertained from previous investigations to be because of thick and compact smear layer and occluded tubules that is not adequately penetrated by self-etch adhesive.

Conclusion

Results obtained in all groups revealed that carbide bur prepared dentin showed highest bond strength compared to others as in agreement with past studies. However, upon comparison with others groups the bond strength of teeth prepared using newly introduced highly efficient in caries removal, chemo mechanical agent Brix 3000 was no different from other papain based chemo mechanical gels used in the similar studies. Thus making Brix 3000, a potential alternative to previously used papian based gels.

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