EFFECT OF ETCHANT SYSTEM ON BOND STRENGTH OF TEETH SUBJECTED TO DESENSITIZING AGENT APPLICATION – AN IN VITRO STUDY

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled **EFFECT OF ETCHANT SYSTEM ON BOND STRENGTH OF TEETH SUBJECTED TO DESENSITIZING AGENT APPLICATION – AN IN VITRO STUDY** is a bonafide and genuine research work carried out by me under the guidance of **Dr.I.Anand Sherwood, M.D.S., Ph.D., Professor and Head of the Department** of Conservative Dentistry and Endodontics, CSI college of dental sciences and research, Madurai.

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INTRODUCTION

INTRODUCTION

Dentin sensitivity is one of the common problems that affects adults and is a painful condition that affects 10% to 20% of the population. Dentin sensitivity or cervical dentinal sensitivity has been defined as a short and sharp pain arising from exposed dentin, typically in response to chemical, thermal, tactile or osmotic stimuli, which cannot be explained as a result of other forms of dental lesions or pathology(1).

The most common cause of dentin sensitivity is abrasion which occurs in the cervical region. It can result due to the abrasiveness of tooth paste , pressure of brushing and the quality of toothbrush. Many stimuli that are known to cause pain on the dentin surface causes the displacement of fluids inside the tubules, that is responsible for the increase in the mechanical stimulation of the nerve fibers in the dentin, the A-fibers of the pulp wall(2). Various theories are there on dentin hypersensitivity. The hydrodynamic theory has been widely accepted. It is a displacement of the tubular contents such as fluids, that might produce deformation of nerve fibers in the pulp despite the absence of nerve fibers in the dentin tubules(2). Thus, products that occlude dentin tubules to any extent can significantly reduce the fluid filtration across dentin and cause dentinal sensitivity(3). Consequently, it can be assumed that if the functional radius of open dentinal tubules reduces, the permeability would also decrease, thus reducing dentinal sensitivity(4).

The diagnosis of dentinal hypersensitivity must correlate the data of anamnesis with the clinical aspects, so that the clinical situations with similar symptoms can be discarded(5). There are two principal treatment options: either by desensitizing the nerve by making it less responsive to stimulation or to plug the dentinal tubules thus preventing fluid flow (6). Treatment modalities for dentin hypersensitivity include neural stimulus blockers, analgesics , protein precipitants, dentin adhesives, restorations ,pulpotomy ,tubule occluding agents, dentin desensitizers and lasers.

Use of toothpastes and desensitizers are topically used techniques which is common and an effective method to manage dentin hypersensitivity. As a first line approach, these are simple, low of cost and an efficient approach for a majority of patients. Different agents have been used for this purpose, including oxalates, which create tubular obstruction by precipitating fine-grained calcium oxalate crystals, protein-precipitating fixative agents and dentin adhesives and protein-precipitating fixative agents(7,8). The durability of these topical treatments is influenced by many factors. The most common problem is the dissolution of the desensitizer materials by oral fluids and saliva(3,9). In 1991, Kerns, Pashley & Scheidt treated dentinal samples with potassium oxalate, showing only a few remaining crystals after a week in the patient's mouth(10).

A new technology which is commercially known as NOVAMIN was launched as an alternative treatment in the management of hypersensitivity. NovaMin is a trademark name that has been given to bioactive glass (e.g Bioglass) which is ground into a fine particulate material with a median size that is less than 20 microns(11). NovaMin, is a synthetic mineral composed of calcium, phosphorous, sodium and silica that releases crystalline hydroxyl-carbonate apatite (HCA) deposits that are structurally analogous to tooth mineral composition(12). It is a biocompatible material which has osteogenic potential. Gillam *et al* demonstrated that bioglass could occlude the dentinal tubules present. Bioactive glass reacts with the saliva depositing hydroxycarbonate apatite (HCA) in the demineralized collagen fibrils and occludes dentinal tubules. Hydroxycarbonate apatite is composed of elements that are naturally occurring in the body and it reacts to form a mineral layer that is chemically and structurally similar to that of natural tooth material (13). Scanning electron microscope (SEM) examination has shown that the application of bioglass material results in the formation of an apatite layer, which occludes the dentinal tubules(14).

According to *Porto et al*, desensitizers containing glutaraldehyde / HEMA are considered to be the first line treatment choice for dentinal hypersensitivity(15). While glutaraldehyde is a biological fixative that is known to cause coagulation of plasma proteins in the dentin fluid by physically blocking the dentinal tubules(16), HEMA physically blocks the dentinal tubules (17). Morphological and clinical studies with an aqueous solution of 5% glutaraldehyde (GA) and 35% HEMA, Gluma desensitizer have shown peripheral blockage of tubules and significant pain relief on subsequent topical application to hypersensitive dentin(7,8). Moreover, Gluma desensitizer has also been shown to either improve or maintain dentin bond strength(18,19).

Moreover, the application of desensitizing agents has been incorporated, almost as a routine procedure, in most of the adhesive restorative procedures irrespective of the bonding approach(20). Also, one still controversial question exists which concerns the effectiveness of the adhesive procedures after performing desensitizing procedures with agents that obliterate the dentinal tubules (21). It is known that the mechanisms of bonding to dentin differ according to the type of the adhesive system used(22).

In addition to different bonding mechanisms currently available, etch and-rinse and self-etch methods may present a variable effectiveness on the dentin substrates, and there are few reports that the latter are less affected by regional variation in the dentin(23). The former uses 32%-37% etchant containing phosphoric acid prior to infiltration with resin monomers, whereas the latter uses self-etching primers and acidic monomers. While phosphoric acid dissolves the smear layer and opens dentinal tubules for infiltration with resinous monomers, self-etching primers partially dissolves hydroxyapatite crystals, thus modifying the smear layer rather than dissolving it and becoming part of the hybrid layer (24,25). However ,a few studies have reported positive or no effect on the bond strength (26)(27). While others have shown almost negative effect on the bond strength when these desensitizing agents were incorporated into the bonding sequence(5,28). Despite the benefits coupled with their use, the bond performance may be affected, thus compromising the integrity and longevity of the adhesive restorations. Hence, evaluation of the effect on different desensitizing agents' application on bond strength of various adhesive systems is required to understand the benefit-risk ratio associated with when they are combined with different adhesive systems.

AIM AND OBJECTIVES:

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To evaluate the role of etch-and-rinse and self-etch on bond strength of teeth subjected to gluma desensitizer in office desensitizer and Sensodyne repair and protect (Novamin). The secondary objective is to analyze the morphological pattern of the hybrid layer in samples treated with desensitizing agents in scanning electron microscope (SEM) and to check the mode of restoration failure.

REVIEW OF LITERATURE

REVIEW OF LITERATURE:

Kerns *et al* **in 1991** evaluated the occlusion of dentin tubules by different clinical procedures including scaling ; root planing and the application of potassium oxalate. A model was urbanized to evaluate the dentinal surfaces in vivo. About six 2 mm x 3 mm sections were removed from the roots of extracted teeth just immediately below the CEJ. About one half of the treated dentinal samples from each donor were incorporated into the removable denture used by the donor and the other half served as a baseline. The dentinal samples were then evaluated at 1 week by scanning electron microscopy (SEM). At day 0 ,no open dentinal tubules were observed in any of the sample due to the presence of the smear layer and oxalate crystals. Evaluation of root planed samples exposed that by 7 days the dentinal tubules had re-opened. The samples that had been treated with potassium oxalate showed only few oxalate crystals by about 7 days revealing open dentinal tubules. Control samples were then etched with EDTA and evaluated in the similar manner. Although the number of dentinal tubules did not significantly show change in the EDTA etched control samples; the diameter of the tubules were dramatically decreased by 4 weeks. They concluded that the smear layer or application of oxalates to occlude dentinal tubules to reduce dentinal sensitivity are relatively short-lived. These procedures can provide patient comfort prior to natural occlusion of the dentinal tubules(10).

Dondi dall'Orologio *et al* in **1993** investigated the effect of topical application of Gluma 3 Primer and Gluma 2000 conditioning solutions on hypersensitive teeth with lesions like abrasion and erosion. Thirty-four patients were included in this trial with at least two teeth of each presenting severe sensitivity. From a total of 116 teeth that were collected, 40 teeth were treated with Gluma 3 Primer, 42 teeth with Gluma 2000 Conditioner and 34 teeth were served as the control. Sensitivity was recorded as a response to tactile and cold air stimuli prior to the treatment as baseline,and immediately after the topical application of these agents after 1 week, 1 month and 6 months. Both the Gluma groups showed a significantly higher reduction in sensitivity between the baseline and postoperative pain scores and between the postoperative and the 1-week responses ($P < 0.05$). The sensitivity scores obtained were not different between 1 week and 6 months period. In the control group, no pain reduction was seen between the baseline and up to 1-month recall. After 6 months period, the sensitivity was spontaneously slightly reduced. At the end of the 6-month observation time period 29 Gluma and 31 Gluma 2000 treated teeth did not showe dentin sensitivity(7).

Reinhardt *et al* in **1995** determined whether the use of Gluma desensitizer as a desensitizing agent on tooth has any effect on the bond strength of a resin composite restoration that is cemented to dentin. Forty extracted naural human molars which were caries free and restoration-free were reduced occlusally to remove enamel. Twenty teeth received a Gluma desensitization treatment and 20 teeth were untreated (controls). After a 7-day storage period of time, the simulated resin composite inlays were then bonded to all of the dentin specimens used, using either All-Bond 2 along with All-Bond Crown & Bridge Cement or OptiBond along with Porcelite Dual Cure. Twenty-four hours later the procedure, the shear bond strength of the specimens was then determined. Statistical analysis using paired t-tests indicated that there was no significant difference in bond strength for Gluma desensitizer-treated specimens when compared with those to the controls, for either bonding material(17).

Schüpbach *et al* in **1997** evaluated the effect of desensitizing system on dentin using a range of microscopic techniques. 12 non-restored natural human molars extracted for prosthodontic purposes were used. Prior to extraction of the buccal cusps, they were removed in such a way that a 2 mm x 2 mm wide dentin surface was being exposed. The surfaces were then treated in 6 ways: (1). application of Gluma 2 cleanser, Gluma 3 primer to which 0.1% w/v fluorescein was applied and Gluma 4 sealer; (2). as in (1) but treatment with H2O/0.1% w/v fluorescein was done instead of the Gluma 3; (3). as in (1) but without Gluma 2; (4). as in (1) but with the application of 5% glutaraldehyde, instead of Gluma 3; (5). as in (1) but without Gluma 4; (6). as in (1) but with the application of 35% HEMA/0.1% w/v fluorescein, instead of Gluma 3. Following extraction, 1 tooth per group was prepared for confocal laser scanning microscopy. The remaining teeth were then fixed and prepared for TEM and SEM evaluation. In samples of procedures (1) and (5), tubular occlusions could be seen till to a depth of 200 micron. In samples of the procedure (4) tubular occlusions were found just to a depth of about 50 microm. Such occlusions were not seen in the control samples (2), in specimens where smear-layer has not been removed (3), or by following application of HEMA alone (6). It was concluded that glutaraldehyde desensitizer can intrinsically block the dentinal tubules. The septa in the dentinal tubules may counteract the hydrodynamic mechanism for dentinal hypersensitivity(47)**.**

Jain *et al* in **1997** evaluated the effect of four commercially available dentin desensitizing agents on dentinal tubular occlusion, chemical composition changes that occur on the dentin surface, and the role of saliva and tooth brushing on these agents. Fifty dentin discs that were obtained from 50 freshly extracted natural human premolar teeth and molar teeth were used in this study. These were randomly divided into five groups of 10 discs in each group. Five discs from each group were subjected to these desensitizing agents, and were viewed under the SEM and were subjected to energy dispersive X-ray analysis. The rest five discs were treated with these desensitizing agents, and were immersed in artificial saliva, and subjected to simulated toothbrushing which is equivalent to 3 weeks of normal brushing and were viewed under the SEM. The agents that were studied are Sensodyne Dentin Desensitizer, Therma-Trol Desensitizer Gel, Gluma Desensitizer and All-Bond DS. Kruskal-Wallis test followed by Wilcoxon signed-rank test showed that Sensodyne Dentin Desensitizer showed the greatest amount of tubular occlusion among these unbrushed samples, followed by Therma-Trol Desensitizer Gel, Gluma Desensitizer and All-Bond DS ($P < 0.05$) in that order(3).

Soeno K *et al* in **2001** investigated the influence of three dentin desensitizing agents (Gluma CPS, MS Coat and Saforide) on the bond strength to dentin subjected to two luting agents (Panavia Fluoro Cement and Super-Bond C & B). Sixty bovine dentin substrates were used. They were divided into 12 subgroups of four treatment conditions (Gluma CPS, MS Coat, Saforide and control) and three adhesive systems (AD Gel sodium hypochlorite + Panavia Fluoro Cement, Panavia Fluoro Cement without AD Gel and Super-Bond C & B). After gluing the treated teeth to steel rods, tensile bond strengths were determined, 24-h and average values (n=5) were compared by analysis of variance (ANOVA). Without prior application of the desensitizing agents, bond strengths of these two groups (Super-Bond C & B, 10.2 MPa; AD Gel + Panavia, 11.5 MPa) were comparable, and they were greater than that of the group bonded with Panavia with no AD Gel conditioning (7.1 MPa). Application of the Saforide ammoniated silver fluoride desensitizer reduced the bond strength of both Super-Bond and Panavia luting agents, whereas the MS Coat polymeric agent had negative impact on bond strength of the Panavia cement only. And they concluded that the use of the Gluma desensitizer did not affect the bond strength of the three adhesive systems used, and the bond strength of Panavia cement with the AD Gel conditioning was not reduced by application of the three desensitizers used(43).

SF Seara *et al* in **2002** evaluated the influence of dentin desensitizer (D/Sense 2) on microtensile bond strength of two different adhesive systems: selfetching primer (Bistite II SC) and one-bottle adhesive (Prime & Bond 2.1). The teeth were randomly divided into four different groups (n=4). G1-D/Sense 2 + Prime & Bond 2.1; G2-D/Sense 2 + Bistite II SC; G3- and G4. The dentin surfaces were bonded with Prime & Bond 2.1 and Bistite II SC respectively, without any previous treatment with D/Sense 2. One sample in each group was prepared for evaluation of hybrid layer using SEM. The specimens were then serially sectioned perpendicular to the adhesive layer.Thus 1 mm2 bounded sticks for the microtensile test were obtained. Then, each stick was tested with microtensile test which was performed at 0.5 mm/min crosshead speed. He concluded that D/Sense 2 desensitizer decreased the bond strength of the Prime & Bond 2.1 and the Bistite II SC bonding systems(29).

Perdigão *et al* in **2003** tested a twofold hypothesis: a self-etch or SE adhesive would result in less postoperative sensitivity than in total-etch or TE adhesive; an Self Etch adhesive would result in poorer enamel marginal integrity than a Total Etch adhesive. Patients were grouped on the basis of obtaining Class I and Class II restorations in molars and premolars. The authors then placed 30 restorations with the Self Etch material (Clearfil SE Bond, Kuraray America, New York); and 36 restorations with Prime & Bond NT (Dentsply Caulk, Milford, Del), that uses 37 percent phosphoric acid to etch enamel and the dentin simultaneously. The Preparations were of standard design, with all the margins in enamel without beveling them. Upon rubber dam isolation, the authors made sure that the enamel and dentin walls were conditioned with the self-etching primer (for Clearfil SE Bond) ; etched with the proprietary 37 percent phosphoric acid (for Prime & Bond NT) followed by application of the equivalent dentin adhesive. Teeth were restored with the hybrid resin-based composite that were indicated for posterior restorations: Clearfil AP-X for Clearfil; SE Bond or Esthet-X Micro Matrix Restorative for Prime & Bond NT. The restored teeth were then evaluated preoperatively and at about two weeks, eight weeks and after six months postoperatively for sensitivity to cold , air and masticatory forces, as well as for the marginal discoloration. The Analysis of variance revealed that there was no statistically significant differences in postoperative sensitivity between the Self Etch and Total Etch materials at any recall time. Marginal discoloration was rated as absent for all restorations at six months gap. Only 1 tooth depicted sensitivity to occlusal forces at about six months. They concluded that the Self Etch adhesive did not differ from the Total Etch adhesive in regard to sensitivity and marginal discoloration. And they also concluded that the Postoperative sensitivity may depend on the restorative techniques rather than the type of dentinal adhesive used(48).

Arrais *et al* in **2004** evaluated the features of dentinal tubular occlusion following application of three commercially available desensitizing agents: potassium oxalate-based / Oxa-Gel (OX); HEMA and glutaraldehyde-based / Gluma Desensitizer (GD); and acidulated phosphate fluoride-based / Nupro Gel (AF). Buccal cervical areas of twenty-four extracted natural human third molar teeth were smoothed, wet-polished with SiC papers and diamond pastes, in order of simulating the clinical aspect of hypersensitive dentinal cervical surfaces. The teeth were then randomly divided into four groups (n=6). According to the dentinal surface treatments: G1:

untreated; G2: OX; G3: GD and G4: AF. Specimens were then fractured in the lingual-buccal direction and they were prepared for SEM analysis. OX promoted tubular occlusion by formation of crystal-like deposits in the lumen of the dentinal tubules. While GL created a thin occlusion layer over the dentin surface and AF application produced precipitates which occluded the dentinal tubules. According to the SEM analysis, all the desensitizing agents were able to occlude the dentinal tubules(4).

Ana Cecilia Correa Aranhaa *et al* in **2006** analyzed Microtensile Bond Strength of Composites to Dentin that was treated with Desensitizing agents. Forty bovine incisors were used,which were divided into four groups (n = 10): G1: control; G2: Gluma Desensitizer (Heraeus Kulzer); G3: Oxa-Gel (Art-Dent) and G4: low intensity laser (MMOptics). The buccal surface of each tooth was wet ground flat using 180-, 400- and 600-grit silicon carbide abrasive papers to expose mid coronal surface of dentin and to create a uniform surface. After application of these desensitizing agents to the exposed dentin, the specimens were then etched with 35% phosphoric acid for 30 s and an adhesive (Single Bond) was applied with an applicator tip and light cured. A 4 mm height crown of composite resin (Filtek Z250) was then built up manually. Then specimens were then trimmed to an hourglass shape with a cross section of 1 mm2. Each specimen was then individually evaluated by a microtensile testing machine at a crosshead speed of 0.5 mm/min. He concluded that among the desensitizing agents that were used, only Gluma Desensitizer did not detrimentally influence on the bond strength values. Thus it is a useful material for dentinal desensitization(21).

Awang RAR *et al* in **2007** compared the shear bond strength of adhesive systems using 2 different dentin surface treatments, with and without a desensitizing agent. Sixteen extracted human premolar teeth were sectioned off at the coronal portion of the tooth to expose their flat dentin surfaces. The surfaces were then finished using 600 Grit Wet Silicon Carbide abrasive papers. The premolars were randomly assigned into two groups: group 1 - control and group 2 – that was treated with MS Coat desensitizing agent. The desensitizer was applied to the samples according to the manufacturer's instructions. Later resin composite was bonded to each surface of dentin using Prime & Bond® adhesive system. The composite resin was then debonded by shear stress. And they concluded that shear bond strength of Prime & Bond® NT (Dentsply, USA) adhesive system will decrease if dentin surface is treated with MS Coat (Sun Medical, Japan) desensitizer(32).

Giselle Maria *et al* in **2009** compared the different treatments for dentinal hypersensitivity in a 6-month follow-up period of time. One hundred and one teeth having non carious cervical lesions were selected for this study. The assessment method used here to quantify sensitivity was the cold air syringe, which is recorded by the visual analogue scale (VAS), prior to the treatment (baseline); immediately after topical treatment and after 1 week, 1, 3 and 6 months. Teeth were then randomly assigned to five groups (n = 20); G1: Gluma Desensitizer (GD): G2: Seal&Protect (SP): G3: Oxa-gel (OG): G4: Fluoride (F): G5: Low intensity laser-LILT (660 nm/3.8 J/cm^2/15 mW). The analysis was based on non-parametric Kruskal-Wallis test which demonstrated statistical differences immediately after the treatment (p = 0.0165). To validate the individual effects of each treatment method, data was submitted to Friedman test. It was observed that Gluma Desensitizer and Seal&Protect showed immediate effect after application. Reduction in the pain level for a period of six-month follow-up was also observed. But, the Low intensity laser presented a gradual reduction of hypersensitivity. Oxa-gel and Fluoride showed the same effects as of the first and third month respectively. It can be concluded that, after a 6-month clinical trial evaluation, all the above therapies showed lower VAS sensitivity values when compared with baseline, independently of their different modes of action(51).

Salian *et al* in **2010** compared the efficacy and safety of dentifrices containing either 5% NovaMin, or 5% potassium nitrate, and a non-desensitizing dentifrice, in vivo on dentinal hypersensitivity in about four-weeks, a double-blind clinical study amongst a population in southern India. As well as, a scanning electron microscopy evaluation was done to investigate whether or not these test products occlude open dentinal tubules in vitro. Clinical evaluation for dentinal hypersensitivity was done using air blast, tactile, and cold water methods. Following baseline measures, the subjects were randomly divided into three different groups and they are treated as follows: 1) Group A--dentifrice containing 5% potassium nitrate; 2) Group B--dentifrice containing 5% NovaMin; and 3) Group C--dentifrice containing no desensitizing ingredients were used. Clinical evaluations were estimated after two weeks and four weeks of product uses. Compared to baseline, there was a significant decrease, in dentinal hypersensitivity in Group A and Group B following four weeks of use of the dentifrices containing 5% potassium nitrate and dentifrices containing 5% calcium sodium phosphosilicate, (NovaMin) respectively. There was also a statistically greater reduction in dentinal hypersensitivity at both two and four weeks following the use of the dentifrice containing NovaMin compared to the use of a non-desensitizing dentifrice, and also the dentifrice containing potassium nitrate. Air and cold water results were significantly lower following 4 weeks of use of the potassium nitrate dentifrice when compared to the non-desensitizing dentifrice. Tubular occlusion were observed in companion in vitro study following treatment with 5% NovaMin; but not after treatment with the 5% potassium nitrate or non-desensitizing dentifrices. They concluded that the dentifrice containing 5% NovaMin occluded dentin tubules, and provided rapid and significantly more relief from dentinal hypersensitivity in four weeks when compared to a dentifrice containing 5% potassium nitrate or a non-desensitizing dentifrice. All the three dentifrices tested in the present study were well-tolerated(13).

Narongdej *et al* in **2010** evaluated the efficacy of 100% NovaMin powder with NovaMin-containing toothpaste in reducing dentinal hypersensitivity when compared with the efficacy of NovaMin-containing toothpaste alone and a desensitizing toothpaste containing potassium nitrate as control. 60 participants were randomly divided into three groups: NovaMin powder with NovaMin-containing toothpaste as (group 1), a placebo powder with NovaMin-containing toothpaste as (group 2) and a placebo powder with the control toothpaste as (group 3). The authors used tactile, cold stimuli and a visual analog scale to record participants' pain at baseline and immediately after powder application and after one week, two weeks, three weeks and four weeks after powder application. Group 1 and Group 2 showed significant hypersensitivity reduction over baseline at all the time points. Group 3 showed significant hypersensitivity reduction after one week onward. Group 1 showed significant improvement when compared with groups 2 and group 3, except for the response to tactile stimulus at about four weeks with group 2. Between group 2 and group 3, there was significant differences after two and four weeks. They concluded that the application of NovaMin powder and NovaMin-containing toothpaste for hypersensitivity reduction is more superior than the application of a desensitizing toothpaste containing potassium nitrate and fluoride(45).

Arisu *et al* in **2011** evaluated the role of cervical hypersensitivity treatments (neodymium yttrium aluminum garnet [Nd:YAG] laser; conventional techniques) on the microtensile bond strengths of adhesives to treated dentin. The buccal part of the cervical enamel of 42 freshly extracted human mandibular third molars was ground flat until cervical dentinis exposed. The dentinal surfaces were then polished with a series of available silicon carbide papers and the smear layer was removed with an ethylenediamine tetra-acetic acid solution. The teeth were then randomly divided into six different groups as follows: group 1- Vivasens; group 2- BisBlock; group 3- fluoride gel; group 4- Nd:YAG laser; group 5- Clearfil SE + Nd:YAG laser; and group 6- no treatment (control). The specimens were then restored with a two-step self-etch adhesive system, with the exception of group 5. Five specimens from each group were then restored with a nanohybrid composite resin. The adhesive interface of the two specimens from each group was observed using scanning electron microscopy. The specimens were then sectioned perpendicularly to the adhesive interface to produce beams ,adhesive area 1 mm(2). The beams were then attached to a microtensile tester which were stressed to failure at 1 mm/min. The data were then compared using one-way analysis of variance at a significance level of 0.05. The microtensile bond strengths of the control groups were significantly higher than that found for the group 1, group 2, group 3, and group 4 ($p < 0.05$). No significant differences were found between group 5 and control group. Most of the premature failures were seen only in group 2 (80%) and lesser premature failures were seen in group 5 (13.3%). The SEM findings were also used to verify the microtensile test findings. They concluded that desensitizing treatment procedures (with the exception of Clearfil SE + Nd:YAG laser) reduced the microtensile bond strength of two-step self-etch adhesive system to dentin(52).

Soderholm *et al* in **2012** aimed to test the hypothesis of stress distribution which is more complex than that is generally assumed during micro tensile testing by evaluating the stress levels in the adhesive regions of virtual dentin-adhesive-composite sticks using FEA (finite elemental analysis). A 3D FEA model which simulates a dentin-adhesive-composite stick was analyzed. The length of the composite and the dentin was made to 5.0 mm each and the thickness of the adhesive layer was made to 0.02 mm. For the stress analysis, either only one of the lateral side of the stick or both the end surfaces were attached. A 20-N load was then applied on the stick with its 1.0 mm^2 cross-sectional area and von Mises stresses were calculated. And they finally concluded that the stress levels which were calculated were higher and more complex than their strength values that were obtained by dividing the load at failure by their cross-sectional area(31).

Andrea Nóbrega Cavalcanti *et al* in **2013** evaluated the effect on the usage of a dental hypersensitivity treatment on the bond strength to dentin surface with etch-and-rinse and self-etching simplified adhesive systems. Forty healthy molars were used. The prepared specimens were then randomly distributed into 4 groups (n=10). According to the combination of surface treatments with desensitizing dentifrices Colgate Sensitive Pro-Relief (Colgate Palmolive®) (test group - with dentifrice and control group - without dentifrice) and type of primary bonding agents (etch-and-rinse and self-etching agents). Resin composite blocks were fabricated on to the dentin surfaces, after application of the above mentioned bonding agents, and the specimens were then sectioned into a rectangular stick-shaped specimens with a cross-sectional area of 0.8mm2 approximately. For evaluating microtensile bond strength of the specimens , 4 sticks were randomly selected from the specimens, and were fixed to a universal testing machine. They concluded that the change occured in the dentin substrate by obliteration of dentinal tubules in the process of relieving dentinal hypersensitivity could further reduce the bond strength of both etch-and-rinse and self-etching bonding agents**(5)**.

Joshi *et al* in **2013** studied the effect of calcium sodium phosphosilicate (NovaMin) containing desensitizing agent, which is a powder-based system, and a hydroxyethyl methacrylate and a glutaraldehyde (Gluma desensitizer), which is a liquid-based system, on the dentinal tubular occlusion by scanning electron microscope (SEM). The effects of the above two groups along with the one control group were compared to evaluate the most effective method of sealing of the dentinal tubules after initial application. 20 specimens were allocated to each of the 3 groups: Control group, Gluma desensitizer group, and NovaMin group. Two extra samples were also prepared and were treated with Gluma Desensitizer and NovaMin; these samples were then longitudinally fractured. The specimens were then prepared from extracted natural sound human premolars and were then stored in 10% formalin at normal room temperature. The teeth were then cleaned for gross debris and were then sectioned to provide 1 to 2 dentin specimens. The dentinal specimens were then etched with 6% citric acid for about 2 minutes and were then rinsed in distilled water. Control discs were then dried, and the test discs were then treated with these desensitizing agents as per the manufacturer's instructions. The discs along with the longitudinal sections were later evauated under the scanning electron microscope. The extent of completely occluded, partially occluded and open dentinal tubules of each group were then calculated. The ratios of partially and completely occluded tubules to the total number of tubules for all the groups was then determined, and the data were statistically analyzed using nonparametric tests. Statistical significance was calculated. NovaMin group showed more completely occluded tubules while comparing Gluma desensitizer which showed more partially occluded tubules . The differences among these groups were statistically significant ($P \leq 0.05$). They concluded that both the materials were effective in occluding dentinal tubules but NovaMin appeared to be more promising in occluding dentinal tubules completely after initial application(11).

Justine L. Kolker *et al* in **2013** evaluate the effect of five dentin desensitizing agents (DDAs) on dentin permeability, using hydraulic conductance, and also morphological tubule changes, with scanning electron microscopy (SEM). The agents can be grouped by their actual mechanism of decreasing fluid flow in the dentinal tubules; i.e., tubule occlusion: Seal and Protect, Gluma & HurriSeal, whereas precipitation of proteins: Gluma, and precipitation of crystals: D/Sense 2 & Super Seal. Thirty extracted non cavitated human molar teeth were sectioned into 1mm mid-coronal dentin disks. Dentin permeability was measured prior and after treatment using bovine serum and phosphate-buffered saline at 10psi. Dentin desensitizing agents were applied to the occlusal surfaces of dentin according to manufactures' instructions. Samples from each group were selected for SEM observation. Kruskal-Wallis ANOVA and Tukey's test were used to evaluate differences between the groups. Mean percent reduction in dentin permeability for each group: HurriSeal= 54.2±35.3 ,SuperSeal= 97.5±4.0, D/Sense 2= 46.6±20.4, Gluma = 39.6±26.7, and Seal & Protect = 33.8±19.4. The data collected provided strong evidence of differences in permeability reduction among these agents ($p<0.01$). Pairwise comparisons of the means demonstrated that the effects of SuperSeal differed significantly from the reductions that were achieved using Gluma, Seal & Protect, and D/Sense 2. Differences in the degree and amount of dentinal tubule occlusion were seen among all DDAs under SEM. Of the materials that were tested, SuperSeal was the most beneficial when treating dentin sensitivity(36).

Kim SY *et al* in **2013** examined changes in dentinal fluid flow (DFF) on application of desensitizing agent and also compared the permeability reduction levels among various types of desensitizing agents. A cervical cavity class 5 , was prepared for the exposure of cervical part of the dentin on an extracted non carious human premolar teeth connected to a subnanoliter fluid flow measuring device under 20 cm of water pressure. The cavity was then acid-etched with 32% phosphoric acid to make the dentin highly permeable. The types of desensitizing agents that were applied onto the cavity were Seal&Protect which is a light-curing adhesive type, SuperSeal and BisBlock which are oxalate types, Gluma Desensitizer which is a protein-precipitation type, and Bi-Fluoride 12 which is a fluoride type. DFF was measured from the time prior to the application of the desensitizing agent , throughout the application procedure to five minutes and after the application. The characteristics and occlusion of dentinal tubules of each desensitizing agent were examined under scanning electron microscopy. The dentinal fluid flow rate after desensitizing agent application was significantly reduced when compared to initial dentinal fluid flow rate , prior to the application for all these desensitizing agents ($p<0.05$). Seal & Protect showed a better reduction in the dentinal fluid flow rate when compared to Gluma Desensitizer and Bi-Fluoride 12. SuperSeal and BisBlock showed a greater reduction in dentinal fluid flow rate when compared to Bi-Fluoride 12 ($p<0.05$). The dentin hypersensitivity treatment effects on the employed desensitizing agents in this study were confirmed through real-time measurements of dentinal fluid flow changes. The light-curing adhesive and oxalate type of desensitizing agent showed greater reduction in the dentinal fluid flow rate than did the protein-precipitation and fluoride types(38).

Patrick R. Schmidlin *et al* in **2013** presented an overview on the management strategies of dentinal hypersensitivity (DHS) and summarized and discussed the therapeutic options. A PubMed literature search was conducted to explore articles dealing with dentinal hypersensitivity prophylaxis and its treatment options. Dentinal hypersensitivity therapy should be initiated with noninvasive individual prophylactic home-care approaches. In-office therapy follows with precipitating, nerve desensitizing, or plugging agents. If the dentin hypersensitivity persists, at reevaluation depending on the hard and soft tissue components present, i.e., presence or absence of cervical lesions , the gingival contour, adhesive type of restorations including sealing or mucogingival surgery may be an option. They permit for the establishment of a physicomechanical barrier. As the placebo effect plays an important role, sufficient patient management strategies and positive corroboration may improve the management of dentinal hypersensitivity in the future and they concluded that lifelong maintenance under the premise of strict control of the causative factors is vital in the management of DHS(41).

Luciene Santana Andreatti *et al* in **2014** analyzed whether the bond strength of resin restorative materials is interfered to the prior use of desensitizing agents. A total of 48 natural non cavitated human extracted molars were divided into six groups. They were grouped according to the conventional application (CV) of the adhesive systems Scotchbond Multipurpose (SB) and Clearfil SE Bond (CF) and their association with, bioglass (BG/Biosilicate®) or arginine (AR/Sensitive Pro-Relief/TM). Bond strengths were assessed by a microshear mechanical test, using a composite resin (Filtek Z350 XT) as restorative material. The mechanical testing was performed at a speed of 0.5 mm/min in a universal testing machine, and the data obtained were submitted to two-way ANOVA and Tukey’s test ($\alpha = 0.05$). The bond strength (MPa) was 17.03 for SBCV; 26.24 for SBBG; 21.3721.19 ;for SBAR for CFCV; 27.09

for CFAR and 29.51 for CFBG group. A significant increase in bond strength ($p < 0.05$) was seen when Biosilicate® was used prior to the self-etching and conventional adhesive systems. Fracture pattern analysis was done by means of optical microscopy which showed a predominance of mixed type fractures. The exception was seen in CFCV group, where adhesive fractures predominated. It was concluded that arginine did not interfere with the bond strength to dentin, while the use of Biosilicate® strengthened the bond between dentin and the adhesive systems that were used(39).

Makkar S *et al* in **2014** evaluated the effect of different dentin-desensitizing agents on the tensile bond strength of composite resin restoration. Twenty-four sound human natural molars were used. The enamel was wet abraded to expose the flat dentin surfaces and polished with a sandpaper. The specimens were then divided into three groups ($n = 8$) according to the type of dentin-desensitizing treatment applied. The first group: where G1 was the control group here no desensitizing agent was used. The second group: where G2 was treated with a desensitizing dentifrice containing a combination of triclosan, potassium nitrate, and sodium monoflorophosphate. The third group: where G3 was treated with Er:YAG laser. Later, the desensitized samples were treated with one step self-etch adhesive according to the manufacturer's instructions and composite microcylinders were packed onto it. The samples were then analyzed for tensile bond strength using universal tensile machine (KMI^{TM}).Statistical analysis of the data obtained showed that the mean values for the tensile bond strengths were 10.2613 MPa, 5.9400 MPa and 6.3575 MPa for the groups 1, 2 and 3, respectively. These values obtained were statistically significant between groups pretreated with laser or dentifrice as compared to the control group. They concluded that Dentifrice and Laser pre-treated dentin has lower tensile bond strength with restorative resin composites when compared to dentin that is untreated(40).

C Sabatini *et al* in **2015** aimed to evaluate the effect of various desensitizing agents on the bond strength using mild and strong self-etching adhesive systems to dentinal surface.The experimental groups had undergone pretreatment with Gluma Desensitizer, MicroPrime B immediately prior to their bonding with self-etching adhesives used such as Optibond XTR, Xeno IV, and iBond. A jig was used to fabricate composite blocks with cylinders, which were stored in artificial saliva for either 24 hours or three months, after which their shear bond strength (SBS) was analyzed using a notched-edge testing device at a crosshead speed of 1 mm/min. The mode of failure distribution was also evaluated at 24 hours and three months. And they concluded that these Desensitizing agents can be used along with the self-etching adhesives to control dentinal hypersensitivity without adversely affecting their bond strength to dentin surface(30).

Prolongado *et al* in **2016** observed the influence of previous and long time treatment with desensitizing dentifrices on bond strength to dentin, by using a self-etching adhesive system. Seventy non-carious bovine incisors were used in this study, and were divided into five groups (n= 14), according to the desensitizing toothpaste used, such as, Group 1: distilled water (WATER) (control); Group 2: Colgate Total 12 (CT12) (control); Group 3: Colgate Sensitive Pro-Relief (CSPR); Group 4: Sensodyne Rapid Relief (SRR); Group 5: Sensodyne Repair & Protect (SRP). Buccal surfaces of the teeth were flattened until the dentin is exposed, and dentin fragments of 4x4x2 mm were obtained. The Fragments were immersed in polyvinyl chloride (PVC) cylinders and were exposed to 17 % EDTA for 1 minute. Subsequently, the specimens were subjected to 20000 cycles of simulated dental tooth brushing. After 24 h in artificial saliva, the specimens were all hybridized (Clearfil SE Bond Ð Kuraray), as well as resin composite cylinders were built on the dentin surfaces. The samples were stored in distilled water, at 37 ¼˚ C for 24 hours, and shear bond strength was evaluated. The maximum bond strength (MPa) value was seen in CT12 group , and the lowest was seen in CSPR group . Data were statistically analyzed using 1-way ANOVA (*p*= 0.05), and results showed that there was no significant difference (p= 0.5986) on considering the Desensitizing Dentrifices factor. The predominant mode of fracture pattern was cohesive type on to the dentin. The previous and long time use of these Densitizing Dentrifices did not affect the dentin bond strength by the use of a self-etching adhesive system(34).

Yilmaz NA *et al* in **2017** evaluated the efficacy and durability of 5 different dentin desensitizers namely (Gluma Self Etch Bond, Gluma Desensitizer Powergel, D/Sense Crystal, Bifluorid 12, Nupro Sensodyne Prophylaxis Paste with Novamin) on tubular occlusion and dentin permeability reduction in vitro. The quantitative changes in tubular permeability of 100 dentin discs were observed after desensitizer treatments and when subjected to post-treatment with 6% citric acid challenge for one minute or immersion in artificial saliva for 24 hours under hydrostatic pressure which was generated by a computerised fluid filtration meter. Qualitative SEM analyses were also carried out after gold sputtering. Dentin permeability almost decreased after desensitizer application in all the groups.On the other hand, only the difference between 'Gluma Self Etch Bond' and 'Nupro Sensodyne Prophylaxis Paste with Novamin' groups were significantly different ($p<0.05$). Dentin permeability increased significantly after post-treatments ($p<0.05$) with 6% citric acid and immersion in artificial saliva. But there was no statistically difference among citric acid-subgroups ($p>0.05$).Above all in the artificial saliva-subgroups, only the difference between 'Bifluorid 12' and 'D/Sense Crystal' and was significantly different ($p<0.05$). In SEM analysis, morphological changes were detected on the dentinal surface and within the dentin tubules following desensitizer treatments and post-treatments. And they concluded that the mentoined desensitizers significantly reduced dentin permeability by changing the morphology of the dentinal surface and/or dentinal tubules. Following post treatments, there was decline in the efficacy of the desensitizers which showed some reduction in permeability values. And also SEM analysis exposed some physical changes in the dentin structure which partly gives an explanation to the reduced efficacy of the tested desensitizers(35).

Jyothi Mandava *et al* in **2017** evaluated and compared the microtensile bond strength of three different bulk-fill restorative composites with nanohybrid composite. Class I cavities were prepared on sixty extracted human mandibular molar. The teeth were divided into 4 groups (n= 15 each). In group I : the prepared class 1 cavities were restored with nanohybrid (Filtek Z250 XT) restorative composite in an incremental method. In group II, III and IV : the bulk-fill restorative composites (Filtek, Tetric EvoCeram, X-tra fil bulk-fill restoratives) were placed at a 4 mm single increment and light cured. The restored teeth were then subjected to thermocycling and the bond strength was evaluated using instron testing machine. The mode of fracture was analyzed by scanning electron microscope (SEM). The bond strength values that were obtained in megapascals (MPa) were subjected to statistical analysis, using SPSS/PC software version 20 software. One-way ANOVA was performed for groupwise comparison of the bond strength. For pairwise comparisons Tukey’s Post Hoc test was used among the groups. The highest mean bond strength was obtained with Filtek bulk-fill restorative that showed statistically significant difference with Tetric EvoCeram bulk-fill ($p < 0.003$) and X-tra fil bulk-fill ($p<0.001$) composites. Adhesive fractures are mostly predominant with X-tra fil bulk fill composites, whereas mixed type of fractures are more common with other bulk fill composites. They concluded that bulk-fill composites exhibited satisfactory bond strength to dentin and can be considered as an alternate restorative material of choice in posterior stress bearing areas(42).

Amit Jena *et al* in **2017** compared the dentinal tubule occluding efficacy of 4 different types of desensitizing dentifrices under a scanning electron microscope (SEM). Sixty-two dentin blocks from extracted human molar teeth measuring 5 mm × 5 mm × 3 mm were obtained and they were randomly divided into five groups: Group one – no treatment (control, $n = 2$); Group two – Pepsodent Pro-sensitive relief and repair ($n = 15$); Group three – Sensodyne repair and protect ($n = 15$); Group four – Remin Pro ($n = 15$);and Group five – toothpaste containing 15% nano-hydroxyapatite (n-HA) crystals ($n = 15$). The specimens were then brushed for 2 min per day for 14 days and were stored in artificial saliva. After final brushing,the specimens were subjected to gold sputtering and were viewed under SEM at ×2000 magnification. Results were statistically analyzed using nonparametric Kruskal–Wallis test and least significant difference using *post hoc* test. They concluded that newer desensitizing dentifrices containing 15% n-HA and Remin Pro provided effective tubule occlusion and thus by reducing the pain and discomfort caused by Dentin Hypersensitivity(33).

Shah *et al* in **2017** evaluated the ability of three available desensitizing dentifrices − SHY-NM (NovaMin), Sensitive Pro-Relief (8% arginine and calcium carbonate) and Thermoseal (10% strontium chloride) − for dentinal tubular occlusion using a scanning electron microscope. The results showed that from all of the desensitizing dentifrices evaluated only the SHY-NM showed the highest percentage of tubular occlusion (95.58%) followed by the Sensitive Pro-Relief (89.90%). The least amount of tubular occlusion was seen inThermoseal (86.12%). They concluded that NovaMin-containing toothpaste and SHY-NM, showed the maximum tubular occlusion and that appears to be a promising desensitizing dentifrice(48).

Reddy *et al* in **2017** evaluated the efficacy of diode laser alone and in combination with different desensitizing toothpastes in occluding the dentinal tubules which were both partially occluded and completely occluded tubules by scanning electron microscope (SEM). Fifty natural human teeth were extracted, on which cervical cavities were prepared and were etched with 17% ethylenediaminetetraacetic acid, and the smear layer was removed to expose the dentinal tubules. The teeth were then divided into five groups: In Group I – Application of NovaMin-formulated toothpaste, in Group II – Application of Pro-Argin™-formulated toothpaste,in Group III – Application of diode laser in noncontact mode,in Group IV – NovaMin-formulated toothpaste followed by laser irradiation, and in Group V – Pro-Argin™-formulated toothpaste followed by laser irradiation. After treatment, the quantitative analysis of the occluded dentinal tubules was observed by SEM analysis. The mean values of percentages of total or complete occlusion of dentinal tubules in Groups I, II, III, IV, and V were 92.73% ± 1.38, 90.67% ± 1.86, 96.57% ± 0.64, 97.3% ± 0.68, and 96.9% ± 6.08, respectively. Further addition of diode laser in (Groups III, IV, and V) yielded a significant occlusion in the dentinal tubules when compared to the desensitizing toothpastes alone (Groups I and II). Diode lasers (Group III) were more efficient in occluding dentinal tubules when compared to the desensitizing toothpastes and was statistically significant ($P < 0.05$). Among these five groups, NovaMin + diode laser (Group IV) showed the highest percentage of occlusion in dentinal tubules(49).

Morsy *et al* in **2018** investigated the clinical performance of three different types of adhesive systems (Futurabond universal adhesive in a self-etch mode, Tetric N-bond self-etch adhesive, and Single bond universal adhesive in a total etch mode) in class V carious lesions over a period of 1 year. A total of 20 patients with three carious cervical lesions participated in this study after obtaining informed consent. A total of 60 restorations were placed in class 5. The distributions of adhesive materials and the teeth were randomized. Cavities were prepared limiting to just removal of carious lesions in incisal and gingival margins in enamel and beveling of incisal cavosurface margin. All the adhesives were applied according manufacturer's directions. All cavities were restored with Grandio SO restorative composite resin following manufacturer's directions. Finishing and polishing were performed using finishing burs and polishing discs. Each restoration was clinically evaluated at the baseline period of (24 h), 6 months and 1 year for retention, margin integrity, secondary caries, margin discoloration, and postoperative sensitivity using modified United state public health service (USPHS) criteria. The results were that there was no statistically significant difference between the tested groups at the evaluation periods regarding marginal adaptation, marginal discoloration and postoperative sensitivity ($P > 0.05$). None of restoration had secondary caries at time of evaluation period(44).

Ozlem *et al* in **2018** compared the efficacyy of the glutaraldehyde-containing agent (GCA); Nd:YAG; Er,Cr:YSGG lasers, and the combination of all of them on the dentinal hypersensitivity (DH) treatment. This study was done with the participation of 17 healthy adult patients who have 100 teeth with DH; the patients were then randomly divided into five groups, according to the treatment protocol: (1) application of GCA on the sensitive teeth; (2) Nd:YAG laser (1 W/cm^2, 10 Hz) irradiation on the sensitive teeth; (3) application of GCA on the sensitive teeth and then Nd:YAG laser irradiation; (4) Er,Cr:YSGG laser (0.25 W/cm^2, 20 Hz) irradiation on the sensitive teeth; (5) application of GCA on the sensitive teeth and then Er,Cr:YSGG laser irradiation. Sensitivity levels were then assessed by Yeaple probe on the buccal surface of all the teeth at a force with a setting of 10 g. Measurements were then performed for 30 min, after 7, 90 and 180 days of therapy to assess the special effects of desensitization. The evaluations were then analyzed using one-way analysis of variance and using repeated measurement test ($P < 0.05$). After the sessions, Dentinal Hypersensitivity was significantly reduced in all the groups at each measurement point. Er,Cr:YSGG laser with or without GCA applications are the most effective in Dentinal Hypersensitivity treatment ($P < 0.05$). Comparison of treatment regimens demonstrated that the values achieved with the Yeaple probe were not significantly higher for Nd:YAG laser groups than GCA alone group. This clinical study demonstrated that the Er,Cr:YSGG laser have a promising potential for treatment of Dentin Hypersensitivity(50).

Saleeta Mushtaq *et al* in **2019** evaluated different desensitizing agents on dentinal tubule occlusion using scanning electron microscope. Thirty human natural teeth were collected from extracted sound maxillary premolars. Samples were then sectioned mesiodistally to get 30 buccal and 30 lingual surfaces, and enamel was removed with discs in order to mimic hypersensitive dentin. Specimens were then randomly divided into four groups. In Group 1: 10 samples were coated with Gluma desensitizer, in Group 2: 10 samples were coated with VivaSens, in Group 3: 10 samples were coated with MS Coat, in Group 4: 10 samples each of its contralateral parts of the samples were coated with Gluma desensitizer, VivaSens, and MS Coat to which no desensitizing agents were applied, which acted as the control. All the specimens were then examined under SEM, and their photomicrographs were looked upon to assess the opening of dentin tubules in the control group and occlusion of dentinal tubules in their contralateral parts that were coated with desensitizing agents. Statistically significant number of tubules got occluded after application of MS Coat desensitizer when compared to tubules that were occluded after the application with VivaSens desensitizer and Gluma desensitizer. They concluded that MS Coat showed better results followed by VivaSens and then Gluma desensitizer in the closure of the dentinal tubules(37).

MATERIALS

MATERIALS:

36 human natural mandibular premolar teeth

NSK airotor, NSK Inc., Japan

Sectioning disk

Sand paper fine grit

Diamond burs MANI SF 13, Mani Co, Japan

Polishing burs MANI TF 12EF

Surgical Artery forceps

Digital vernier caliper

Gluma Desensitizer (Heraeus Kulzer GmbH)

Sensodyne Repair and Protect ,powered by Novamin , Group Pharmaceuticals Limited,India

Sensodyne tooth brush

37.5% Phosphoric Acid Gel, Kerr

OptiBond™ S, Single Component Total-Etch Dental Adhesive, Kerr Optibond ™ Solo, Kerr Corp., USA

Applicator tips, Kerr OptiBond

PALFIQUE Bond, self-etch, Tokuyama Dental Corporation,Japan

Tetric N Ceram, Bulk fill composite, Ivoclar Vivadent

Light Curing Unit LED Woodpecker,China

Composite instrument Blue Titanium , GDC

Loctite Super Bonder® Flex Gel; Henkel Ltda, Itapevi, SP, Brazil

Gript cable tie – white zip self locking nylon wire tags

Fusayama/Meyer Artificial Saliva

Universal testing machine (Tinius Olsen, India Pvt Ltd.in Noida, Uttar Pradesh)

Scanning electron microscope (TESCAN VEGA3, Brno – Kohoutovice, Czech Republic)

METHODOLOGY:

METHODOLOGY

A sample of 36 sound freshly extracted human mandibular premolar teeth were selected after obtaining clearance from ethical commitee. They were stored in 0.1% thymol solution. The enamel in the occlusal surface of the crown was removed using sectioning disk. And the enamel in the proximal surface were removed using coarse and fine diamond straight fissure burs (MANI SF 13), (MANI TF 12EF). The roots of the premolars were then removed using sectioning disk at the junction of cemento enamel junction. The cervical third of the crown portion of the teeth were again sectioned perpendicular to the long axis of the tooth .Thus, dentin disks were obtained. The dentin disks were again cut into two halves – the buccal portion and the lingual portion. It was made sure that the smear layer was produced with the diamond burs. The samples were all stored in artificial saliva for about two weeks before the bonding procedure.

The samples were randomly divided into two groups: Group 1 – etch-and-rinse (n=18), Group 2 – self-etch (n=18). Group 1 was further subdivided into 1A - Gluma Desensitizer (Heraeus Kulzer GmbH) (n=6), 1B - Sensodyne Repair and Protect, powered by Novamin (Group Pharmaceuticals Limited,India) (n=6) ,1C - control where no desensitizing agents were applied (n=6). Group 2 was similarly subdivided into 2A - Gluma Desensitizer (Heraeus Kulzer GmbH) (n=6), 2B - Sensodyne Repair and Protect, powered by Novamin (Group Pharmaceuticals Limited,India) (n=6) ,2C - control where no desensitizing agents were applied (n=6). The area to which the desensitizer was applied was limited to 4 mm long and 3 mm wide on the buccal surface over the teeth.

BONDING PROCEDURE:

Group 1A and Group 2A : Gluma desensitizer

Gluma Desensitizer was applied using applicator tips using a gentle but a firm, rubbing motion and left to dry for 30 seconds. Bonding procedures were started with etch-and-rinse (37.5% Phosphoric Acid Gel, Kerr, OptiBond™ S, Single Component Total-Etch Dental Adhesive, Kerr) and self-etch (PALFIQUE Bond**,** self-etch, Tokuyama Dental Corporation) adhesive systems which were applied to these groups. And they were bonded with Bulk fill composite (Tetric N Ceram, Bulk fill composite, Ivoclar Vivadent) of 4mm thickness and curing was done with Light Curing Unit LED (Woodpecker) for 40 seconds.

Group 1B and Group 2B : Sensodyne repair and protect

Desensitizing tooth paste (Sensodyne Repair and Protect ,powered by Novamin) was applied on the dentin surface with smooth rubbing movements for one minute. The surfaces were then washed carefully with distilled water. This procedure was repeated 2 times a day with 12 hours interval totaling 28 applications for 2 weeks with a soft brush .The specimens were then stored in artificial saliva at 37˚C . The bonding procedures were then started with etch-and-rinse (37.5% Phosphoric Acid Gel, Kerr, OptiBond™ S, Single Component Total-Etch Dental Adhesive, Kerr) and self-etch (PALFIQUE Bond, self-etch, Tokuyama Dental Corporation) adhesive systems which were applied to these groups. And they were bonded with Bulk fill composite (Tetric N Ceram, Bulk fill composite, Ivoclar Vivadent) of 4mm thickness and curing was done with Light Curing Unit LED (Woodpecker) for 40 seconds.

Group 1C and Group 2C : control

No desensitizing agents were used in control group. Etch-and-rinse (37.5% Phosphoric Acid Gel, Kerr, OptiBond™ S, Single Component Total-Etch Dental Adhesive, Kerr) and self-etch (PALFIQUE Bond, self-etch, Tokuyama Dental Corporation) adhesive systems were used. And they were bonded with Bulk fill composite (Tetric N Ceram, Bulk fill composite, Ivoclar Vivadent) of 4mm thickness and curing was done with Light Curing Unit LED (Woodpecker) for 40 seconds.

All the samples were immersed in artificial saliva for 2 weeks under 37˚C.

Product :	**Composition :**	**Application mode :**
Gluma Desensitizer	HEMA (25%-50%) Glutaraldehyde (5%-10%) Water	Apply desensitizer and let it sit for 30-60 s Dry surface until fluid film disappears Apply adhesive resin
PALFIQUE Bond, self-etch, Tokuyama Dental Corporation	Acetone, isopropyl alcohol, water, peroxide, 3D-SR monomer ,HEMA, Bis-GMA, and TEGDMA, Biphenol A di	Apply and wait for 10 sec. Air dry for 5 sec. Light cure for 10 sec or more Restore with composite

OptiBond™ S, Single Component Total-Etch Dental Adhesive, Kerr	Bis-GMA, HEMA, GDMA, GPDM, ethanol, CQ,ODMAB, BHT, fumed silicon dioxide, A174,barium aluminoborosilicate, Na2Si6F (31513) (43)	Etch with 37.5% phosphoric acid for 15 s, rinse for 15 s and dry for 5 s, apply the adhesive and rub for 15 s, dry for 3 s, and light cure for 20 s (43)
Sensodyne Repair and Protect ,powered by Novamin	calcium, sodium, phosphorous and silica that releases deposits of crystalline hydroxyl-carbonate apatite (HCA)	Apply a small quantity of the product directly on the sensitive teeth. Start brushing for 1 minute.

MICROTENSILE BOND STRENGTH:

After adhesive procedure, the restored samples (n=30), 5 in each group were randomly selected for mechanical testing and 1 in each group (n=6) was allotted for scanning electron microscope analysis. The samples were prepared into rectangular sticks with a cross- sectional area of approximately $1mm^2$ .This process was done using diamond burs with a high speed handpiece (NSK airotar, Japan) under air/ water spray coolant by holding the samples firmly with an artery forceps. During the reduction process, the width and length of the samples were measured using Digital Vernier caliper. The samples were approximately reduced into 1×1×6 mm.

The sticks were individually tested for micro tensile bond strength. For microtensile bond strength , the rectangular sticks were glued to Gript cable tie – white zip self locking nylon wire tags using cyanoacrylate (Loctite® Super Bonder® Flex Gel; Henkel Ltda, Itapevi, SP, Brazil).

After half an hour , the whole unit was attached to the jaws of a Universal testing machine (Tinius Olsen, India Pvt Ltd.in Noida, Uttar Pradesh).

A 100N load cell was used to exert a tensile force at a cross head speed of 0.5mm/min. The microtensile bond strength was obtained and was expressed in MPa.

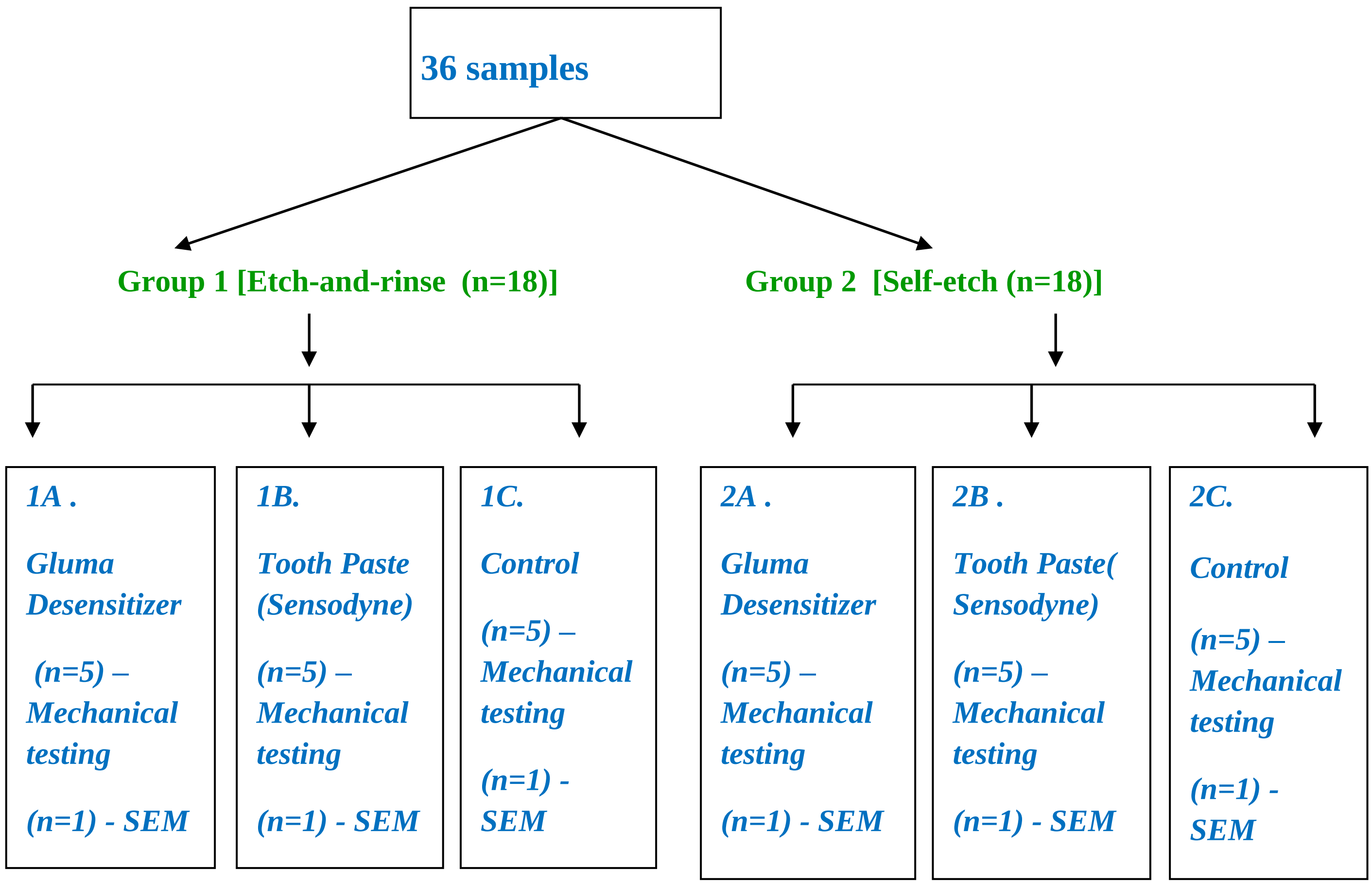
After microtensile bond strength analysis, each of the specimens were observed using a microscope (Labomed, Prima icroscope , USA) under 2.5x magnification to observe the type of fracture (Cohesive / Adhesive).

SCANNING ELECTRON MICROSCOPE (SEM) EXAMINATION:

One sample selected in each group (n=6) with bonded composite resins to analyze the morphological pattern of the hybrid layer in specimens that were treated with desensitizing agents. The samples were hand polished using polishing burs and fine abrasive papers. They were decalcified by immersing in 6 m0l/HCl to demineralize mineral components present on the dentin surfaces not protected by the resin. This method enhances the contrast between non and resin infiltrated dentin. They were then immersed in 10% sodium hypochlorite for 10 minutes. Sodium hypochlorite removes the exposed collagen fibres. Later, they were rinsed in water and air dried.

The specimens were then mounted on the SEM, prior to which gold sputtering was done and examined at 8.0 kV with 1000x magnification

CONSORT FLOW CHART



ETCH-AND-RINSE (OptiBond™ S, Single Component Total-Etch Dental Adhesive, Kerr)

SELF-ETCH (PALFIQUE Bond**,** self-etch, Tokuyama Dental Corporation)

After microtensile bond strength testing, 5 samples from each each groups were observed for cohesive/adhesive fractures using operating microscope (Labomed Prima, USA) under 2.5x magnification.

One sample selected in each group (n=6) was selected for SEM analysis at 8.0 kV with 1000x magnification.

FIGURES:

FIGURES

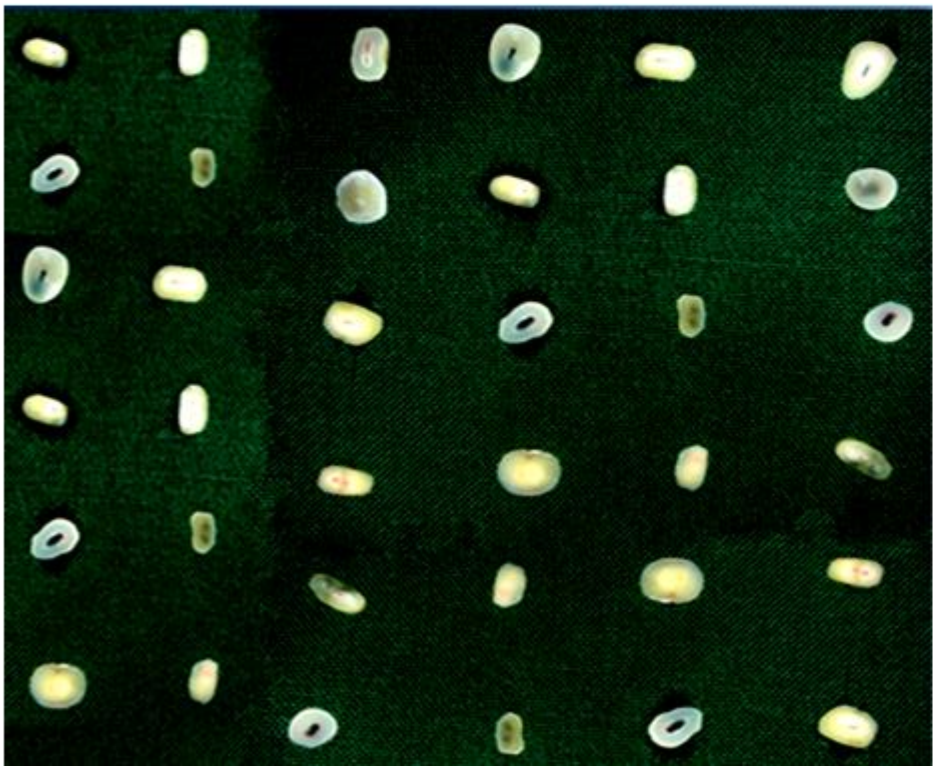


FIGURE 1 – 36 dentin disks

FIGURE 2: buccal surfaces of the dentin disks

FIGURE 3: 37.5% Phosphoric Acid Gel, Kerr

FIGURE 4: Applicator tips, Kerr OptiBond

FIGURE 5 : OptiBond™ S, Single Component Total-Etch Dental Adhesive, Kerr

FIGURE 6: **PALFIQUE Bond,** self-etch, Tokuyama Dental Corporation

FIGURE 7: Sensodyne Repair and Protect ,powered by Novamin , Group Pharmaceuticals Limited,India

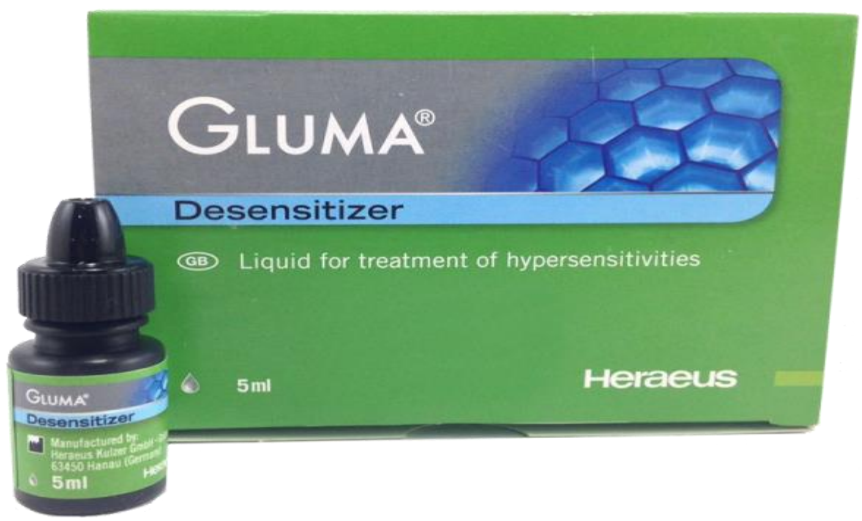


FIGURE 8: Gluma Desensitizer (Heraeus Kulzer GmbH)

FIGURE 9 : Tetric N Ceram, Bulk fill composite, Ivoclar Vivadent

FIGURE 10 : Rectangular stick of approximately $1mm^2$ cross sectional area

FIGURE 11 : Loctite® Super Bonder® Flex Gel; Henkel Ltda, Itapevi, SP, Brazil

FIGURE 12 : Digital vernier caliper

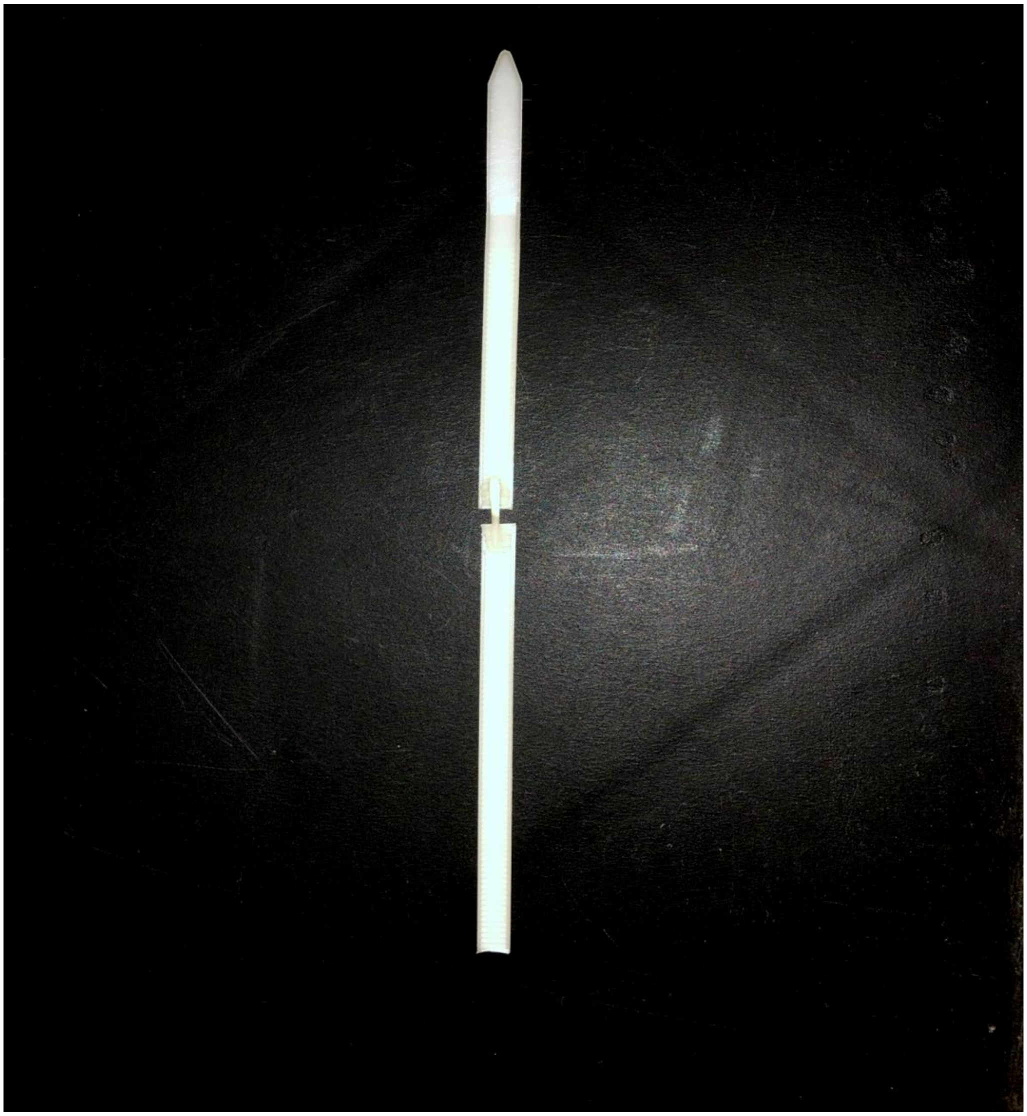


FIGURE 13 : Sample glued to Gript cable tie – white zip self locking nylon wire tags

FIGURE 14 : Universal testing machine (Tinius Olsen, India Pvt Ltd.in Noida, Uttar Pradesh)

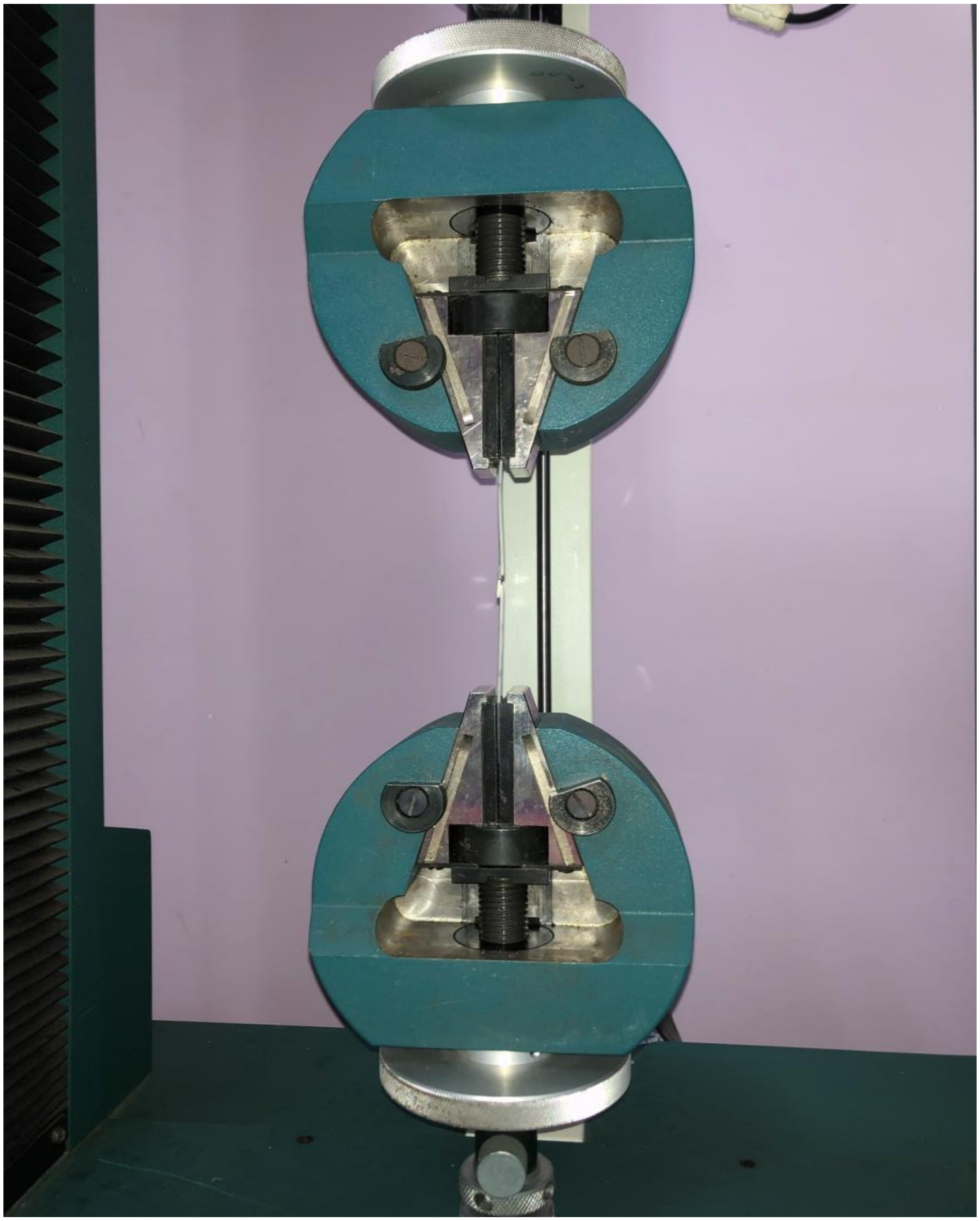


FIGURE 15 : Fractured sample in : Universal testing machine

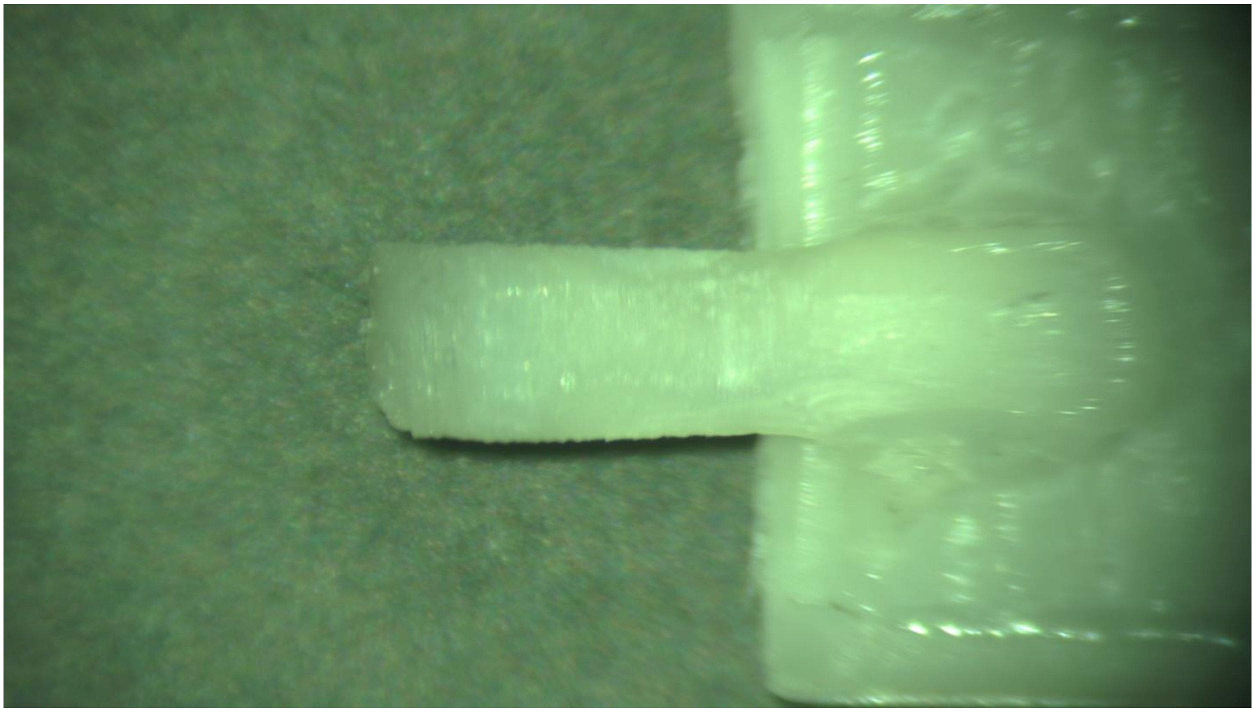


FIGURE 16: Adhesive fracture

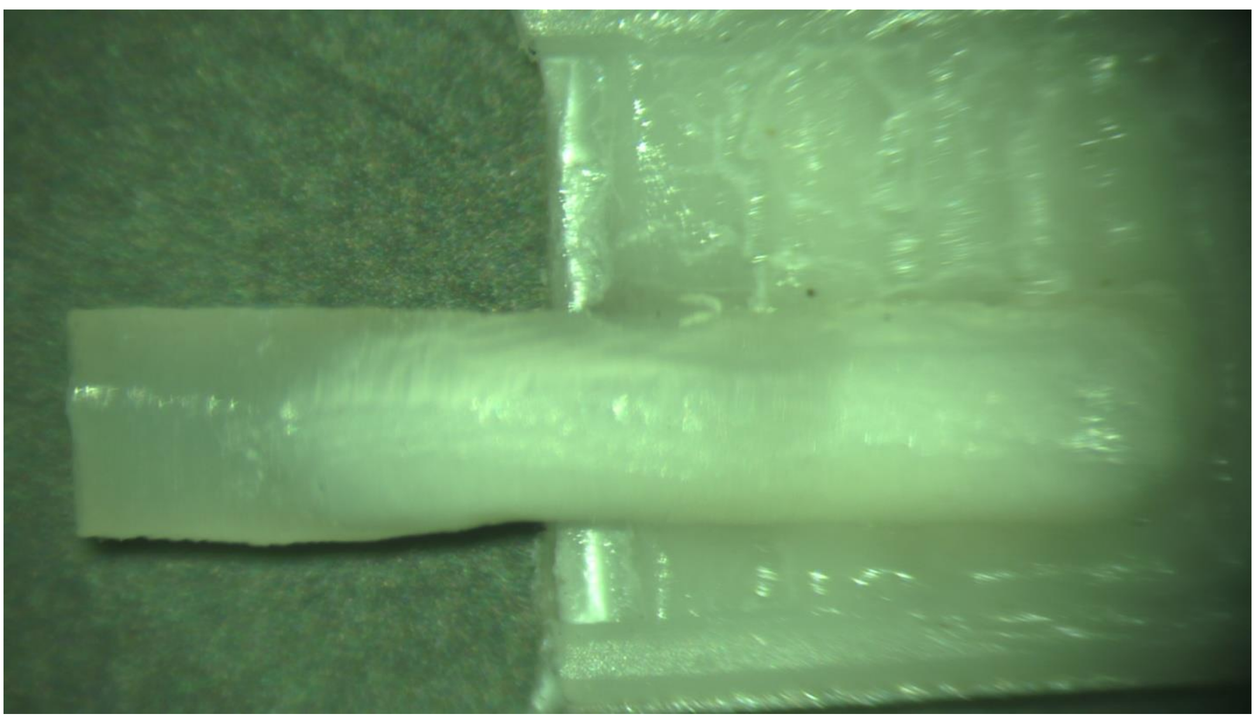


FIGURE 17: Cohesive fracture

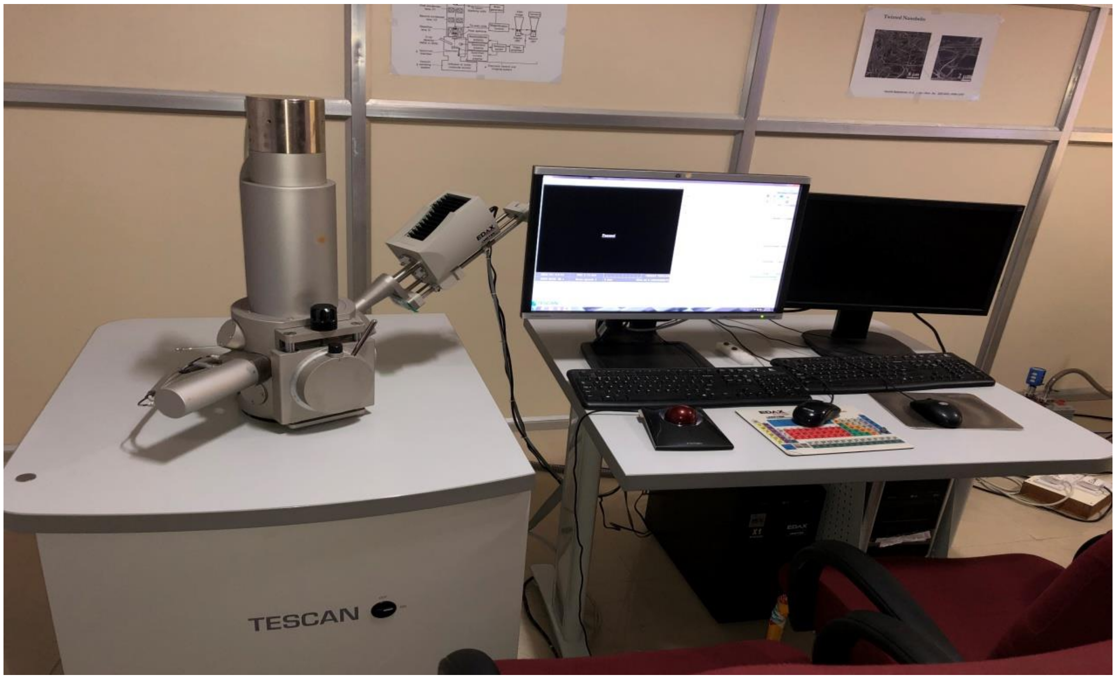


FIGURE 18 : Scanning electron microscope

FIGURE 19 : Gold sputtering

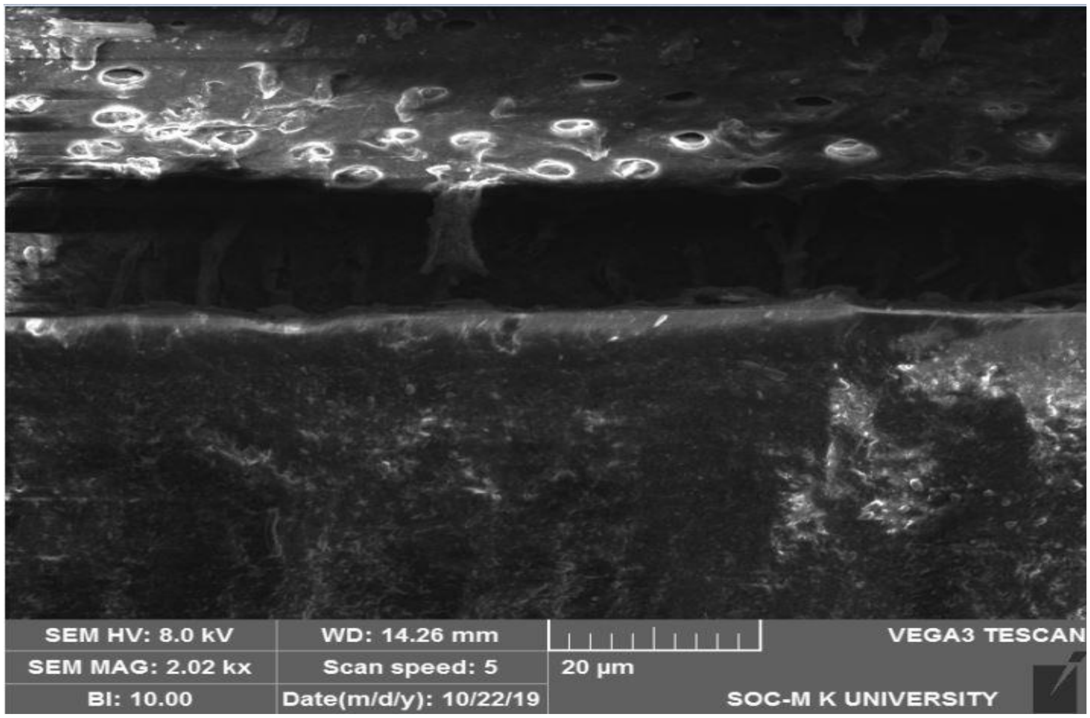


FIGURE 20: SEM image of Group 2C, self-etch group- control sample

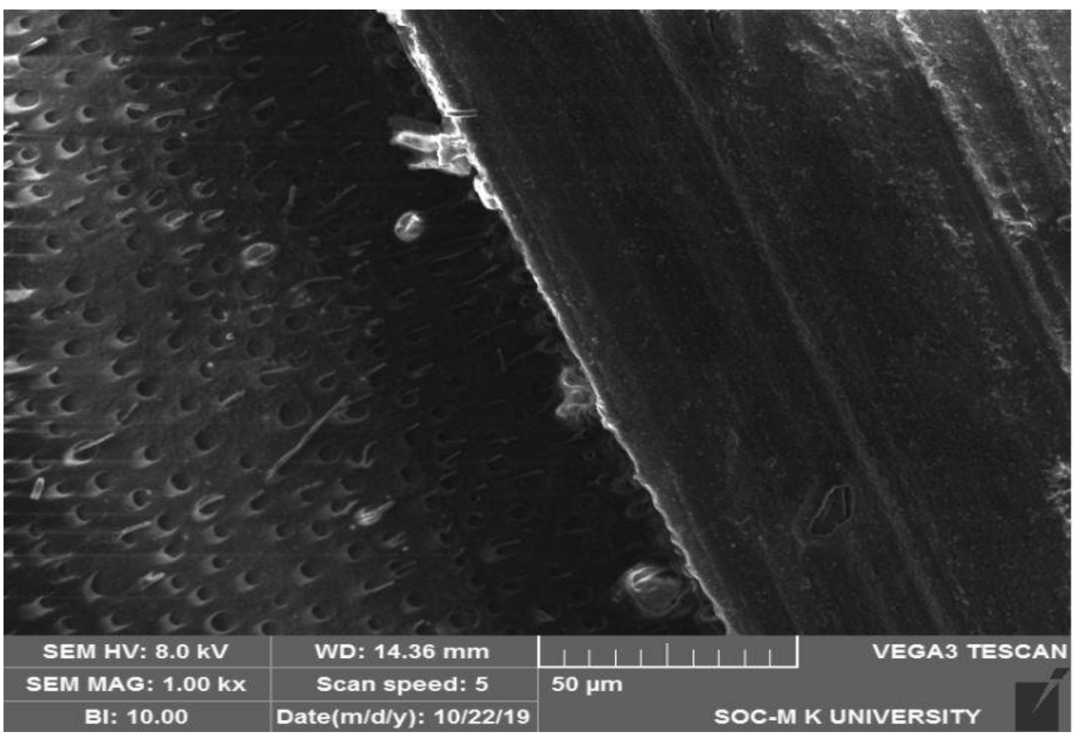


FIGURE 21: SEM image of Group 1C, etch-and-rinse group – control sample

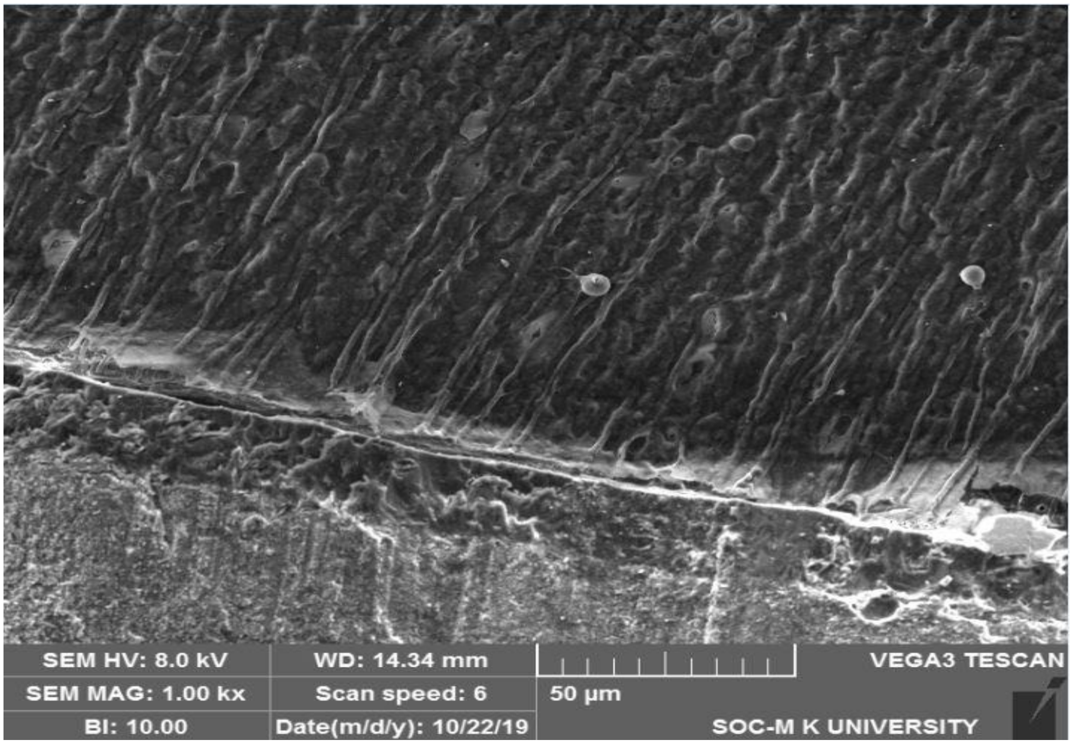


FIGURE 22: SEM image of Group 2A, self-etch group – Gluma desensitizer sample

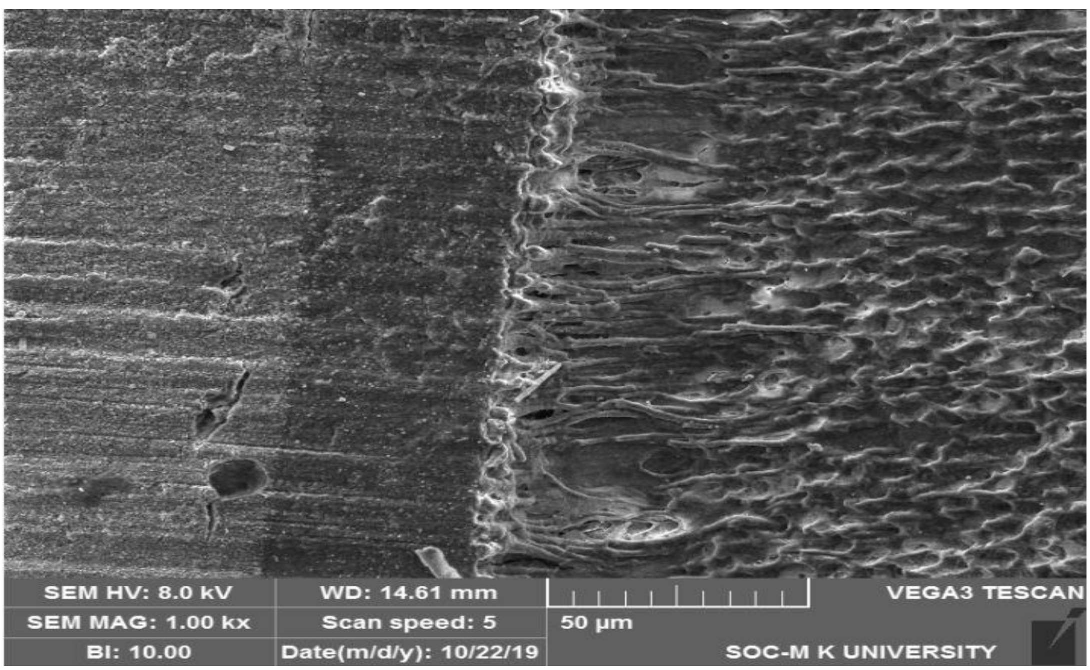


FIGURE 23: SEM image of Group 1A, etch-and-rinse group – Gluma desensitizer sample

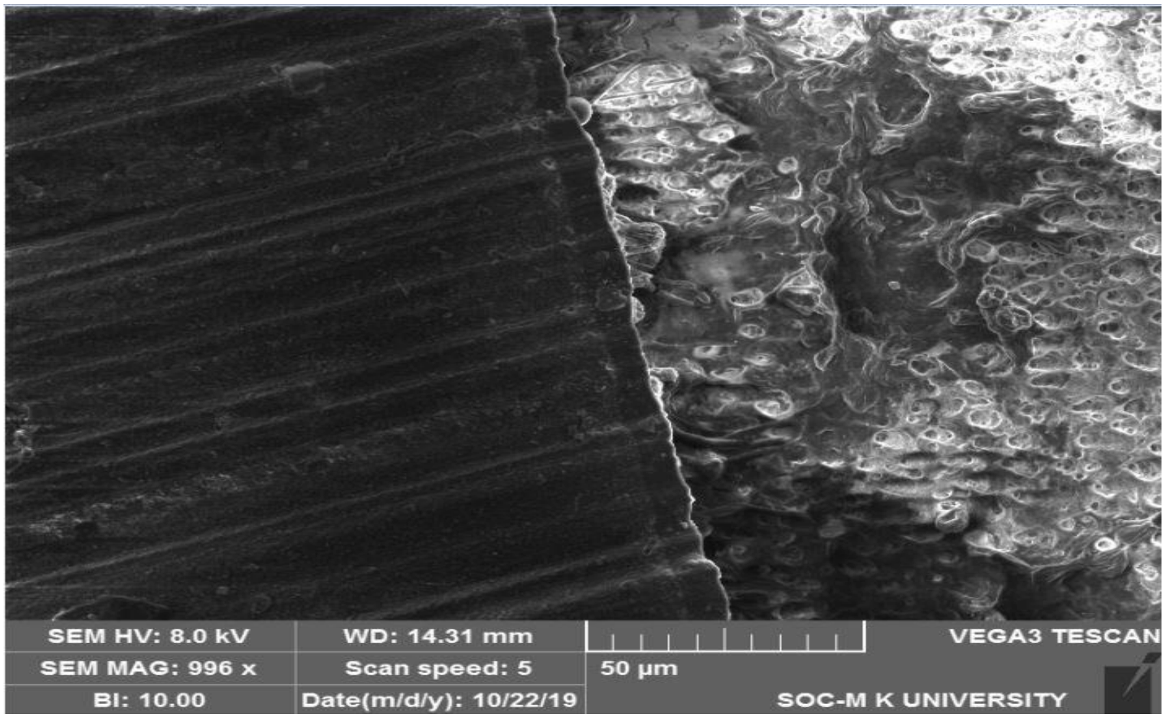


FIGURE 24: SEM image of Group 2B, self-etch group – Sensodyne repair and protect sample

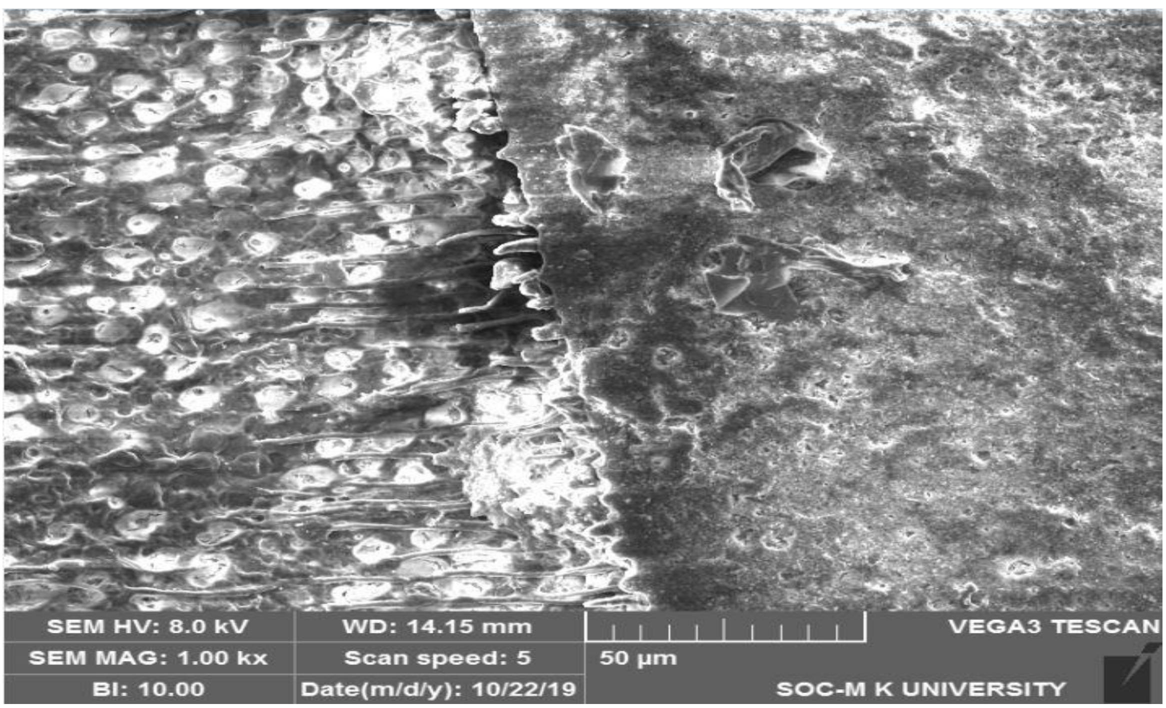


FIGURE 25: SEM image of Group 1B, etch-and-rinse group – Sensodyne repair and protect sample

RESULTS:

RESULTS:

All the values were tabulated and statistical analysis was done using Software SPSS, Version 23.0 (IBM Corp., USA). The data exhibited normal distribution as analyzed by Shapiro-Wilk test (Table 1). Mean microtensile bond strength (mpa) of etch-and-rinse and self-etch groups are shown in Table 2.One way ANOVA showed significant differences in bond strength values between the etchant groups (p =0.05). Microtensile bond strength between the groups and within the groups was calculated using One Way ANOVA Variance is shown in Table 3. The mean microtensile bond strength between the etch-and-rinse group and self-etch group showed significant difference. Self-etch group showed significantly greater bond strength when compared to the etch-and-rinse group in Table 3. But no significant difference was seen among the desensitizer agent groups, Sensodyne paste, Gluma Desensitizer and control group in both the etch-and-rinse and self-etch category which is shown in Table 4 and Table 6. Analyzing the type of fracture 67% of the failures were adhesive, 30 % were cohesive and 3% were fracture within the tooth in table 8. Considering the groups separately etch-and-rinse group showed 80% cohesive, 13% adhesive and 7% fracture within the tooth. The self-etch group showed 57% cohesive and 43% adhesive failure. When considering within the groups Sensodyne paste group had higher incidence of adhesive failure when compared to Gluma Desensitizer and control group in self-etch group and etch-and-rinse group but was not significant. Whereas the Gluma Desensitizer and control group had higher incidence of cohesive fracture when compared to Sensodyne paste group in both etch-and-rinse and self-etch group. The chi square analysis is shown in table 9. Table 10 shows the univariate analysis of variance which confirms that significant difference is seen within etch type and not with dentin treatment. Table 11 shows post hoc test depicting no significant difference among between Gluma Desensitizer, Sensodyne paste group and control groups.

Scanning electron microscope images of the additional samples are shown in Figure 20, Figure 21, Figure 22, Figure 23, Figure 24 and Figure 25.

SEM images of etch-and-rinse group showed thick and homogenous hybrid layer in control group and non-homogenous, thin hybrid layer in the other two desensitizer treated groups.

SEM images of self-etch group showed the formation of thick and homogenous hybrid layer in the control group. In GLUMA applied group, dentin tubules showed tubules occluded with adhesive penetration. In desensitizing toothpaste group the tubules were occluded with mineral deposits.. And if the bonding is due to resin tag (micro-mechanical) the control group would have had significantly greater microtensile bond strength but there was no significant difference between the microtensile bond strength in the control group and the two treated groups. The concept of bonding mechanism here is more of chemical interaction than resin tag formation (micro-mechanical). And this bonding is stable even after dentin being treated with desensitizing agents.

TABLES AND GRAPHS:

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TABLE 1 : Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Micro Tensile Strength	.107	30	.200*	.979	30	**.797**

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

TABLE 2 : MEAN MICROTENSILE BOND STRENGTH (MPa) OF ETCH-AND-RINSE AND SELF-ETCH GROUPS

ETCH TYPE	Mean (MPa)	N	Std. Deviation
Etch-and-rinse	10.4047	15	2.01831
Self-etch	13.7007	15	2.85650
Total	12.0527	30	2.95215

GRAPH 1: MEAN MICROTENSILE BOND STRENGTH OF ETCH-AND-RINSE AND SELF-ETCH GROUPS

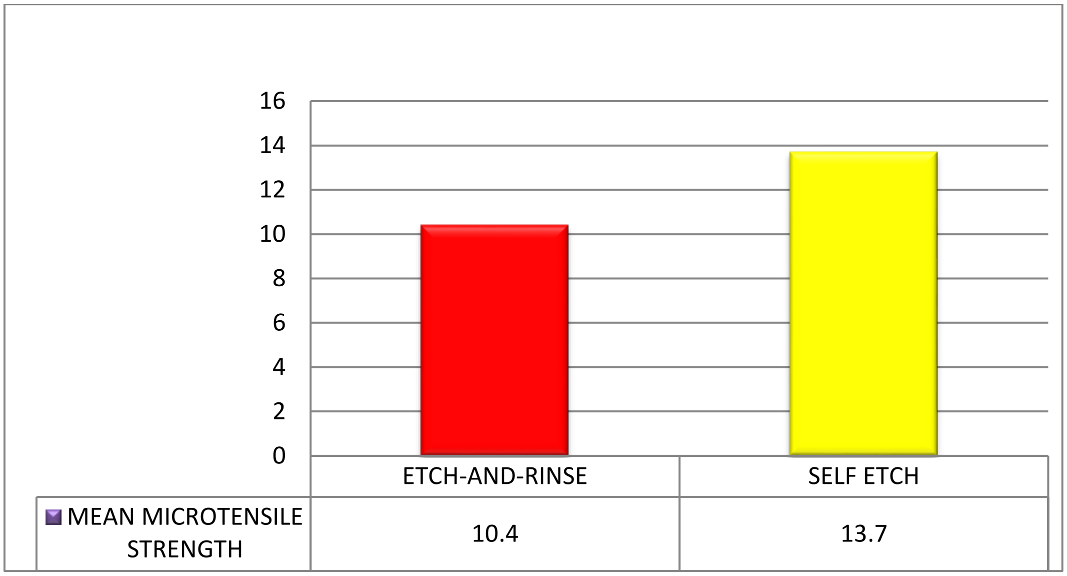


TABLE 3 : ANOVA TABLE

		Sum of Squares	df	Mean Square	F	Sig.
Micro Tensile Strength * ETCH TYPE	Between Groups (Combined)	81.477	1	81.477	**13.321**	**.001**
	Within Groups	171.264	28	6.117		
	Total	252.741	29			

TABLE 4 : MEAN MICROTENSILE BOND STRENGTH OF 3 GROUPS (1A,1B,1C) IN ETCH-AND-RINSE GROUP

Dentin Treatment	Mean (MPa)	N	Std. Deviation
Desensitizing Toothpaste	12.5600	5	1.52151
GLUMA	9.1300	5	1.46823
Control	9.5240	5	.98969
Total	10.4047	15	2.01831

a. ETCH TYPE = Etch-and-rinse

GRAPH 2 : MEAN MICROTENSILE BOND STRENGTH OF 3 GROUPS (1A,1B,1C) IN ETCH-AND-RINSE GROUP

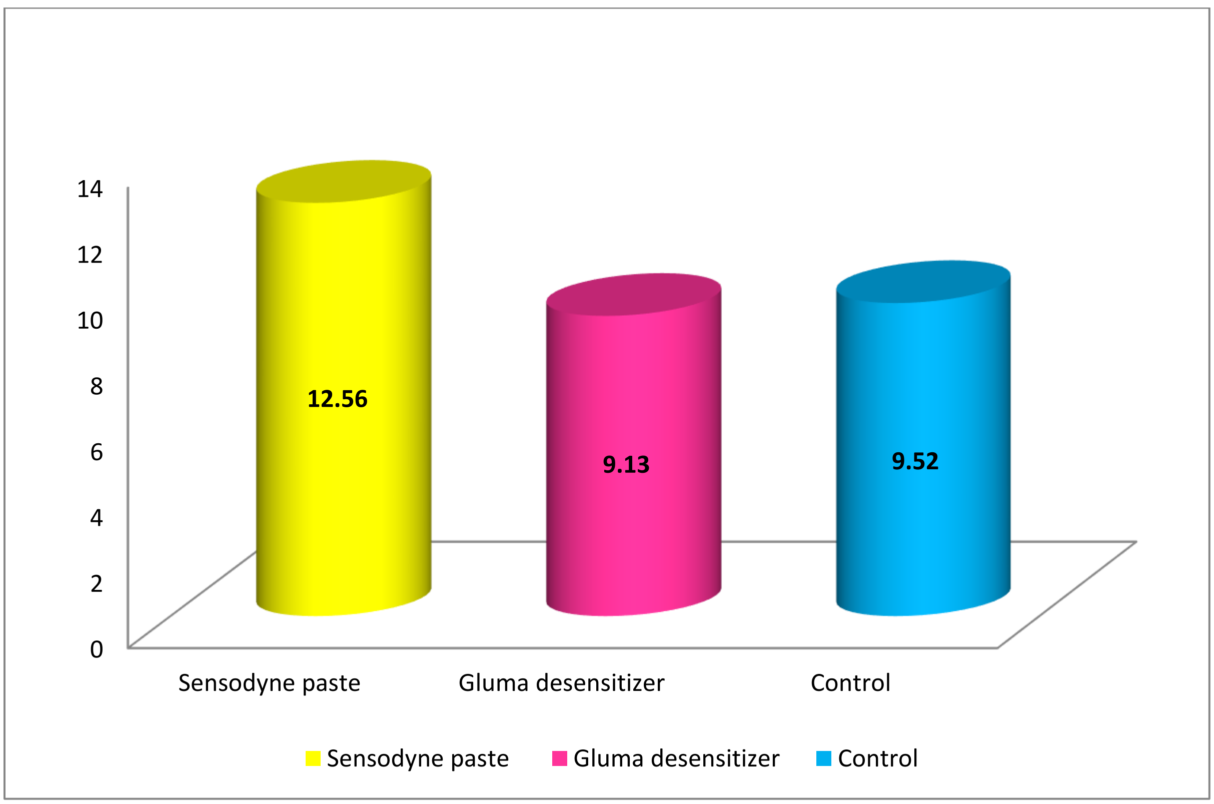


TABLE 5 : ANOVA TABLE

			Sum of Squares	df	Mean Square	F	Sig.
Micro Tensile Strength * Dentin Treatment	Between Groups	(Combined)	35.229	2	17.615	9.696	.003
	Within Groups		21.801	12	1.817		
	Total		57.030	14			

TABLE 6 : **MEAN MICROTENSILE BOND STRENGTH OF 3 GROUPS (2A,2B,2C) IN SELF-ETCH GROUP**

Dentin Treatment	Mean	N	Std. Deviation
Sensodyne Toothpaste	13.5940	5	2.15127
GLUMA	14.2400	5	3.43834
Control	13.2680	5	3.39064
Total	13.7007	15	2.85650

a. ETCH TYPE = Self-etch

GRAPH 3 : MEAN MICROTENSILE BOND STRENGTH OF 3 GROUPS (2A,2B,2C) IN SELF-ETCH GROUP

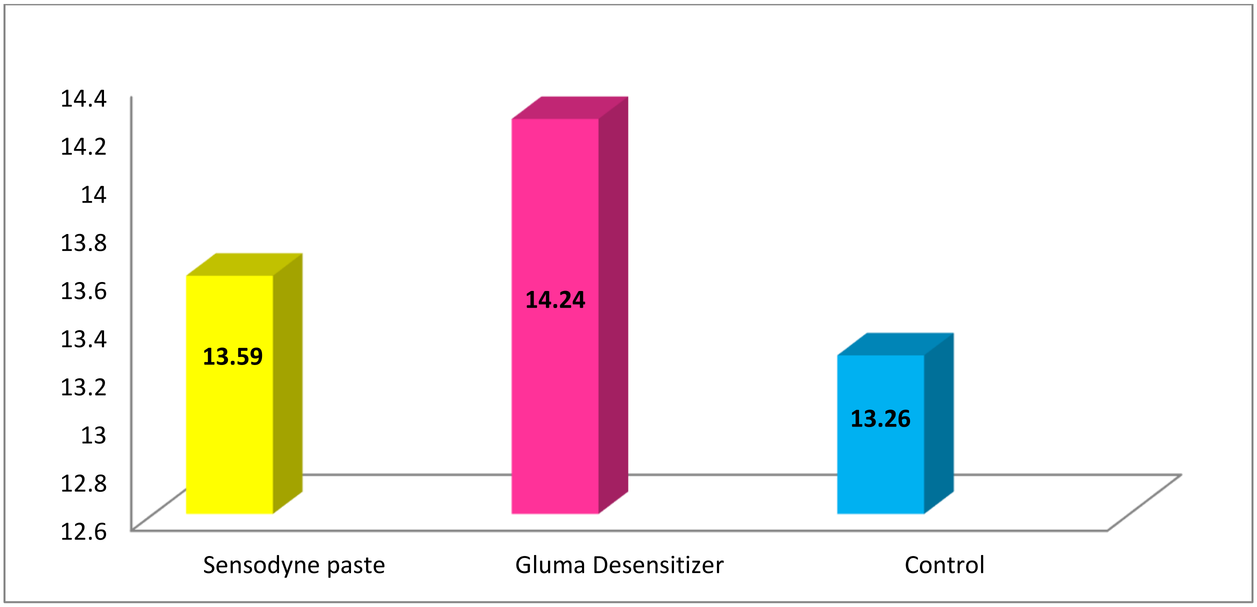


TABLE 7 : ANOVA TABLE

			Sum of Squares	df	Mean Square	F	Sig.
Micro Tensile Strength * Dentin Treatment	Between Groups	(Combined)	2.447	2	1.224	.131	.878
	Within Groups		111.787	12	9.316		
	Total		114.234	14			

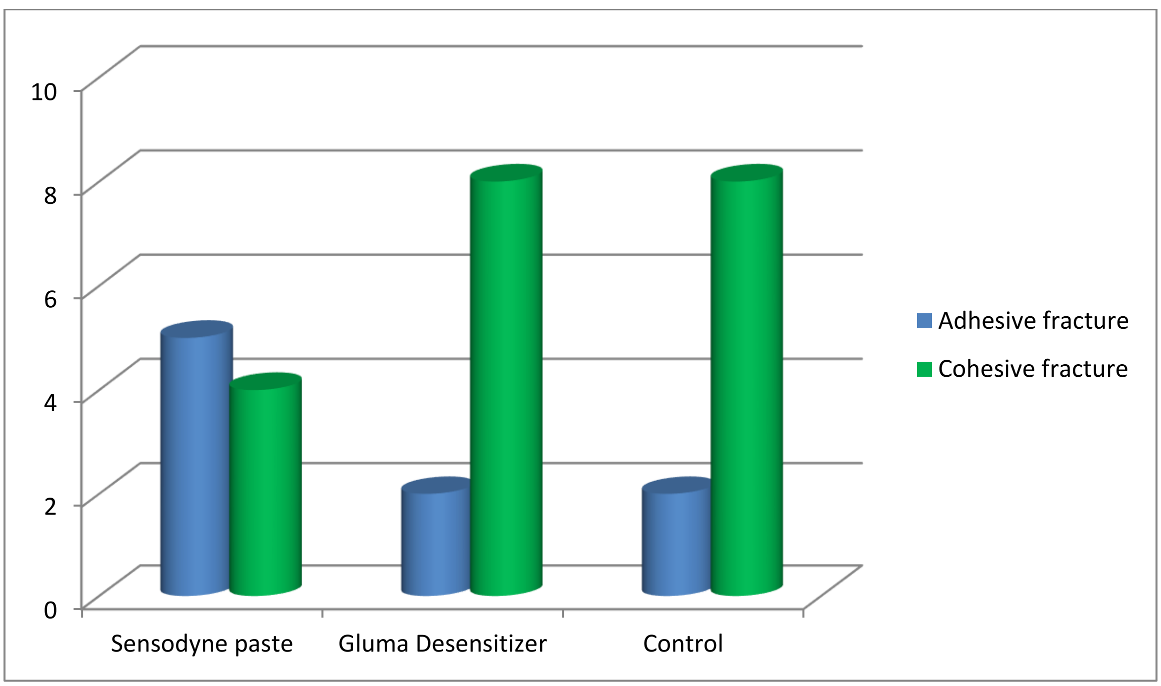
a. ETCH TYPE = Self-etch

TABLE 8 : Dentin Treatment * Type of Fracture * ETCH TYPE Cross tabulation

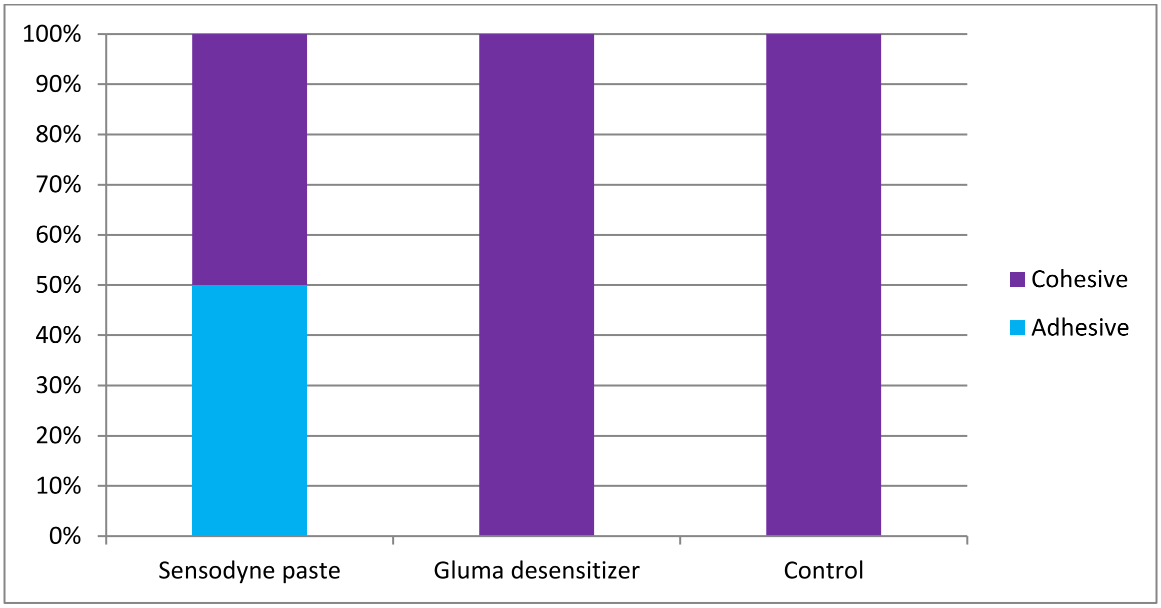
ETCH TYPE				Type of Fracture			Total
				Adhesive	Cohesive Composite	Cohesive Tooth fracture	
Etch-and-rinse	Dentin Treatment	Desensitizing Toothpaste	Count	2	2	1	5
			% within Dentin Treatment	40.0%	40.0%	20.0%	100.0%
		GLUMA	Count	0	5	0	5
			% within Dentin Treatment	0.0%	100.0%	0.0%	100.0%
		Control	Count	0	5	0	5
			% within Dentin Treatment	0.0%	100.0%	0.0%	100.0%
	Total		Count	2	12	1	15
			% within Dentin Treatment	13.3%	80.0%	6.7%	100.0%
Self-etch	Dentin Treatment	Desensitizing Toothpaste	Count	3	2		5
			% within Dentin Treatment	60.0%	40.0%		100.0%
		GLUMA	Count	2	3		5
			% within Dentin Treatment	40.0%	60.0%		100.0%
		Control	Count	2	3		5
			% within Dentin Treatment	40.0%	60.0%		100.0%
	Total		Count	7	8		15
			% within Dentin Treatment	46.7%	53.3%		100.0%
Total	Dentin Treatment	Desensitizing Toothpaste	Count	5	4	1	10
			% within Dentin	50.0	40.0%	10.0%	100.0

		Treatment	%			%
	GLUMA	Count	2	8	0	10
		% within Dentin Treatment	20.0 %	80.0%	0.0%	100.0 %
	Control	Count	2	8	0	10
		% within Dentin Treatment	20.0 %	80.0%	0.0%	100.0 %
Total		Count	9	20	1	30
		% within Dentin Treatment	30.0 %	66.7%	3.3%	100.0 %

GRAPH 4 : TYPE OF FRACTURE AMONG SIX GROUPS



GRAPH 5 : TYPE OF FRACTURE IN ETCH-AND-RINSE GROUP



GRAPH 6 : TYPE OF FRACTURE IN SELF-ETCH GROUP

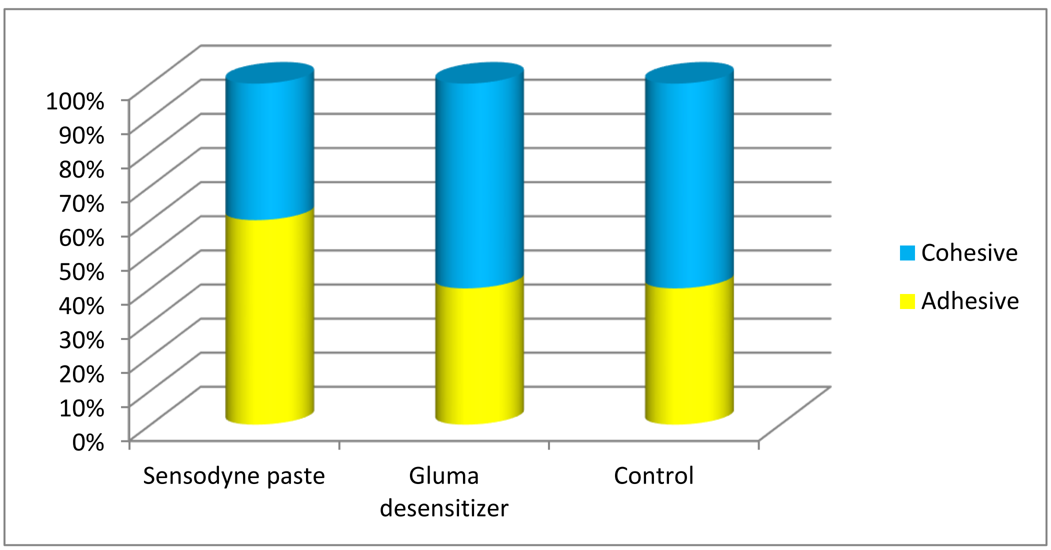


TABLE 9 : Chi-Square Test

ETCH TYPE		Value	df	Asymptotic Significance (2-sided)
Etch-and-rinse	Pearson Chi-Square	7.500[b]	4	.112
	Likelihood Ratio	8.282	4	.082
	Linear-by-Linear Association	.477	1	.490
	N of Valid Cases	15		
Self-etch	Pearson Chi-Square	.536[c]	2	.765
	Likelihood Ratio	.537	2	.764
	Linear-by-Linear Association	.375	1	.540
	N of Valid Cases	15		
Total	Pearson Chi-Square	5.600[a]	4	.231
	Likelihood Ratio	5.809	4	.214
	Linear-by-Linear Association	.737	1	.391
	N of Valid Cases	30		

TABLE 10:Univariate Analysis of Variance

Tests of Between-Subjects Effects

Dependent Variable: Micro Tensile Strength

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	119.153[a]	5	23.831	4.281	.006
Intercept	4358.003	1	4358.003	782.949	.000
ETCHTYPE	81.477	1	81.477	14.638	.001
DentinTreatment	16.156	2	8.078	1.451	.254
ETCHTYPE * DentinTreatment	21.520	2	10.760	1.933	.167
Error	133.587	24	5.566		
Total	4610.744	30			
Corrected Total	252.741	29			

a. R Squared = .471 (Adjusted R Squared = .361)

TABLE 11: Post Hoc Tests
Dentin Treatment

Multiple Comparisons

Dependent Variable: Micro Tensile Strength

Tukey HSD

(I) Dentin Treatment	(J) Dentin Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Desensitizing Toothpaste	GLUMA	1.3920	1.05510	.399	-1.2429	4.0269
	Control	1.6810	1.05510	.268	-.9539	4.3159
GLUMA	Desensitizing Toothpaste	-1.3920	1.05510	.399	-4.0269	1.2429
	Control	.2890	1.05510	.960	-2.3459	2.9239
Control	Desensitizing Toothpaste	-1.6810	1.05510	.268	-4.3159	.9539
	GLUMA	-.2890	1.05510	.960	-2.9239	2.3459

Based on observed means.

The error term is Mean Square(Error) = 5.566.

DISCUSSION:

DISCUSSION

Desensitizing agents seal the dentinal tubules by blocking the openings. Before the use of adhesive restoration in non carious cervical lesions (NCCL), it may be an important preliminary method for the relief of dentinal hypersensitivity (39). However, there have been reports that the desensitizing agents may make it difficult for the adhesive system to infiltrate, and consequently hybridize the dentin, resulting in lower bond strength, and contributing to gaps at the bonded interface in the areas of stress (21)(32).

The desensitizers that are currently used and available in the market are diverse. The desensitizer that is used in our investigation is Gluma Desensitizer and Novamin® based desensitizing toothpaste. The active component of Gluma Desensitizer is 5% glutaraldehyde. Its desensitizing mechanism remained elusive until Schupbach and others showed that topical application of glutaraldehyde/ HEMA combination products resulted in a series of horizontal partitions within jthe lumens of exposed dentinal tubules(8). More recent spectroscopic studies in vitro revealed that the glutaraldehyde in Gluma reacts with plasma proteins such as albumin to form protein precipitates, which then react with HEMA to form a mixture of poly-HEMA copolymerized with glutaraldehyde–cross-linked albumin(54). These precipitates occlude the dentinal tubules, and supresses dentin sensitivity. The longevity of these precipitates in the dentinal tubules has not been investigated. Dentinal fluid and saliva contain esterases that could degrade the ester and peptide bonds in these intratubular precipitates(55)(56). Saliva also contains matrix metalloproteinases (MMPs) and kallikreins that could attack collagen and plasminogen, respectively(57,58). If these enzymes degrade the Gluma-created occluded precipitates, then their desensitizing activity would be lost if the intratubular precipitates were destroyed(30). That is why a restoration might be necessary for long term prevention of dentinal hypersenstivity. Restorative treatment has good benefits as the dentinal tubules are effectively occluded by resinous monomers. While it is desirable to reduce sensitivity, it is also important to evaluate the possible adverse effects of these desensitizing agents on the diffusion and adhesion of composite with dentin. In addition, the interference of desensitizing agents in bond strength to dentin may occur as a result of the neutralization of acid etching by the deposits formed on the treated substrate, consequently inhibiting the formation of an efficient and uniform hybrid layer(59). The satisfactory results achieved with Gluma desensitizing agent occurred because the product is normally recommended for use under restorations to reduce postoperative sensitivity, after the dentinal smear layer has been removed and before cementation procedures; it has not been found to affect bond strength values of adhesive systems(43).

The active ingredient NOVAMIN® in Sensodyne Repair and Protect toothpaste is the inorganic chemical calcium sodium phosphosilicate ($CaNaO_6Psi$). The use of bioglass paste for dentin hypersensitivity management was suggested by Lee *et al* in 2005(60). It was observed to produce considerable sealing depth in dentinal tubules(61).The physical occlusion of NovaMin particles begins in the dentinal tubules when the material is exposed to an aqueous environment. Sodium ions (Na^+) in the particles immediately begin to exchange with hydrogen cations (H^+ or H_3O^+) in the tooth which rapidly release the calcium ions (Ca^+) in the particle structure as well as phosphate ions (PO_4^{3-}) to be released from the material(61). This early series of reactions occur within seconds of exposure to saliva and the release of the calcium and phosphate ions continue as long as the particles are exposed to the oral environment. A localized, transient increase in oral pH occurs during the initial exposure of the material because of its release of sodium(61). This increase in pH helps to precipitate the calcium and phosphate ions from the NovaMin particles, along with calcium and phosphorus found in saliva, to form a calcium–phosphate (Ca–P) layer(45). As the particle reactions and the deposition of calcium and phosphate complexes continues, this layer crystallizes into hydroxycarbonate apatite, which is chemically and structurally equivalent to biological apatite(45). The combination of the residual NovaMin particles and the hydroxycarbonate apatite layer results in the physical occlusion of dentinal tubules, which relieves hypersensitivity(45).

At dentin, the phosphoric-acid treatment exposes a microporous network of collagen that is totally deprived of hydroxyapatite and also removes the smear layer completely. The primary bonding mechanism of etch & rinse adhesives to dentin is primarily diffusion-based and depends on hybridization or infiltration of resin within the exposed collagen fibril scaffold, which should be as complete as possible(62). True chemical bonding is rather unlikely, because the functional groups of monomers may have only weak affinity to the *''hydroxyapatitedepleted''* collagen(62). Removal of the smear layer increases the permeability of the dentin tubules radically, thus permitting fluid flow from outside the pulpal chamber, and vice versa. After removal of the smear layer by an acid, dentin permeability through the dentin tubules increases by more than 90%(62) . But in self etch with more acidic and aggressive conditioner, the smear layer and smear plugs will be removed more completely. The thickness of the hybrid layer and the presence of resin tags do not overly influence the bonding performance in self etch adhesives, chemical interaction between the monomers and hydroxyapatite may be a plausible explanation for the good performance of self-etch adhesives(62)(63).

From the results of the present observation, it could be speculated that total etch completely removes the occluded crystals in the dentinal tubules , without leaving any / partial hydroxyapatite crystals thus leading to degradation of the collagen fibres and decreasing the bond strength. While phosphoric acid dissolves the smear layer and opens dentin tubules for infiltration with resin monomers, self-etching primers partially dissolve hydroxyapatite, modifying the smear layer rather than dissolving it and thus becoming part of the hybrid layer (24,47). Thus it was able to interact chemically with the hydroxyapatite and had better bond strength to dentin compared to the total etch. And also, Because of the water content in Gluma Desensitizer it also serves as rewetting agents that may expand the demineralized collagen network and further increase its surface energy. They all facilitate in the diffusion of resinous monomers into the partially demineralized dentin, and by improving the resin-dentin bonds(30). In view of the fact that the acidity of self-etching adhesives continues to demineralize the dentin under the hybridized layer, we can speculate that further diffusion into the dentin matrix and chemical bonding or interaction of some resin monomers in these groups would have continued to strengthen hybrid zone(30). In addition to being regarded as less technique sensitive, self etching adhesives are also known to yield lower postoperative sensitivity compared with etch-and rinse systems.(25) This is largely the result of the less aggressive demineralization pattern and thus the more superficial interaction with dentin, which leaves tubules largely obstructed with smear minimizing water movement across the interface(64,65). However, postoperative sensitivity is still a relatively common finding with self-etching adhesives, perhaps because of the continued action of the acidic monomers, which causes further demineralization beyond the depth of adhesive resin infiltration, leaving areas of unencapsulated collagen at the bottom of the hybrid layer where fluid movement can still occur(66).

In Sensodyne Repair and Protect toothpaste, the active substance present in it promotes deeper obliteration of dentinal tubules which is supposed to be more resistant to acidic challenges than the occluded crystals of Gluma Densensitizer. Further, the occluded layer of acid-resistant calcium oxalate crystals interferes with the resin infiltration in the demineralized collagen matrices(27). Thus more number of adhesive fractures were seen in Sensodyne Repair and Protect toothpaste group than in Gluma Densensitizer group. Studies on the use of self-etching agents on enamel indicated the need for selective acid etching before the application of these adhesive systems; and some manufacturers have now included this modification of technique in their instructions for use(5).

Studies regarding bulk fill composites have shown that bulk fill composites perform equally to conventional resin based composites in terms of fracture toughness. Though bulk-fill materials may be limited in terms of shade and translucency of the materials in comparison to conventional hybrid RBCs(67).

Further bond degradation studies with larger sample size and longer incubation periods are needed to identify the differences in degradation patters when using various combinations of adhesives and desensitizing agents. One of the limitations of the present study could be the sample size of 36, which may have limited our ability to detect statistically significant difference. Further evaluation of different combinations of adhesive materials and desensitizers, as well as evaluation of desensitizers with different mechanisms of action, in the bonding sequence is necessary.

SUMMARY:

SUMMARY

The aim of the present study is to evaluate the role of etch-and-rinse and self-etch on bond strength of teeth subjected to Gluma ,an office desensitizer and Sensodyne repair and protect (Novamin). The secondary objective is to analyze the morphological pattern of the hybrid layer in specimens treated with desensitizing agents in scanning electron microscope and evaluate the type of restoration failure. A sample of 36 sound freshly extracted human mandibular premolar teeth were selected for current investigation.

The samples were randomly divided into two groups: Group 1 – etch-and-rinse (n=18), Group 2 – self-etch (n=18).

Group 1 was further subdivided into 1A - Gluma Desensitizer (Heraeus Kulzer GmbH) (n=6), 1B - Sensodyne Repair and Protect, powered by Novamin (Group Pharmaceuticals Limited,India) (n=6) ,1C - control where no desensitizing agents were applied (n=6). Group 2 was similarly subdivided into 2A - Gluma Desensitizer (Heraeus Kulzer GmbH) (n=6), 2B - Sensodyne Repair and Protect, powered by Novamin (Group Pharmaceuticals Limited,India) (n=6) ,2C - control where no desensitizing agents were applied (n=6).

After adhesive procedure, the restored samples (n=30), 5 in each group were selected for mechanical testing and 1 in each group (n=6) was allotted for scanning electron microscope analysis.

After microtensile bond strengths,each of the specimens were observed using a microscope (Labomed, Prima icroscope , USA) under 2.5x magnification to observe the type of fracture (Cohesive / Adhesive).

One sample was taken randomly in each group (n=6) with bonded composite resins to analyze the morphological pattern of the hybrid layer in specimens that were treated with desensitizing agents. The specimens were then mounted on the SEM, prior to which gold sputtering was done and examined.

All the values were tabulated and statistical analysis was done using Software SPSS, Version 23.0 (IBM Corp., USA).

CONCLUSIONS:

CONCLUSIONS

From the present study it can be concluded that,

- Bond strength increased with self-etch and it performed better when compared to etch-and-rinse along with the desensitizers used and was statistically significant.
- Higher number of adhesive fractures were seen in Sensodyne Repair and Protect group when compared to Gluma Desensitizer and the control group.
- When dentin has been treated with desensitizing agents it is preferable to opt for mild self-etching bonding agents.

REFERENCES:

REFERENCES

1. Collaert B, Fischer C. Dentine hypersensitivity: a review. Vol. 7, Dental Traumatology. 1991. p. 145–52.

2. BRAENNSTROEM M, ASTROEM A. A STUDY ON THE MECHANISM OF PAIN ELICITED FROM THE DENTIN. J Dent Res [Internet]. [cited 2019 Aug 30];43:619–25. Available from: http://www.ncbi.nlm.nih.gov/pubmed/14183350

3. Jain P, Vargas MA, Denehy GE, Boyer DB. Dentin desensitizing agents: SEM and X-ray microanalysis assessment. Am J Dent [Internet]. 1997 Feb [cited 2019 Aug 30];10(1):21–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/9545916

4. Arrais CAG, Chan DCN, Giannini M. Effects of desensitizing agents on dentinal tubule occlusion. J Appl Oral Sci [Internet]. 2004 Jun [cited 2019 Aug 30];12(2):144–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21365138

5. Cavalcanti AN, Souza ES de, Lopes G dos S, Freitas AP de, Araújo RPC de, Mathias P. Effect of a desensitizing dentifrice on the bond strength of different adhesive systems. Brazilian J Oral Sci. 2013;12(2):148–52.

6. Jacobsen PL, Bruce G. Clinical dentin hypersensitivity: understanding the causes and prescribing a treatment. J Contemp Dent Pract [Internet]. 2001 Feb 15 [cited 2019 Aug 30];2(1):1–12. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12167939

7. Dondi dall’Orologio G, Malferrari S. Desensitizing effects of Gluma and Gluma 2000 on hypersensitive dentin. Am J Dent [Internet]. 1993 Dec [cited 2019 Aug 30];6(6):283–6.

Available from: http://www.ncbi.nlm.nih.gov/pubmed/7880476

8. Schüpbach P, Lutz F, Finger WJ. Closing of dentinal tubules by Gluma desensitizer. Eur J Oral Sci [Internet]. 1997 Oct [cited 2019 Aug 30];105(5 Pt 1):414–21. Available from: http://www.ncbi.nlm.nih.gov/pubmed/9395102

9. Ciucchi B, Bouillaguet S, Holz J, Pashley D. Dentinal fluid dynamics in human teeth, in vivo. J Endod. 1995;21(4):191–4.

10. Kerns DG, Scheidt MJ, Pashley DH, Horner JA, Strong SL, Van Dyke TE. Dentinal tubule occlusion and root hypersensitivity. J Periodontol [Internet]. 1991 Jul [cited 2019 Aug 30];62(7):421–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/1920008

11. Joshi S, Gowda AS, Joshi C. Comparative evaluation of NovaMin desensitizer and Gluma desensitizer on dentinal tubule occlusion: A scanning electron microscopic study. J Periodontal Implant Sci. 2013 Dec;43(6):269–75.

12. Vahid Golpayegani M, Sohrabi A, Biria M, Ansari G. Remineralization Effect of Topical NovaMin Versus Sodium Fluoride (1.1%) on Caries-Like Lesions in Permanent Teeth. J Dent (Tehran) [Internet]. 2012 [cited 2019 Aug 30];9(1):68–75. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22924104

13. Salian S, Thakur S, Kulkarni S, LaTorre G. A randomized controlled clinical study evaluating the efficacy of two desensitizing dentifrices. J Clin Dent [Internet]. 2010 [cited 2019 Aug 30];21(3):82–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21207919

14. Gillam DG, Tang JY, Mordan NJ, Newman HN. The effects of a novel Bioglass dentifrice on dentine sensitivity: a scanning electron microscopy investigation. J Oral Rehabil [Internet]. 2002 Apr [cited 2019 Aug 30];29(4):305–13. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11966962

15. Porto ICCM, Andrade AKM, Montes MAJR. Diagnosis and treatment of dentinal hypersensitivity. J Oral Sci [Internet]. 2009 Sep [cited 2019 Aug 30];51(3):323–32. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19776498

16. Qin C, Xu J, Zhang Y. Spectroscopic investigation of the function of aqueous 2-hydroxyethylmethacrylate/glutaraldehyde solution as a dentin desensitizer. Eur J Oral Sci [Internet]. 2006 Aug [cited 2019 Aug 30];114(4):354–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16911108

17. Reinhardt JW, Stephens NH, Fortin D. Effect of Gluma desensitization on dentin bond strength. Am J Dent [Internet]. 1995 Aug [cited 2019 Aug 30];8(4):170–2. Available from: http://www.ncbi.nlm.nih.gov/pubmed/7576381

18. Cilli R, Prakki A, de Araújo PA, Pereira JC. Influence of glutaraldehyde priming on bond strength of an experimental adhesive system applied to wet and dry dentine. J Dent [Internet]. 2009 Mar [cited 2019 Aug 30];37(3):212–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19124185

19. Ravikumar N, Indira R, Shankar P. Shear bond strengths of two dentin bonding agents with two desensitizers: An in vitro study. J Conserv Dent [Internet]. 2011 [cited 2019 Aug 30];14(3):247. Available from: http://www.jcd.org.in/text.asp?2011/14/3/247/85802

20. Farghal NS, Abdalla AI, El-Shabrawy SM, Showaib EA. The effect of combined application of new dentin desensitizing agent and deproteinization on dentin permeability of different adhesive systems. Tanta Dent J. 2013 Dec;10(3):138–44.

21. Aranha ACC, Siqueira Junior ADS, Cavalcante LMA, Pimenta LAF, Marchi GM. Microtensile bond strengths of composite to dentin treated with desensitizer products. J Adhes Dent [Internet]. 2006 Apr [cited 2019 Aug 22];8(2):85–90. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16708719

22. Silva e Souza MH, Carneiro KGK, Lobato MF, Silva e Souza P de AR, de Góes MF. Adhesive systems: important aspects related to their composition and clinical use. J Appl Oral Sci [Internet]. [cited 2019 Aug 30];18(3):207–14. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20856995

23. Pereira PN, Okuda M, Sano H, Yoshikawa T, Burrow MF, Tagami J. Effect of intrinsic wetness and regional difference on dentin bond strength. Dent Mater [Internet]. 1999 Jan [cited 2019 Aug 30];15(1):46–53. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10483395

24. Perdigão J, Lopes M. Dentin bonding--questions for the new millennium. J Adhes Dent [Internet]. 1999 [cited 2019 Aug 30];1(3):191–209. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11725668

25. Perdigão J, Geraldeli S, Hodges JS. Total-etch versus self-etch adhesive: Effect on postoperative sensitivity. J Am Dent Assoc. 2003;134(12):1621–9.

26. Sailer I, Tettamanti S, Stawarczyk B, Fischer J, Hämmerle CHF. In vitro study of the

influence of dentin desensitizing and sealing on the shear bond strength of two universal resin cements. J Adhes Dent. 2010;12(5):381–92.

27. Bhatia S, Krishnaswamy M. Effect of two different dentin desensitizers on shear bond strength of two different bonding agents to dentin: An in vitro study. Indian J Dent Res. 2012 Nov;23(6):703–8.

28. Külünk S, Saraç D, Külünk T, Karakaş O. The effects of different desensitizing agents on the shear bond strength of adhesive resin cement to dentin. J Esthet Restor Dent [Internet]. 2011 Dec [cited 2019 Aug 30];23(6):380–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22142297

29. Seara SF, Erthal BS, Ribeiro M, Kroll L, Pereira GDS. The influence of a dentin desensitizer on the microtensile bond strength of two bonding systems. Oper Dent [Internet]. [cited 2019 Aug 22];27(2):154–60. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11933906

30. Sabatini C, Wu Z. Effect of Desensitizing Agents on the Bond Strength of Mild and Strong Self-etching Adhesives. Oper Dent [Internet]. [cited 2019 Aug 22];40(5):548–57. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25575197

31. Söderholm KJ, Geraldeli S, Shen C. What do microtensile bond strength values of adhesives mean? J Adhes Dent. 2012;14(4):307–14.

32. Rar A, Sm M, Wzw MN. Effect of desensitizing agent on shear bond strength of an adhesive system. 2007;32–5.

33. Jena A, Kala S, Shashirekha G. Comparing the effectiveness of four desensitizing toothpastes on dentinal tubule occlusion : A scanning electron microscope analysis. 2017;269–72.

34. Prolongado U, Dentífrica DP. Influence of Prolonged use of Desensitizing Dentifrices on Dentin Bond Strength of Self-Etching Adhesive System. 2016;10(1):135–42.

35. Yilmaz NA, Ertas E, Orucoğlu H. Evaluation of Five Different Desensitizers: A Comparative Dentin Permeability and SEM Investigation In Vitro. Open Dent J. 2017;11(1):15–33.

36. Effect of desensitizing agents on dentin permeability and dentin tubule occlusion Justine L. Kolker.

37. Mushtaq S, Gupta R, Dahiya P, Kumar M, Bansal V, Melwani S. Evaluation of different desensitizing agents on dentinal tubule occlusion: A scanning electron microscope study. Indian J Dent Sci [Internet]. 2019 [cited 2019 Aug 31];11(3):121. Available from: http://www.ijds.in/text.asp?2019/11/3/121/261950

38. Kim SY, Kim EJ, Kim DS, Lee IB. The evaluation of dentinal tubule occlusion by desensitizing agents: a real-time measurement of dentinal fluid flow rate and scanning electron microscopy. Oper Dent [Internet]. [cited 2019 Aug 31];38(4):419–28. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23110582

39. Andreatti LS, Lopes MB, Guiraldo RD, Borges AH, Dorilêo MCO, Gonini A. Efffect of desensitizing agents on the bond strength of dental adhesive systems. Appl Adhes Sci. 2014;2(1).

40. Makkar S, Goyal M, Kaushal A, Hegde V. Effect of desensitizing treatments on bond strength of resin composites to dentin- A n in vitro study. J Conserv Dent. 2014 Sep 1;17(5):458–61.

41. Schmidlin PR, Sahrmann P. Current management of dentin hypersensitivity. Vol. 17, Clinical Oral Investigations. 2013. p. 55–9.

42. Mandava J, Vegesna D prasanna, Ravi R, Boddeda MR, Uppalapati LV, Ghazanfaruddin MD. Microtensile bond strength of bulk-fill restorative composites to dentin. J Clin Exp Dent. 2017 Aug 1;9(8):e1023–8.

43. Soeno K, Taira Y, Matsumura H, Atsuta M. Effect of desensitizers on bond strength of adhesive luting agents to dentin. J Oral Rehabil. 2001;28(12):1122–8.

44. Morsy K, Abdalla A, Shalaby M. Clinical evaluation of three adhesive systems in class V carious lesions. Tanta Dent J [Internet]. 2018 [cited 2019 Sep 12];15(3):132. Available from: http://www.tmj.eg.net/text.asp?2018/15/3/132/243076

45. Narongdej T, Sakoolnamarka R, Boonroung T. The effectiveness of a calcium sodium phosphosilicate desensitizer in reducing cervical dentin hypersensitivity: a pilot study. J Am Dent Assoc [Internet]. 2010 Aug [cited 2019 Sep 11];141(8):995–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20675425

46. Schüpbach P, Lutz F, Finger WJ. Closing of dentinal tubules by Gluma desensitizer. Eur J Oral Sci [Internet]. 1997 Oct [cited 2019 Sep 11];105(5 Pt 1):414–21. Available from: http://www.ncbi.nlm.nih.gov/pubmed/9395102

47. Perdigão J, Geraldeli S, Hodges JS. Total-etch versus self-etch adhesive: Effect on postoperative sensitivity. J Am Dent Assoc. 2003;134(12):1621–9.

48. Shah S, Shivakumar AT, Khot O, Patil C, Hosmani N. Efficacy of NovaMin- and Pro-Argin-containing desensitizing dentifrices on occlusion of dentinal tubules. Dent Hypotheses. 2017;8(4):104–9.

49. Reddy GV, Akula S, Malgikar S, Babu PR, Reddy GJ, Josephin JJ. Comparative scanning electron microscope analysis of diode laser and desensitizing toothpastes for evaluation of efficacy of dentinal tubular occlusion. J Indian Soc Periodontol. 2017 Mar 1;21(2):102–6.

50. Ozlem K, Esad GM, Ayse A, Aslihan U. Efficiency of Lasers and a Desensitizer Agent on Dentin Hypersensitivity Treatment: A Clinical Study. Niger J Clin Pract [Internet]. 2018 Feb [cited 2019 Sep 28];21(2):225–30. Available from: http://www.ncbi.nlm.nih.gov/pubmed/29465059

51. Aranha ACC, Freire Pimenta LA, Marchi GM. Clinical evaluation of desensitizing treatments for cervical dentin hypersensitivity. Braz Oral Res. 2009;23(3):333–9.

52. Arisu HD, Dalkihç E, Üçtaşli MB. Effect of desensitizing agents on the microtensile bond strength of a two-step self-etch adhesive to dentin. Oper Dent [Internet]. [cited 2019 Sep 28];36(2):153–61. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21777097

53. Moosavi H, Kimyai S, Forghani M, Khodadadi R, Forghani M. The Clinical Effectiveness of Various Adhesive Systems: An 18-Month Evaluation.

54. Munksgaard EC. Amine-induced Polymerization of Aqueous HEMA/Aldehyde During

Action as a Dentin Bonding Agent. J Dent Res. 1990;69(6):1236–9.

55. Lin BA, Jaffer F, Duff MD, Tang YW, Santerre JP. Identifying enzyme activities within human saliva which are relevant to dental resin composite biodegradation. Biomaterials [Internet]. 2005 Jul [cited 2019 Sep 11];26(20):4259–64. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15683649

56. Finer Y, Santerre JP. Salivary esterase activity and its association with the biodegradation of dental composites. J Dent Res [Internet]. 2004 Jan [cited 2019 Sep 11];83(1):22–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/14691108

57. Ingman T, Tervahartiala T, Ding Y, Tschesche H, Haerian A, Kinane DF, et al. Matrix metalloproteinases and their inhibitors in gingival crevicular fluid and saliva of periodontitis patients. J Clin Periodontol [Internet]. 1996 Dec [cited 2019 Sep 11];23(12):1127–32. Available from: http://www.ncbi.nlm.nih.gov/pubmed/8997658

58. Hernández CC, Donadi EA, Reis ML. Kininogen-kallikrein-kinin system in plasma and saliva of patients with Sjögren’s syndrome. J Rheumatol [Internet]. 1998 Dec [cited 2019 Sep 11];25(12):2381–4. Available from: http://www.ncbi.nlm.nih.gov/pubmed/9858433

59. Pashley DH, Carvalho RM, Pereira JC, Villanueva R, Tay FR. The use of oxalate to reduce dentin permeability under adhesive restorations. Am J Dent [Internet]. 2001 Apr [cited 2019 Sep 11];14(2):89–94. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11507806

60. Lee B-S, Chang C-W, Chen W-P, Lan W-H, Lin C-P. In vitro study of dentin hypersensitivity treated by Nd:YAP laser and bioglass. Dent Mater [Internet]. 2005 Jun

[cited 2019 Sep 11];21(6):511–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15904693

61. Shah S, Shivakumar A, Khot O, Patil C, Hosmani N. Efficacy of NovaMin- and Pro-Argin-containing desensitizing dentifrices on occlusion of dentinal tubules. Dent Hypotheses [Internet]. 2017 [cited 2019 Sep 11];8(4):104. Available from: http://www.dentalhypotheses.com/text.asp?2017/8/4/104/219447

62. Van Meerbeek B, De Munck J, Yoshida Y, Inoue S, Vargas M, Vijay P, et al. Buonocore memorial lecture. Adhesion to enamel and dentin: current status and future challenges. Oper Dent [Internet]. [cited 2019 Sep 12];28(3):215–35. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12760693

63. Giannini M, Makishi P, Ayres APA, Vermelho PM, Fronza BM, Nikaido T, et al. Self-Etch adhesive systems: A literature review. Vol. 26, Brazilian Dental Journal. Associacao Brasileira de Divulgacao Cientifica; 2015. p. 3–10.

64. M. U, Y. M, A. A, Y. G, A. A. Self-etching adhesives and postoperative sensitivity. Am J Dent [Internet]. 2004 [cited 2019 Sep 12];17(3):191–5. Available from: http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L39205906%0Ahttp://xv9lx6cm3j.search.serialssolutions.com/?sid=EMBASE&issn=08948275&id=doi:&atitle=Self-etching+adhesives+and+postoperative+sensitivity.&stitle=Am+J+Dent&title=Americ

65. Perdigão J. New developments in dental adhesion. Dent Clin North Am [Internet]. 2007 Apr [cited 2019 Sep 12];51(2):333–57, viii. Available from:

http://www.ncbi.nlm.nih.gov/pubmed/17532916

66. Peumans M, De Munck J, Van Landuyt K, Lambrechts P, Van Meerbeek B. Three-year clinical effectiveness of a two-step self-etch adhesive in cervical lesions. Eur J Oral Sci. 2005 Dec;113(6):512–8.

67. Chesterman J, Jowett A, Gallacher A, Nixon P. Bulk-fill resin-based composite restorative materials: A review. Vol. 222, British Dental Journal. Nature Publishing Group; 2017. p. 337–44.

ANNEXURES:

ANNEXURE 1

The Diocese of Madurai - Ramnad

C.S.I. College of Dental Sciences and Research

129, East Veli Street, Madurai - 625 001. Tamilnadu, India.

Ph : 0452 - 2321708, 2336604 Fax : 2336605

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ETHICAL COMMITTEE

Prof. Dr. A. Charles, M.S., M.Ch.	Prof. Dr. S. Kalaivani, M.D.S.	Prof. Dr. N. Gururaj, M.D.S.,
PRESIDENT	VICE - PRESIDENT	SECRETARY

Title of the work : Effects of Etchant system on bond strength of the teeth subjected to desensitizing agent application – An In –Vitro study

Principal investigator : DrV. Nivedha , I MDS **CSICDSR/IEC/0035/2017**

Department: Conservative Dentistry & Endodontics

The request for an approval from the Institutional Ethical Committee (IEC) for the above mentioned study, submitted by the principal investigator is considered on the IEC meeting held on 08.09.2016 at CSI College of Dental Sciences and Research, Madurai. The members of the committee, the president, vice president, and the secretary are pleased to approve the proposed work mentioned above and is '**Advised to proceed with the study'**

The principal investigator and their team are directed to adhere the guidelines given below:

1. You should get detailed informed consent from the patients/participants and maintain confidentiality.
2. You should carry out the work without detrimental to regular activities as well as without extra expenditure to the Institution.
3. You should inform the IEC in case of any change of study procedure, site and investigation or guide.
4. You should not deviate from the area of work for which you have applied for ethical clearance.
5. You should inform the IEC immediately in case of any adverse events or serious adverse reactions. You should abide to the rules and regulations of the institution(s).
6. You should complete the work within the specific period and if any extension of time is required, you should apply for the permission again and do the work.
7. You should submit the summary of the work to the ethical committee on completion of the work.
8. You should not claim funds from the institution while doing the work or on completion.
9. You should understand that the members of IEC have the right to monitor the work with prior intimation.
10. Your work should be carried out under the direct supervision of your Guide/Professor.

Dr.A.Charles MS MCh

President

Dr.N.Gururaj MDS

Secretary

ANNEXURE 2

URKUND

Urkund Analysis Result

Analysed Document:	plagarism dox.docx (D60724434)
Submitted:	12/10/2019 4:28:00 PM
Submitted By:	vnivedha93@gmail.com
Significance:	8 %

Sources included in the report:

thesis completed.docx (D34763235)