Comparative Evaluation Of Resistance To Fracture Of Endodontically Treated Maxillary Premolars Restored With Three Different Generations Of Dentin Bonding Systems: An Vitro Study

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Abstract: Background and objectives: To evaluate and compare the shear bond strength of fifth (total etch) generation, sixth (two-step, self etch adhesive) generation and seventh (one step, self etch adhesive) generation dentin bonding agents. Methodology: Group A(control group), B(control group), and C(experimental group) were made. In all the groups, except group- A, endodontic access cavities were prepared. The apical preparation was finished with F1 and F2 Protaper universal files followed by obturation. Excess GP coronal to the orifices was removed and condensed using heated hand pluggers. Standardized Class 2 MOD cavities were prepared for all groups except for the group A. After cavity preparation, all the teeth of the experimental group were then considered for the final coronal restorations. Results: The mean Shear Bond Strength obtained by 5th generation (group C) is highest, followed by 6th generation (group D) and 7th generation (group E). Conclusion: this study shows that the easier to use adhesive systems are inferior to multi-step adhesive systems. [Rijhwani A, Natl J Integr Res Med, 2019; 10(1):6-10]

Key Words: shear bond strength, fith generation, sixth and seventh generation dentin bonding agents, fractured endodonticaly treated tooth

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Introduction: The awareness of the present community about the dental treatment available through different media have let the patients opt for root canal treatment rather than extraction. The rate of success of endodontic therapy is very high. However, root canal therapy should not be considered successful until the final coronal restoration has placed. As these teeth run at higher risk of fracture because of several factors like dehydration and loss of dentin, loss of tooth structure from caries, preparation of access cavity and instrumentation of root canal.[1,2,3] Therefore, intracoronal strengthening of teeth is important to protect them against fracture, particularly in posterior teeth where stresses generated by occlusal forces can lead to fracture of unprotected cusps.[4] Currently, all the endodontically treated teeth are given full cuspal coverage restoration, to increase the long-term success of treatment.[5,6] Though these restorations reinforce the teeth, they often require extensive tooth preparation and cost considerations to the patients. Hence it is important to examine alternative methods for the restoration of endodontically treated teeth.

There are various restorative materials used to restore endodontically treated tooth. These include silver amalgam alloy, composite resin, glass inomer cement, and resin-modified glass inomer materials. Dental amalgam and composite resins are the most commonly used ones. The use and success rate of dental amalgam have been well documented but there use is declining dentistry mainly due to the unaesthetic appearance and concern about the hazards of mercury. As an alternative to amalgam, a direct adhesive restorative technique with composite resin have been proposed. [7]

Due to the technique sensitivity, i.e. the higher risk of overetching or overdrying of dentin structure which results in an insufficient penetration of the collagen fiber network, new types of adhesives which were simpler to use have been developed. .Two such systems evolved, one consisting of an acidic primer and a bonding resin, referred to as a sixth generation adhesive self etch primer and bonding and another in which the etchant, primer, and adhesive were combined into single delivery system, marketed as the seventh generation of adhesive systemsself etch adhesive . These adhesive systems – characterized by acidic monomers that are not rinsed from the tooth surface – have become popular due to a purported simplified technique, which requires fewer steps and eliminates clinical procedure regarding residual dentin moisture. These systems act by simultaneously conditioning, demineralizing, and

infiltrating both the enamel and the dentin.[8] Hence, the present study is undertaken to determine and evaluate the shear bond strength of fifth total etch, sixth two-step, self etch adhesive and seventh one step, self etch adhesive generation dentin bonding agents. Shear bond strength testing was used in this study as a screening tool to help understand and predict the clinical behavior of adhesives.[9]

Aims And Objectives. : Aim: To measure the resistance to fracture of endodontically treated premolars restored with three different generations of bonding agents. Objectives: 1.To compare the fracture resistance of intact teeth and endodontically treated teeth restored with three different denting bonding agents. 2.To evaluate and compare the shear bond strength of fifth (total etch) generation, sixth (two-step, self etch adhesive) generation and seventh (one step, self etch adhesive) generation dentin bonding agents.

Materials and Methods: Sample Collection: The present in –vitro study was carried out at dental college and hospital, Udaipur. A total of hundred freshly extracted human maxillary premolars which were extracted for periodontal or orthodontic reasons were collected from the Department of Oral and Maxillofacial Surgery, Darshan Dental College and Hospital; and various dental clinics in Udaipur city. The teeth were washed and stored in normal saline at room temperature till use. All the samples were then divided into 5 equal groups of 20 teeth each.

Group-A (Control Group) : This group contained unaltered teeth as a control.

Group-B (Control Group) :In all the teeth of this group, endodontic access cavities were prepared, biomechanical preparation was performed, and the root canals were obturated with gutta-percha points. A superimposed standard MOD cavity was then prepared in all teeth.

GROUP C : (experimental group): In this group, all samples were prepared as that of group-B. The cavities were etched and prime, and bond NT bonding agent(5^{th} generation dentin bonding agent) was applied and cured.

Prime and Bond NT Dentin Adhesive: Teeth were lightly air dried. The etchant was applied to the prepared specimens. Left for 15 seconds and rinsed with water for 15 seconds. Excess water was blotted off using an absorbent pellet. The surface appeared glistening without pooling of water. Then 2-3 consecutive coats of adhesive were applied immediately after blotting, to the etched dentin for 20 seconds with gentle agitation using a fully saturated applicator.

The surface was gently air thinned for 5 seconds to evaporate the solvents and then it was light-cured for 10 seconds. Then the respective specimens were bonded with resin composite.

Group D (experimental group): In this group, all samples were prepared as that group-B. Adper SE plus bonding agent(6^{th} generation bonding agent) was applied and cured.

Adper SE plus Dentin Adhesive: Teeth were lightly air dried. One drop of liquid A was dispensed into one of the mixing wells and one drop of liquid B into the second mixing well. The entire bonding area was applied with liquid A using microbrush. So that a continuous red colored layer was obtained on the surface,
Liquid B was scrubbed onto the entire wetted surface of the bonding area using a new microbrush. The disappearance of the red colors indicated that the etching components had been activated. Scrubbing was continued with moderate finger pressure for 20 seconds to ensure a proper etch. Gently air thinned for 10 seconds to evaporate water. Liquid B was reapplied as a second coat to the entire bonding surface. It was lightly air thinned to adjust film thickness. Then light cured for 10 seconds.

Group E (experimental group): In this group, all the samples were prepared as that of group B. This group received an application of G-Bond light curing bonding agent(7^{th} generation DBA) and then restored with posterior composites.

G – Bond Dentin Adhesive :Teeth were lightly air dried. Few drops of liquid were dispensed from the bottle. It was applied to the dentinal surface immediately using disposable applicators. It was left undisturbed for 5 to 10 sec. Then it was dried thoroughly for 5 sec under maximum pressure. The final result was a thin, rough, adhesive film with the appearance of frosted glass and which does not move under further air pressure. Then light cured for 10 seconds.

Methods: In all the groups, except group- A, endodontic access cavities were prepared. The apical preparation was finished with F1 and F2 Protaper universal files followed by obturation. . Excess GP coronal to the orifices was removed and condensed using heated hand pluggers. Standardized Class 2 MOD cavities were prepared for all groups except for the group A as shown in Fig .1. After cavity preparation, all the teeth of the experimental group were then considered for the final coronal restorations as stated earlier.All the hundred samples were mounted vertically in self-curing acrylic resin blocks, with roots embedded up to 2mm apical to CEJ for each sample. The samples were then placed on a lower plate of the universal testing machine, and a vertical loading force was applied at the occlusal surface at a crosshead speed of 1mm per minute until fracture occurred. The force required to fracture the tooth was recorded in Mega Pascal Units(Mpa).This procedure was repeated for all the specimens, and the recorded values were then subjected to statistical analysis.

Results : Table 1: Shows the shear bond strength in MPa obtained by each sample in all the Experimental groups (C, D, E).

Table 1: Table Of Mean And Standard Deviation

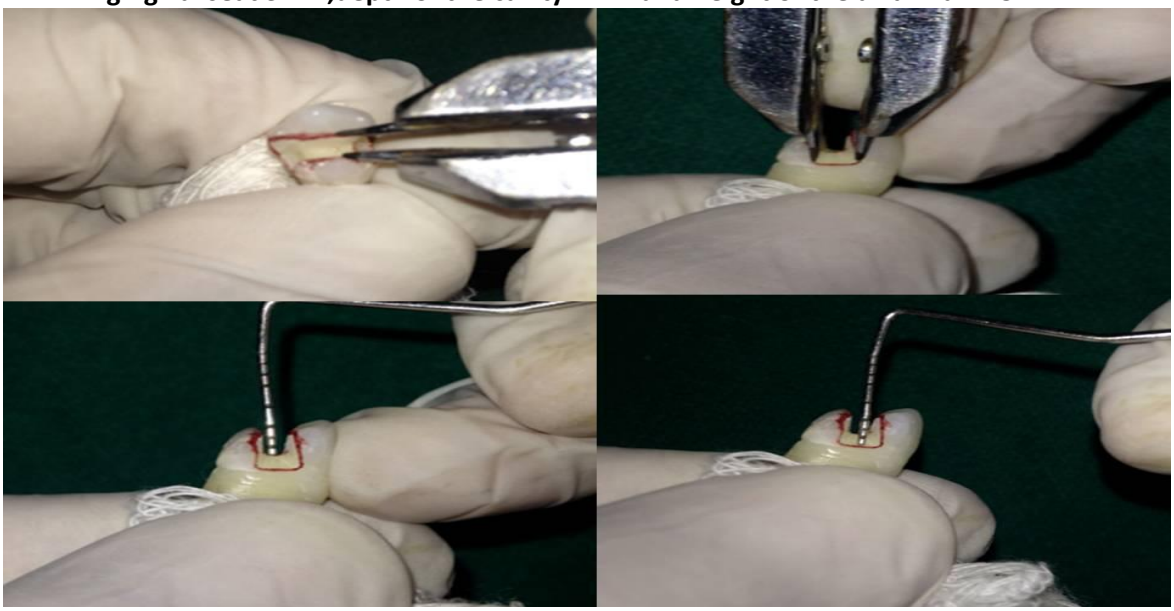
	Group	Mean (SBS)	S.D.	N
Prime & Bond NT	C	18.20	6.21	20
Adper SE-Plus	D	13.74	3.72	20
G – Bond	E	13.05	2.90	20

Table Shows that the mean SBS obtained by 5th generation (group C) is highest, followed by 6th generation (group D) and 7th generation (group E).

Table 2: shows Comparison between 5th, 6th & 7th Gen DBA by Analysis of Variance (ANOVA test)

Source of variation	SS	df	MS	P
Between groups	312.727	2	156.364	0.001
Within groups	1144.209	57	20.074	
Total	1456.937	59		

Fig.1: Shows different dimensions of prepared class 2 MOD cavity with occlusal width of 2mm,width of gingival seat 3mm,depth of the cavity 2mm and height of the axial wall 1.5mm



Discussion : It is a well-documented fact that sound unprepared teeth are more resistance to fracture than the endodontically treated teeth. Hence, restoration of the endodontically treated teeth is an important aspect of restorative dentistry. Many studies have shown that the fracture resistance of the endodontically treated teeth increases when they are restored with composite resin restorations. [10-16] According to the results obtained from the present study, it was observed that group C

(Prime and Bond NT,5th generation DBA) gave the highest mean shear bond strength (18.2 MPa) compared to all the experimental groups. Group E(G – Bond,7th generation DBA) gave the lowest

mean shear bond strength (13.0 MPa) compared to all the other groups. Group D (Adper SE Plus,6th generation DBA) gave mean shear bond strength (13.7 MPa) almost similar to group E.

Prime and Bond NT (5th generation bonding agent) is a total etch dental adhesive composed of Di & tri methacrylate resins, Functionalized amorphous silica, PENTA, Photoinitiator, Stabilizers, Cetylamine hydrofluoride, and Acetone. The etch and rinse (5th generation bonding agent) is still the most effective approach to achieving efficient and stable bonding to enamel and dentin. This may be because phosphoric acid treatment causes selective dissolution of hydroxyapatite in enamel which is followed by formation of resin tags around the enamel prisms when the resin bonding agent is applied and polymerized.[17]

In dentin, the phosphoric acid treatment exposes a microporous network of collagen that is nearly totally deprived of hydroxyapatite..As a result, the primary bonding mechanism of etching and rinse adhesives to dentin is primarily diffusion based and depends on hybridization or infiltration of resin within the exposed collagen fibril scaffold, is as complete as possible.[17]

The second reason, for the high SBS of Prime and Bond NT, is the presence of an organic solvent, i.e., acetone. Acetone is a frequently used solvent which efficiently removes water from the surface because of volatilization of surface water. It allows deeper and more complete infiltration of resin monomer within the demineralised subsurface dentin.[18]

The other reason is that Prime and Bond NTwas filled with silica nanofillers which have been functionalized by a special salinization process. This process makes the nanofillers more compatible with the resin matrix and allows it to serve as a cross linker. The filler content improves the mechanical and elastic properties of the bonding agent to withstand the stresses caused by mastication and act as an “Elastic buffer” underneath the composite restoration.[18]

In the present study, Adper SE Plus (6th generation bonding agent) which is a two bottles self etch resulted in shear bond strength of 13.7 MPA. This may be because the acidic component is not sufficient to overcome the buffering potential of the dentin. As the smear layer is not removed by this system, the partially demineralized smear layer becomes incorporated into the hybrid layer. This explains why the self etches adhesives produce thinner hybrid layer than etch and rinse systems. This could be the reason for lower shear bond strength[19].
Another reason for the lower bond strength of Adper SE Plus is because water is the solvent in this adhesive. After application of primer/ adhesive, the solvent is kept within the interfacial structure The resultant interfacial structure becomes hydrophilic and thus, more prone to hydrolytic degradation[14].

In the present study, self etch adhesive (G-Bond) showed the lowest bond strength value as compared to total-etch adhesive systems . G-Bond is a HEMA free adhesive consisting of 4 – MET, UDMA, Acetone, Water, Silanated colloidal silica and Initiator. In other words, it is a complex mixture of hydrophobic and hydrophilic components, together with water and high concentration of solvents. Due to this complex nature of mixed solutions and HEMA free adhesive, it is prone to phase separation and formation of droplets within the adhesive layer. G- Bond contains water and acetone as solvents and this may have caused reduced shear bond strength.[12,16]

The second reason for low strength may be because a very thin dentin hybrid layer formed. This is due to the relatively high pH of G Bond. It causes poor infiltration of resin monomer into demineralized dentin which leaves nano spaces in the hybrid layer.[20]

Conclusion : study shows that the easier to use adhesive systems are inferior to multi-step adhesive systems. Since in vitro investigations are not capable of predicting clinical success and due to the inherent limitation of an in vitro study, the bonding and sealing ability of these self etch adhesive systems (6th and 7th generation bonding agents) to dentin warrant further investigation.

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