Original Research Article

EFFECT OF DIFFERENT ETCHING TIME ON BOND STRENGTH OF COMPOSITE RESIN TO DENTIN

ABSTRACT:

The aim of the study is to evaluate the bond strength of composite resin to dentin surface with various etching protocol. Three sample groups, consisting of ten permanent mandibular first molar teeth in each group were established. The buccal surfaces of the samples were grinded with the help of straight fissured diamond abrasive removing enamel layer . Group I- Samples were etched with 37% phosphoric acid for 15 seconds, Group II- Samples were etched for 30 seconds, Group III- Samples were etched for 60 seconds. All the samples were then washed for 1 min and dried. Samples were then bonded for 15 seconds and restored with composite resin and cured. Samples were subjected under universal testing machine for bond failure.Results :Bond strength is much higher in group B than in group C and A with a confidence of more than 98.828%. (P value -0.0675). Conclusion: Within the limitations of this in vitro study; it can be concluded that-30seconds of etching time gives better bond strength due to longitudinal tubules which influences the dentin hybridization process in the sense of forming more resin tags that, in turn, contribute to bond strength.

KEYWORDS: Etching, adhesives, 37% phosphoric acid, universal testing machine, dentin adhesives.

INTRODUCTION:

Over the years, phosphoric acid etching has become the standard procedure for bonding to improve the surface characteristics before the application of adhesive bonding agents and fissure sealant [1]. The penetration of adhesive resin monomers into the porous zone results in the formation of resin tags, thereby establishing micromechanical interlocking within the etched surface. Therefore, regardless of the adhesive system, using phosphoric acid supports achievement of a strong and durable bond [2]. Phosphoric acid etching gel is

applied to dentin substrate to remove the smear layer. After rinsing, the dentin surface becomes demineralized with exposure of the collagen fibers. This would leave collagen fibers exposed and susceptible to hydrolysis, possibly weakening the bonding [3]. Thus, it is speculated that as shallow a demineralization as possible might give the adhesive system a better chance to diffuse into the entire collagen network [4]. For that, acid-etching time of 15 seconds has been suggested by various authors, aiming at an adequate bond to normal dentin. Dentin hybridization is a modern dental adhesion procedure, which was first described by Nobuo Nakabayashi et al. (1982) [5]. Hybridized dentin begins under the dentin surface after surface und subsurface demineralization and adhesive monomer infiltration into exposed collagen network [6]. Thus, the result of the revolutionary discovery by Nakabayashi and colleagues has opened new horizons of restorative dentistry.Over the years, phosphoric acid etching has become the standard procedure for adhesive dentistry. In 1954 Buonocore introduced acid etching procedure as a pretreatment method that enhances the strength bonding of composite resins for the first time [7]. It's clinical application presented in 1976 by Cueto and Buonocore. The dentin surface becomes demineralized with exposure of the collagen fibers [8]. To obtain adequate resin-dentin bonding, resin monomers must penetrate this demineralized surface dentin in order to produce hybridization. The clinical success of restorative material depends upon a good adhesion with dentinal surface so as to resist various dislodging forces acting within the oral cavity [9].

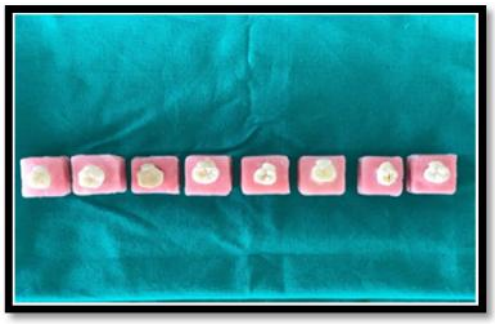
The need for restorative material, with better bond characteristics and strength to withstand the stress of masticatory forces, leads to the recent advances in the restorative dentistry. The composite resins are one of the commonest restorative material used now a days due to its aesthetic appearance but they have some imperfections such as polymerization shrinkage [10].

The present study was to to evaluate the bond strength of universal sub micron hybrid composite resin BRILLIANT EverGlow-Coltene, to dentin surface with various etching protocol.

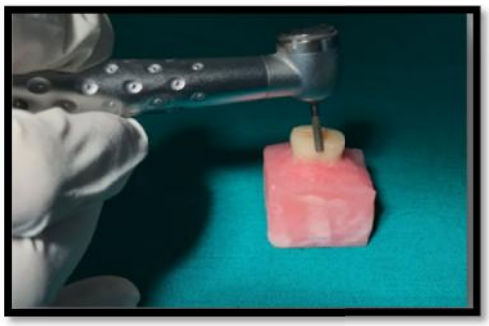
MATERIALS AND METHOD:

30 extracted human permanent mandibular molar teeth with neither carious lesions nor restorations, were selected for this in vitro study. Each tooth underwent scaling and root planing with an ultrasonic device to remove residual organic tissue. Then, the teeth were immersed in 2.5% sodium hypochlorite solution and rinsed with running water for 10 min.

Acrylic blocks were prepared by cold cure acrylic resin material. The selected molars were embedded into the blocks. The blocks were then put in water to avoid expansion of the material. The buccal surfaces of the samples grinded with the help of straight fissured diamond abrasive upto dentinal surface,3mm in depth.



Acrylic Mold Prepared For Each Samples



The buccal surfaces of the samples grinded with the help of straight fissured diamond abrasive upto dentin surface

Dentinal surfaces were acid etched with 37% phosphoric acid into following groups:

Group A:- 15 seconds

Group B:- 30 seconds

Group C:- 60 seconds

37% Phosphoric Acid

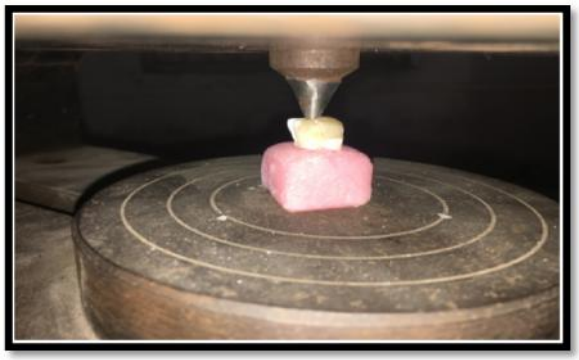
Etching of Dentin Surface

Etching was done to make the surface smear free.Samples were then bonded with One coat Bond SL by Coltene and light cured with LED light for 20 seconds and restored with BRILLIANT-EverGlow-Coltene submicron hybrid composite light cure composite resin . The specimens were stored in distilled water for 24hrs.

Application of Bond

Curing After Application of Bond

Specimens were then transferred to the Universal testing machine with a crosshead speed of 0.5mm/min until fracture with tip diameter 1.5mm. Subjected to compressive test determination which created buckling of the restoration which results in formation of a tensile stress in the dentinal walls.



Specimens transferred to the UTM with a crosshead speed of 0.5 mm/min until fracture with tip diameter 1.5mm.

Universal Testing Machine

The load required to debond the specimen was recorded. Placed in the lower assembly of the machine and the force was applied with the help of a knife-like mandrel which engaged the blocks and dislodged it. Bond strength was calculated according to the following formula and expressed in kilo newton

The load required to debond the specimen was recorded

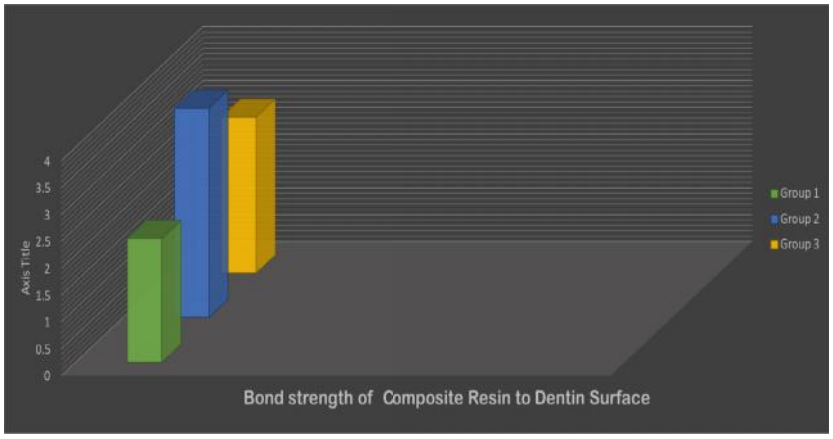
(KN):

Stress = Failure load (N)/surface area (mm^2)

RESULT & STATISTICAL ANALYSIS

Oneway ANOVA

Descriptives



Bond strength is much higher in group B than in group C and A with a confidence of more than 98.828%. (P value -0.0675)

Groups	Mean deviation	Standard deviation	Sum	Average	Variance
A	4.88	3.15	16.7543	2.347	0.858
B	8.85	0.37	21.664	3.76	1.839
C	6.63	0.73	17.663	2.66	0.676

SOURCE OF VARIATION	SS	df	MS	F	P-value	F crit
Between groups	2.33	1	2.4457	21.5674	0.0675	2.5567
Total	2.49	17				

DISSCUSION:

Acid etching technique using phosphoric acid is well accepted for various applications in dentistry. Among mechanical properties bond strength of restorative materials is important because it provides sufficient strength to resist intraoral compressive & tensile forces that are produced in function & parafunction [11]. Different etching times with the same phosphoric acid concentration result in different morphologic changes of demineralized dentin surface. There is a direct correlation between etching time and the depth of demineralized zone. The hybrid layer thickness correlates directly to the etching time [12]. Increased etching time demineralizes dentin surface to a depth greater than that to which resin monomers can penetrate, producing a thick, poorly infiltrated hybrid layer [13].

The acid etching time recommended for dentin with 37% phosphoric acid gels commonly employed with etch and rinse system has been 30 seconds.

Ustunkol et al., Batra et al. and Taschner et al. claimed etching process has a significant effect on bond strength of methacrylate-based composite.

Adebayo et al. showed higher bond strengths of the nano hybrid composite [14].

Koliniotou-Koumpia et al, Sampaio et al. said there is no difference of bond strength between nano hybrid composite and bulk fill composite on etching [15]. Dentin is heterogeneous, consisting of hydroxyapatite and collagen. The degree of mineral content in dentin is quite variable, depending on whether it is near the DEJ or deeper in close proximity to the pulp. Acidity of monomer also caused change in surface chemistry and morphology of dentin, which in turn can influence bonding. A significantly thicker hybrid layer was noted in areas with perpendicular tubule orientation than in areas with parallel tubule orientation [16].

Mechanical behaviour depends upon the concentration and particle size of the inorganic filler. For evaluating the bond strength, the study samples were stored in distilled water with few thymol crystals, to maintain aseptic conditions before cavity system, with hydrophilic components, which can dislodge moisture from the conditioned dentin and attain an intimate interaction at the demineralized intertubular and peritubular dentin, creating the hybrid layer, which is essential for an ideal bond to dentin which is similar to studies conducted by Kallenos et al. and Gupta et al [17].

The present study showed that 30 seconds acid etching with 37% phosphoric acid gave better bond strength than 60 seconds and 15 seconds. Hence these findings confirmed that the different etching times with the same phosphoric acid concentration result in different morphologic changes of demineralized dentin surface. This was very evident in the striking changes in the number, diameter and surface area of dentinal tubules, intertubular surface area, appearance of the dentin surface porous zone containing smear layer and demineralized residual collagen particles with dentin demineralization products in acid globules, and the completely dissolved peritubular dentin cuff that happened after prolonged etching time [18].

CONCLUSION:

1. When 37% phosphoric acid is applied a dentin substrate free of smear layer is not created for the etching time of 15 seconds.
2. Within the limitations of this in vitro study; it can be concluded that- 30seconds of etching time gives better bond strength due to longitudinal tubules which influences the dentin hybridization process in the sense of forming more resin tags that, in turn, contribute to bond strength.

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