

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

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

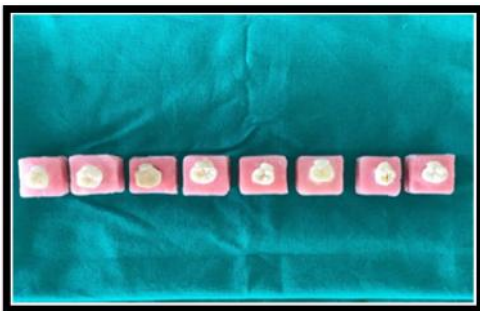
55 The need for restorative material, with better bond characteristics and strength
56 to withstand the stress of masticatory forces, leads to the recent advances in the
57 restorative dentistry. The composite resins are one of the commonest restorative
58 material used now a days due to its aesthetic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

60 The present study was to to evaluate the bond strength of universal sub micron
61 hybrid composite resin to dentin surface with various etching protocol.

62 **MATERIALS AND METHOD:**

63 30 extracted human permanent mandibular molar teeth with neither carious
64 lesions nor restorations, which were recently extracted for periodontal or
65 orthodontic reason, were selected for this in vitro study, teeth were obtained
66 with free and informed consent by the patient. Each tooth underwent scaling
67 and root planing with an ultrasonic device to remove residual organic tissue.
68 Then, the teeth were immersed in 2.5% sodium hypochlorite solution and rinsed
69 with running water for 10 min.

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



74
75 Acrylic Mold Prepared For Each
76 Samples
77



78
79 The buccal surfaces of the samples
80 grinded with the help of straight
81 fissured diamond abrasive upto dentin
82 surface

79 Dentine surfaces were acid etched with 37% phosphoric acid into following
80 groups:

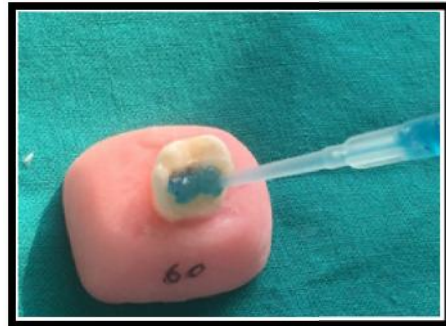
81 Group A:- 15 seconds

82 Group B:- 30 seconds

83 Group C:- 60 seconds



84 37% Phosphoric Acid



Etching of Dentin Surface

87 Samples were then bonded and light cured with LED light for 20 seconds and
88 restored with light cure composite resin. The specimens were stored in distilled
89 water for 24hrs.

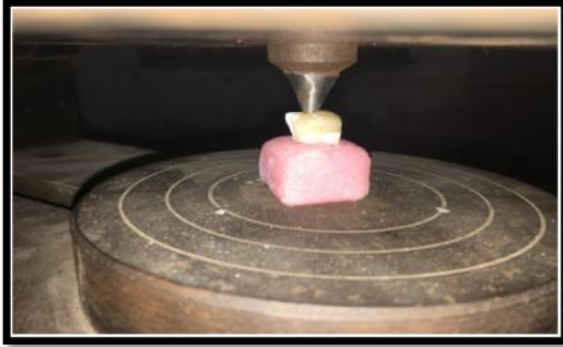


90 Application of Bond



Curing After Application of Bond

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



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

Universal Testing Machine

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

104



105

106

107

The load required to debond the specimen was recorded

108 (KN):

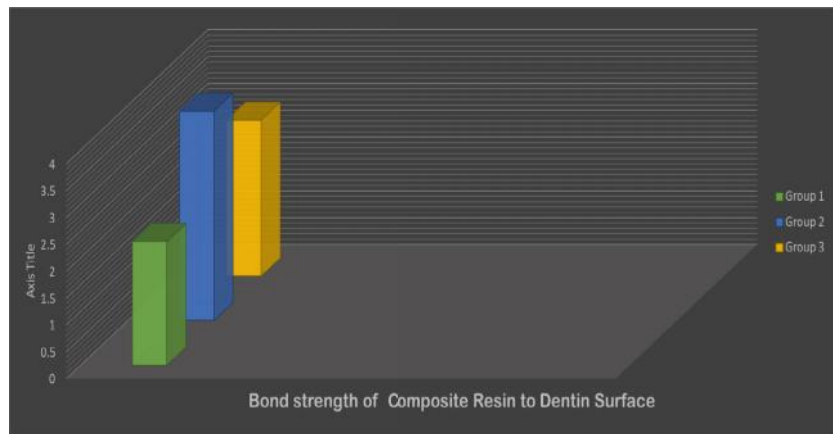
109 Stress = Failure load (N)/surface area (mm²)

110

111 **RESULT & STATISTICAL ANALYSIS**

112 **Oneway ANOVA**

113 **Descriptives**



114

115

116 Bond strength is much higher in group B than in group C and A with a
117 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

118

119

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				

DISCUSSION:

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. Efficiently removed smear layer and no precipitates were observed in teeth after 30 seconds etching with 37% phosphoric acid.
3. 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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