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Effect of Thrichloracetic-Acid as an Etching Agent on Composite-Resin Bond Strength to Dental Tissues

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Abstract: Trichloracetic-acid (TCA) was introduced as an adjunct material capable of eliminating bleeding and cervical fluid especially in cervical restoration placement. The aim of this study was to evaluate the effect of 30 and 50% trichloracetic-acid as an etching agent on bond strength of composite-resin to enamel and dentin. Seventy-two intact human molar teeth were divided into 6 equal groups randomly. In the first 3 groups smooth enamel surfaces were prepared in buccal surfaces. In the remaining 3 groups the occlusal surface was reduced so that superficial dentine was exposed. Then, surface treatment was performed by different materials as follows: groups 1 and 4 by 37% phosphoric acid; groups 2 and 5 by 35% trichloracetic-acid and groups 3 and 6 by 50% trichloracetic-acid. Then Single Bond (3M ESPE) was applied and composite-resin cylinder (Z100, 3M ESPE) was cured. The samples were incubated in distilled water at 37°C for 24 h and composite cylinders were applied under shear force. The data was analyzed by ANOVA. Mean fracture strengths in the study groups ordered from 1-6 were: 19.91±9.02, 18.43±5.69, 19.05±5.48, 10.83±7.22, 10.04±5.57 and 9.48±1.97. There were no significant differences in bond strength of composite-resin using 37% phosphoric acid, 35 or 50% trichloracetic-acid to neither enamel nor dentine ($p>0.05$). TCA could etch enamel and dentin similar to phosphoric-acid. Trichloracetic-acid application as an enamel and dentine etchant especially in cervical restorations, where it can act both as an etchant and an astringent or gingival fluid reducer, needs to be more investigated.

Key words: Bond strength, composite-resin, acid etching, trichloracetic acid

INTRODUCTION

Phosphoric acid as an etching agent for tooth enamel was introduced by Bounocor (1955). Since, then it has been used for many years to etch enamel and recently for etching dentine. The mentioned process leads to successful bonding of resin to enamel (Glasspoole and Erickson, 1994). Other acids have also been investigated as dentine and enamel etchant (Retief *et al*., 1986; Zidan and Hill, 1986; Berry *et al*., 1990).

Controlling gingival fluid and hemorrhage especially in clinical procedures adjacent to gingiva has always been a problem in clinical dentistry (Donovan *et al*., 1985). Contamination of the cavity to be restored not only impedes visualization and accessibility, but also reduces the durability of the restoration due to micro leakage (Jokstad, 1999; Iovan *et al*., 2004; Spahr *et al*., 2000; Saayman *et al*., 2005).

Numerous methods and materials have been innovated so far which generally consist of mechanical methods, chemical methods and combination of both (Jokstad, 1999). Traditionally some chemicals including epinephrine, aluminum chloride and ferrous sulfate have been using for this reason. Furthermore, more currently in order to cauterize gingival tissue electro surgery and lasers are used (Nemetz and Seibly, 1990; Akca *et al*., 2006; Kopac *et al*., 2001).

Trichloracetic acid (TCA) is a chemical escarotic agent that has been used in medicine and dentistry for more than a century (Lewinstein and Rotstein, 1992). The material is prepared by oxidation of chloral hydrate with nitric acid and manufactured by chlorination of acetic acid. Its aqueous solution is highly acidic reaching a pH of 1.0. It is mainly used as a decalcifier and fixative in microscopy and as a precipitant of proteins. In medicine, it has been used as a cauterizing agent particularly for

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dermatologic and ophthalmic purposes (Lewinstein and Rotstein, 1992). The main therapeutic application of the material in dentistry has traditionally been the removal of excess gingival tissue prior to restorative procedures (Heithersay, 1999). In the mentioned study, Heithersay applied a 90% aqueous solution of TCA to the resorptive cervical defect in 101 patients in order to eliminate the gingival hyper plastic tissues and establish a sound substrate for tooth restoration by glass ionomer and composite resin. Three and five years follow up of these cases were reported to be 100% successful (Heithersay, 1999).

When applying medicament to a cervical root resorption defect, it makes contact with dental hard tissues at the CEJ to exert its caustic effect (Lewinstein and Rotstein, 1992).

Also the material has been strongly recommended for immediate hemostasis and control of gingival fluid flow in restoring of cervical lesions in the form of an supersaturated solution (Mount and Hume, 1998; Mount and Bryant, 1998). Such a material produces a defined zone of coagulation necrosis when applied to soft tissues. This zone of coagulation necrosis separates from the adjacent tissue within a few days (Heithersay, 1985, 1999; Mount and Hume, 1998).

An experimental study of the effects of TCA applied to soft tissues in rat showed an absence of inflammation in the adjacent soft tissue and unimpeded healing (Heithersay and Wilson, 1988). After that, the material was used successfully for treatment of the invasive cervical resorption and careful debridement of initial resorption of external root surface with gingival hyperplasia (Heithersay, 1999, 2000; Evans, 2000) and in conjunction with electrosurgery as a very effective procedure (Mount and Hume, 1998).

One study evaluated the effect of TCA on microhardness and surface morphology of human dentine and enamel. The study reported that the duration of TCA treatment has a progressive effect on the microhardness of enamel. In addition, application of 90% TCA for 60 sec leaves an etched appearance on the enamel surface and after 90 sec, the etching pattern is destroyed and the enamel surface becomes erosive. They have also reported that TCA produces the etching appearance at the dentinal surface (Lewinstein and Rotstein, 1992).

Other researchers introduced TCA as an effective dentin conditioner with acceptable shear and tensile bond strengths for bonded restorations (Galun *et al*., 1994).

Considering this fact that TCA is an acid and when used as an haemostatic agent might possibly contact cavity margins, especially in cervical restorations which are in close proximity to the marginal gingiva, this study intended to use 35 and 50% TCA as etching agents and compare them to when 37% phosphoric acid is used by measuring the shear bond strength of composite-resin to enamel and dentine.

MATERIALS AND METHODS

Seventy-two intact human third molar teeth, 30-40 years of age, which have been extracted lately due to periodontal diseases, were brushed and stored in 0.2% thymol solution. After rinsing, they were divided randomly into 6 equal groups. In the first 3 groups the buccal surfaces were grinded by 600 grit paper disk so that the rodless enamel was removed and a flat enamel surface was attained. In the remaining three groups (groups 4-6) the occlusal surface was reduced by diamond disk to expose the superficial dentine. After irrigation the roots of teeth were mounted by self-cure acrylic resin (Acropars, Iran). Then the surface treatment was performed by different materials as follows:

In groups 1-3 the enamel surfaces were etched, respectively, by 35% phosphoric acid (3M ESPE, St. Paul, MN, USA), 35% TCA-gel (Amin Pharm. Co., Isfahan, Iran) and 50% TCA-gel (Amin Pharm. Co., Isfahan, Iran) for 30 sec and then irrigated for 15 sec and dried for 5 sec. Afterwards, Single Bond adhesive agent (3M ESPE, St. Paul, MN, USA) was applied according to manufacturer´s instructions and cured for 20 sec (Coltolux 2.5, Colton, USA). Composite cylinders filled with Z100 composite resin, A3 (3M ESPE, St. Paul, MN, USA) were bonded to the enamel surfaces using plastic molds (3 mm of internal diameter and 4 mm of length). The curing process was performed in 1 side at the end and 3 sides at the periphery of the cylinder, respectively each one for 30 sec.

Similarly, in groups 4-6 after irrigation and cleansing the dentinal surface, etching was performed, respectively by 35% phosphoric acid (3 M ESPE, St. Paul, MN, USA), 35% TCA (Amin Pharm Co., Isfahan, Iran) and 50% TCA (Amin Pharm Co., Isfahan, Iran) for 15 sec and then irrigated for 15 sec and gently dried for 5 sec. Afterwards, the bonding process was performed as for the enamel groups.

All the teeth were incubated (Behdad, Iran) at 37°C and 100% humidity for 24 h. Then the teeth were thermocycled for 500 cycles (55±5°C), each cycle consisted of 30 sec of stop followed by 10 sec of transmission. Then, shear force was exerted on each cylinder by DARTEC machine (HC10, England) with a speed of 1 mm min^{-1} until fracture occurred. Data were analyzed by ANOVA test using SPSS software.

RESULTS

The results of shear bond strength for all specimens are summarized in Table 1. According to, these findings

Table 1: Shear bond strength of the study groups (Mpa)

	Bond strength		
Groups	Minimum	Maximum	Mean±SD
1	8.49	32.11	19.91±9.02
2	6.51	26.45	18.43±5.69
3	10.75	27.16	19.05±5.48
4	2.97	28.01	10.83±7.22
5	4.24	20.65	10.04±5.57
6	7.36	13.86	9.48±1.97

Table 2: Fracture mode distribution in study groups

Mode of fracture groups	Cohesive (enamel or dentin)	Mixed (tooth/ interface)	Adhesive (interface)	Cohesive (Composite resin)
1	61.66	29.99	8.35	0.00
2	45.00	41.66	13.34	0.00
3	41.66	43.33	15.01	0.00
4	0.00	18.34	65.00	16.66
5	0.00	24.34	60.00	15.66
6	0.00	41.64	41.66	16.80

no significant difference was recognized between the first 3 groups (enamel groups) ($p = 0.89$) as well as the other 3 groups (dentine groups) ($p = 0.80$).

Additionally, the fracture modes using stereomicroscope (x 10) were investigated in all specimens and the modes of fracture including cohesive fracture in enamel or dentine, mixed fracture and adhesive fracture, were summarized in Table 2.

DISCUSSION

TCA was first discussed as an acid capable of decalcifying enamel and dentine in 1992. Its decalcifying effect has had a direct relationship with the time of application on dental tissues. In the mentioned study, enamel microhardness in three application times (30, 60, 90 sec) progressively decreased (Lewenstien and Rotstein, 1992). TCA has been widely used as a successful agent in treatment of invasive cervical lesions, with or without surgical access, followed by bonded restorations. (Heithersay, 1985, 1988, 1999, 2000; Mount and Hume, 1998; Mount and Bryant, 1998; Evans, 2000). One study was found that the material is a very effective dentin conditioner which also increases the shear and tensile bond strengths (Galun *et al*., 1994). Considering TCA particularly as an etching agent has been proposed in this study.

When using the TCA for cauterizing gingiva and controlling hemorrhage it might come in contact with dental tissue, which shows the importance of the study carried out by Lewenstien and Rotsteiw (1992). It is obvious that if any kind of acid comes in contact with mineralized surfaces such as enamel or dentine, it could remove the mineral ingredients and demineralizes the surface. On the other hand, for the process of bonding a resin to the enamel, when the surface is demineralized by acid etching, the bonding resin penetrates into the existence porosities and cured, so the substrate's lost strength would reversed. In the case of TCA, it is predictable that when it is used for hemorrhage control in marginal gingiva and unintentionally contacts the cavity margins, the demineralization of tooth tissue would occur. That is why the dual use of TCA for controlling hemorrhage and sulcular fluid seepage and as an etchant has been intended by the authors.

Previously, TCA has been used in the form of a supersaturated solution which was made immediately before application by mixing its crystals with water (Mount and Hume, 1998; Mount and Bryant, 1998). In this study TCA was prepared in the form of gel, in 2 concentration levels of 35 and 50% with the same viscosity as 35% phosphoric acid. Considering this fact that TCA is a cauterizing material, using its gel form with steady concentration makes it easier for the operator to control it.

In this study, the mean bond strength for neither enamel nor dentine did not differ significantly from control group. Meanwhile, mean bond strength when 50% TCA was used was more similar to that of control group. It seems that when TCA is used in the range of 40-50%, it has enough H^+ ions to etch enamel. However, a precise conclusion about TCA needs to be investigated further especially by SEM and TEM studies in addition to enamel and dentine surface analyses.

In this study, fracture mode results were also studied in enamel and dentine groups. Considering groups 1-3, most enamel cohesive fracture was observed in phosphoric acid group. It might show that phosphoric acid probably produces a more homogenous enamel etched surface, although for precise conclusion it might be better to compare 2 materials under equal conditions.

In comparing groups 4-6, group 6 in which 50% TCA was used, showed the highest percentage of mixed fracture. It seems that TCA with this level of concentration demineralizes dentine more which is not necessarily infiltrated by resin layer. Therefore, the hybridoid layer formation probably leads to more fracture in dentine. Further studies in future will be necessary to interpret these processes exactly. Also, further investigations concerning etching, biocompatibility and bonding characteristics of TCA will be needed.

CONCLUSION

Considering the limitations of the present study we may conclude that:

- TCA not only cauterizes soft tissue, which makes it a good choice to control hemorrhage in tooth colored cervical restorations, but also can have etching effect on enamel and dentine that seems to be capable of producing a suitable substrate for resins bonding. This aspect of TCA application yet needs to be more investigated. The dual-purpose use of TCA is not recommended until its precise pros and cons are determined.

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