THE IMPORTANCE OF ENAMEL DEPROTEINIZATION IN CLINICAL DENTISTRY: A REVIEW

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SUMMARY

Acid-etching employs dental etchants and is used frequently when bonding dental restoration to teeth. By dissolving minerals in enamel, the etchants remove the outer 10 micrometers on the enamel surface and make a porous layer 5–50 micrometers deep. This roughens the enamel microscopically and results in a greater surface area on which to bond. Acid etching with H₃PO₄ is not achieved over the entire adhesion surface of the tooth. Sodium Hypochlorite solutions have been used as wound and endodontic irrigant as early as 1920 due to its bactericidal and proteolytic properties. Irrigation of the root canals with sodium hypochlorite solutions is now widely accepted. Removing the organic content from the enamel surface with 5.2% sodium hypochlorite (NaOCl) as a deproteinizing agent prior to phosphoric acid etching has shown promising effect in improving the enamel surface area. However no relevant work has been done in Pakistan, so study must be conducted locally to find out the effect of sodium hypochlorite as a deproteinizing agent before acid etching.

Key Words: Enamel Deproteinization, Acid etching, Sodium Hypochlorite, Phosphoric acid.

INTRODUCTION

Tooth enamel is one of the main tissues of teeth in vertebrates. It is one of the hardest and most highly mineralized substances in human body.¹ Ninety-six percent of enamel is composed of mineral, whereas water and organic material constitutes the remaining four percent. In humans, the thickness of enamel varies over the entire surface of tooth. It is thickest at the cusps measuring up to 2.5 mm, whereas at the cementoenamel junction (CEJ) it is the thinnest.¹ The main mineral content of enamel is calcium phosphate in the crystalline form called the hydroxyapatite crystals. This large mineral content in enamel accounts for its strength and brittleness. Enamel lacks collagen, as found in dentin and bone, but it contains two unique classes of proteins - amelogenins and enamelins. These proteins help in the development of enamel by serving as a framework for minerals to form on, among other functions.¹

Because of its brittle nature enamel, if not supported by underlying dentin is susceptible to fracture. Therefore understanding enamel orientation is very important in restorative dentistry.² Acid-etching, invented in 1955, is used for bonding dental restorations...
to teeth with the help of dental etchants.\textsuperscript{3,4} These etchants dissolve the minerals in enamel resulting in the formation of micro porosities over the tooth surface. This porous layer is about 5-50 micrometers deep.\textsuperscript{3} This roughens the enamel surface microscopically thereby providing a greater surface area for the bonding of restorations.

Acid-etching can have varied effects on the enamel surface. Certain factors such as the type and duration of etchant applied and the current condition of enamel surface play an important role in determining the quantity and quality of acid-etching.\textsuperscript{3}

The surface changes produced in enamel surface were first described by Gwinnet (1971) and Silverstone (1975), who classified enamel etching into 3 patterns on the basis of enamel micromorphology.\textsuperscript{5,6} Type 1 is a pattern where the enamel rods are dissolved; in type 2 the interrods are dissolved; and in type 3 both rods and interrods are dissolved. Clinically, however it gives a white, chalky appearance showing only the quantity of the etched surface but not its quality.\textsuperscript{5,6} However based on the retentive quality provided by the porous layer it was later identified by Silverstone that most of the etching patterns were of types 1 and 2. The type 3 pattern lacked the micro retention offered by the other two.

**IMPROVING TOOTH BONDING**

Different studies have been conducted in an effort to improve the retention between enamel surface and the restorative materials. Bonding to enamel depends upon the type of etching agent, duration of etching, concentration of acid being used and composition of the enamel surface.\textsuperscript{7} Other efforts such as air abrasion and laser have also been analyzed but did not provide satisfactory results.\textsuperscript{8,9} One such effort was done by Espinosa et al, who polished the enamel surface with the intention to remove the organic components that interfered with effective enamel etching.\textsuperscript{10} They found that enamel deproteinization with sodium hypochlorite before phosphoric acid etching increased the etched surface area to double when compared with conventional phosphoric acid etching.

Sinohara MS (2006) carried out a study to analyze the etching pattern of SES self-etching bonding system in comparison with 35% phosphoric acid etchant.\textsuperscript{11} Aqueous mixtures of polymerizable acidic monomers and methacrylate are the main components of Self etching systems, while esters from phosphoric acid, carboxylic acid derivatives have been used to develop the acidic monomers.\textsuperscript{12,13,14,15} However it was found that etching produced by self-etching system was less effective than that produced by phosphoric acid.

Fava M et al (2003) evaluated the morphological aspects of the enamel of teeth after etching with 36% phosphoric acid or a non-rinse conditioner. Electron micrographic analysis showed that both etching agents were effective for etching the enamel of teeth causing formation of micro porosities on the enamel surface, but the etching pattern was more effective with the use of 36% phosphoric acid.\textsuperscript{16} The main aim of all these investigations was to improve the adhesive properties of the enamel for the better retention.

It has been proved that a generalized retentive morphological area over the entire enamel surface provides a strong adhesion which is achieved by good etching. However recent studies have shown that enamel etching with H$_3$PO$_4$ is not attained over the entire adhesion surface and that 69% of the treated surface had no etching whereas 7% presented feeble etching and only 2% was ideally etched. These results are generally seen in clinical practices where sealants, adhesive restorations and orthodontic brackets are failing.\textsuperscript{17} Deproteinization of enamel involves the removal of organic content i.e. proteins from the enamel. Sodium hypochlorite (NaOCl) has been used successfully in endodontics as an irrigating solution to disinfect, remove debris, as well as organic materials from the canals.\textsuperscript{18,19}

**UPDATES**

Till date few studies have been carried out utilizing NaOCl as a deproteinizing agent for the improvement of tooth bonding. One such study utilized 5.2% sodium hypochlorite (NaOCl) as a deproteinizing agent before phosphoric acid etching carried out by Espinosa et al. (2008) It showed that prior deproteinization by NaOCl doubled significantly enamel’s retentive surface to 94.47%.\textsuperscript{30} This technique seemed effective in removing organic elements from the enamel structure as well as the acquired pellicle thereby conserving the tooth structure and improving its adhesive properties. But the use of sodium hypochlorite prior to acid etching was put in doubt by Bhoomika et al. (2010) who carried out a study in accordance with the study done by Espinosa et al (2008) and observed that enamel deproteinization did not grossly alter the surface topographic features of enamel before acid etching.\textsuperscript{20}
CLINICAL IMPORTANCE

Acid etching is an important aspect in clinical dentistry but the surface area etched ideally is only 2%. This is generally seen in clinical practices where sealants, adhesive restorations and orthodontic brackets are failing, which results in repeated dental visits thus prolonging the dental treatment and increasing its cost. In order to improve the bonding of orthodontic brackets and restorative materials to enamel other techniques are now being developed. One such method is to remove the organic content i.e. proteins (deproteinization) from enamel which has shown promising results in in-vitro studies. This method increases the enamel surface area and thus makes bonding more efficient. However, there is a need to validate these findings.

DISCUSSION

The objective was to observe the effect of enamel deproteinization before acid etching on the enamel surface area of Pakistani population through the application of 5.25% sodium hypochlorite (NaOCl) and 3% NaOCl for 60 seconds respectively. To measure the surface area obtained with conventional acid etching with 37% Phosphoric acid (H3PO4) alone as well as with the application of NaOCl (5.25% and 3%) before conventional acid etching thereby observing weather NaOCl application can lead to better bonding of dental restorative materials on the surface of enamel or not.

CONCLUSION

Sodium Hypochlorite solutions have been used as wound irrigants since 1915 and as an endodontic irrigant as early as 1920 due to its bactericidal and proteolytic properties. Different concentrations of NaOCl (1%-5%) have been now widely accepted as root canal irrigant. Since the use of 5.2% NaOCl as a deproteinizing agent before acid etching is not conventionally used therefore further studies should be carried out to evaluate the effectiveness of NaOCl in improving the adhesive properties of enamel by increasing the etched enamel surface area.

REFERENCES

16 Fava M; Myaki SI; Arana-Chavez VE; Fava-de-Moraes F. Effects of a Non-Rinse Conditioner on the enamel of primary teeth. Braz. Dent. J. 2003; 14(3).