Custom made profile projector: A new, innovative, and economical way to evaluation of tooth enamel loss after acid etching: An *in vitro* study

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Abstract

Introduction: Aim of this *in vitro* study is to evaluate the loss of tooth enamel after acid etching using a custom made profile projector (×100). **Materials and Methods:** Twenty human extracted maxillary and mandibular premolars were collected, and each tooth was mounted on an acrylic block (2 cm × 1 cm) along with a 0.8 mm stainless steel wire partially embedded in acrylic in front of the buccal surface of the teeth. The 0.8 mm wire was used for reference; the image appeared on the projection screen was 80 mm implying that magnification ×100 has been achieved. Fabrication of custom made profile projector followed the principles of optics. Two projections of each sample before and after etching were projected. The projection was recorded using tracing paper. The difference between the two tracings before and after etching was measured using a millimeter scale. This reading was converted into microns, i.e., 1 mm = 10 μ. **Results:** The statistical method used for this study is a measure of central tendency. The research shows that the average enamel loss was around 15.25 microns. The median is a value at the midpoint of the group, and median for enamel loss is 15 μ. Mode for enamel loss is 15 μ that means most frequent or most repetitive enamel loss is 15 μ. The maximum enamel loss was 25 μ, and minimum of that was 10 μ. **Conclusions:** The results of this study indicate that etching enamel with 37% phosphoric acid for 30 s loses 15 μ of surface enamel using an economical and efficient custom made profile projector.

Key words: Acid etching, collimated point light source, custom made profile projector, optics

INTRODUCTION

Buonocore[1] revolutionized dentistry with his historical paper. “A simple method of increasing the adhesion of acrylic filling material to enamel surfaces” depicting the advantage of etching and bonding of acrylic to enamel;[1] it forever changes the practice of dentistry. Efforts have been made to develop or introduce a simplified alternative, but enamel acid etching remains the most effective procedure for stable enamel bonding. Although acid etching is considered the most popular procedure in dentistry, there are characteristics that deserve special attention because of how crucial they can be in many clinical situations. A routine etching with 37% phosphoric acid for 30 s is commonly used routine protocol for acid etching.[2] Retention characteristics of etched surfaces depend on the enamel’s chemical composition and etching time.[3-5]

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Roughness is described as a complex role of irregularities or little projections and indentations that characterizes a surface and influence on wetting, quality of adhesion, and brightness. Despite micro-mechanical roughness being pointed out as primordial to obtain efficient adhesion to enamel,[6,7] the precise etched enamel characteristics involved and the metrical scale or unit in which adhesion occurs are not known.

The effect that surface roughness exerts on adhesion is not completely understood.[8] However, asserted that if a surface is roughened, producing more surface area, and if intimate contact between the adhesive and adherent is established, the actual adhesive bonding will be stronger because of the increase in surface area.

In all previous studies, the loss of enamel is evaluated by scanning electron microscopy, profilometer, atomic force microscopy, etc.[6,9-11] All this options are too expensive and not readily available. Considering this, we have come up with a simple, efficient, and economical way–a custom made profile projector, which is based on the basic principle of optics.[12,13]

MATERIALS AND METHODS

Twenty human maxillary and mandibular premolars extracted from orthodontic patients. Teeth with caries, restorations, enamel defects, hypocalcification, or fluorosis on the buccal surfaces were excluded.

Each tooth is mounted on an acrylic block (2 cm × 1 cm) along with a 0.8 mm stainless steel wire partially embedded in acrylic in front of the buccal surface of the teeth [Figure 1].

Material

1. Custom made profile projector [Figure 2] consists of
   a. Collimated point light source: Monochromatic light (light-emitting diode [LED]) with battery
   b. Two lenses having different diopters
2. Tooth sample
3. Projection screen
4. Thirty-seven percentage phosphoric acid
5. Darkroom
6. Tracing paper
7. Lead pencil.

Profile projector

The idea of using a profile projection, which was created by James Hartness and Russel W. Porter, comes from mixing optics and measurement in a device.

Definition

A profile projector (often simply called as an optical comparator in context) is a device that applies the principle of optics for the inspection of manufactured parts.

In a comparator, the magnified silhouette of a part is projected on the screen, and the dimension and geometry of the part are measured against the prescribed limits.

It is also employed for inspection and comparing very small parts, which play a very significant role in systems structure as an application of quality.

Profile projector can reveal imperfections such as bur scratches, indentations, and undesirable chamfers which both micrometers and calipers cannot reveal.

Design of custom made profile projector

A custom made profile projector assembly consists of a wooden platform on which two adjustable vertical stands are fitted to mount the appropriate lenses, a table (T) for placing the sample, and on another stand (S) on which light source (LED) is placed, magnification of which is adjusted to ×100 by applying the basic principle of optics [Figure 3].

Method

1. The assembly was arranged in a darkroom
2. Mounted tooth sample was placed on the table between the two lenses; the distance between the light source and the lenses, and finally, the distance between the profile projector assembly and the projection screen were adjusted and fixed according to the principle of optics
3. Etching the buccal surface of tooth was done using 37% phosphoric acid for 30 s
4. Turning on the light source, the profile of the sample was projected on the projection screen [Figure 4]
5. Two projections of each sample were projected
   a. Before etching
   b. After etching
6. The image was projected on a white matte drawing paper that was attached to the wall using a sticking tape. Matte paper reduces penumbra formation, giving a sharply defined image so that it will be less straining to the eyes and can be easily traced and measured
7. The size of 0.8 mm wire appeared on the projection screen is 80 mm which means the magnification of ×100 is obtained. It acts as a reference for both magnification as well measuring distance from the tooth surface
8. The projection was recorded using tracing paper. The image was traced from one end of the projected image to the projected convex surface of the tooth [Figure 5]
9. The difference between the two tracings before and after etching was measured using a millimeter scale [Figure 6]
10. This reading was converted into microns, i.e., 1 mm = 10 μ

11. In this manner, readings were taken and measured for 20 samples.

Statistical analysis

Statistical analysis of 20 samples was done. The statistical method used for this study was to measure central tendency. The mean, median, and mode are all the measures of central tendency. They attempt to describe what the typical data point might look like. Values obtained from the statistical analysis have been shown in [Table 1].

RESULTS

The research shows that the average enamel loss was around 15.25 μ. The median is a value at the midpoint of

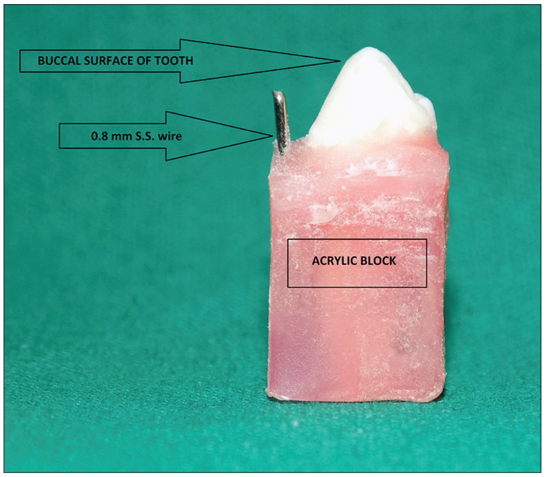

Figure 1: Each tooth is mounted on an acrylic block (2 cm × 1 cm) along with a 0.8 mm stainless steel wire partially embedded in acrylic in front of the buccal surface of the teeth

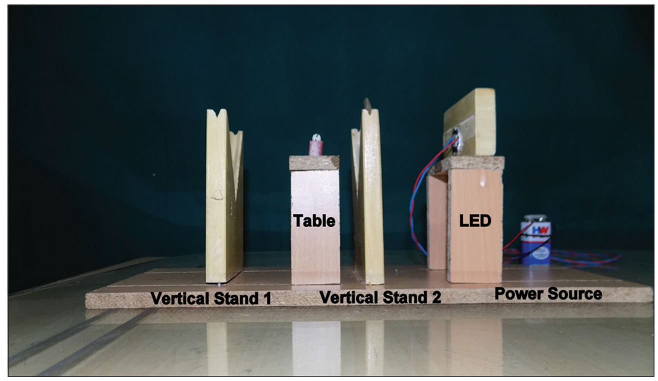

Figure 2: Custom made profile projector

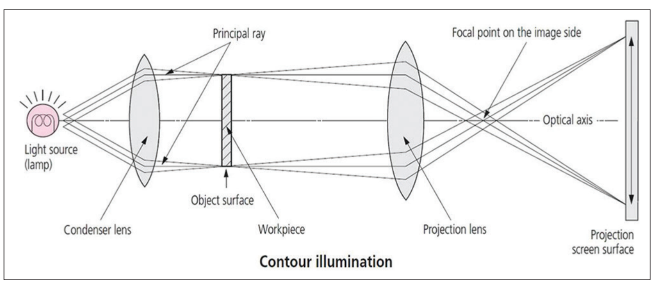

Figure 3: Ray diagram of profile projector

Figure 4: Tooth sample projected on projection screen

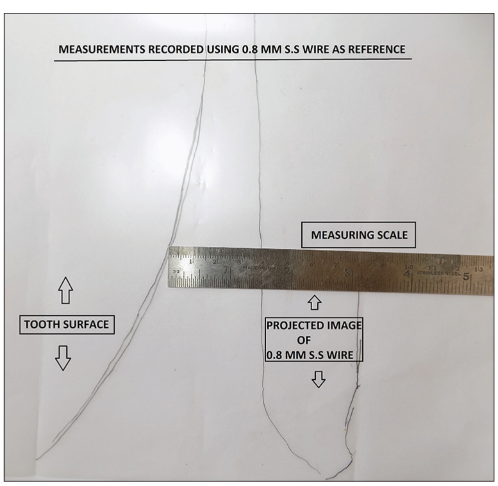

Figure 5: The image was traced from one end of the projected image to the projected convex surface of the tooth

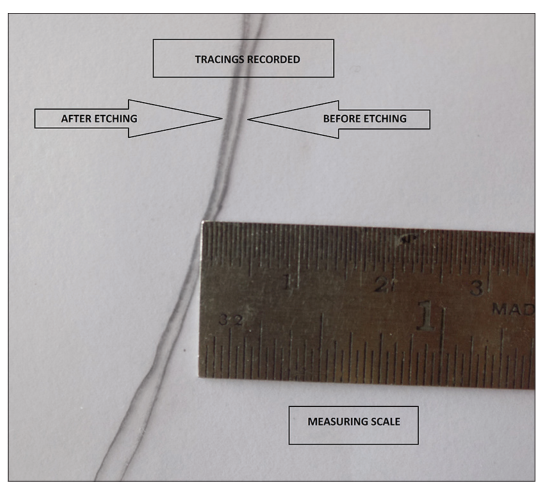

Figure 6: The difference between the two tracings before and after etching was measured using a millimeter scale

Table 1: Statistical analysis

n (number of observations)	Mean	Median	Mode	Minimum	Maximum	Variance	SD
20	15.250	15.00	15	10	25	24.9342	4.9934

SD – Standard deviation

the group, and median for enamel loss is 15 μ. The mode is the value that appears most frequently in the group of measurements, according to this research. Mode for enamel loss is 15 μ that means most frequent or most repetitive enamel loss is 15 μ. The maximum enamel loss was 25 μ and minimum of that was 10 μ.

DISCUSSION

The modern bonding system for resin-based materials is based on a micromechanical retention principle. To achieve this, an acid, generally a 37% orthophosphoric acid, is used to transform the smooth enamel surface into an irregular surface and increase its surface free energy, and some amount of enamel loss is accepted.[14] The superficial 100 μm of enamel is the fluoride rich layer. Most of the damage to the enamel during bonding and debonding is well within this fluoride rich layer, leaving adequate protection for the remaining enamel structure.

In this study, we used a custom made profile projector that was based on the principles of optics. The study quantifies the loss of enamel occurring during one of the most commonly performed procedure, which is acid etching. Though the depth of acid etching has been extensively studied,[6,9-11] the surface loss has been an aspect less ventured by researchers. Advantages of custom made profile projector:

1. It is an economical and very efficient tool
2. A single setting of the specimen provides observation, comparison, and inspection of several dimensions and characteristics in a projector
3. Several people can observe the projected image simultaneously. Thus, the projectors are handy tools when images are to be inspected by a group of people
4. There is no physical contact between the specimen and the measuring instruments in projectors. Thus, the specimen to be inspected is free from mechanical distortion or defects. This increases the accuracy in measurement
5. The open screen, commonly at eye level, permits the observation of the image in unrestricted position under more natural conditions than viewing through a microscope eyepiece.

Our custom made projector not only measures enamel loss, but it will also helpful in dentistry for many purposes such as bur scratches, indentations, and undesirable chamfers in restorative dentistry.

CONCLUSION

The results of this study indicate that etching of enamel with 37% phosphoric acid for 30 s reduces 15 μ of surface enamel as shown using an economical and efficient custom made profile projector.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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