SEM STUDY REGARDING DENTAL EROSION ON EXTRACTED TEETH IMMERSED IN HYDROCHLORIC ACID

Cristina-Angela Ghiorghe*, Claudiu Topoliceanu, Galina Pancu, Simona Stoleriu, Gianina Iovan

“Gr. T. Popa” University of Medicine and Pharmacy - Iași, Romania, Faculty of Dental Medicine Department of Odontology, Periodontology and Fixed Prosthodontics

*Corresponding author: Cristina – Angela Ghiorghe, Lecturer, DMD, PhD
“Gr. T. Popa” University of Medicine and Pharmacy, Iași, Romania
e-mail: drangycris@yahoo.com

ABSTRACT

The aim of study was to determine, using SEM microscopy, the changes of enamel surfaces of teeth imersed in 0,06 ml0/l hydrochloric acid (pH1,2). The choice for this solution is to simulate the gastric juice attack related to erosive lesions on oral dental surfaces of patients with gastroesophageal reflux disease (GERD). The study group included 20 extracted healthy human teeth, 10 maxillary teeth and 10 mandibular teeth. After samples preparation, every tooth was cut in three slices. The three slices were imersed in distilled water (control sample), hydrochloric acid (30 minutes), hydrochloric acid (1 hour). The samples were analysed in SEM microscopy, followed by an analysis of minerals concentration. The results showed, for samples imersed in hydrochloric acid, the apparition of important surface changes, as enamel pores enlargement, irregular structure of enamel prisms and significantly decrease of calcium, phosphat ions concentrations. Conclusions: The demineralisation of enamel tissues is directly related to repeated acid attacks; the dissolution rate of enamel in acid erosion depends on chemical parameters of solution (pH, concentration); the study highlights the risk of gastroesophageal reflux disease (GERD) for the hard dental tissues.

Key words: dental erosion, enamel, hydrochloric acid, SEM microscopy

INTRODUCTION

The ultrastructural aspects of dental erosion and physical and chemical features of affected dental surfaces under erosive attack, can be assessed using diverse laboratory techniques.

SEM microscopy performs qualitative analysis of the enamel surfaces changes under erosive processes. SEM microscopy determines the extension of the affected enamel surfaces regarding the alteration degree of enamel prisms accordingly to SEM images [1].

MATERIAL AND METHODS

The study included 20 unaffected human teeth extracted for periodontal and orthodontic reasons, 10 maxillary and 10 mandibular teeth. After extraction, teeth were stored in formalin solution 10%.

The organic and anorganic debris were removed using mechanical and chemical procedures (immersion in NaOCl sol.5,25%).

The coronal samples were cut in vestibular-oral and mesio-distal plans, using diamond discs. Every dental crown was divided in three slices. The three slices were immersed in distilled water (control sample), hydrochloric acid (30 minutes), hydrochloric acid (1 hour). Every slice was prepared using paper discs to obtain 10 μm slices. After washing in clean water, every slice was...
immersed in resin plate. The samples were analysed in SEM microscopy (SEM model VEGA II LSH., TESCAN Cehia. The SEM microscope was connected to a EDX detector (QUANTAX QX2, BRUKER/ROENTEC, Germany).

RESULTS
The microscopic images (Fig. 1) show the enamel-dentine junction (EDJ). The enamel prisms are unaffected and present regular orientation.

The microscopic images (Fig. 2) show porous enamel, with irregular structure associated with small hydroxyapatite crystals condensed at enamel surface.

After immersion of teeth fragments in hydrochloric acid for 1 hour (Fig. 3), SEM images show the enlargement of the enamel pores, the destruction of the enamel structure and the apparition of small fissures.

Figure 1. Images 100X, 500 X SE 1 (control sample)

Figure 2. Images 100 X SE, 500 X SE (sample 1, after 30 minutes)
The study included the analysis of enamel chemical composition, related to concentration of calcium, phosphate and oxygen. The samples immersed in hydrochloric acid for 30 minutes and 1 hour, were compared with control sample. The study was performed using Bruker AXS detector (QUANTAX QX2, BRUKER/ROENTEC, Germany). Using this device, it were recorded the chemical spectrum of the enamel composition and minerals quantity (μg).

In figure 4 (control sample 1), the chemical analysis records 45.64 μg% calcium concentration and 19.34 μg% phosphate concentration. The recorded values are close to the normal concentration range.

Figure 5 (sample 1, 30 minutes immersion) shows an important decrease of enamel calcium and phosphate concentrations (calcium = 3.35 μg%, phosphate= 2.50 μg%) as well as the apparition of another microelements (carbon= 15.99 μg%, chlorine = 2.75 μg%). The carbon ions results from the degradation of the enamel organic structure, chlorine ions penetrate the dilated enamel pores.

After 1 hour, enamel chemical composition analysis records a reprecipitation of calcium and phosphate ions, associated with microscopic aspect of microcristals stored on the enamel surface (Fig. 6).
DISCUSSIONS

The SEM study confirms the results highlighted by other similar studies regarding the demineralisation processes of enamel and dentine under the action of hydrochloric acid (major component of gastric acid). The clinical effect, produced by the opening of dentinal tubules, is the apparition of cervical dentinal sensitivity, as a result of dynamic changes of dentinal fluids and dental tissues loss.

Field J. & al. (2010), in a study performed on extracted teeth, observed that SEM can be used to measure in vitro resorption of hard dental tissues. The SEM images can analyse the composition, structure, can highlight small areas and can be viewed 3-D. The dental surfaces, in conventional SEM, must be covered with gold to prevent electrostatic loading [1].

Pollyana S. Castro, Alex S. Lima, Tiago L. Ferreira, and Mauro Bertotti (2011), showed that the enamel dissolution rate in acid erosion, depends on some chemical parameters (pH, calcium and phosphate ions concentration). The enamel dissolution is a fast process that produces the extensive diffusion of protons layer in solution. The dissolution mechanism is controlled by interfacial processes. The presence of fluorine ions can reduce the erosion rate of hydroxyapatite. SEM microscopy can investigate the chemical reactions associated with the acid erosion and can clear up the protective mechanisms. The covering with NaF varnishes represents one of the
preventive techniques regarding dental erosive demineralization. The profilometry is another monitoring method that can be used regarding the evolution of acid erosion and the efficacy of diverse preventive and therapeutic approaches [2].

Barbour & al.(2006) demonstrated that the increase of calcium ions concentration can diminish the erosive effects. The decrease of enamel hardness after immersion in juices with high concentrations of citric acid is similar with the results obtained in our study [4,5].

The values of calcium and phosphate ions obtained in our study are related with the results obtained in other similar studies focused on the enamel demineralisation processes produced by diverse acids [5]. SEM microscopy observed first changes of enamel structure at the interface prism/prism wall. Further the hidroxyapatite crystals reduced their diameters. After 1 hour of immersion in hydrochloride acid, SEM images show the destruction of organic component and micro fissures. The quantitative analyse demonstrates the enamel minerals loss by the carbon ions apparition, after one hour of immersion in hydrochloride acid.

CONCLUSIONS

- The demineralisation of enamel tissues is directly related to repeated acid attacks;
- The dissolution rate of enamel in acid erosion depends on chemical parameters of solution (pH, concentration);
- SEM analysis of enamel structural changes as well as chemical analysis can clear up the dental erosion mechanisms;
- The study highlights the risk of gastroesophageal reflux disease (GERD) for the hard dental tissues.

REFERENCES

3 Barbour ME, Rees GD. The role of erosion, abrasion and attrition in tooth wear. J Clin Dent. 2006;17(4):88-93