SCANNING ELECTRON MICROSCOPIC OBSERVATIONS OF THE ENAMEL SURFACE BEFORE AND AFTER ETCHING BY ORTHOPHOSPHORIC ACID*

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■ ABSTRACT: Ten unerupted human third molars were examined under the scanning electron microscope. In the fractured surfaces can be observed an external "prismless" layer at the buccal and lingual faces. The specimens treated by phosphoric acid *in vitro* showed three basic etching patterns. The type I etching pattern showed a rough enamel surface with the prism core removed. The type II etching pattern showed that the prism cores are left projecting towards the enamel surface, and the type III, showed the loss of prism with irregular arranged structures. The effects of acid-etching on the enamel surface depend on the variation of tooth morphology, selected surface and changes in enamel structure.

■ KEYWORDS:Dental enamel; prismless layer; acid etching, dental; microscopy, electron, scanning.

Introduction

The existence of the "prismless" enamel layer have been described by several authours.[1,2,3,4,5,7,9,10,11,12,16,17,18,21] On the other hand, some papers reporting the effects of acid treatment on tooth enamel indicate a consensus about the general classification of effects obtained.[13,19] However, there are a great number of variables which may affect the result obtained, such as: tooth morphology, the surface and the type, tooth, method of application and time of the acid etching.[8,14]

In the present study, we have examined the surface of enamel of unerupted teeth; before and after treatment with orthophosphoric acid, employing the scanning electron microscope.

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Material and methods

Ten unerupted humans third molars were sectioned transversaly at the cervical third in order to separate the crowns from the roots. Then, all teeth were fractured in a bucco-lingual and mesio-distal plans using a vice. In five teeth, 37% orthophosphoric acid (Kulzer) at 37°C was applied to the buccal and lingual surfaces for 60 seconds, employing the routine clinic procedures. All these specimens were rinsed in distilled water and dehydrated in an increasing series of alcohols. After air drying, the specimens were mounted on a metal stubs and coated with gold ions using a Balzers Ion Sputter SCD-040 device. Specimens were examined under a JEOL, JSM-P15 Scanning Electron Microscope.

Results

In the scanning electron microscopy images, a normal surface of human third molar teeth showed several depressions which are formed by alternating parallel grooves with slight elevations or convex ridges (Figure 1). The "prismless" layer was found in the three regions (cervical, middle and occlusal), both in the buccal and lingual faces (Figure 2). The thickness of the "prismless" enamel layer presents an increasing value from occlusal to cervical region.

The specimens treated by 37% phosphoric acid showed several cavities in the enamel surface (Figure 3). Based on the classification described by Silverstone et al.,[19] three types of effects are observed (types I, II, III): the Figure 3 reveals the type I etching-pattern characterized by a rough enamel surface. In some samples appeared less affected areas, presenting a relatively smooth surface: in the type II etching pathern may be seen a heavly damaged area and the prism cores are left projecting towards the original enamel surface (Figure 4). High magnification views show fissures that have been produced by the acid-etching extended along the lenght of the prism. The effect of acid etching is quite different according the enamel surface (Figure 5). Many samples are characterized by a random pattern of dissolution of enamel, presenting several forms of sulci (Figure 6), which depend on the porosity of enamel surface (Figure 7).

In the type III etching pattern, the internal surface of these cavities is characterized by the loss of prism peripheries with irregular arranged structures (Figure 8). Some adjacent areas remains mineralized and are clearly observed as a smooth surface.

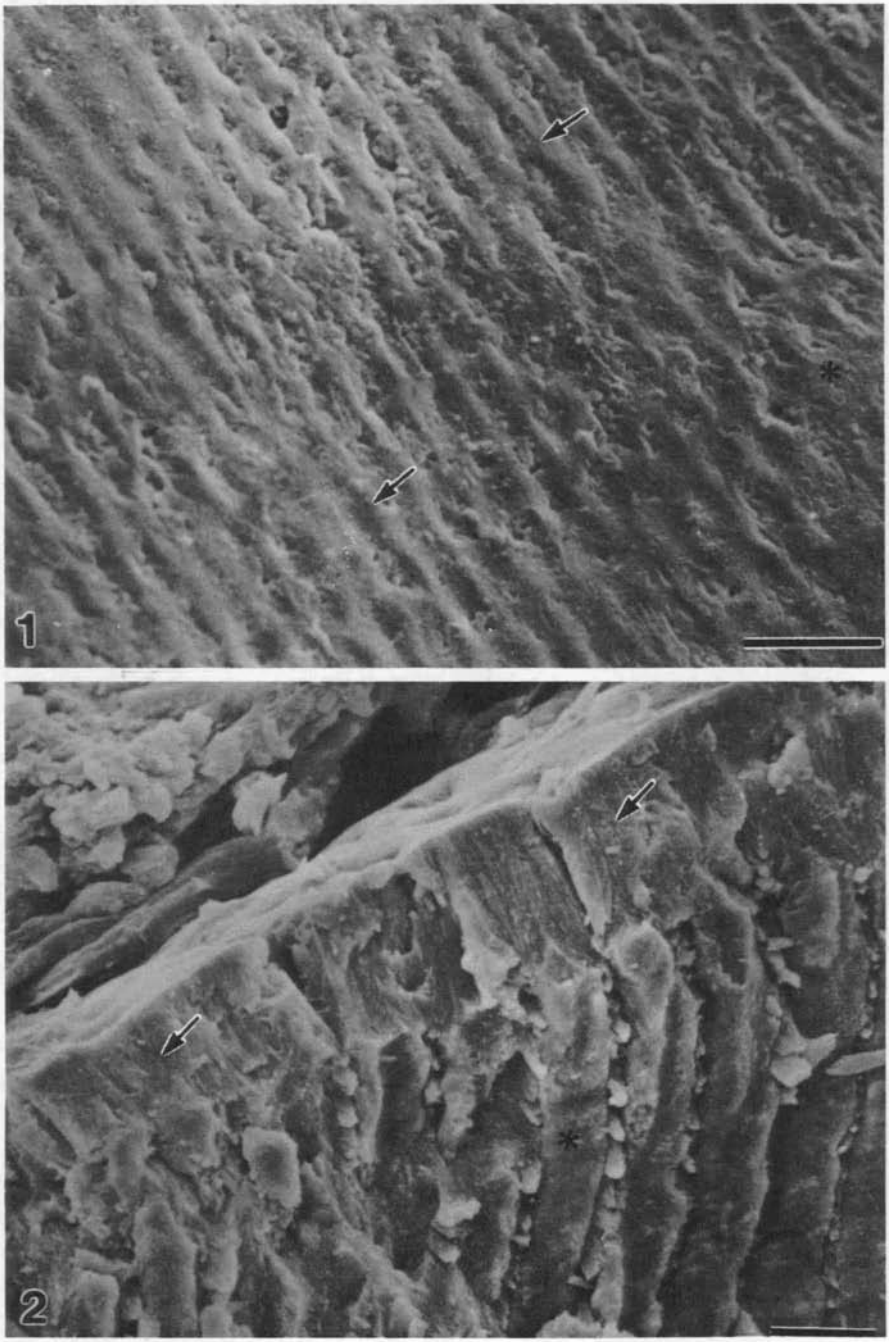
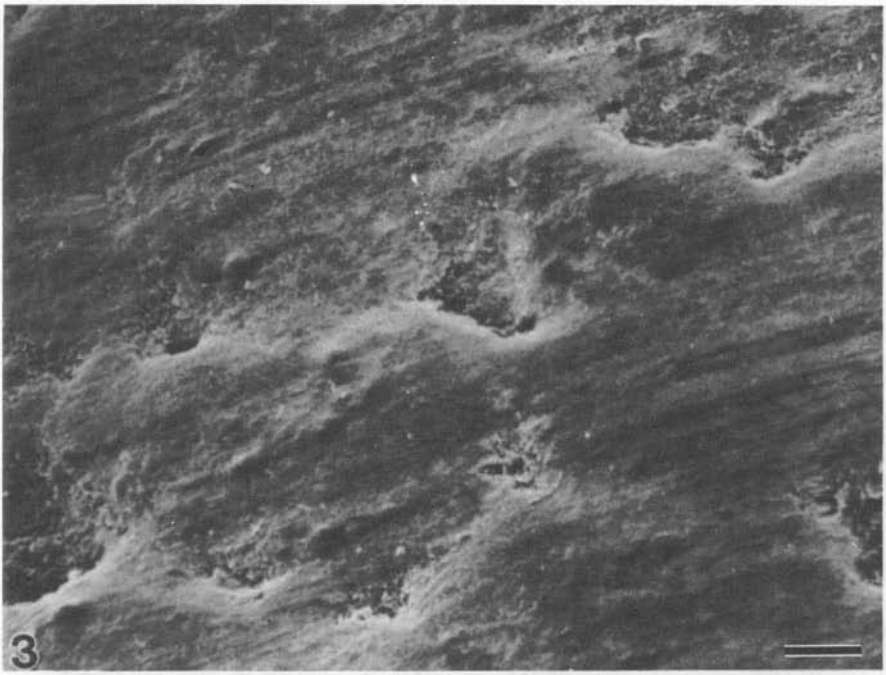


FIGURE 1 – Lower left third molar. Shows occlusal site of lingual face with smooth surface (*) and rows of normal enamel structure (arrows). Bar: 10 μm. 3.000X

FIGURE 2 – Lower right third molar. SEM of fractured occlusal enamel surface of vestibular face showing the "prismless" layer (arrows) and enamel prisms (*). Bar: 10 μM. 3.000X.



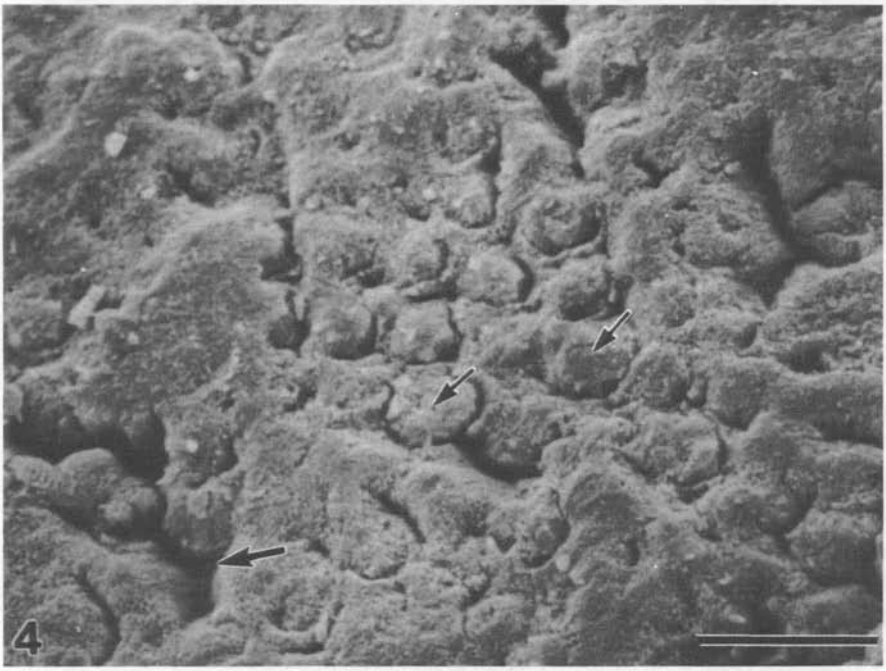
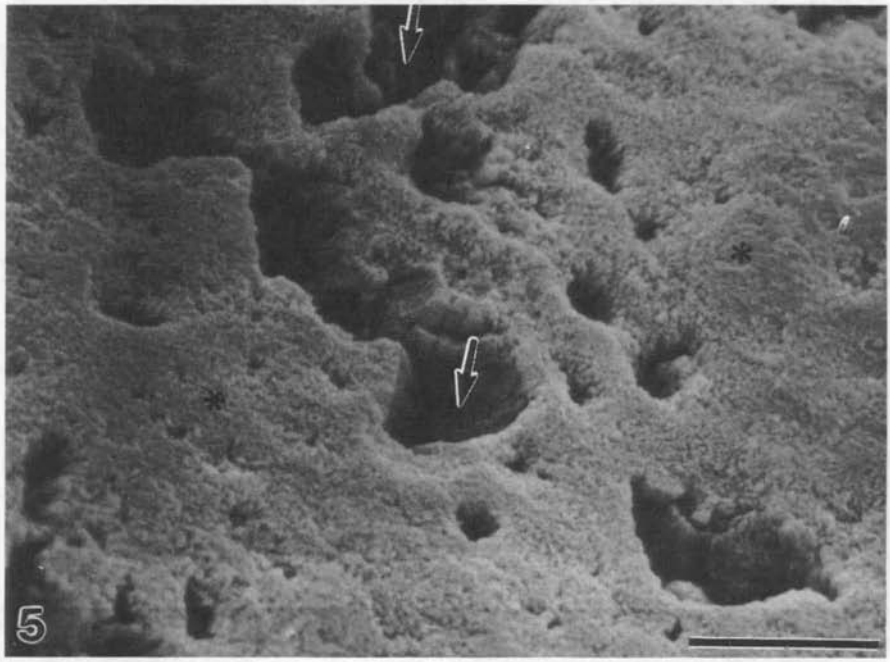


FIGURE 3 – Lower left third molar. SEM view of coronal enamel of lingual face treated with 37% of orthophosphoric acid. Bar: 10 μm. 240X

FIGURE 4 – Upper right third molar treated with orthophosphoric acid. Occlusal site of lingual face, evidencing the prism cores (small arrows) and damaged areas (large arrows). Bar: 10 μm. 2.400X



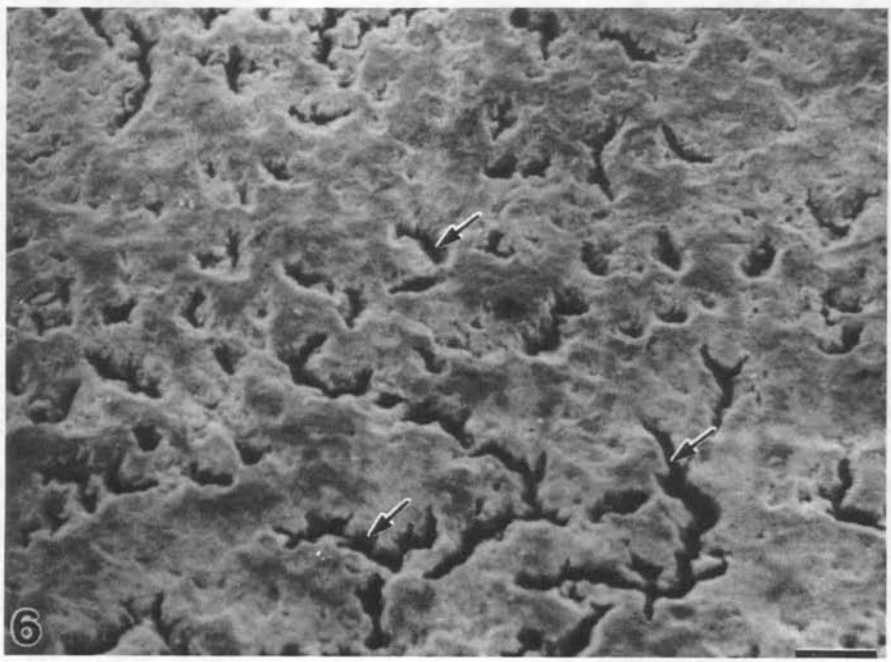
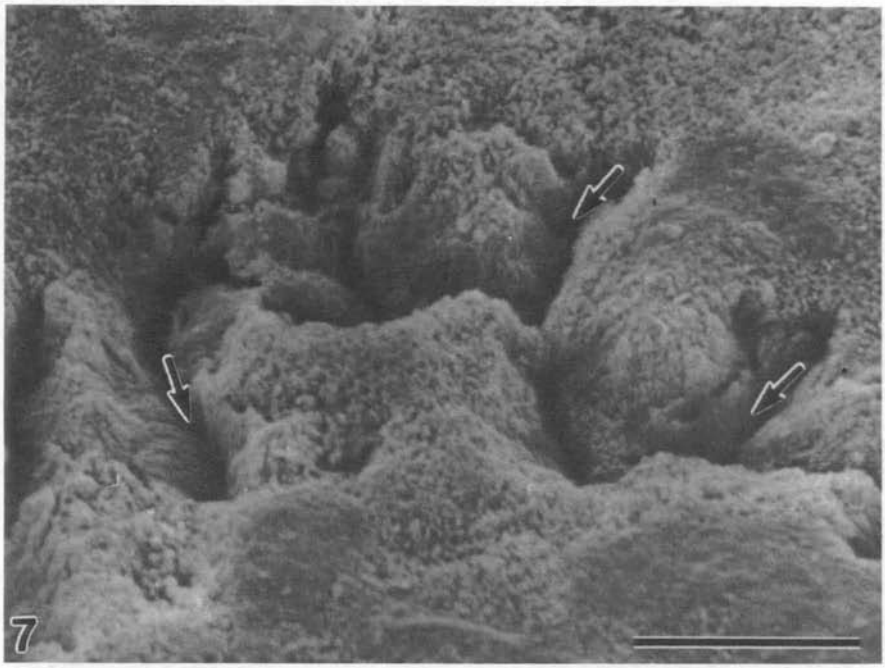


FIGURE 5 – Upper right third molar treated with orthophosphoric acid. Irregular depressions or holes (arrows) and smooth enamel surfaces. Bar: 10 µm. 1.500X.

FIGURE 6 – Upper right third molar treated with orthophosphoric acid. Occlusal site of buccal face evidencing a random pattern of dissolution (arrows). Bar: 10 µm. 900X



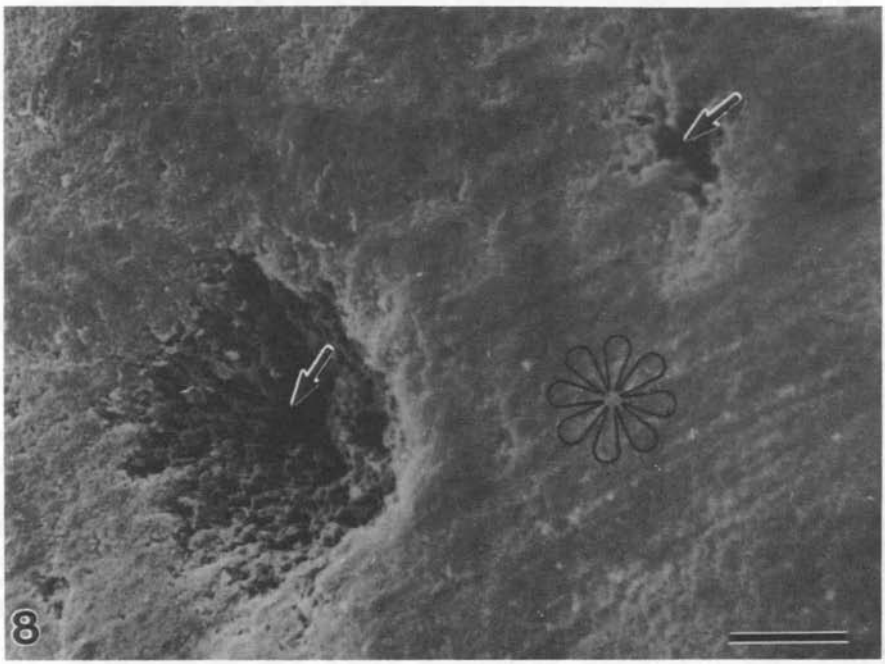


FIGURE 7 – Upper right third molar treated with orthophosphoric acid. Middle of coronal enamel shows some cavities (arrows) and smooth surface. Bar: 10 μm. 6.000X.

FIGURE 8 – Lower third molar treated with orthophosphoric acid. Middle of coronal enamel shows some cavities (arrows) and smooth surface (*). Bar: 10 μm. 600X.

Discussion

Our results demonstrated that acid-etching process promotes the formation of cavities of variable dépths as already reported.[13,19,22] The diversity of cavities may be due to variations in the enamel structure and the degree of porosity of the aprismatic layer.[8]

Based on the application of phosphoric acid on the buccal and lingual faces during 60 seconds it was confirmed that there are differences in the deep of cavities. This result has been related to the solubility of the enamel prism and its dependence upon the orientation of the hydroxiapatite crystals.

Our findings also confirm the existence of three types of classifications previously reported after acid dissolution:[13, 19, 20] type I showing dissolution of the prism heads; type II showing dissolutions of the periphery of the prism and type III having a dissolution of head and periphery simultaneously.

Nuti-sobrinho et al.[15] and Fucks et al.[2] reported the type I result on the occlusal surface of premolars and on the buccal surface of deciduous upper incisor.

However, it appears that the presence of an "prismless" enamel layer affects the nature of the surface obtained after acid-etching. This study demonstrated that there is an important link between acid-etching timing and penetration (dissolution) of the "prismless" layer. On the other hand, the results also support the evidence that the acid treatment produces cavities of several types adhesion of filling material.

FAVA, M, WATANABE, I., FAVA-DE-MORAES, F. Observações ao microscópio eletrônico de varredura da superfície do esmalte aprismático antes e depois de tratamento pelo ácido ortofosfórico. *Rev. Odontol. UNESP*, São Paulo, v. 23, n. 2, p. 231-239, 1994.

■ *RESUMO: Dez terceiros molares humanos inclusos foram examinados, empregando o método de microscopia eletrônica de varredura. A camada do esmalte aprismático pode ser observada nas superfícies fraturadas das faces vestibular e lingual. As peças tratadas pelo ácido ortofosfórico* in vitro *mostraram três tipos básicos de resultados. O tipo I de ataque ácido mostra uma superfície rugosa de esmalte com a remoção da porção central do prisma de esmalte. O tipo II mostra que a porção central do prisma permanece intacta mas ocorre a dissolução da substância periférica. O tipo III revela uma superfície com imagens de prismas do tipo I e II dispostas irregularmente. O efeito do ataque ácido mostrou ser dependente da variação na estrutura do esmalte, de superfície para superfície e de dente para dente. Estes resultados indicam diferentes previsões na adesão de resinas ou selantes.*

■ *PALAVRAS-CHAVE: Esmalte dentário; camada aprismática; condicionamento ácido; microscopia eletrônica de varredura.*

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