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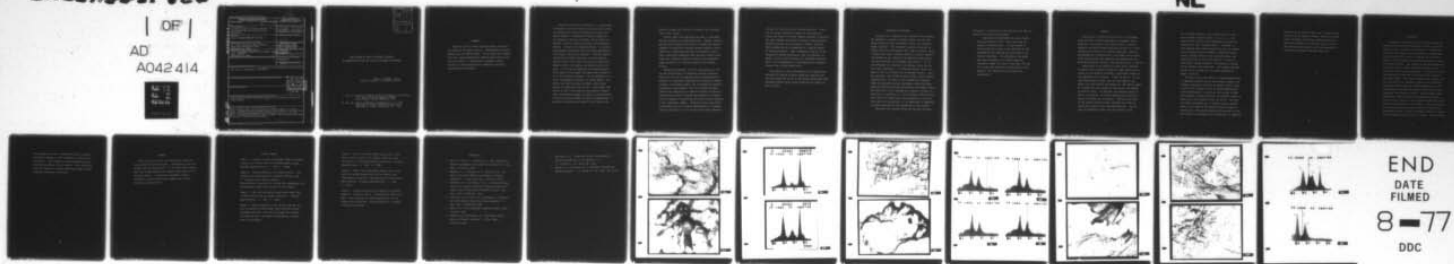
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THE EFFECTS OF EDTA ON DENTURE CALCULUS:
AN EXAMINATION USING THE SCANNING ELECTRON MICROSCOPE

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ABSTRACT

EDTA was used to remove calcified debris from salivary deposits on denture acrylic. Examinations were performed using the SEM and EDAX. It was found that soaking only with sodium hypochlorite removed almost none of the calcified debris. A combination treatment of EDTA, followed by sodium hypochlorite removed the calculus - calcified and uncalcified.

Patients with natural dentition are continuously encouraged to practice proper plaque control in order to eliminate the threat of dental caries and periodontal disease. Elimination of dental plaque and the removal of calculus are basic, and of prime importance to the prevention of caries and periodontal disease. Patients with complete dentures or partial prosthodontic appliances have often been neglected in oral hygiene instruction programs. Salivary deposits consisting of similar materials to those found on natural teeth can be found on plastic and porcelain denture teeth, cast metals, and denture acrylic surfaces. It is just as important for denture wearers to be aware of the dangers of plaque and calculus as it is for dentulous patients. For all patients it is still a fundamental principle to remove plaque. Deposits that form on denture surfaces which touch mucosa can compromise oral health. Love, Goska, and Mixon¹ in their investigations discovered a significant relationship between the degree of uncleanness of dentures and the amount of mucosal inflammation. A definite correlation was found to exist between the

amount of plaque and calculus on dentures and inflammation of the tissues.

Several other investigations were made to determine the best methods for cleaning dentures. Shannon, McCrary, and Starcke² evaluated the ability of commercial denture cleansers to decolorize stained salivary deposits and to remove this accumulated material from denture acrylic. Their conclusions supported other previous studies which found that commercial denture cleansers are disappointingly ineffective in removing deposits from denture acrylic.

Anthony and Gibbons⁶, in their investigation of the use and effectiveness of commercial denture cleansers found that half of the denture wearers studied found it necessary to supplement immersing in a commercial denture cleanser with brushing and/or use of household cleansers; and despite advertisements, only 5% of those patients studied used immersing in a denture cleanser exclusively. These denture wearers revealed that commercial cleansers were not capable of dissolving calcified salivary deposits to any significant degree. Nicholson, Stark, and Scott⁴ investigated the use of sodium hypochlorite as a denture cleanser and found it to be of more value than commercial

cleansers in loosening heavy calculus deposits. Brushing was always required to remove all the deposits. Peyton and Craig⁸ state that regular brushing of dentures and some commonly used denture cleansers and dentifrices produce scratches on the surface of denture acrylics. These methods are not recommended as a routine method of cleaning dentures. They recommend a solution of one teaspoon of sodium hypochlorite, and two teaspoons of Calgon in half a glass of water for overnight immersion. This is not recommended for cleaning partial removable dentures that contain base metals.

The purpose of this investigation is to examine the structure of denture calculus using the scanning electron microscope and to see if the decalcifying agent EDTA (ethylene diamine tetra acetic acid) has any effect on this calculus.

MATERIALS AND METHODS

Specimens for examination were obtained from patients who appeared to be heavy calculus formers and who were being treated at Epes Army Dental Clinic, Fort George G. Meade, Maryland. The specimens consisted of pieces of denture acrylic approximately 2mm X 2mm X 2mm taken (with a dental bur) from a complete denture or partial denture. The outside of one surface of the specimen consisted of calculus attached to the denture base acrylic. All of the specimens were obtained from dentures which, at the time, were functional. A selfcuring acrylic repair was done to fill in the defect in the denture acrylic. Next, the specimens were divided in half, using a small pointed diamond stone. One-half of the specimen was examined under the scanning electron microscope (Model AMR-1000, Advanced Materials Research Corporation, Burlington, Mass.) The other half of the specimen was treated by either (1) immersing it completely in a 10% solution of EDTA in water for a period of eight hours, and sonicating in an ultrasonic unit for ten minutes, or (2) immersing it completely in sodium hypochlorite and sonicating for two minutes.

Specimens were examined using the scanning electron

microscope. Preparation of the specimens for SEM consisted of the following treatment:

Specimens were dehydrated in ethyl alcohol and were allowed to dry. Next, they were cemented to aluminum stubs. A small amount of silver paint was placed at the interface of the specimen and the aluminum base providing a conductive attachment. The specimen on the aluminum stub was placed in a Vacuum Evaporator (Technics, Hummer II) where a thin layer (50-100 A°) of gold and palladium was deposited on the surface. The specimen was then ready for examination.

RESULTS

Examination of denture calculus prior to treatment, using the SEM, revealed aggregates of roughened debris attached to the denture base acrylic (Figs. 1a and b). Analysis with EDAX (Energy Dispersive Analysis of X-rays) confirmed the presence of calcified material. Calcium and phosphorus K characteristic X-ray peaks were present; other primary peaks that appeared were produced by the gold and palladium coating of the specimen (Figs. 2a and b).

Examination of the denture calculus after treatment (soaking in 10% solution of EDTA for eight hours and sonicating for ten minutes) revealed a significant change in the appearance of the debris (Figs. 3a and b). At the same magnification (200X), the size and shape of the debris were much smaller and broken up. The debris appeared loosened from the surface of the acrylic and reduced to smaller pieces. In addition, the relative amount of debris was reduced. At higher magnification the debris appeared smoother and less porous. Analysis with EDAX of the denture calculus after treatment with EDTA revealed the absence of any calcified material. The calcium and phosphorus peaks that were present in the

pre-treatment analysis, were clearly absent in the post-treatment analysis (Figs. 4a, b, c, d). The material that remained after treatment with EDTA was uncalcified, soft, loosened debris. Treatment of this specimen with sodium hypochlorite for two minutes in an ultrasonic device produced a relatively clean acrylic surface devoid of any calcified debris and relatively free of soft, loose debris. A layer of thin patchy residue remained. No brushing or wiping of any surfaces were performed - only soaking and sonicating; first in EDTA then in sodium hypochlorite (Figs. 5a and b).

In order to test the effects of sodium hypochlorite in removing calcified debris from denture acrylic, the original specimen of calculus on denture acrylic (Figs. 1a and b) was allowed to soak in sodium hypochlorite with sonication for two minutes. The results of SEM investigation revealed that most of the thick layers of debris were still present (Figs. 6a and b). The only noticeable difference was a slightly cleaner surface. Analysis with EDAX of the denture calculus which was treated only with sodium hypochlorite revealed not only the presence of phosphorus and calcium but, in addition,

the presence of chlorine (Fig. 9a). However, EDAX analysis of the denture calculus that was treated first with EDTA, followed by sodium hypochlorite, showed no phosphorus, no calcium, and no chlorine. The chlorine peak appeared only from specimens on which calcified debris remained (Fig. 9b).

DISCUSSION

Investigation of denture acrylic calculus using the SEM and EDAX revealed the presence of thick, calcified blocks of debris attached to the acrylic. Soaking and sonicating the denture acrylic calculus in sodium hypochlorite had little effect in removing the calcified debris, but did remove soft protein-like material from the acrylic surface. The effects of sodium hypochlorite were seen only on samples which had previously been treated to remove calcified debris. In addition, a chlorine residue was observed in specimens that contained calcified debris. The chlorine appeared to complex with the calcium and was recorded by EDAX in all calcified specimens treated only with sodium hypochlorite. The decalcifying agent EDTA was used to remove calcium and phosphorus from denture calculus. SEM and EDAX studies showed that calcified debris was removed from denture calculus after soaking in 10% solution of EDTA for eight hours and sonicating for ten minutes. Also, examination of the denture acrylic surface revealed no short term deleterious effects of EDTA on denture acrylic, or formation of chlorides on the acrylic surface. These observa-

tions suggest a possible combination denture cleanser - soaking the denture in EDTA overnight to remove calcified debris - then soaking in sodium hypochlorite and sonicating to remove the soft debris. This method will allow the removal of calculus and heavy plaque without scraping, polishing, or brushing.

SUMMARY

EDTA was used to remove calcified debris from salivary deposits on denture acrylic. Examinations were performed using the SEM and EDAX. It was found that soaking only with sodium hypochlorite removed almost none of the calcified debris. A combination treatment of EDTA, followed by sodium hypochlorite removed the calculus - calcified and uncalcified.

FIGURE LEGENDS

Figure 1. Scanning electron micrographs (SEM) of denture surface with a heavy layer of calcified dental plaque. Original magnifications: a. X200 b. X2000.

Figure 2. Energy dispersive x-ray spectra from a. the surface of an isolated piece of denture calculus, and b. calculus upon a denture surface.

Characteristic x-ray peaks of calcium (Ca), phosphorus (P), and conductive metal coating (Au, Pd) are evident.

Figure 3. SEM calcified dental plaque after eight hours in EDTA solution and ten minutes sonication. Original magnifications: a. X200 b. X2000.

Figure 4. Energy dispersive x-ray spectra from the surface of denture calculus before (dots) and after (bars) treatment with EDTA. Vertical lines mark the location of characteristic x-ray peaks for phosphorus, calcium, gold, and palladium.

Figure 5. SEM of calcified dental plaque after eight hours in EDTA solution, ten minutes sonication, and two minutes in sodium hypochlorite-sonication. Original magnifications: a. X200 b. X2000.

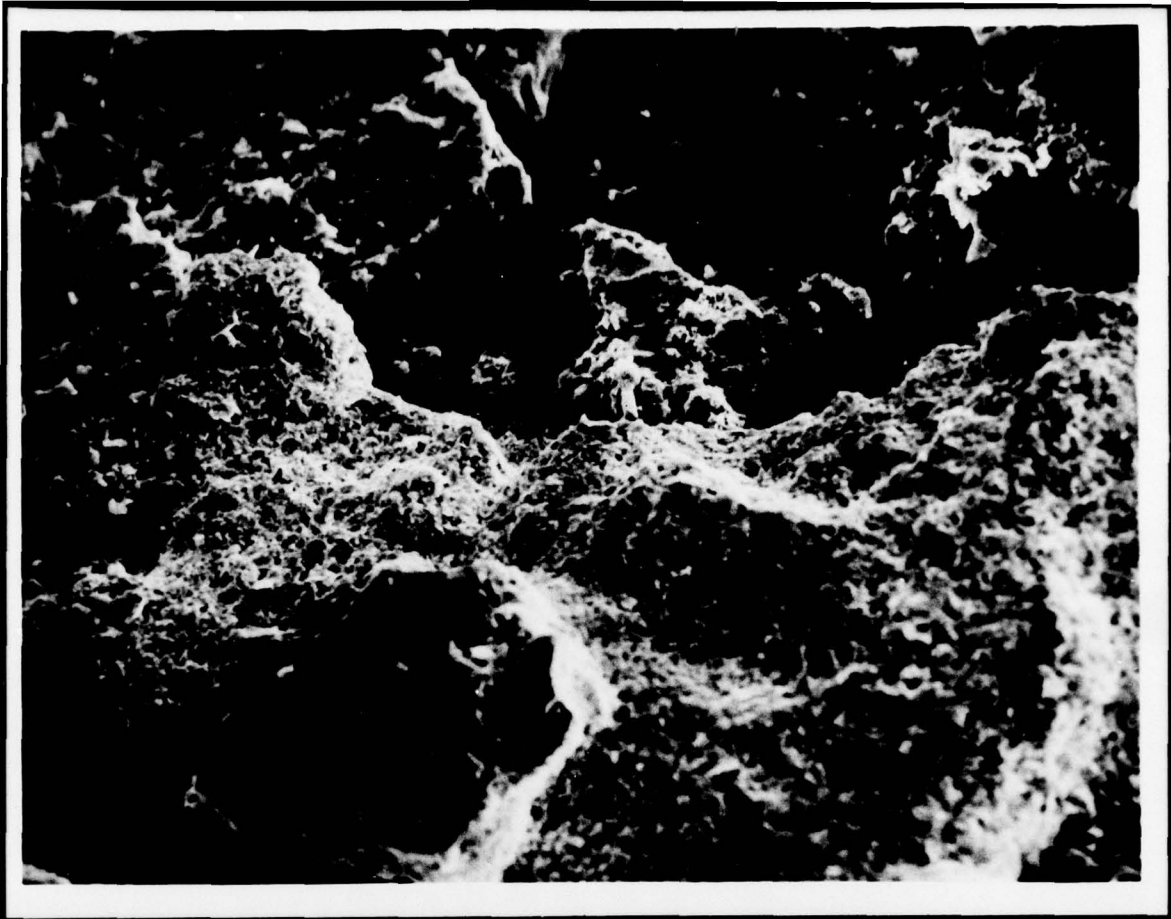
Figure 6. SEM of calcified dental plaque after treatment with sodium hypochlorite for two minutes with simultaneous sonication. Specimen was not treated with EDTA solution. Original magnifications: a. X200 b. X2000.

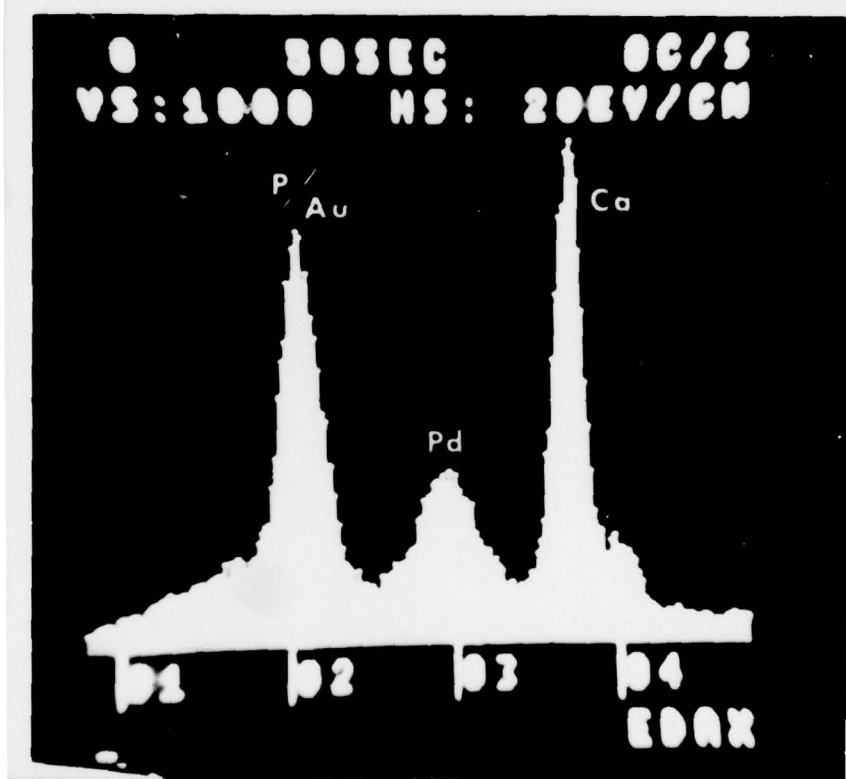
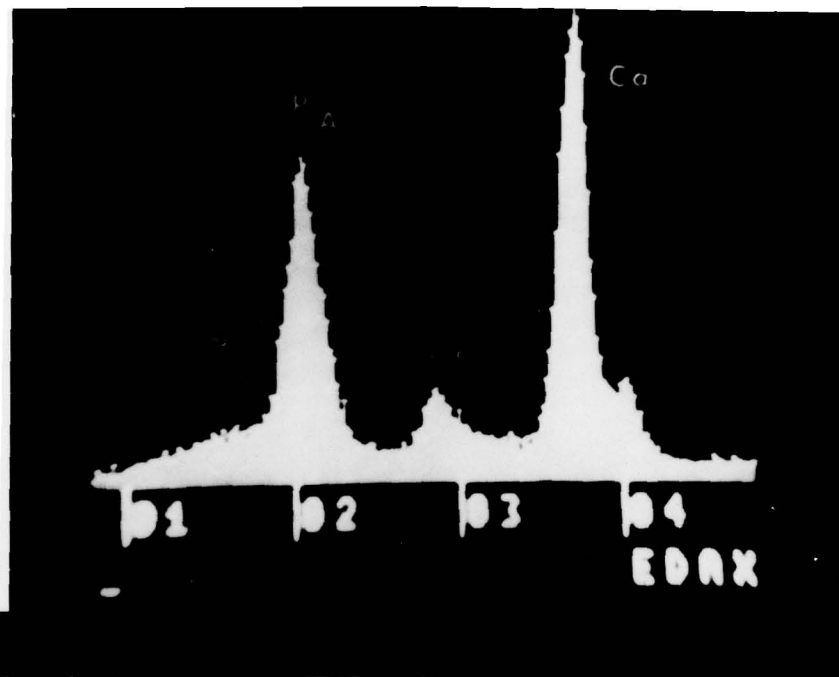
Figure 7. Energy dispersive x-ray analysis of denture plaque a. calcified, and b. decalcified by EDTA treatment - after exposure to sodium hypochlorite for two minutes with sonication. Chlorine peak (Cl) is absent in decalcified plaque.

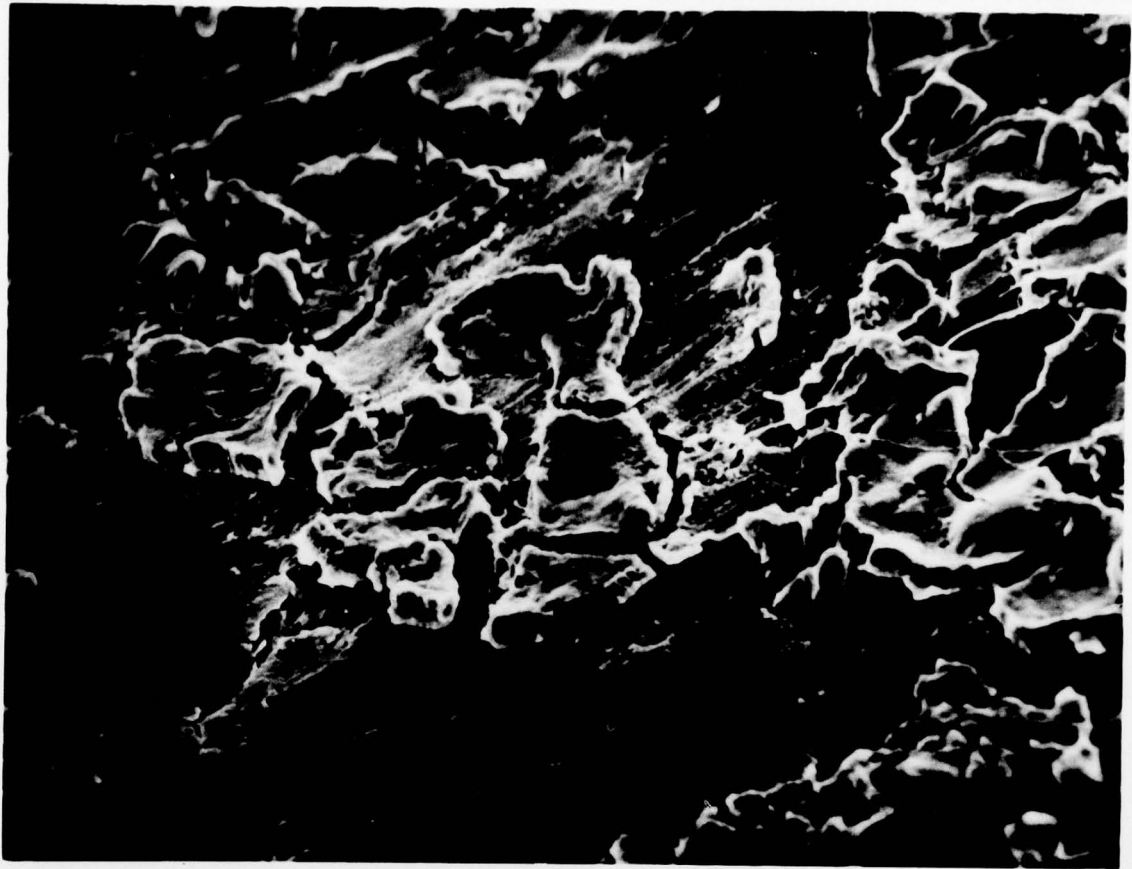
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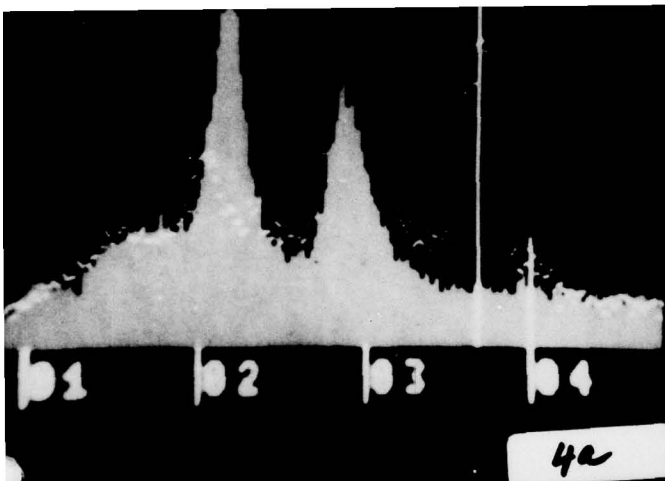




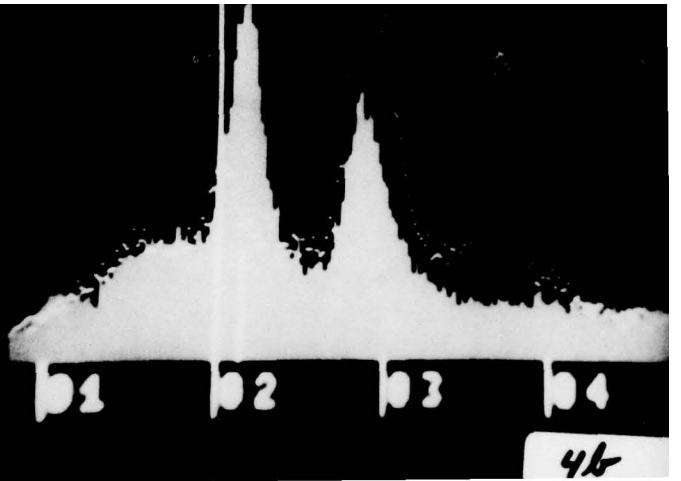
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