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SEM Analysis of Tooth Enamel

Zoran Azinović[1], Jadranka Keros[2], Dino Bukovć[3] and Ana Azinović[4]

[1] Department of Dental Pathology, School of Dental Medicine, University of Zagreb, Zagreb, Croatia
[2] Department of Dental Anthropology, School of Dental Medicine, University of Zagreb, Zagreb, Croatia
[3] Department of Dental Prosthodontics, School of Dental Medicine, University of Zagreb, Zagreb, Croatia
[4] Croatian Restoration Institute, Department of Restoration of Archaeological Founds, Zagreb, Croatia

A B S T R A C T

SEM analysis contains researches of tooth enamel surfaces of two populations. First group of samples is tooth enamel of prehistorically ancestor from Vučedol and the second group of samples is enamel of modern Croatian citizen. Even on small number of human teeth samples from cooperage site of Vučedol (3,000 BC) and today's Croatian people, we can conclude about chewing biometry of prehistorically ancestors and today's modern Croatian people, comparing interspecifically the morphology of enamel microdefects. With the interspecific comparison of morphology changes on tooth occlusal surfaces, we can connect the size and shape of abrasive particles and diet with microdefects of tooth enamel.

Key words: *enamel, microwear, dental adaptation, diet*

Introduction

Taking the fact that there are no two same histological structured teeth or equally chemically built, we were intrigued by the comparison of morphological specifics of human enamel during five thousand years. How much can the results of the research and the interspecifical comparison make the judgment of some future evolution and involution changes and pathological cases easier? From the time when man began to grow corn, produce alcohol, cultivate sugar and salt, evolution of diet habits started so fast that our anatomy and physiology could not adapt, so there are many chronic diseases of modern people caused by diet disorder: diabetes, cancer, heart diseases, tooth decay (caries), and periodontal disease[1].

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Legović et al. (1998)[2,3] affirmed in their longitudinal studies the connection between orthodontics malocclusion with general body growing and chronically respiration disease in Croatian population. Other group of Croatian authors with their researches affirmed the role of certain bacteria, Veillonela and Streptococcus mutans, in etiology of infective endocarditis[4]. The connection between changeable diet habits and the level of dental adaptation is the most in a bigger and faster loss of teeth and abrasive changes on the biting teeth surfaces. Ćatović et al. (1998)[5] affirmed the assumption that abrasion affects the lower teeth than the upper ones. Prpić Mehičić et al. (1988)[6] have also researched the abrasion changes in workers at the textile industry, and they affirmed that the most defects are in the enamel of frontal teeth with clear aesthetics and functional problems.

Dental microdeffects analysis are used in scientific literature for comparison between the died out mammals and modern people in their biometry of chewing. Teaford et al. (1996)[7] researched the dental microdeffects in three branches of anthropoids in early Oligocene from Fayum, Egypt. The results affirmed the connection between all the three anthropoid branches and modern primate who mostly eat fruits. The research also discovered very important differences in enamel microstructure at the three researched branches, and the author concluded that the microstructure elements with different diet are response for difference enamel microdefects.

Hojo et al. (1989)[8] is researching SEM enamel microdefects connected with two populations of one archaeological site in west Japan. SEM analysis shows that the tooth microdefects of late Stone Age horizon are much bigger than enamel microdefects in modern population horizon.

Walker's[1] hypothesis from 80's last century are suggesting that diet habits all kinds are leaving deep effects on different biological aspects. We can see different kinds of diet through the amount and shape of microdefects.

Harmon et Rose (1988)[9] and Pastor (1992)[10] are telling us about the role of dental microdefects in diet reconstruction, the research results are affirming the hypothesis of the connection between way of diet and enamel microdefects in teeth.

Material and Methods

The aim of this research is to compare ultramicroscopic changes of human enamel, who lived in Vučedol in the cupper age (3,000 BC) and today's Croatian citizen. SEM analysis contains research of enamel surface on the biting surface in the lower jaw molars of males.

In purpose of comparable research we prepared two sample groups of enamel. In the first group there were samples of occlusal surface enamel of first molar in the lower jaw from copper age – Vučedol. The second group samples were prepared of occlusal surface of the first molar in the lower jaw of a modern Croatian citizen. Samples of enamel's chewing surfaces were taken for microstructural analysis. A part of samples were treated by 36% ortophosphoric acid during 60 seconds, then washed and dried with compressed air.

All the samples were treated in same way, steamed with layer of gold in a device S 150 Sputter Coater-Edwards. The sample's surface is coated with a gold layer which thickness is 10–15 nano meters to get a better electrically conduction of the samples. The samples are researched in *PLIVA d.d., Department for Quality Control,* on a scanning electronic microscope (SEM) JSM – 5,800 JEOL, 15 kV. SEM analysis are very suitable for surface morphology research. In this technique the reflected and secondary elec-

trons are transformed into electric signals with certain detector. Because they are electric charged they can be diverted in a focus with an electromagnet and they are brought over in a cathode pipe where we get a picture. To avoid any eventually atmosphere effects, those researches are made in a devoid of air space. The amount of reflected and secondary electrons depends on the tension we use, on the detectors position and on the samples surface. The picture of sample's surface based on the electrons has a deep sharpness and very clear relief. The results are evaluated by computer treated microphotographs, device HEWLETT PACKARD ultra VGA 1,600.

Results and Discussion

SEM analysis covered the research of enamel occlusal surface. On the samples of two groups, results of research are grouped by the level of abrasive changes of occlusal surfaces. On Figure 1 is micrography of enamel surface in cupper age tooth. (Vučedol, 3,000 BC). Top of the Figure 1 shows that the enamel surface looks smoother even on a small enlargement. In the middle there is a line that separates enamel from dentine surface. The macroscopic research shows a totally loss of an enamel part on the occlusal surface, so this scanning microphotography is made on the passing part from enamel to the exponated dentine on biting surfaces of teeth.

Figure 2 shows the same sample but only the enamel surface on a bigger enlargement. The enamel surface is rough, with surface defects wide fissures and niches, covered with different size and number particles, but homogeny shaped with a base. This figure is suggesting huge and different types of abrasive changes on the both biting surfaces. Our results correspond completely with ones given by M. F. Teaford from 1991 and 1994[11,12].

Figure 3 shows enamel surface of today's modern Croatian citizen. Macroscopic researches did not discover the exponated dentine of occlusal surface. The enamel surface is not totally smooth, differently to Figures 1 and 2, it has less surface defects and roughness.

The biggest difference is discovered on a big enlargement on Figure 4. Surface defects are minimal, fissures are following the natural shape of enamel prisms, and they cannot be connected with the abrasion happened by changes and defects.

Figure 5 shows enamel structure of cupper age tooth. Enlargement is 13,000 × and shows many enamel prisms, their size and orientation. Also, we may follow the arcade form of enamel prism orientation, with an enamel dark zone on the interprismatic part. The ratio between prisms and the interprismatic space tells us that enamel contains much more anorganic parts and in the enamel structure more enamel prisms are represented. Figure 6 shows enamel structure of modern Croatian citizen tooth. Here should be mention that we have prepared samples from Figures 5 and 6 treating them chemically (etching enamel – regular way of modern laboratory researches of enamel and dentine structures). The way the enamel prisms look and its shape after etching by an acid agents is suggesting that the enamel prism centers are saved and their shape is not changed, the prism's periphery which is poor with anorganic components is lost and the interprismatic space is bigger[13].

Comparing these two figures of microstructure changes of enamel prism morphology, we can suppose that both sample, despite huge time distance, are very similar in their chemistry and structure specifications of tooth enamel[14].

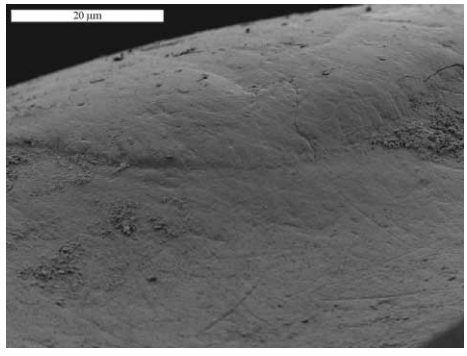

Fig. 1. SEM micrography of tooth occlusal surface of cupper age human tooth (110 ×).

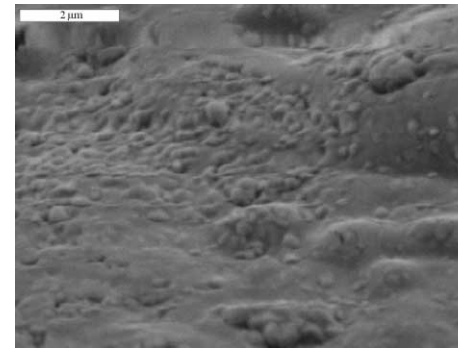

Fig. 2. SEM micrography of enamel surface from Figure 1 (13,000 ×).

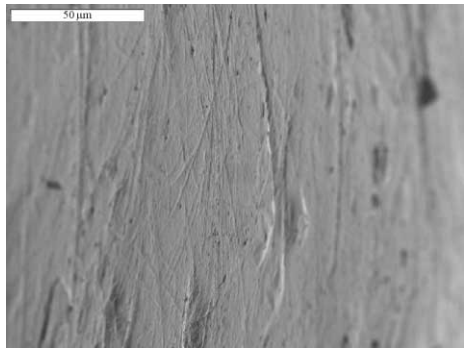

Fig. 3. SEM micrography of enamel surface of today's modern Croatian citizen (110 ×).

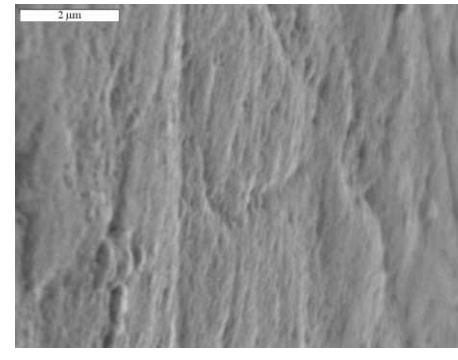

Fig. 4. SEM micrography of enamel surface from Figure 3 (13,000 ×).

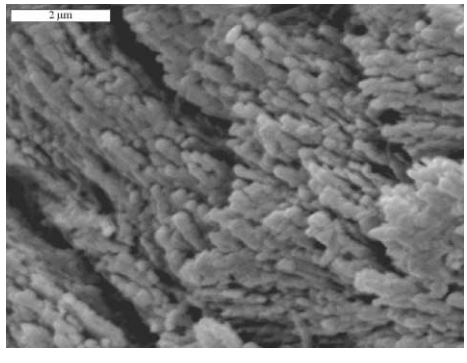

Fig. 5. SEM micrography of etched enamel of a cupper age human tooth (13,000 ×).

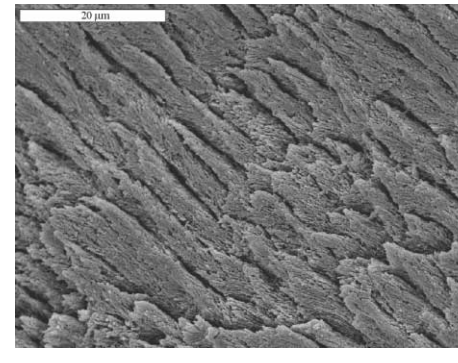

Fig. 6. SEM micrography of etched enamel of today's modern Croatian citizen (13,000 ×).

There are many different ways to find out our prehistorically ancestor's diet. Between all methods a significant place takes:

1. Interspecific comparison of teeth morphology;
2. Microwear researches;
3. Food remains analysis from archaeological sites;
4. Diagnosis of metabolic diseases caused by diet.

Interspecific comparison of tooth morphology is the base of our study and includes understanding the dental adaptation of certain nutrition or diet.

If we have in mind that mammals use their teeth in many purposes, and that the mammal teeth are just a part of digestion system, then it's possible to conclude about dental adaptation[1].

Conclusions

Samples used in this study are small in number, so the results should be taken as preliminary ones. However, we can get certain conclusions that can be a good suggestion for further studies:

1. The interspecific comparison of the morphological changes on the surfaces of the teeth between two populations shows the connection of size, number and abrasive particles from the food with the microdefects of enamel.
2. Less evidence of another kind of defects (caries, erosion) from Vučedol time suggests less cariogene diet by prehistorically ancestors.
3. Fast evolution of diet habits of modern people was not followed by such fast dental adaptation, so the direct effect is a high incidence of caries of hard tooth tissues and chronically periodontal disease.

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Z. Azinović

Department of Dental Pathology, School of Dental Medicine, University of Zagreb, Gundulićeva 5, 10000 Zagreb, Croatia

SEM ANALIZA ZUBNOG ENAMELA

S A Ž E T A K

SEM analiza obuhvaća istraživanja caklinske površine zuba dviju populacija. Prva skupina uzoraka je caklina zuba prapovijesnog pretka stanovnika Hrvatske, a druga skupina uzoraka caklina suvremenog stanovnika Hrvatske. Iako na malom broju uzoraka ljudskih zuba iz bakrenodobnog lokaliteta Vučedol (3000 g.p.K.) i današnjeg stanovnika Hrvatske, interspecifičnom usporedbom morfologije caklinskih mikrooštećenja možemo zaključivati o biometriji žvakanja prapovijesnih predaka i današnjeg stanovnika Hrvatske. Interspecifičnom usporedbom morfoloških promjena okluzalnih površina zuba može se dovesti u vezu veličina i oblik abrazivnih čestica i prehrane s mikrooštećenjima cakline zuba. SEM analiza je potvrdila da su abrazivne promjene na caklini zuba čovjeka iz Vučedola opsegom veće i češće nego promjene na caklini današnjeg stanovnika Hrvatske.