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tytuł pracy: ***„Ocena niektórych makro i mikroelementów w szkliwie zębów bez zmian patologicznych”***

SUMMARY

Introduction

Enamel is the hardest tissue of the human body, which stands out physiological constancy of its structure. Due to its unique structure it serves the protective function against chemical, thermal and biological factors in relation to dentin and pulp. Enables biting and crushing foods, gives the final shape of the crowns of teeth and determines tooth wear resistance.

More and more research suggests that the resistance of enamel to external factors depends on its chemical composition and structural composition, which is formed in the proces of odontogenesis.

Calcium and magnesium are essential components for the formation of the enamel. Calcium is present mainly in the form of hydroxyapatite, which is an elementary unit of the enamel. Magnesium occurs in the enamel, mainly as magnesium phosphate and has a significant impact on the quality and construction of the hard tissues of the tooth. Zinc and copper are associated with the construction and changes of enamel matrix. Suitable concentrations of all of these minerals and their relative proportions in the subsequent layers of enamel of the teeth, with no lesions, may indicate the absence of disturbances during enamel's maturation and its resistance to pathological conditions.

Aim of the study

The aim of the study is to evaluate the contents of calcium, magnesium, zinc and copper in different depths of the enamel of teeth with no visible pathological changes and determining the ratio of concentrations of these elements for the specific enamel layer.

Material and methods

The study used 15 human incisors, medial, upper with ended development, without visible lesions, removed due to mechanical trauma with in alveolar ridge or periodontal changes. The teeth came from donors aged 18-21 years.

On the labial surface of each tooth, 7 longitudinal cuts at 150μm were made. The cuts were made with Microm HM 355 S of International GmbH device. The cutting plane and the distance between successive cuts was determined on the basis of the course and the distance between Retzius' lines. The resulting material was subjected to acid biopsy with 0,1 mol/l perchloric acid ($HClO_4$) in an amount of 1 μl during 60 seconds. The first acid biopsy was performed on the labial surfaces of teeth examined before placing them in the device Microm HM 355S and making the first cuts. The resulting biopsies were placed in test tubes of type Safe-Lock Eppendorf capacity of 1,5 ml. The samples were subjected to digestion with concentrated nitric

acid in a microwave mineralizer Plazmatronika, Poland. Calcium, magnesium and zinc content in enamel biopsies was determined by flame method with air-acetylene flame. The copper concentration was determined by electrothermal method using the argon. The concentration of all elements has been marked on the atomic absorption spectrometer Z-5000 with Zeeman correction, Hitachi, Japan., based on the calibration curve, determined by this device. The results were subjected to statistical analysis in the program Statistica 10.0 PL

Results

Studies have shown that the lowest average concentration of calcium was observed in the superficial layer of enamel (1,42 mg/l), and the highest at a depth of 750-900 μm (14,70333 mg/l). The lowest average concentration of magnesium is visible on the surface of teeth tested (0,34267 mg/l), while the highest at adepth of 900-1050 μm (0,08267 mg/l). The lowest concentration of zinc (0,03667 mg/l) and copper (10,42267 μg/l) was observed in the superficial layer of enamel. The highest zinc concentration at a depth of 150-300 μm (0,08933 mg/l) and copper at a depth of 450-600 μm (20,982 μg/l).

There have been statistically significant ($p < 0$) strong positive correlation between calcium contents in the different depths of the enamel. It was observed that with increasing content of calcium on enamel surface increases the calcium content at a depth of 450-600μm ($p=0,043$). The same correlation applies to calcium depths 0-150 μm and 300-450 μm ($p = 0$), 150-300 μm and 300-450 μm ($p = 0,001$), 150-300 μm and 450-600 μm ($p = 0,012$), 300 -450 μm and 750-900 μm ($p = 0,032$), 450-600 μm, and 600-750 μm ($p = 0,011$), 600-750 μm and, 900-1050 μm ($p = 0$), and 750-900 μm and 900-1050 μm ($p = 0,003$). It was also noted statistically significant ($p < 0$) positive, strong correlations between magnesium contents in the different layers of enamel. With the increase in the magnesium content at the depth of 150 – 300 μm, the magnesium content at a depth of 300 – 450 μm ($p = 0,036$) is also increasing. The same relation was observed as compared to the concentrations of magnesium at a layer of 150 – 300 μm 450 – 600 μm ($p = 0,016$), 300-450 μm and 450-600μm ($p = 0,005$). It was also found periodicity of increase and decrease of ratio of calcium to magnesium over the entire thickness of the enamel. The increase in this ratio was recorded at depths 0-150 μm (44.06 : 1), 300-450 μm (52,41:1), 600-750 μm (49.20:1), but its decline was found at depths of 150-300 μm (37,70:1), 450-600 μm (36.97:1) and 750-900 μm (48.26:1).

The conducted analysis showed astatistically significant ($p <0$), strong, positive correlations between the contents of zinc in different layers. With the increase in the zinc contentat a depth of 0-150μm zinc contentat a depth of 450-600 μm ($p =0,021$) is increasing. The same relationship was observed at depths of 150-300 μm and 300-450 μm ($p = 0,034$), 150-300 μm and 450-600 μm ($p = 0,019$), 150-300 μm and 600-750 μm ($p = 0,01$), 450-600 μm and 600-750 μm ($p =0,026$), 450-600 μm 750-900 μm ($p = 0,043$), 600-750 μm and 750-900 μm ($p = 0,038$) and 600-750 μm and 900-1050 μm ($p =0,016$).

The study also rated the distribution of mutual ratio of average concentrations of calcium to zinc. The increase in this ratio was observed at depths of 0-150 μm (143,94:1) 300-450 μm (177,42:1) 600-750 μm (207,08:1) and 750-900 μm (279,16:1) while its decline was found at depths of 150-300 μm (127,47:1), 450-600μm (136,03:1) and 900-1050 μm (207,48:1). It was assessed also a mutual ratio of magnesium to zinc, which tends to increase with the increase of

the depth of enamel from 0 to 900 μm. The minimum value of this ratio was recorded on the surface of the enamel (2.25:1), the maximum value in the layer 750-900 μm (5,78:1).

It has also been reported statistically significan ($p < 0$), strong positive correlation between the concentrations of copper at a depth of 0-150 μm and 600-750 μm ($p = 0,025$), and 0-150 μm and 900-1050 μm ($p = 0,044$). The same relationship exists between the average concentrations of copper at a depth of 600-750μm, and 900-750 μm ($p = 0$) and 600-750 μm and 900-1050 μm ($p = 0,007$). The mutual ratio of calcium to copper was also determined. The increase in this ratio was observed at a depth of 0-450 μm (from 136,24:1 to 795,13:1) and 600-1050 μm (from 711,99:1 to 998,071:1). The distribution of the mutual ratio of average concentrations of magnesium to copper was also analyzed. The increase ratio of magnesium to copper was observed at depths of 0 to 300μm (from 7,93:1 to 18,36:1) and 600 to1050 μm (from 14,47:1 to 23,55:1).

They were also found statistically significant strong, positive, correlations between the content of zinc and copper at a depth of 150-300 μm ($p = 0,018$), 450-600 μm ($p = 0,44$) and 600-750 μm ($p = 0,007$). Specific course of mutual ratio of these two minerals at different depths of the enamel was also noted. The lowest value of the ratio of zinc to copper was observed at a depth of 750-900 μm (17,70: 1), and the highest at a depth of 150-300 μm (18,36:1).

Conclusions:

Analysis of the results allowed to draw the following conclusions

- Lowest content of calcium, magnesium, zinc and copper occurs in the superficial layer of enamel.
- With the increase of the depth of enamel content of calcium and magnesium is increasing.
- With the increase of the depth of enamel the mutual ratio of the magnesium to the zinc content is also increasing (except for the layer adjacent to dentin), which may be related to an increase in the magnesium concentration with depth of the enamel.
- Periodicity of the ratio of the average concentrations of the minerals (Ca:Mg, Ca:Zn, Ca:Cu, Mg:Cu) is an evidence of association between mineral composition of mature enamel and periodical stepwise process of enamel formation, which is reflected in the structure by Retzius' lines.
- Lack of correlation between tested minerals in the outer layer of enamel (up to 150 μm) and in the layer adjacent to dentin (900-1050 μm), and the relationship between the presence of tested minerals in the other layers, indicates that the mineral composition of the enamel is determined in the stage of enamel maturation in pre-eruptive period, with the exception of the enamel layer bordering with saliva

and dentin, where the ion exchange is possible after the period of eruption of the teeth.

- Designated contents of the analyzed elements and their relative proportions create a standard, that testifies of the correct process of mineralization and maturation of the enamel during pre-eruptive period.