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Impact of dysplastic scoliosis on chemical composition of permanent teeth enamel

Abstract: The overall chemical composition of enamel, as well as its peculiarities, depending on the tooth surface (cervix, equator and cusp) and depth of the layer (superficial, sub-superficial and deep), has been analyzed on the slices of permanent teeth, extracted according to orthodontic indications in children with scoliosis, using the X-ray diffraction method. A significant decrease in calcium content and increase in potassium, phosphorus and sulfur content in the whole enamel, as well as on the different portions of tooth, regardless of the depth and surface, have been discovered.

Keywords: children, dysplastic scoliosis, chemical composition of enamel.

Violation of the dental tissues resistance is crucial in the pathogenesis of dental caries. Abnormalities in chemical composition of hard dental tissues, poor enamel structure and inherited tendency of tissues to caries are critical in its development [1,2,3].

Generally, a tooth mineral base is composed of isomorphic apatite crystals, and its mineralization involves a number of chemical elements. In this way the ions of calcium, phosphorus and other mineral components that substitute them

isomorphically or act as the catalysts of the mineralization processes are of particular importance [1,4]. The composition of chemical elements in apatite crystals is strictly balanced and change in the content of one of them affects the distribution of other elements and their proportion defines the basic properties of tooth enamel, i.e., caries resistance or caries susceptibility [2,5].

The enamel resistance to caries is associated not only with the structure and properties of dental tissues but also with the state of the body. It is known that children with scoliosis have decreased structural and functional enamel resistance [6,7] that leads to the development of different forms of dental caries, and its intensity is 1,2-3,1 times higher than in healthy children [8].

PURPOSE

The paper was aimed at the study of peculiarities of chemical elements distribution in the enamel of permanent teeth in children with dysplastic scoliosis.

OBJECTS AND METHODS

Enamel of 10 slices of five permanent teeth, extracted according to orthodontic indications in children aged 12-13 years, suffering from scoliosis (Group II), and enamel of the same number of slices in healthy children of the same age (Group I) has been studied. The analysis of the state of hard dental tissues has been evaluated on the basis of the data related to the content of eleven chemical elements in the enamel, namely, CaO, MgO, Al_2O_3, SiO_2, K_2O, Na_2O, Fe_2O_3, P_2O_5, SO_3, ZnO, Cl. The investigations have been carried out on the different portions of the crown of tooth (cervix, equator and cusp) and different depth from its surface (superficial, sub-superficial and deep layers). Mineral composition of 180 portions of enamel has been analyzed. Chemical composition of enamel has been studied by the method of X-ray spectroscopy microanalysis. The analysis has been carried out on the *JSM – 820* scanning electron microscope with the *Link AN 10/85 S* power dispersing microanalysis system. On each investigated portion the total content of eleven chemical elements was taken as 100% and content of each of them was measured in normalized mass percents (norm.mas.%), respectively. Statistical processing has been carried out using the Student's t-tests [9].

RESULTS AND DISCUSSION

Findings of the study have shown the significant changes in the total content of many chemical elements in the enamel of children with scoliosis. The content of calcium, sodium and chlorine is significantly lower in children from Group II. Calcium

content is accounted for 51,38±0,15 norm.mas.% that is significantly lower as compared with the control group (55,97±0,16 norm.mas.% (p<0,001)). Notably, the content of such elements as magnesium, aluminum, sulphur, potassium, iron, phosphorus and silicon was tending to significant increase, especially for potassium, sulphur and silicon. Their percentage in the teeth of children of Group II is significantly higher than in Group I (by 8,5 times, 1,6 times and 1,6 times, respectively; p < 0.01)) (Table 1).

Table 1

Total content of chemical elements in enamel of permanent teeth of children with scoliosis and healthy children

Chemical element	Healthy children (norm.mas.%)	Children with scoliosis (norm.mas.%)
CaO	55,97 ± 0,16	51,38 ± 0,15**
MgO	0,45 ± 0,02	0,67 ± 0,04**
Al_2O_3	0,08 ± 0,005	0,12 ± 0,007**
SiO_2	0,23 ± 0,01	0,37 ± 0,02*
K_2O	0,02 ± 0,005	0,17 ± 0,008**
Na_2O	0,16 ± 0,008	0,13 ± 0,006*
Fe_2O_3	0,06 ± 0,005	0,09 ± 0,008*
P_2O_5	41, 75 ± 0,14	45,63 ± 0,12**
SO_3	0,47 ± 0,02	0,76 ± 0,03**
ZnO	0,34 ± 0,046	0,34 ± 0,023
Cl	0,44 ± 0,015	0,31 ± 0,01**

Note: ** - the difference is significant with regard to indices of healthy children (p< 0,001),

* - the difference is significant with regard to indices of healthy children (p< 0,01).

Changes in mineral composition of the tooth enamel of children with scoliosis have been detected, too, depending on the anatomical portion of the tooth. A significant decrease in calcium content has been discovered on each portion of tooth (cervix, equator and cusp): cervix portion – 50,79±0,22 norm.mas.% against 55,71±0,28 norm.mas.%; equator portion – 52,27±0,21 norm.mas.% against

56,11±0,24 norm.mas.%; cusp portion – 51,66±0,16 norm.mas.% against 56,14±0,22 norm.mas.% (p<0,001).

Similar changes has been detected in the chlorine content in the cervical area (0,20±0,02 norm.mas.% against 0,35±0,02 norm.mas.%) and on the equator (0,39±0,02 norm.mas.% against 0,59±0,01 norm.mas.%); sodium content – on the cusp (0,10±0,01 norm.mas.% against 0,22±0,01 norm.mas.%) and in the cervical area (0,14± 0,01 norm.mas.% against 0,19± 0,01 norm.mas.%) (p<0,001). In addition, a significant increase in the content of magnesium, phosphorus, sulphur and potassium (p<0,001) has been found in all portions of tooth; increase in silicon content has been found on the cusp and equator (p<0,001) and concentration of iron was tending to increase, too (p>0,05).

Data related to peculiarities of distribution of chemical elements in tooth enamel of children with scoliosis, depending on the investigated depth, is of great interest. At all levels (superficial, sub-superficial and deep) samples of enamel of children with scoliosis showed significant decrease in calcium content (51,01±0,35 norm.mas.%; 51,59±0, norm.mas.%; 51,52±0,19 norm.mas.%, respectively) as compared to healthy children (55,75±0,30 norm.mas.%; 55,92±0,26 norm.mas.%; 56,26±0,30 norm.mas.%, respectively) (p<0,001). Concentration of calcium is the lowest on the enamel surface with the increase in sub-superficial layer and decrease in the deep layer.

Similar changes have been detected at all layers with regard to chlorine content (0,35±0,02 norm.mas.%; 0,33±0,03 norm.mas.%; 0,25±0,03 norm.mas.%, respectively) as compared with healthy people (0,46±0,02 norm.mas.%, 0,46±0,02 norm.mas.%, 0,39±0,03 norm.mas.%, respectively) (p<0,001).

In addition, a significant increase in concentration of silicon (p<0,05), potassium (p<0,001), phosphorus (p<0,001) and sulphur (p<0,001) has been found in tooth enamel of children with scoliosis at all levels (superficial, sub-superficial and deep). In the sub-superficial and deep layers a significant decrease in sodium content (p<0,01) along with aluminum content (p<0,01) increase has been detected; a significant increase in iron amount has been discovered in the sub-superficial layer (p<0,001) and concentration of zinc was tending to decrease (p>0,05).

Generally, physical and chemical properties of tooth enamel are greatly dependent on its major inorganic components, namely, calcium and phosphorus [1, 3]. A significant decrease in calcium content and increase in phosphorus content has

been detected at all levels (superficial, sub-superficial and deep) and tooth portions (cusp, equator and cervix) in children with scoliosis, as compared with healthy children, that leads to lowering of Ca/P ratio, i.e., to lowering of enamel mineralization level, especially at the superficial levels. In Group II Ca/P index was 1,12±0,01; 1,13±0,007; 1,13±0,006, respectively and in Group I it was 1,34±0,02; 1,34±0,01; 1,35±0,01, respectively ($p<0,001$).

We hypothesize that such distribution of calcium and phosphorus in the enamel is associated with phosphorus-and-calcium metabolism disorder in children with scoliosis [8]. Therefore, primary mineralization of the enamel organic matrix occurs due to the formation of not fully formed apatite crystals, i.e., crystals which have empty spaces in the lattice sites.

Calcium and phosphorus content in the tooth enamel, as well as the amount of those chemical elements, involved into enamel structure and which are dynamic in the process of its maturation, influences the degree of enamel persistence or its resistance to caries [2]. According to Antonishyn B.V [5] the potassium and sulphur content is higher in the tooth enamel of young animals, i.e., during the stage of its maturation. Being the components of enzymes, hormones and vitamins, they are involved into metabolism of proteins, fats and carbohydrates through the redox reaction that causes its increased content. Their amount decreases with age during the process of further mineralization [4,5]. We hypothesize, that the percentage of potassium and sulphur in the tooth enamel of children with scoliosis indicates about the slowing down of the processes of its “maturation”.

CONCLUSIONS:

1. A significant decrease in calcium content and increase in potassium, phosphorus and sulphur content in the tooth enamel of children with scoliosis, as compared with healthy children, has been detected in toto and on the different portions of tooth, depending on the depth and surface.

2. Lowering of the calcium/phosphorus ratio in the tooth enamel of children with scoliosis is the evidence of inadequate degree of enamel mineralization and indicates about the lowering of its resistance.

3. Slowing down of the processes of enamel “maturation”, which is the risk factor for dental caries development, may result in the increase of potassium and sulphur percentage in the tooth enamel of children with malposture.

4. Discovered imbalance of mineral composition of tooth enamel in children with scoliosis, in our view, in some way reflects the state of balance of such elements in the whole body. Therefore, the resulting data are valuable from the point of view of correction of the discovered changes both by the application of local remineralizing therapy and influence on the total mineral metabolism.

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