

Biochemical indexes of mineral metabolism in patients from the polluted region affected by chronic periodontitis

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Abstract

To be living at the most advanced technological area in history is to exist and face pollution one of the most serious threats to all living things on the planet. It is a well known fact that industrial pollutions cause a considerable number of health problems and stomatological in particular. This article demonstrates the results of our study regarding investigation of some biochemical indexes in children and adults from the polluted area. We have examined 1236 scholars and 133 workers of Burstyn Thermoelectric Station. The findings suggest that the prevalence of stomatological disorders reaches up to 84,2–93,5% in all examined, the statistic shows also that 31,6 % of six year old children have decayed teeth, in 12 year old children this index is more than 76,8% and almost 92,3% in those aged 15–17 years. Symptoms of periodontal disorders were observed in 37,1–78,3% of children, the orthodontic pathology was diagnosed in 43,9–61,2% of all examined scholars. People that work at the Burstyn Thermoelectric Station are affected by periodontal pathology and demonstrated disordered mineral metabolism in the blood serum and oral liquid with decreased level of Calcium and increased amount of Phosphates.

Keywords

biochemical indexes, chronic periodontitis, dental caries, blood serum, oral liquid

Introduction

One of the great task of modern medicine and dentistry in particular centers on preservation of public health. The provision of general health care for population expresses a biggest challenge and is declared on the list of United Nations as being the most important prospect until 2030 and is recorded by number 3 “Provision of healthy life style and promoting of well-being at any age”. The World Health Organization stated that it is essential to establish a stable eco-system that will provide condition for health preservation and improvement and to ensure successful outcomes together with efficient prophylaxis.

However, pollution remains nowadays one of the most serious threats to all living things on the planet. The findings of the authors (Mathu-Muju and Wright 2006; Verbytska 2007; Lygidakis et al. 2008; Stelmachivska and Berzin 2008) suggested that these severe ecological factors such as technological contaminations, lack of micro elements, excess of salts of heavy metals disturb the correlation “men-biosphere” and might lead to endemic illnesses. Researchers in different countries (Serdyuk 2011; Moiseenko et al. 2017; Antypkin et al. 2018) have shown that there is an increasing number of general disorders, chronic diseases, morpho-functional changes and a significant decreasing number of healthy children as a

result of industrial contaminations and Ukraine is no exception. The health in children as the most vulnerable part of population presents a vital issue and generally reflects the environmental changes. Moreover, children are more sensitive to contamination as they respond often than adults with intoxication, immune deficiency and by other pathological conditions. It has been proved by many investigations that dental health is also highly influenced by geochemical condition of the region as well as by anthropogenic pollution.

The West Ukraine is an example of geochemical environmental mosaic in micro and macro elements. However, there is a Fluoride and Iodine deficiency in this region comparing to normal biological indexes as well as deficiency of other microelements such as Copper and Zinc. In addition, there is an increased amount of xenobiotics in some areas as a result of anthropogenic contamination due to the activity of some enterprises and Burstyn Thermoelectric Station in particular (TES). The findings provided by authors (Popovych et al. 2015; Popovych and Rozhko 2018) demonstrated that the Burstyn TES is the most powerful energy enterprise in West Ukraine and the main pollutant of the area. The data provided by Ministry of Ecology and Natural Resources in 2018 demonstrates that Burstyn TES as a part of PAT "DTEK Westenergo" takes third place in Ukraine on emission of harmful substances into atmospheric air. The later is on the list of 100 factories with the greatest disadvantageous impact to the environment and human health in general. According to authors (Chomenko et al. 2006; Laisiet al. 2009; Ostapko 2011; Popovych et al. 2018) heavy metals occupy a special place among of chemicals that pollute the environment. This is due to their resistance in the environment, high toxicity, ability to cumulate and adverse effects on the body in relatively small concentrations.

Objective

The study of mineral metabolism in the blood serum and oral liquid of children and adults from the polluted region.

Materials and methods

To investigate the prevalence of stomatological diseases and peculiarities of their clinical course in people that permanent live in bad ecological environmental area, we have examined 1236 scholars from Burstyn and surrounding villages (Bovshiv, Bilshivci, Zadnistriansk, and Kinashiv). The presented study is based on the research conducted at Department of Stomatology of Educational and Scientific Institute of Postgraduate Education of «Ivano-Frankivsk National Medical University» "Clinical efficiency in complex treatment of the hard dental tissues and periodontium in people from ecologically bad regions"; the state registration number in Ukraine is 0118U004144. We also investigated the stomatological pathology in workers of

Burstyn TES. We are grateful to department of education, science and youth policy of Ivano-Frankivsk State Administration and local authorities for their great support in our investigation. Without their help and friendship our research would not have been possible.

The clinical examination and treatment of the patients were conducted at out-patients clinic of Burstyn TES and at Postgraduate Department of Ivano-Frankivsk National Medical University. It was essential to take a comprehensive case history before the investigation that consisted of: personal details, presenting complains (beginning, duration, mode, progress) because the various conditions might cause or predispose to oral problems and likewise may affect oral and dental care. Details about previous illnesses, treatment and allergies have also been recorded.

The examination itself consisted from extra oral and intraoral examinations. During extra oral examination we have assessed the following structures: facial symmetry and proportion, state of the skin, pathological changes of the lips and soft tissues of Maxilla-facial area. Any possible findings were recorded. A systemic approach has been adapted also for intraoral examination: soft tissues, frenal attachment, tongue-tie, gingival and periodontal tissues, teeth and occlusion.

We have examined 133 workers of Burstyn TES as well. The examination of adults was performed by the same algorithm as examination of the pediatric patients. Among them were 109 men and 54 women aged from 20 to 49 years. The chronic periodontitis of I, II degree was diagnosed in 125 of all examined individuals and 8 people were diagnosed with exacerbation of chronic periodontitis that is 93%, 98% and 6,02% accordingly. Besides, all patients were provided with clinical, biochemical and radiological investigations. The gained results were recorded in personal and examination charts. Biochemical investigations were conducted at biochemical laboratory of medical and biological chemistry at Ivano-Frankivsk National Medical University.

Biological liquids (blood and oral liquid) were dried by temperature 70–80 °C. After the drying they were ashen in a muffle furnace by temperature 450–500 °C. Mineralization lasted until the ash was completely coal free. The content of micro and microelements was estimated in coal solutions by C-115 "Saturn" according to the requirements of State Standardization 30178-96 and 26570-85.

Estimation of Calcium in biological liquids. The method is based on the ability of Calcium together with a dye Arsenzo III convert blue in a neutral condition and to have maximum absorption by 590–650 nm. The mixture was mixed afterwards, maintained by room temperature during 10 minutes and colorimeter by 590–650 nm.

Estimation of non-organic Phosphorus was performed by the standard kit „Simko Ltd". The method is based on interaction of non-organic Phosphorus with Ammonium Molybdate by building Phosphorus-Molybdate complex with a maximum absorption when a wave length is 340 nm that is proportional to concentration of non-organic Phosphorus.

Estimation of alkaline phosphatase was conducted by the standard kit „Simko Ltd". Alkaline phosphatase splits

up the phenyl-phosphate by building phenol. The result of oxidation between phenols with 4-amino-phenasolis a formation of red complex and the activity of enzyme is proportional to the increase in optical density of the solution.

Estimation of acid phosphatase was also conducted by the standard kit „Simko Ltd”. The method is based on calculation of phenol that is released by hydrolysis of disodium phenyl phosphate. Phenol and oxidizer build together the red complex in alkaline environment that intensively absorbs 510 nm light waves.

The data was preceded with the Statistica10,0 and the gained results were processed by Student distribution law. The difference between the comparing groups is considered as being statistically proved if the gained certain index (p) does not exceed the selected initial level ($\alpha = 0,05$) or was equal, therefore the term ($p \leq 0,05$) was maintained.

Results and discussion

The findings of our examination suggest that the prevalence of stomatological disorders among all investigated is around 84,2–93,5% and in some cases is even higher up to 99,5%, the damage of the hard dental tissues is 31,6 % in 6 year olds and in 12 year old children this index is more than 76,8% and progresses up to 92,3% in 15–17 year olds. However, the intensity of dental caries does not demonstrate the high rates.

The gained data shows that periodontal disorders were diagnosed in 37,1–78,3% of children, orthodontic pathology such as anomalies of occlusion, tooth position and crowding were observed in 43,9–61,2%. There were also combined conditions, for example, molar-incisor hypomineralization and periodontitis that accomplished malocclusion (Figs 1, 2). Some children were diagnosed with anomalies of tooth size and number, microdontia (Fig. 3), primary hypodontia (Fig. 4) and supernumerary teeth.

Many children demonstrated diseases of oral mucosa and the tongue (Fig. 5) that might indicate the disordered function of gastrointestinal tract and liver. We observed also manifestations of oral allergy such as atopic cheilitis (Fig. 6) and angular cheilitis.

Dental caries still remains a prevalent disease among pediatric population and cervical initial caries was a common pattern in examined children. A part from a frontal cervical caries there were many cases of cervical caries in molars and premolars in 13–14 year old children. According to medical history many children were also affected by general somatic pathology such as gastrointestinal disorders, allergies and respiratory problems. We provided all children with keepsakes for parents to encourage them to bring their children for regular dental check up, planned investigation and treatment.

According to our findings there is a Calcium-Phosphorus imbalance in people diagnosed with chronic generalized periodontitis that work at Burstyn TES reflected in a decrease of Calcium and an increase of phosphates in the blood serum and oral liquid (Table 1).



Figure 1. A 14-year-old boy D., 14. , Medial bite, vestibular position of 13, 23, caries of tooth 11.



Figure 2. A 15-year-old boy B. Molar-incisor hypomineralization, vestibular position of tooth 13, periodontitis.



Figure 3. A 12-year-old girl L. Microdontia affecting 12.



Figure 4. A 13-year-old boy D. Primary hypodontia of 12, 22.

As can be seen from Table 1 and Figure 7 the content of Calcium in the blood serum fell by 15,83%, $p < 0,05$ in those affected by chronic periodontitis of I degree and fell by 25,90%, $p < 0,05$ in case of chronic periodontitis of II degree in comparison with healthy people. The amount

Table 1. Indications of Calcium-Phosphorus metabolism in patients with chronic periodontitis, ($M \pm m$).

Indexes		Group of patients		
		Healthy n = 27	Chronic periodontitis, I degree n = 54	Chronic periodontitis, II degree n = 52
Calcium, mmol/l	Blood serum	2.78 ± 0.13	2.34 ± 0.14 $p < 0,05$	2.08 ± 0.13 $p < 0,05$ $p_1 > 0,05$
	Oral liquid	1.88 ± 0.15	1.40 ± 0.11 $p < 0,05$	1.18 ± 0.10 $p < 0,05$ $p_1 > 0,05$
Phosphates, mcg/ml	Blood serum	41 ± 2.86	59.5 ± 3.16 $p < 0,001$	71.5 ± 3.62 $p < 0,001$ $p_1 < 0,05$
	Oral liquid	73 ± 3.60	86 ± 3.42 $p < 0,05$	102.5 ± 3.86 $p < 0,001$ $p_1 < 0,001$
		n = 28	n = 54	n = 54
Alkaline phosphatase mmol/s.l	Blood serum	1.77 ± 0.20	2.38 ± 0.17 $p < 0,05$	2.88 ± 0.17 $p < 0,001$ $p_1 < 0,05$
	Oral liquid	0.27 ± 0.02	0.44 ± 0.03 $p < 0,001$	0.52 ± 0.03 $p < 0,001$ $p_1 < 0,05$
Acid phosphatase, mmol/s.l	Blood serum	0.17 ± 0.03	0.31 ± 0.03 $p < 0,05$	0.38 ± 0.03 $p < 0,001$ $p_1 < 0,05$
	Oral liquid	5.32 ± 0.30	8.61 ± 0.34 $p < 0,001$	11.07 ± 0.58 $p < 0,001$ $p_1 < 0,001$

Notation: p-degree of probability between indexes of healthy individuals and those with chronic periodontitis of I degree and chronic periodontitis of II degree; p_1 – degree of probability between indexes of chronic periodontitis of I and II degree.

**Figure 5.** Child aged 12 years. The plaque on the tongue, desquamate glossitis.**Figure 6.** A 7-year-old girl. Atopic cheilitis.

of Calcium has changed significantly also in oral liquid of the patients as periodontitis progressed. There was a reduction by 25,54% in case of I degree and by 37,24% in case of II degree comparing to healthy, intact periodontium (Table 1, Figure 8, $p < 0,05$).

The amount of phosphates in the blood serum has risen by 44,15%, ($p < 0,001$) in those with chronic periodontitis of I degree and by 76,23%, ($p < 0,001$) in case of degree II in comparison with ($41,00 \pm 2,86$) mcg/ml in healthy individuals. The data demonstrates that there is a rise of this

index in oral liquid by 18,17% ($p < 0,05$) and by 41,04% ($p < 0,001$) in case of chronic periodontitis of I and II degree accordingly. The contain of phosphates in people with healthy periodontium was ($73,00 \pm 3,60$) mcg/ml.

Physiological processes in periodontal tissues are influenced by the activity of alkaline and acid phosphatase that indicate Calcium-Phosphorus metabolism. The study demonstrated the changes in activity of both phosphatases that can be considered as a biomarkers of metabolism. We have established that they experienced multi-directional changes in our patients. The activity of both phosphatases has increased in patients with chronic periodontitis permanently affected by salts of heavy metals that responded to the severity of pathological process (Table 1).

The activity of alkaline phosphatase in the blood serum of the patients with chronic periodontitis of I degree raised by 34,46% – up to ($2,38 \pm 0,17$) mmol/s.l and by 62,71% – up to ($2,88 \pm 0,17$) mmol/s.l in patients with II degree of chronic periodontitis comparing to ($1,77 \pm 0,20$) mmol/s.l in people with healthy periodontium ($p < 0,001$, Fig. 9).

The results obtained by investigation of oral liquid in patients with chronic periodontitis also demonstrate definite increase of both indexes (Fig. 10). In case of chronic periodontitis of I degree there was a rise up to ($0,44 \pm 0,03$) mmol/s.l and up to ($0,52 \pm 0,03$) mmol/s.l in case of chronic periodontitis of II degree that shows the difference with healthy periodontium ($0,27 \pm 0,02$) mmol/s.l reflected by 62,96% and 92,59% accordingly ($p < 0,001$). This process can be explained as a compensatory reaction of the organism affected by progressive periodontal distraction.

The acid phosphatase is produced by osteoclasts in the extracellular medium and is considered as a marker of bone resorption in which its amount in the blood serum increases. The statistic indicates that in people with healthy periodontium this index was equal ($0,17 \pm 0,03$) mmol/s.l. On the other hand, there was an increase of acid phosphatase by 82,35% – up to ($0,31 \pm 0,03$) mmol/s.l ($p < 0,05$) in blood serum of those with I degree of chronic periodontitis. As chronic periodontitis progressed, there has been a credible climb in activity of acid phosphatase by 123,53% – up to ($0,38 \pm 0,03$) mmol/s.l comparing with healthy people ($p < 0,001$).

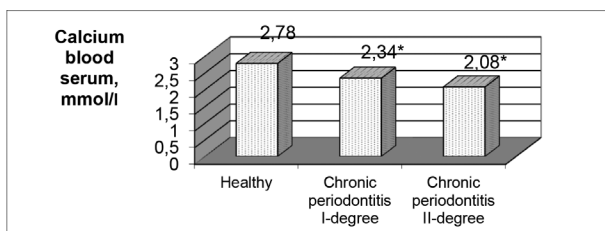


Figure 7. Contents of Calcium (mmol/l) in blood serum in patients with chronic periodontitis. Notation.* – the difference between indexes in healthy people and those diagnosed with chronic periodontitis of I and II degree is statistically probable.

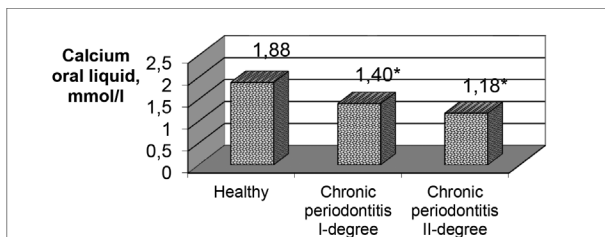


Figure 8. Contents of Calcium (mmol/l) in oral liquid (B) in patients with chronic periodontitis. Notation.* – the difference between indexes in healthy people and those diagnosed with chronic periodontitis of I and II degree is statistically probable.

In addition, the same regularity was observed in oral liquid of the affected patients (Table 1). The acid phosphatase, in particular, increased by 62,45% and by 108,08% in patients with chronic periodontitis of I and II degree respectively in comparison with healthy periodontium ($5,32 \pm 0,30$) mmol/s-l ($p < 0,001$).

It ought to be indicated that rising activity of acid and alkaline phosphatase in oral liquid is also detected in patients affected by de-compensated caries, acute apical periodontitis as well as by some inflammatory odontogenic conditions of the jaws such as pericoronaritis and periostitis. Moreover, there is the tendency for increase before the interference and over the early post operative period and the tendency for reduction over the processes of regeneration.

In conclusion it has to be summarized that the data gained by our investigation appear to confirm the tight link between the pathological activity in periodontal tissues and indicators of bone metabolism. The obtained results demonstrate enhanced activity of both alkaline and acid phosphatase as the important enzymes in min-

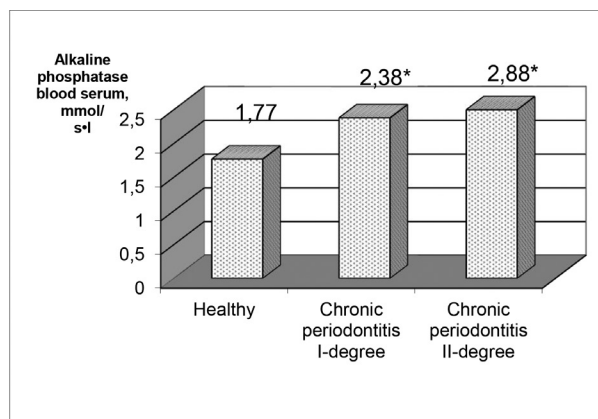


Figure 9. Activity of alkaline phosphatase mmol/s-l in blood serum in patients with chronic periodontitis. Notation.* – the difference between healthy and affected is reliable.

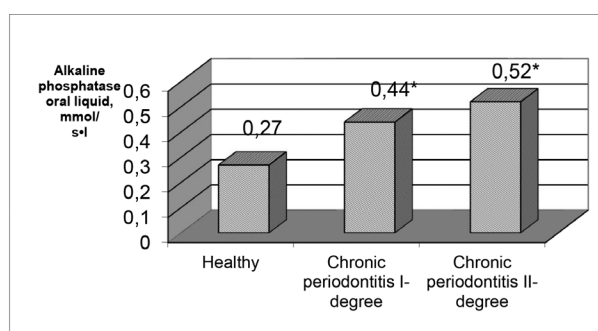


Figure 10. Activity of alkaline phosphatase mmol/s-l in oral liquid in patients with chronic periodontitis. Notation.* – the difference between healthy and affected is reliable.

eral metabolism with a deficit of Calcium and an excess of Phosphates in biological liquids of the patients from Burstyn TES diagnosed with chronic periodontitis. The findings suggest that the results of our research can be useful in assessment of the affected periodontal tissues and in determination of management in patients with periodontal disorders.

The figures of our study show that the number of stomatological disorders in population from the polluted region is on the growth, furthermore, there are many combined conditions, occurred mostly in children and the regional solution solving program on prophylaxis is definitely required.

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