Limited effect of low frequency magnetic fields on the concentrations of calcium, magnesium and fluoride in saliva

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Abstract. *Aim.* To assess the influence of low frequency magnetic fields on the contents of calcium, magnesium and fluoride in saliva. *Subjects and methods.* Sixty two patients were subjected to magnetic stimulation with low frequency magnetic fields of mean induction 3 μT at the first intervention and 4 μT at the following fourteen ones. Saliva was sampled before magnetic stimulation and after the 5th, 10th and 15th interventions. The contents of calcium and magnesium ions were measured by means of atomic absorption spectrometry. The content of fluoride was determined using an ion-selective electrode. *Results.* No statistically significant differences were found between the calcium concentrations before magnetic stimulation and after 5, 10 and 15 interventions. Statistically significant differences in the magnesium concentrations were observed only between 10th and 15th interventions. No statistically significant differences in fluoride concentrations were found. *Conclusion.* Low frequency magnetic fields have no or weak influences on the content of calcium, magnesium and fluoride in saliva.

Key words: saliva, magnesium, calcium, fluoride, magnetic stimulation

Saliva constitutes a natural environment for teeth, parodontium and mucous membranes of the oral cavity and creates a microenvironment, determining the proper course of many biochemical and physical reactions [1]. Calcium and magnesium belong to the mineral elements of saliva. They participate in building the enamel and their altered content may lead to a pathology of hard tissue and caries development. Ionized calcium helps the maintenance of tooth mineral integrity by modulating mineralization and demineralization [2]. Some authors assume that an elevated level of calcium in saliva occurs in patients with periodontitis [3].

Magnesium is a component of organic matrix tooth enamel [4]. Some authors claim that the decreased content of magnesium ions in saliva may lead to various changes and occurs most frequently in people with periodontitis [5]. It has also been stated that salivary magnesium concentrations are significantly higher in patients with parotid malignant tumors [6].

Fluorides reveal their bacteriostatic properties by blocking the activity of enzymes and inhibit the growth of dental plaque, which in turn lowers its cariogenicity. The presence of fluoride reduces enamel mineral loss by diminishing the solubility of dental hydroxyapatite, which becomes more resistant to demineralization [2].

Magnetic therapy provides a non-invasive, safe and easy method to directly treat the site of injury, source of pain and inflammation [7, 8]. The most effective clinical applications relate to bone unification, pain reduction and soft tissue oedema [7]. Magnetic fields have also proved to be effective in the

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regeneration of periapical bone lesions [9, 10]. However, there is no defined biological mechanism described, capable of explaining the observed effects. It is obvious that cells (leukocytes, platelets, keratinocytes, osteoblasts) and proteins (fibrin, collagen, elastin and growth factors) exhibit alterations, when exposed to magnetic field [5, 7, 11, 12].

No studies have been found concerning the influence of low frequency magnetic fields of low induction on the content of bioelements in saliva. The aim of the present investigation was then to examine, if a magnetic field has any influence on the content of calcium, magnesium and fluoride in saliva.

Subjects and methods

The study group comprised 62 patients referred for magnetic stimulation treatment due to periapical osteolytic tooth lesions. Magnetic stimulation by the Viofor JPS system (Med&Life, Komorow, Poland) was carried out once a day, for 10 minutes, five days a week (excluding Saturdays and Sundays) for 15 day period. An elliptic applicator generating a low frequency magnetic field of mean induction 3 μT at the first intervention and 4 μT at the following ones was used.

The control group consisted of 62 patients, matching the study group regarding to age, referred for dental treatment in which no magnetic stimulation treatment was prescribed.

All the patients gave their consent for saliva sampling and analysis of the mineral content. The principles outlined in the Declaration of Helsinki were carefully followed.

Non-stimulated mixed saliva (2 mL) was sampled to a plastic container once a week in every patient included in the study, in a fasting state or at least two hours after a solid or liquid meal, in a separate room and a comfortable sitting position. In the study group saliva sampling was carried out before magnetostimulation and after the 5th, 10th and 15th magnetostimulation interventions. Patients from the control group had saliva sampled three times before routine visits for dental treatment.

The contents of calcium and magnesium ions were established by means of atomic absorption spectrometry with the use of spectrometer PU 9100X (Philips Scientific, Cambridge, UK). In order to determine the content of calcium and magnesium, 0.5% lanthanum solution (Lanthannitrat-Hexahydrat, Merck, Darmstadt, Germany) was used as a ionization buffer. The analysis was carried out in an oxygen acetylene flame (F-AAS). The reading was taken from the curve traced on the basis of Titrisol (Merck, Darmstadt, Germany) standards.

To determine the content of fluoride, an ion-selective electrode was used to measure the potential value. The quantity of fluorides in the solution examined was determined on the basis of the potential difference before and after adding an appropriate standard.

The data distribution of all variables was checked by using the Shapiro-Wilk test. In order to compare data of normal distribution, Wilcoxon paired test was used and for the latter – Student's t test.

Results

Distribution of ion concentrations (mmol/L) in saliva in the study and control groups is presented in *table 1*. No statistically significant changes were found between the calcium concentrations before magnetic stimulation and after 5, 10 and 15 interventions. In the control group, calcium ion concentrations did not reveal any statistically significant changes between the examinations.

The average concentration of magnesium ions in the saliva of patients from the group examined showed a slight downward tendency, however statistically significant differences were obtained only for values between 10th and 15th interventions ($p < 0.03$). No statistically significant differences were found in the control group.

The average value of fluoride ion concentrations in saliva of the patients treated with magnetic stimulation showed slight fluctuations, but no statistically significant differences were found between the interventions. However, in the control group, the average values of fluoride ion concentrations revealed significant changes. Highly statistically significant differences were obtained for the values between: 1st and 2nd examinations, 1st and 3rd examinations, and 2nd and 3rd examinations.

Discussion

In available publications, no data concerning the influence of electromagnetic fields on concentration of electrolytes in saliva have been found. The mean calcium concentrations found in the present study are similar to those reported by other authors [7, 13, 14], *e.g.* 1-4 mmol/ L (40-160 mg/L). The slight differences may be due to the fact that the content of calcium ions is characterized by regular fluctuations connected with food intake and the time between

Table 1. Distribution of ion concentrations (mmol/L) in the saliva of dental patients subjected to magnetic stimulation due to periapical osteolytic lesions and matching control subjects.

Calcium	**Study group, n = 62**	**Before magnetic stimulation**	**After 1st intervention**	**After 2nd intervention**	**After 3rd intervention**
	Mean	33.9	34.2	36.4	34.5
	SD	11.2	11.0	11.9	12.1
	Control group, n = 62	**1st examination**	**2nd examination**	**3rd examination**	
	Mean	33.9	33.2	32.5	
	SD	10.7	10.7	10.5	
Magnesium	**Study group, n = 62**	**Before magnetic stimulation**	**After 1st intervention**	**After 2nd intervention**	**After 3rd intervention**
	Mean	7.70	7.32	7.79	7.48
	SD	3.65	3.61	3.25	3.35
	Control group, n = 62	**1st examination**	**2nd examination**	**3rd examination**	
	Mean	7.00	9.63	8.19	
	SD	3.70	3.88	6.37	
Fluoride	**Study group, n = 62**	**Before magnetic stimulation**	**After 1st intervention**	**After 2nd intervention**	**After 3rd intervention**
	Mean	4.88	4.75	4.74	4.48
	SD	1.94	1.77	1.65	1.64
	Control group, n = 62	**1st examination**	**2nd examination**	**3rd examination**	
	Median	3.74	3.94	4.13	
	min-max	1.39-8.86	1.45-8.16	1.56-9.17	
	Q_1 -Q_3	2.91-5.59	3.11-5.57	3.19-5.49	

the last meal and saliva sampling could be different in the particular investigations.

Most studies describing the composition of saliva do not report magnesium values due to its low content, but the concentrations of magnesium are very similar to the values reported for healthy individuals by Aps and Martens [15] *e.g.* 0.2 mmol/L (4 mg/L) as well as Gradinaru *et al.* [6] *e.g.* 0.14 mmol/L.

It might be supposed that the concentration of fluoride in total saliva is related to its consumption, depending on the fluoride content in the environment, especially drinking water. Other important sources of fluoride are products used in caries prevention, especially toothpaste. The statistically significant increase of fluoride concentration in the saliva of the control group could be explained by its increasing supply. It is possible that during dental treatment, with improving oral status, patients were better motivated to maintain good oral hygiene and were brushing their teeth more often and more carefully, especially just before visiting the dentist, which resulted in the increase of fluoride concentration in saliva. The patients subjected to magnetic therapy did not have to show their teeth to the dental professional during the procedure, because it was extraoral and might not have had such a motivation factor.

Some authors notice that the effects depend on the parameters of the magnetic field applied, including its type, intensity of induction, localization and time of exposure [7, 8, 15, 16], thus the results of the present study may not apply to different systems and devices used for magnetic stimulation.

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