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The change of electric potentials in the oral cavity after application of extremely low frequency pulsed magnetic field

Zmiana elektropotencjałów w jamie ustnej po zastosowaniu impulsowego pola magnetycznego z zakresu ELF

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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Summary

Electric potentials occurring in the oral cavity deserve attention as they may cause various diseases and subjective feelings, which are very difficult to treat. The aim of this study was to evaluate the electric potentials within the oral cavity in patients with metal fillings and metal prosthetic restorations, after using a pulsed electromagnetic field. The study was carried out on 84 patients. The Viofor JPS Classic device was used in the treatment. It generates a pulsed electromagnetic field with low induction of the extremely low frequency (ELF) range. Average values of electric potentials in the preliminary test were about the same in both groups; they were 148.8 mV and 145.5 mV. After another appliance of ELF fields there was found a steady decline in the average value of electric potentials in the study group. This decrease was statistically highly significant, while mean values of electric potentials in the control group were characterized by a slightly upward tendency. The obtained statistically significant reduction of electric potentials in the oral cavity of patients having metal fillings and metal prosthetic restorations, after application of the Viofor JPS Classic device, implies a huge impact of ELF pulsed electromagnetic field on inhibition of electrochemical processes, as well as on inhibition of dental alloy corrosion.

Key words: **electric potentials in the oral cavity • oral electrogalvanism • variable ELF magnetic fields**

Streszczenie

Pojawiające się w jamie ustnej elektropotencjały nie są obojętne, gdyż mogą wywoływać różne schorzenia oraz powodować występowanie subiektywnych nieprzyjemnych odczuć, których leczenie jest bardzo trudne. Celem badań była ocena elektropotencjałów w jamie ustnej u pacjentów użytkujących metalowe wypełnienia i uzupełnienia protetyczne po zastosowaniu impulsowego pola magnetycznego z zakresu ELF. Badania przeprowadzono u 84 pacjentów. Do zabiegów wykorzystano urządzenie Viofor JPS Classic, które generuje impulsowe pole magnetyczne o niskiej indukcji z zakresu ELF (Exremely Low Frequence). Średnie wartości elektropotencjałów w badaniu wstępnym były prawie takie same w obu grupach badanych i wynosiły odpowiednio 148,8 mV i 145,5 mV. Po kolejnych zabiegach polem ELF stwierdzono stały spadek średnich wartości elektropotencjałów. Spadek ten był istotny statystycznie. Natomiast w grupie kontrolnej średnie wartości elektropotencjałów charakteryzowały się tendencją wzrostową. Uzyskane istotne statystycznie zmniejszenie elektropotencjałów w jamie ustnej pacjentów użytkujących metalowe wypełnienia i uzupełnienia protetyczne, po zastosowaniu urządzenia Viofor JPS Classic, sugeruje wpływ impulsowego pola magnetycznego ELF na zahamowanie procesów elektrochemicznych oraz korozji dentystycznych stopów metali.

Słowa kluczowe: **elektropotencjały jamy ustnej • elektrometalozy • zmienne pola magnetyczne ELF**

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Introduction

As a result of dental treatment we can introduce different metal alloys in the patient's oral environment. Every metal immersed in electrolyte solution attains its specified, characteristic potential. The existence of different potentials between two zones of the same metal or two different metals in the same electrolyte leads to electrochemical cell formation and microcurrent flow. Saliva of the mouth is a good ionic conductor; it fulfills a role as a good electrolyte [3,5,19]. It is able to absorb new metal ions, which means that in the oral cavity of patients who are using metal fillings and prosthetic appliances, there will never be a balance between metal and electrolyte. The acidic environment in the mouth causes the simultaneous formation of many microcells [1,3].

Electric potentials in the oral cavity are not negligible as regards the mucous membranes, parodontium and lips, as they may cause various diseases and the occurrence of subjective feelings, which are very difficult to treat.

In this study we decided to assess whether a variable magnetic field can affect the formation or elimination of the electric potentials.

The aim of this study was to evaluate the electric potentials within the oral cavity in patients with metal fillings and metal prosthetic restorations, after using a pulsed electromagnetic field with low induction with the ELF range.

Materials and Methods

The concept of the Viofor JPS system is a device based on the JPS method. The abbreviation JPS is taken from the names of this method's authors, i.e. professors Feliks Jaroszyk, Janusz Paluszak, and Aleksander Sieroń. To date, more than 120 scientific papers reporting use of the Viofor JPS system have been published in journals with an international scope. More information about the JPS Viofor system can be found in the references. Using the Viofor JPS system device and system elliptic applicator (both devices are manufactured by Med & Life Poland) obtained a variable inhomogeneous magnetic field, which was applied to the examined patients. Spectral structure of the generated magnetic field consisted of a set of two basic pulse types with saw-shaped appearance (falling in the range of frequencies from 180 Hz to 195 Hz), a set of basic pulse packages in the frequency range 12.2–29 Hz, groups of packages (2.8–7.6 Hz) and series of packages (0.08–0.3 Hz). The Viofor JPS system device gives the possibility to choose different spectral compositions of alternating magnetic field programs. The essence of various programs rests on selection of these mechanisms' mutual duration time: electrodynamic E effects on ionic currents in the body, magnetomechanical M magnetic field effects the particles with unadjusted magnetic spins and body's liquid cations and anions of ion cyclotron resonance (ICR). We adopted the symbols M1 and P2 or P3 for determining appropriate programs: M1 means the application of the magnetic field with a constant average magnetic induction; P2 or P3 is the variable magnetic field application based on two basic types of pulses (using JPS) in a way that the total length of mechanism E and M is comparable to the duration of ICR [7,8,9]. Details concerning the technical specification of the Viofor JPS device and elliptical applicator for the M1 P2 program are contained in the User's Manual [18] on page 36 Table 9. From the data contained therein it may indicate that for the P2 M1 program on the surface of the elliptical applicator, the average value of induction, where I means the intensity set at JPS regulator (0.5–12). While, the peak induction. Both $\overline{B}$ Bmax=100 • I and Bmax are expressed in μT.

Procedures for determining the magnetic induction

We used two courses of action in adopting procedures for determining the magnetic induction B. The first involved a theoretical analysis based on a known combination of reducing the induction with the distance x, described functionally as $\overline{B}$=f (x-2). The second way was to verify the above theoretical connection by measurements of induction $\overline{B}$. For the measurement of induction $\overline{B}$ a magnetometer made in France, CHAUVIN ARNOUX C.A42 was used. Because the magnetometer CHAUVIN ARNOUX C.A42 was checked and certified by the Polish Office of Weights

Table 1. Values of the electric potentials ΔV (mV) in the oral cavity of patients from the study group

Characteristics of distribution	Before treatments	After 5 treatments	After 10 treatments	After 15 treatments
n	42	42	42	42
min–max	80.5–264.0	72.5–255.5	49.0–218.0	53.0–185.5
Q1–Q3	105.8–175.5	99.7–161.0	98.0–156.5	81.3–129.0
me	146.9	136.9	123.9	96.0
M±SD	148.8±45	136.9±45	126.8±38	103.1±31
W	0.937	0.943	0.982	0.963
p	<0.03	<0.05	>0.83	>0.28
Wilcoxon's sequence of pairs test	p<0.001			
		p<0.001		
			p<0.001	
			p<0.001	
				p<0.001

n – size of the group, min – minimum value, max – highest value, Q1 – first quartile, Q3 – third quartile, me – median, M – mean, SD – standard deviation, W – Shapiro–Wilk test, p – significance level

and Measures, in the further analysis only results of average induction $\overline{B}_z$ obtained with the magnetometer were taken into account. The $\overline{B}_z$ values were measured at 1 cm distance from the elliptical applicator surface. It follows that the reduction of induction at 1 cm distant from the elliptical applicator surface did not exceed 20% of its initial value. In this paper, including this particular distance range, the values of magnetic induction associated with the impact of alternating magnetic fields on biological tissues of tested patients should be considered. Since the suppression factor of a variable magnetic field through biological tissues is negligible, the analysis of induction changes with the distance made in the air environment are sufficient.

Measurement of the electric potentials ΔV

To measure the electric potentials the digital voltmeter ViofordDent was used. An additional advantage of digital voltmeters is the convenience of their application and immediately displayed measurement.

Research

The study was carried out on 84 patients aged from 37 to 71 years. All patients had metal fillings or metal the same alloy prosthetic restorations for at least 5 years. Patients were divided into two groups. Group I consisted of 42 patients who were sent for ELF field treatment from dental indications. The procedures were performed using a Viofor JPS Classic device with elliptical applicator for 15 days. This appliance generates a pulsed electromagnetic field with low induction of the extremely low frequency (ELF) range. The elliptic applicator produces an inhomogeneous variable magnetic field. Group II was a control group of 42 patients who reported to the dental surgery for treatment, but did not require application of ELF field treatment. The electric potentials ΔV were consecutively measured twice with a digital millivoltmeter. One electrode was in contact with the metal and the second electrode with the base of the oral cavity. Both results were summed up, then the average value for the test before surgery after 5, 10 and 15 treatments was calculated. In the control group, ΔV measurements were performed at intervals of one week. The results were statistically analyzed, based on Shapiro-Wilk and Wilcoxon test.

Results

The results are shown in Tables 1 and 2 and Figure 1.

Table 1 shows that the average value of the electric potentials ΔV in the oral cavity of patients from group I, using metal fillings and prosthetic appliances, of the ELF field before surgery was 148.8 mV, after the 5th intervention 136.9, after the 10th intervention 123.9 mV, and after the 15th intervention 96.0 mV. Statistically significant differences were obtained for the value before the treatments and the values after 5, 10 and 15 treatments, and between the 5th and 15th surgery, and the 10th and 15th surgery. Statistically significant differences were obtained for the values before treatments, values after 5, 10 and 15 treatments, between the 5th and 15th surgery, as well as between the 10th and 15th surgery.

Table 2 shows that the values of electric potentials ΔV in the oral cavity of patients from group II, using metal fillings and prosthetic appliances, increased and was in the 1st study 145.5 mV, in the 2nd test 148.7 mV, and 154.2 mV in the

Table 2. Electric potentials ΔV values (mV) in the oral cavity of patients in the control group

Characteristics of distribution	1st test	2nd test	3rd test
N	42	42	42
min–max	100.5–300.0	100.0–300.0	99.8–300.0
Q1–Q3	125.5–161.0	126.5–164.5	130.8–171.3
me	144.4	150.5	147.4
M±SD	145.5±35	148.7±35	154.2±37
W	0.839	0.850	0.902
P	<0.001	<0.001	<0.001
Wilcoxon's pairs sequence test		p<0.004	

n – size of the group; min – minimum value; max – highest value; Q1 – first quartile; Q3 – third quartile; me – median; M – mean; SD – standard deviation; W – Shapiro-Wilk test; p – significance level.

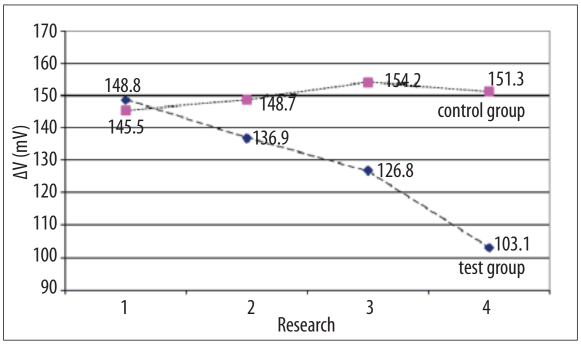

Fig. 1. Mean values of the electric potentials ΔV in the oral cavity of patients from the study group and control group

3rd study. Between the 1st and 3rd study, a statistically significant increase of the electric potentials ΔV was observed.

Figure 1 shows that the average values of electric potentials in the preliminary test were about the same in both treatment groups and equaled 148.8 mV and 145.5 mV. After several surgeries with ELF fields, a steady decline in average values of the electric potentials from 148.8 mV to 103.1 mV after 15 treatments was found. This decrease was highly statistically significant. By contrast, in the control group the mean values of electric potentials were rising slightly.

Discussion

Several studies have found that increasing the amounts of certain chemical elements and their salts in saliva leads to the emergence of microcurrents in the mouth. Then a galvanic battery arises and the generated electricity causes corrosion of dental alloys and an unpleasant sensation in the mouth. To these changes disposes acidic saliva, and local mechanical and chemical irritations [1,18]. Electrochemical reactions that may occur in the oral cavity gave rise to the electrogalvanism concept. This phenomenon is currently being studied. The result of this process is not only a loss of aesthetic appearance of the alloy (dulling of the surface) or worsening material damage. The most important are the biological nature consequences, that is to say the negative impact of the released ions on the human body. The resulting galvanic currents can affect the physiological activity of body tissues, the consequences being emerging lesions called electrometalosis [3,5,15,16,19,20]. From the literature it is known that in healthy people, who do not have metal alloys in the oral cavity, a difference in electric potential of about 30–50 ΔV did not cause any clinical symptoms [5]. The results obtained by other authors confirm that if in the oral cavity there is at least one metal alloy, it increases the value of electric potentials. The research shows that the presence of electric potentials above 120 mV is an indication to remove the metal from the oral cavity [5]. Our research results, both in the test group before using ELF fields and in the control group, showed the average value of electric potentials above 145 mV. In addition, in patients in the control group after two weeks there was an electric potential increase in the oral cavity, which may indicate different electrochemical processes occurring during the contact with saliva and consumed food. Our own research found much higher potentials, suggesting the need of replacing metal additions in these patients' mouths.

Many authors have reported that pulsed electromagnetic fields, in English literature called extremely low frequency magnetic field (ELF-MF), support the processes of tissue respiration, activate or inhibit enzymatic reactions, stimulate the activity of serum enzymes, affect the acid-alkaline balance and water-electrolyte balance, accelerate the angiogenesis process, and affect protein synthesis, the processes of replication, transcription of nucleic acids and the processes of cell proliferation [2,4,11,14].

Researchers agree that the electromagnetic fields' biophysical effects are the result of the impact on the uncompensated magnetic spins of paramagnetic elements, effects on components of cell membranes, displacement of moving electrical charges as a result of electrodynamic, magneto-mechanical, ion cyclotron resonance and Hall effects, depolarization of the cells with their own automatism, and changes of certain physico-chemical properties of water [13,14]. Based on these data, reducing the value of electric potentials in the oral cavity may be the result of stopping the precipitation to the saliva of such elements as copper, zinc and iron. Reduction of these elements in patients' saliva after the ELF field surgery may be the result of basic physical mechanisms, where the field reacts with inorganic matter. The magnetic ions include iron, titanium, vanadium, cobalt, chromium, nickel, copper and molybdenum; their magnetic state can be changed in the presence of magnetic fields [10]. Concentration decrease of copper, zinc and iron in the patient's body may also result from another mechanism, when the field impacts on the uncompensated electric charges. As a result of electrochemical processes in patients' oral cavity there appear ionized elements, so in a physical sense their charges are uncompensated. Many studies indicate that the activation of the electromagnetic field changes the direction of moving electric charges, so that the ions begin to move in a certain passage of wheel radius. Exceeding a certain induction of external magnetic field value leads the paramagnetic elements' axis to being set along the magnetic field force lines. This in turn inhibits the movement of these ions. The consequence of the above mentioned field's functioning mechanisms may be a redistribution of ions, which leads to firmness and retention of electrochemical processes and metal corrosion processes in the oral cavity [6,12,17,20].

Conclusions

1. Mean values of electric potentials in the oral cavity of patients using metal fillings and metal prosthetic restorations are very high and indicate the presence of large amounts of metal ions.
2. After treatment using alternating ELF magnetic field, reduced values of potentials ΔV were observed, which prevents the need for replacing the prosthetic restorations.
3. The obtained statistically significant reduction of electric potentials, in the oral cavity of patients with metal fillings and metal prosthetic restorations, after application of the Viofor JPS Classic device, implies a huge impact of ELF pulsed electromagnetic field on inhibition of electrochemical processes, as well as on inhibition of dental alloy corrosion.

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