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Współczynnik skuteczności fizykoterapeutycznej pól magnetycznych po wszczepieniu implantu zębowego

Magnetic Fields Physiotherapeutic Effectiveness Coefficient After Dental Implant Implantation

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Streszczenie

Celem pracy było oszacowanie najefektywniejszego oddziaływania magnetostymulacji stało- i zmiennopolowej oraz magnetostymulacji z ledoterapią w przypadku doznań bólowych po wszczepieniu implantu zębowego.
Materiał i metoda. Spośród pacjentów w biernej fazie leczenia ortodontycznego aparatem stałym wybrano 42 osoby z pojedynczymi brakami zębowymi w żuchwie u których wszczepiono implant zębowy, do osłabienia doznań bólowych wykorzystano magnetostymulację stałopolową (Magnetouche) u 14 osób, zmiennopolową (Viofor JPS) u 14 osób, zmiennopolową z ledoterapią (R i RIR) u 14 osób. Oceny doznań bólowych dokonano na podstawie skali bólu MNRS. Pierwsze badanie odczucia bólu rozpoczynano 3 godziny od zabiegu implantacji, następne po cyklicznej magnetostymulacji.
Wyniki. W aplikacji magnetostymulacji stałopolowej doznanie bólowe ustępowało po dobie od zabiegu, przy korzystniejszym efekcie indukcji magnetycznej 60 mT. Przy magnetostymulacji zmiennopolowej efekt działania przeciwbólowego był większy w przypadku trzeciej kombinacji sygnałów – program M_2P_3. Przy magnetostymulacji z ledoterapia RIR efekt był najlepszy, co potwierdzono przy pomocy wprowadzonego wskaźnika skuteczności fizykoterapeutycznnej – WSF.
Wniosek. W stomatologii do stosowania osłabienia odczuwania bólu należałoby zalecić magnetostymulację JPS(M_2P_3)+RIR.

Słowa kluczowe:

magnetostymulacja stałopolowa, magnetostymulacja zmiennopolowa JPS, magnetostymulacja zmiennopolowa z ledoterapią, skala bólu MNRS, wskaźnik skuteczności fizykoterapeutycznej WSF

Abstract

The purpose of this study was to estimate the most efficient effect of steady and variable field magnetic stimulation and magnetic stimulation with LED light therapy in case of sensation of pains after the dental implant implantation.
Material and method. 42 persons were selected from among the patients at the passive stage of orthodontic treatment with a fixed apparatus, with single tooth lacks in the submaxilla, in whom a dental implant had been implanted, where to mitigate the sensation of pain the steady field magnetic stimulation (Magnetouche) was used in 14 persons, the variable field (Viofor JPS) in 14 persons, and the variable field with LED light therapy (R and RIR) in 14 persons. The sensation of pain was evaluated using the pain scale of MNRS. The first sensation of pain test was started 3 hours after implantation and the next ones after cyclical magnetic stimulation.
Results. In the steady field magnetic stimulation the sensation of pain ceased after 24h treatment, with the most beneficial magnetic induction effect at 60 mT. For the variable field magnetic stimulation the analgesic effect was bigger in case of the third signal combination – M_2P_3 program. The best effect was obtained with the magnetic stimulation with LED light therapy RIR, what was confirmed using the physiotherapeutic effectiveness coefficient – WSF.
Conclusion. In the stomatology, the magnetic stimulation JPS(M_2P_3)+RIR should be recommended to attenuate the sensation of pain.

Key words:

steady field magnetic stimulation, variable field magnetic stimulation JPS, variable field magnetic stimulation with LED light therapy, MNRS pain scale, physiotherapeutic effectiveness coefficient WSF

Introduction

The literature of the last fifteen years more and more often addresses issues related with the physiotherapeutic effect of the magnetic fields on the human organism. Physiotherapy is a discipline that uses physical stimuli in rehabilitation. Magnetic fields (MF), both with steady and variable fields as well as with added light influence the structures of the living organism basically at the atomic-molecular level [1, 2]. However, the fact is that many influence mechanisms still remain unknown. It indicates the need for further research, in different investigative and clinical situations, in the area of the magnetic therapy effect on the human organism, both in general medical and dental cases. In the available literature the most frequently examined was the effect of the magnetic fields on the sensation of pain [3-8]. In the researches the pain evaluation scales include the following types: graphic, verbal, analogue-visual and numerical [9, 10].

The purpose of this work was to estimate the most efficient effect of steady and variable field magnetic stimulation and magnetic stimulation with LED light therapy in case of the sensation of pain after the dental implant implantation in the condition of uniform testing model.

Material and method

The patients were qualified for the research upon completed orthodontic treatment, in which it was required to embed a single dental implant - the volunteers gave their consent to participate in the research in writing. The conditions of homogeneity of the adapted research project limited the patient selection: general good health condition, single tooth lacks in the submaxilla, completed active orthodontic treatment with a fixed apparatus or condition after the apparatus removal. As a result of the assumed selection criteria, the group of 42 patients was chosen, at the age of 23 to 42 years, that were subject to investigation. Due to the fact that appearing sensation of pain is always subjective, also after the dental implantation, for the pain evaluation a modified scale of NRS – Numerical Rating Scale, (MNRS) [11] was used.

In each of the examined persons, the single dental implantation was preceded by performance and analysis of the radiological conical computer tomography (CBCT), in which the diameter and the length of the dental implant was determined together with the virtual placement of the implant in three dimensional submaxilla reconstruction. The used implants were Legacy 3 Implant Direct from Sybron with a conically shaped V class titanium, with a double thread crossing through a quadruple mini thread near the neck, with a sanded surface and a joint based on the internal cone and 2.5 mm hexagon, maintaining the platform switching rule. During one surgery that was performed in the morning hours till 11:00 ± half an hour, it was planned to embed only one implant in the side submaxilla section. One hour before the treatment the patients were administered 1 table of 600 mg Clindamycin and again the same dose 6 hours after the

treatment for a short-term prophylactic against the endocardium inflammation. The surgical treatment was performed in local anaesthesia, giving two phials of 1.8 ml articaine each with adrenaline in ratio 1/200. In all investigated cases the through gingival healing was used. The wound was provided with two pad sutures and if required with knot sutures, using stitches 4-0 thick Vicryl Plus from Ethicon.

The examination of the effect of the steady field magnetic stimulation, variable field magnetic stimulation and variable field magnetic stimulation with LED light therapy on the pain feeling attenuation started after three hours after completion of the implantation procedure, that is after the anaesthesia had ceased. This time was conventionally assumed as 0.

The magnetic applicator Magnetouche was used in testing the effect of the steady field magnetic stimulation on the sensation of pain reduction. The applicator was used in two different distances from the implant location: d_1 = 0.6 cm or d_2 = 1.8 cm. In the variable field magnetic stimulation the used combinations of electric signals of the magnetic stimulation device Viofor JPS included the second one (M_1P_3 program) and the third one (M2P3 program). In the magnetic stimulation with LED light therapy only the third combination of electric signals was included – M_2P_3 program of Viofor JPS, correlated with simultaneous LED light application, the used light was red in colour (R) or it was combined red and infrared light (RIR). The stimulation was applied for 7 patients in each of the six magnetic field applications, 42 patients in total.

After the first assessment of the pain level, each patient was exposed to non-invasive steady field or variable field magnetic stimulation or variable field magnetic stimulation with LED light therapy during 12 minutes - the time was counted down automatically. The sensation of pain reading was performed every 2 hours and the application was repeated every 4 hours until the sensation of pain ceased. After each application the patient assessed his or her pain in the scale from 0 to 10 – the recorded value was a mean value received from the patients. The measurement was performed until about 10:00 PM ± half an hour, to start data collecting the next day about 11:00 AM ± half an hour. The examination was finished at average readings of the MNRS scale, when the patient could hardly differentiate the sensation of pain and its absence.

The knowledge of the pain lasting times allowed to determine the physiotherapeutic effectiveness coefficient of the magnetic stimulation – WSF.

The WSF coefficient was determined from the formula:

$$WSF = \frac{\overline{\Delta k}}{t}$$

where: $\overline{\Delta k}=\overline{k_{max}} - \overline{k_{min}}$, t – time of pain effect

The WSF unit is [h^{-1}]. For practical reasons, it was assumed $\overline{k_{min}}=1$, as the patient at this value could not state if the pain effect was present or not. Data collected during application indicate that $\overline{k_{max}}$ is included between average and intense

pain. In the research it was assumed that $\overline{k_{max}} \cong 6,4$. Thus $\overline{\Delta k}=6,4-1=5,4$, assuming such value $\overline{\Delta k}$ an equation was obtained that determines the WSF in the form of:

$$WSF=5,4 \cdot t^{-1} \ [h^{-1}]$$

Results

The results of the obtained pain reduction effect while using 6 different physiotherapeutic options are summarized in Table 1.

Table 1. Averaged pain scale results ($\bar{k}$) depending on the reading time t(h) for six magnetic stimulation options

Type of application	Reading time t(h) starting from the first application of the magnetic stimulation							
	0	2	4	6	8	21	23	25
	Pain scale (0-10) MNRS ($k \pm s_k$) $^{-}$ -							
Magnetouche + d_2 ($\overline{B_2}$)≅2,2 mT	6,1±0,3	5,8±0,2	5,5±0,3	5,1±0,2	4,5±0,4	3,8±0,3	3,0±0,3	1,9±0,4
Magnetouche + d_1 ($\overline{B_1}$)=60 mT	6,2±0,2	5,5±0,2	4,7±0,4	3,4±0,3	1,6±0,3	1,2±0,2	0,6±0,3	0
JPS (M_1P_3) {$\overline{B}$}=6	6,3±0,3	5,5±0,2	4,6±0,3	3,2±0,4	2,0±0,4	1,1±0,4	0,5±0,4	0
JPS (M_2P_3) {$\overline{B}$}=6	6,5±0,2	5,3±0,3	4,0±0,4	2,3±0,3	1,0±0,4	0,5±0,4	0	0
JPS (M_2P_3)+R {$\overline{B}$}=6	6,6±0,2	5,1±0,3	3,8±0,3	2,4±0,4	0,5±0,4	0	0	0
JPS (M_2P_3)+RIR {$\overline{B}$}=6	6,4±0,3	4,6±0,2	2,4±0,3	0,5±0,4	0	0	0	0

In both steady field magnetic stimulation applications the sensation of pain ceased after 24h of the surgery, but significantly more beneficial analgesic effect was reached upon the magnetic induction = 60 mT in patients with a single implant in the tooth socket part of submaxilla, comparing to the magnetic field induction = 22 mT. Similar analgesic effect was obtained using the variable field magnetic stimulation. Significant effect was noted after the second magnetic field application, moreover the analgesic effect was greater in case of the magnetic stimulation based on M_2P_3 program - the third combination of signals. The best analgesic effect was reached after the use of magnetic-light applicators JPS+RIR, slightly weaker with respect to the sensation of pain reduction, when the exposure to JPS+R applicators was used. The physiotherapeutic effectiveness of physical factors was determined due to maintaining the research subject

homogeneity condition with the same type of the pain effect source.

From the results the WSF coefficients were calculated for individual types of magnetic stimulation. The pain curve determined as "Magnetouche + d_2" was approximated to the value of $\overline{k_{min}}$=1. The WSF coefficient for individual application situations is presented in Table 2. Comparing the results of the physiotherapeutic effectiveness coefficient WSF, it may be seen that WSF for JPS(M_2P_3)+RIR magnetic stimulation is the biggest and it is WSF = 0.98. It was enough to determine $\overline{k_{max}}$ and assume that $\overline{k_{min}}$=1, so there was no need to perform laborious procedure of the pain curves designation. Introduction of the WSF facilitated the procedure of determining therapeutic effectiveness for selected physical stimuli.

Table 2. Results of the Physiotherapeutic Effectiveness Coefficient (WSF) for individual types of magnetic stimulation used after the dental implant implantation

	JPS (M2P3) + RIR	JPS (M2P3) + R	JPS (M2P3)	JPS (M1P3)	Magn. +d1	Magn. +d2
WSF (h-1)	0,98	0,72	0,68	0,25	0,24	0,20

WSF - Physiotherapeutic Effectiveness Coefficient

Discussion

In the study the research model was used, i.e. clinical investigation. When undertaking the clinical investigation it is always required to remember about its usefulness, some benefits that may obtain a specific patient or a group of patients now and in the future, and the risk that must be taken into account and that may not threat the participants, both in legal and ethical aspects, according to which such research may be carried out [12]. The consent from Bioethical Commission at UMP was obtained for this research project, so all preconditions in this extent were fulfilled.

All cases presented by the authors, where the dental implantation surgery was applied, were in the passive stage after the active orthodontic treatment of the dental-occlusive disorders. The orthodontic operation was used to prepare the place for implantation - enough space was obtained in the tooth socket in the submaxilla at the parallel teeth placement. The implantation procedure is often preceded by directed orthodontic therapy [13, 14].

An unavoidable consequence of the dental implantation surgery is the pain that may be caused both by disturbance of soft tissues in pariodontium and the osseous tissue of submaxilla. The pain is a subjective sensation, so its objective measurement is difficult [15, 16]. In order to improve the objectiveness of the sensation of pain assessment, the NRS numeric scale was modified, using combination of the NRS scale advantages, the graphic and verbal scale, and it was called the modified MNRS. This scale is easy to understand by the patients and it ensures significant repeatability of the sensation of pain reading results, which allows evaluation of the analgesic therapy.

For the analgesic effect of non-homogeneous magnetic field (MF) the specialist literature mentions two equivalent terms, namely stable field magnetic therapy and stable field magnetic stimulation. These works embrace high diversity of the pain sources, as well as physical parameters that specify the magnetic applicators used in the researches. The following are mentioned for the pain sources: chronic ache of head, nape, shoulders, back, pelvis, genitals, feet, knees, hips, joints and other organs. Large diversity of the pain sources and large extent of the MF physical parameters (this applies in particular to the magnetic induction and spatial distribution of the MF) make it difficult or even disallow the analysis of the MF therapeutic effectiveness in the stable field magnetic stimulation [3, 7]. In this research the problem was eliminated by the use of homogeneous research mode. It is worth mentioning that the MF therapeutic effectiveness depends not only on the magnetic induction, but also on its gradient. In case when the average induction of the applied MF was 60 mT, a significant pain reduction was observed.

The magnetic field impact on the living organism also involves the following effects: bioelectrical, biochemical and bioenergetic. The consequence of these molecular effect is increased release of endogenous opiates from β-endorphins group. These substances are responsible for rising the sensation of pain threshold. It must be noted that the analgesic effect is present not only while the organism is exposed to the magnetic field, but also after the exposition is stopped [1, 2, 8]. The research that we performed and the obtained results allow to state that the analgesic effect of the MF on the part of a living organism is reached, when its average induction has a value of several tenths of mT. In case when its induction is at the level of several mT, the analgesic effect is weaker.

Despite of the works [17-19] dedicated to the magnetic stimulation effect on the sensation of pain attenuation, it is difficult to compare therapeutic effectiveness of the discussed physical factors due to different: pain sources, places of application on the organism, structure of variable magnetic field and absence of comparable examination conditions, however, in the quoted works a distinct analgesic effect of the magnetic stimulation was observed.

Due to the homogeneous research model and the fact that the pain was caused by the same source - dental implantation, the physiotherapeutic effectiveness was determined using the formula resulting from the performed research project. It was determined that the magnetic stimulation therapeutic effectiveness for 6 magnetic stimulation options was the biggest when using M_2P_3 program with VIOFOR JPS device with LED light therapy.

Conclusion

From the presented pain curves and the WSF determination for individual types of the magnetic stimulation, the recommended one for use in stomatology to reduce the sensation of pain should be JPS(M_2P_3)+RIR magnetic stimulation.

The analgesic effect is induced by the electromagnetic field that affects the part of a living organism, while the electromagnetic fields impact on the living matter has synergistic and multi-level character.

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