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Physiotherapeutic methods of pain relief following the placement of a single tooth implant during the passive phase of orthodontic treatment

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Abstract

The aim of this study is to compare the physiotherapeutic effectiveness of static field magnetotherapy (magnetostimulation), variable magnetic field stimulation, as well as variable magnetic field stimulation combined with LED light therapy, for pain relief in an experimental model involving the placement of a dental implant after the completion of orthodontic treatment in the case of individual missing teeth. The study involved 42 patients aged between 23 - 42 years who had had implants inserted in the alveolar part of the mandible to replace missing individual teeth in the passive phase, after the completion of active orthodontic treatment using fixed appliances. Pain assessment was evaluated according to the MNRS scale, a modification of the Numerical Rating Scale (NRS), for increased objectivity.

Keywords: pain, pain scales, dental implants, physiotherapy

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Introduction

Dental implant surgery is an invasive and bloody procedure which places a foreign object in the body. In the course of the healing process, an implant should become fully osseointegrated, but sometimes it can be rejected by the body, for example if inflammation develops. The trauma connected with the implant procedure results in damage to the periodontal soft tissue and bone tissue, as well as adversely affecting their function, which triggers defence and repair reactions, leading to the restoration of morphological structures and achieving functional homeostasis [1]. Every surgical procedure is accompanied by a moderate inflammatory reaction, which is beneficial because it helps to reduce bleeding and remove necrotic tissue. It also affects the excretion of exo- and endotoxins, thus restricting the extent of the inflammation and preventing its spread [2]. An inevitable consequence of dental implant surgery is pain. Pain is a subjective sensation and its objective assessment is therefore difficult. Most commonly, pain assessment is conducted using graphic, verbal, visual-analogue and numerical scales [3].

The aim of this study is to compare the physiotherapeutic effectiveness of static field magnetotherapy (magnetostimulation), variable magnetic field stimulation, as well as variable magnetic field stimulation combined with LED light therapy, for pain relief in an experimental model involving the placement of a dental implant after the completion of orthodontic treatment in the case of individual missing teeth.

Materials and methods

The study involved 42 patients aged between 23 - 42 years who had had implants inserted in the alveolar part of the mandible to replace missing individual teeth in the passive phase, after the completion of active orthodontic treatment using fixed appliances. The mean age of the patients was 35 years and 3 months. Each surgical procedure was preceded by interdisciplinary planning involving orthodontic, prosthetic and implant specialists, supplemented by an analysis of a radiological image obtained through cone beam computed tomography (CBCT) with an assumed slice thickness of 0.2 mm, during which the diameter and length of the implant were determined, and the implant was virtually positioned in a three-dimensional reconstruction of the patient's mandible. Figure 1 a) b) and c) shows a representative example.

After surgery, a cooling pack was applied for about two hours; the patients were provided with written instructions and asked to come for the first and subsequent measurements of pain levels after the local anaesthesia had worn off. Examination of the influence of static field magnetic stimulation, variable magnetic field stimulation, as well as variable magnetic field stimulation combined with LED light therapy, on the alleviation of pain began three hours after the completion of the dental implant surgery, when the anaesthesia had worn off. The pain rating was done according to a modification of the Numerical Rating Scale (NRS), called the MNRS scale (Figure 2), which made the assessment more objective. The modified scale combined the advantages of the NRS scale with those of graphic and verbal scales. The researchers ensured that the patients understood the nature of the MNRS scale; as well as what the extreme values (0 and 10) and the median value (5) signified.

Each of the patients assessed the k value on the MNRS scale three times at any given time. For further analysis the average k value from these readings was used. The individual groups of patients comprised on average 7 people each. The final measurements in each case took into account the mean of the average $\overline{k}$ values of pain assessment readings. The aim of the adopted procedure was to as objectively as possible assess changes in the level of pain while the patients were undergoing various types of magnetostimulation. Additionally, standard deviations of the mean value from the averages of all the test results were calculated. This procedure helped eliminate dispersion between the individual test results obtained for each patient and made the analysis of the impact of particular types of magnetostimulation on pain assessment independent of such factors as a different tissue structure or different lengths or diameters of individual implants. The research project was approved by the Bioethics Committee of the Poznań University of Medical Sciences (No. DBN-KB-971/11).

Results

A pain relief effect was achieved through using JPS magnetostimulation, also with LED light therapy. By ensuring the homogeneity of the research material and the same origin of pain it was possible to determine the physiotherapeutic effectiveness of the analysed physical factors. In order to compare the pain curves after the application of the two types of magnetic fields and LED light therapy, they are presented in Table 1, and for better illustration they are also shown in Fig. 3. In the figure, each point $\overline{k}$ is an average of about 20 readings. The dotted line marks [illegible]$_n$, which equals 1. In practice, such a value for the average reading on the MNRS scale means that the patient finds it difficult to distinguish whether or not they experience any pain. The points of intersection between the [illegible]$_n = 1$ line and the individual pain curves made it possible to determine on the computer the numerical values for the duration of pain. These are marked on the **t** axis (smaller numbers).

Application	Pain scale $\overline{k}$	Time								
		0	2	4	6	8		21	23	25
Magnetouche + d_2 $\overline{B_2} \cong 2{,}2$ mT–static field	MNRS ($\overline{k} \pm s_{\overline{k}}$)	6,1±0,3	5,8±0,2	5,5±0,3	5,1±0,2	4,5±0,4	break night	3,8±0,3	3,0±0,3	1,9±0,4
Magnetouche + d_1 $B_1 = 60$ mT–statis field	MNRS ($\overline{k} \pm s_{\overline{k}}$)	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) $\overline{\{B\}} = 6$–variable field	MNRS ($\overline{k} \pm s_{\overline{k}}$)	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) $\overline{\{B\}} = 6$ –variable field	MNRS ($\overline{k} \pm s_{\overline{k}}$)	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 $\overline{\{B\}} = 6$– magneto-optic	MNRS ($\overline{k} \pm s_{\overline{k}}$)	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 $\overline{\{B\}} = 6$ magneto optic	MNRS ($\overline{k} \pm s_{\overline{k}}$)	6,4±0,3	4,6±0,2	2,4±0,3	0,5±0,4	0		0	0	0

Table 1: A comparison of the influence of static field and variable-field magnetostimulation (JPS) as well as magneto-optical stimulation (JPS + RIR) on pain relief after dental - implant placement

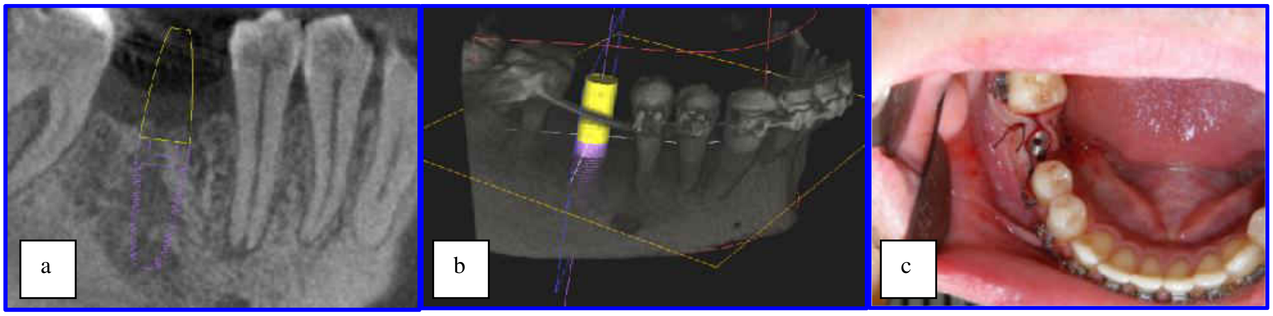

Figure 1: Patient F.B. aged 32. a) A graphic representation of the planned implant procedure; b) 3-D visualisation; c) Condition immediately after implant placement - Legacy implant, diameter/length 4.7/10 mm, site 46 (own materials)

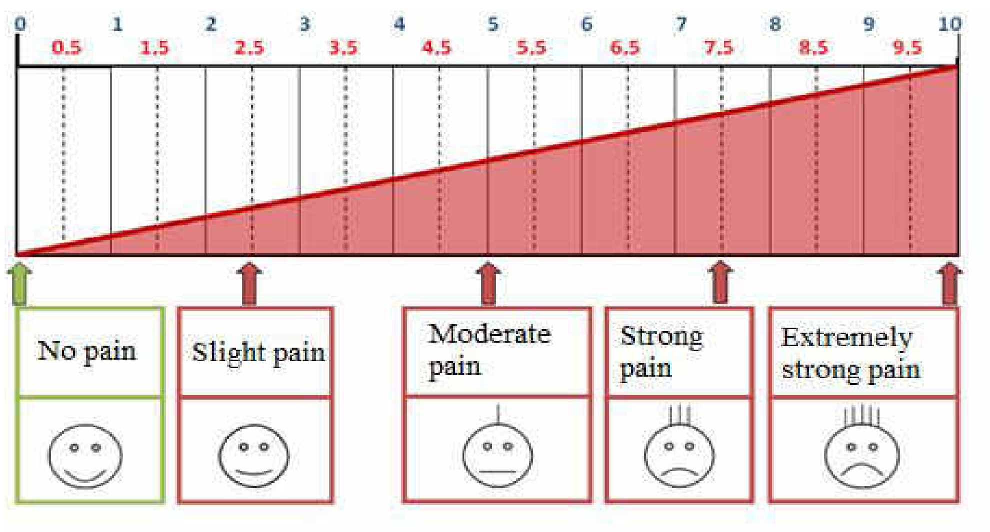

Figure 2: The MNRS scale – a modified NRS scale, expanded by the addition of graphic and verbal scales

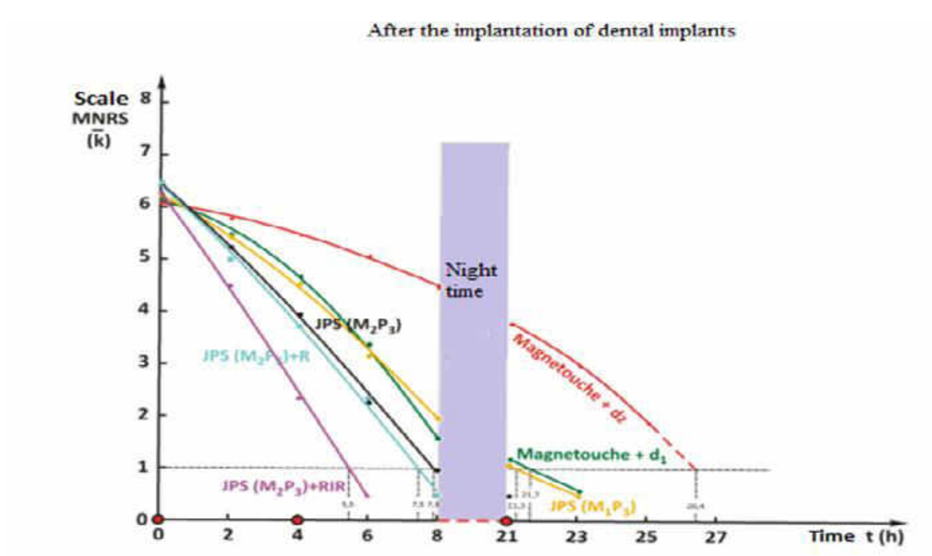

Figure 3: A comparison of the influence of static field and variable field magnetostimulation (JPS) as well as magneto-optical stimulation (JPS+RIR) on pain relief after dental implant placement

Discussion and Summary

The primary rationale for undertaking this study were discrepancies in the findings of studies published in specialist journals as well as a lack of comparative analyses relating to the effectiveness of the studied methods of physiotherapy in relieving pain in similar experimental models, hence the adopted experimental model. In the literature, the Numerical Rating Scale (NRS) is usually used for assessing the level of pain [4]. In dentistry acute pain is frequent, and for its assessment the NRS and VAS scales are most commonly used, which are considered to be equivalent in terms of pain intensity assessment [3]. Combining the advantages of the NRS scale and the graphic scale, an original MNRS scale was created. After analysing the results of the study it can be concluded that this scale is useful in clinical applications. It is possible that the MNRS scale will be added to previously used scales. The MNRS scale is easy to understand by patients and is characterized by significant repeatability of pain assessment readings, which enables an appropriate evaluation of analgesic therapy.

Pain can be caused by a violation of both the continuity of periodontal soft tissues and the mandibular bone as well as by an inflammatory reaction, normal after any surgical procedure. In none of the studied cases did the inflammation spread, which would have happened if the healing process had not been progressing correctly. Inflammation can develop if the post-operative wound becomes infected with the bacterial flora in the mouth, or if a patient does not properly follow post-operative recommendations such as those relating to hygiene, reducing the chewing function or a proper diet. Clinical signs of inflammation include redness and an elevated temperature due to vasodilatation; edema caused by a leakage of formed elements of blood and plasma as well as lymph into tissues; pain as a result of a stimulation of pain receptors by inflammatory mediators (histamine, serotonin, kinin) and the pressure caused by an accumulation of immune system cells; and a reduction or loss of function of the affected organ. In the early stage of inflammation, phagocytic and endothelial cells secrete proinflammatory cytokines, which include IL-1 a/b, IL-6, IL-8, and TNF [5,6,7] In the light of earlier research [6], it appears that the values of immunoglobulin G (IgG) and acute-phase proteins are higher both in the case of peri-implantitis and gingivitis, but at the same time there are no significant differences between these two conditions. This suggests that inflammatory and immune responses are similar in the mucosa around the implant and the gingiva, and that similar mechanisms are responsible for the creation of gingivitis and peri-implantitis. Acute-phase proteins are involved in the clotting process, the removal and regeneration of tissues, and in suppressing the growth of bacteria. Therefore determining the concentration of C-reactive protein (CRP) is useful in the early detection of bacterial infection and in postoperative monitoring, also in the case of procedures performed within the oral cavity such as third molar extractions or tooth extractions with alveolar ridge augmentation [1]. However, the placement of a single implant does not induce a significant increase in CRP concentration. In this study the presence or level of proinflammatory cytokines or acute-phase proteins were not assessed because each of the patients had no more than one implant, so in the light of the studies cited a significant increase in CRP concentration after surgery was not to be expected.

In the literature two equivalent concepts exist, namely magnetotherapy and magnetostimulation, which refer to the impact of non-uniform magnetic fields (MF) on the human body [8]. In the world literature one can find research indicating that MF does not have any effect on alleviating pain [9,10], as well as research which confirms the impact of magnetic fields on pain relief [11-15].

The study presented in this paper examines this problem using the previously described homogeneous experimental model. It is also important that each participant voluntarily consented to participate in this clinical study, having been assured that at every stage of the research project they will be able to withdraw from further participation without any consequences, which is consistent with ethical and legal principles [16]. The findings of the entire study make it possible to conclude that an analgesic effect was achieved. The study confirmed the pain-relieving effect of both JPS magnetostimulation and JPS magnetostimulation combined with LED light therapy. By ensuring the homogeneity of the research material and the same origin of pain it was possible to evaluate the physiotherapeutic effectiveness of these treatment methods. On the basis of an analysis of the pain curves, the use of JPS(M_2P_3)+RIR magnetostimulation ought to be recommended for use in dentistry in order to lower the sensation of pain.

Due to the fact that there is no literature relating to the use of physical methods for the relief of pain in patients after orthodontic treatment with fixed appliance who received single-tooth implants, the findings of this study cannot be related to other studies, which indicates the novelty of this research in this respect.

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