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Physical therapy treatment in chronic wounds – the high voltage stimulation and the magnetotherapy

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Abstract

Introduction and purpose of the work. Wounds which last in the human body longer than 4-8 weeks are regarded as chronic wounds. Healing process in those wounds does not take place. Medical staff of different specialties should be involved to ensure proper efficiency of the wound healing process. The purpose of the study was to analyze the literature of using physical therapy such as the high voltage therapy, the magnetotherapy and the magnetostimulation in the chronic wound healing process.

Brief description of the state of the art. The High Voltage Stimulation is used not only for pain treatment but also in different kinds of wounds. The unipolar or dipolar set is applied, and one or two electrical circuits could be used. Under the active electrode, the primer soaked in physiological saline is used and placed on the wound (the size of the primer is matched to the size of the wound). If the dipolar set is used, electrodes are fixed in opposite parts of the wound. The stimulation is induced with current which does not invoke any movement. The magnetotherapy is a kind of physical therapy which uses the magnetic fields of 1-to 10-20 mT and the frequency under 100 Hz. In the magnetostimulation, the magnetic induction amounts from 1 pT to 100 mT, the frequency from 1 to 1000 Hz.

Summary (conclusions). All clinical studies showed that different kinds of physical therapy such as the magnetostimulation, the magnetotherapy, and the high voltage therapy accelerate

the process of wound healing. Unfortunately, the application of physical therapy in order to improve the wound healing process is still limited.

Key words: wound, magnetotherapy, magnetostimulation, high voltage stimulation.

Introduction and purpose of the work.

Wounds which last in the human body longer than 4-8 weeks are regarded as chronic wounds. Healing process in those wounds does not take place. The largest group of chronic defects includes venous ulcers, decubitus ulcers and ulcerations in the course of diabetes mellitus. Chronic wounds are mostly caused by serious complications of different diseases and local blood flow disorders. Tissues are not provided with proper supplementation of minerals and oxygen, and therefore, trophic skin changes occur. Unnecessary metabolic products gather in those places – in consequence it leads to changes in cellular metabolism and necrosis. Damaged tissues decompose. A wound which was not treated or was treated in an incorrect way in its first stadium could be the reason of local or general body infection. Medical staff of different specialties should be involved to ensure proper efficiency of the wound healing process. [1, 2, 3]

The wound healing process could be divided into three phases: inflammation, proliferation and remodeling. The last phase thereof, i.e. the phase of remodeling, involves scar formation and reconstruction. This phase may last several months or years. In the case of the healing process of chronic wounds, the treatment process should be supported with all possible measures, therefore, a holistic approach to such patients is extremely important. It should include an overall assessment of the patient's health, location of the lesion, wound bed, wound healing stage, and all accompanying symptoms. [1, 2, 3]

Physical therapy treatment in the chronic wound healing process could include: phototherapy e.g. laser, ledotherapy, polarized light, electrotherapy: iontophoresis, galvanization, high voltage therapy, microcurrents, magnetotherapy, magnetostimulation, magnetoleadotherapy, and ultrasoundtherapy.[4]

Disorders in the healing process of the chronic wound could be caused by not surgical dressing or wrong dressing of the wound. There are as well wounds, at which the healing process is incorrect from the very beginning. The healing process of those kinds of chronic wounds could be long-term or they may even not heal at all. The complexity of reasons of the improper healing process requires a multidisciplinary approach. There are three groups of patients who can have problems with chronic wounds:

- patients with central nervous system disorders. In such cases, the reason of chronic wounds, especially bedsores, could include lack of movement, problems with sensitivity, or local circulation disorders. Typical places of bedsores are: heels, trochanters, and the sacral region.
- patients with venous and arterial insufficient peripheral circulation system. Here the most common sores include leg ulcers.
- elderly people experiencing diseases typical of this age. [5]

The purpose of the study was to analyze the literature of using physical therapy such as the high voltage therapy, the magnetotherapy and the magnetostimulation in the chronic wound healing process.

Description of knowledge

The High Voltage Stimulation

The High Voltage Stimulation is used not only for pain treatment but also in different kinds of wounds. Electrodes made of carbon rubber or aluminum plates are applied therein. Electrodes are fixed a few centimeters from each other. The unipolar or dipolar set is applied, and one or two electrical circuits could be used. Under the active electrode, the primer soaked in physiological saline is used and placed on the wound (the size of the primer is matched to the size of the wound). If the dipolar set is used, electrodes are fixed in opposite parts of the wound. The stimulation is induced with current which does not invoke any movement. [6]

In the High Voltage Stimulation three kinds of impulses could be used:

- Biphasic pulses
- Monophasic double pulses – “M” shaped, and
- Monophasic single pulses

The electrotherapy voltage which is used in that kind of treatment could reach 500V, however, it mostly falls within 100-150 V. Impulse duration is 5-200 μ s, and its frequency amounts to 1-125 Hz. Even if high peak current value is used for the treatment, because of short impulse duration, the electricity is dissipated in tissues. The average level of an interfering current on tissues amounts to 1-2 mA. [6]

In order to achieve better effectiveness of therapy, the electrode polarity is important. The changed polarization is used, or only the cathode or the anode electrode. The treatment lasts from 7 to 14 weeks, or until the end of the healing process and it could be applied 5-6 times per week in sessions which last 50-60 minutes/each. For the majority of patients, the High Voltage Stimulation is tolerated and painless. Mostly in the case of wounds and ulceration, the monophasic double pulses are used: the voltage: 80-100V, 100-150V, 150-200 V, the frequency – 30 Hz, 50 Hz, 60-64 Hz, 80 Hz, 100 Hz, 105 Hz or 120-150 Hz, and the pulse time mostly 100 μ s. Mostly at the beginning the cathodal stimulation is used. Because of its antibacterial effects, the inflammation level decreases, it dissolves clots and coagulated fragments of blood's morphological bodies, stimulates proliferation of fibroblasts and skinning from the wound edges. The treatment is applied 5-6 times weekly for 50 minutes. [6]

In later stages of treatment, the anodal stimulation is applied. This stimulation accelerates granulation, increases the congestion under the active electrode, acts as an analgesic and strengthens the tensile strength. That kind of stimulation could be used for 4-6 weeks. [6]

At the end of the healing process, the alternating stimulation is recommended - 20 minutes for cathodal stimulation and 30-40 for anodal. [6]

The High Voltage Stimulation in different studies – examples.

Materniak et al. [6] described effectiveness of that kind of stimulation and illustrated it with an example of a 48-year-old female with three leg ulcers, which had existed in her body for many years. This woman was under medical care, and was ambulatory and hospital treated. The High Voltage Stimulation was applied for 16 weeks, 5 days weekly for 50 minutes. At first, the cathodal stimulation was used in eight sessions, and subsequently, the anodal stimulation was applied. After the cathodal stimulation, bottoms of wounds started to appear more red, after the fourth anodal treatment the epidermis started to appear on edge of the

wound. The anodal stimulation was continued till the end of the treatment. From time to time after a weekend break, the purulent secretion occurred, and therefore, the cathodal stimulation was applied for 1-2 days. After the treatment, one ulcer was healed, but the surface of the wound was reduced by 50-70%, and its volume by about 98%. [6]

The effectiveness of that kind of treatment was also confirmed by Polak et al. [2]. The authors showed the research of that kind of therapy in two cases of chronic wounds. In first case the bedsore could not heal properly for 3 months, while in the second case for one month. The monophasic double pulses were used - the time of impulse was 100 μ s, the period lasted 10 m/sec, and frequency 100 Hz. The voltage of 60-100 V was dosed only so that the patient could experience a delicate feeling of sensitivity without muscles contraction. Firstly, the cathodal stimulation was applied, after two weeks of treatment the bottom of wounds looked better and therefore, this kind of stimulation was continued till the end of the treatment. In both cases the authors observed progress of the wound healing process. Also Polak et al. [7] confirmed purposefulness of that kind of treatment. The authors compared the effectiveness of therapy in two groups of patients. Group A consisted of 10 patients with 16 bedsores, with the initial surface on average of $2,5 \pm 2,57$ sq. cm. The average age was $81 \pm 15,21$, and the bedsores had lasted for 2,63 months. Group B (the control group) consisted of 12 patients with 14 bedsores with the initial surface of $3,38 \pm 2,2$ sq. cm. The average age was $79 \pm 10,04$, and the bedsores had lasted for 2,27 months. Mostly there were bedsores of the second level. In each case, prophylactics and a similar standard local treatment were applied. In group A, the High Voltage Stimulation was applied additionally, the parameters were as follows: 100 μ s, 100 Hz, 100-50V, 5 days weekly, 50 minutes once a day. After 4 weeks of treatment, the obtained results were evaluated. The statistically significant reduction of the wound surface, the width, and the length was observed in both groups, but the results proved to be statistically better in Group A than Group B. Also Polak with another group of researches [8] proved effectiveness of treatment of cathode high-voltage monophasic pulsed current in a group of patients with pressure ulcers. It was a prospective, randomized, double-blinded controlled clinical study. The patients were divided into two groups. In the first group of patients, with an average age of $79,93 \pm 8,5$ years old, the cathodal stimulation was applied 5 days weekly for 50 minutes with the following parameters applied: 154 μ s, 100Hz, 0,24A, 250 μ s. The results were compared after 6 weeks of treatment. After only 1 week, the treatment result of reducing the wound surface was statistically more significant in the first group than in the second one, after 6 weeks of treatment, the reduction of the wound surface in the first group was $80,31\% \pm 29,02\%$ compared to the second group – $54,65\% \pm 42,65\%$.

Magnetotherapy and magnetostimulation

The magnetotherapy is a kind of physical therapy which uses the magnetic fields of 1-to 10-20 mT (depends on the authors) and the frequency under 100 Hz, an impulse shape depends on the device: rectangular, triangular, or sinusoidal. In the magnetostimulation, the magnetic induction amounts from 1 pT to 100 mT, the frequency from 1 to 1000 Hz. The shape of a basic impulse is mostly similar to a saw. Those impulses are applied in packages (12,5-29HZ), groups of packages (2,8-7,9Hz) and series (0,08-0,3Hz). [9, 10, 11]

Biophysical and biology effects are the reason for the use of magnetotherapy in treating wounds and problems with soft tissues. Those effects include: antiphlogistic, antiseptic, analgesic effects, which influence the wound healing process positively; increase of the

intensity of oxygen utilization processes and tissue oxygenation; intensification of the anaerobic respiration, which brakes the lipid peroxydation process, disintegrating cellular membranes and respiratory enzymes; collagen, shaping the scar framework provides for the mechanical properties of the scar; synthesis process; intensification of the angiogenesis, formation of the collateral circulation in tissues which are damaged, formation of epidermis. [9, 10, 11]

Canedo-Dorantes et al. [12] conducted research on 26 patients with diabetic foot ulcers. The patients were divided into two groups. Both groups were treated using the magnetotherapy. The frequency (120Hz), the impulse shape (sinusoidal) and the dose of magnetic induction (0,4-0,9 mT) were the same. The time was different in those groups, in group A the patients had a 20-minute therapy twice a week, group B - 25 minutes twice per week. The patients underwent 100-day-therapy, or the treatment lasted until the healing process was completed. The healing time of wounds was: in group A 61,48+/-33,08, and group B 62,56+/-29,33. The authors did not observe any side effects of the therapy.

Sieroń [13] in the study conducted among people with chronic leg ulcers divided the patients into two groups and applied the magnetotherapy. In the first group, a sinusoidal shape of impulse, the magnetic induction – 4,5 mT and the frequency 40 Hz were applied. In the second group those parameters were different: a rectangular shape of impulse, the magnetic induction – 8,4 mT and the frequency -5 Hz. The time was the same in both groups – 12 minutes daily, 5 times weekly. An additional dermatological therapy was not applied during the therapy - only treatment that maintained sterility of the wound. The treatment was continued until epidermis covered the wound. The results of the treatment were similar in both groups. The therapy of all patients was continued to complete the healing process of the wound. The majority of patients needed treatment which lasted from 40 (3 patients) to 75 (12 patients) sessions, only one person needed 105 treatment sessions to finish the healing process. Also Sieroń, but with another group of researchers [14], applied magnestimulation on patients with venous leg ulcers. The authors divided their patients into two groups. The first group applied the magnetostimulations with parameters such as: 10 mT of magnetic induction, 5 m/sec of pulse time, and a 12-minute-therapy every day. The second group underwent a placebo therapy, during which the machine did not apply any magnetic fields. The period of treatment was the same in both groups – 8 sessions. The width, length, volume, and the surface of the ulcers were evaluated on the fourth and the eighth day of the therapy in each patient. All those parameters were improved after the treatment in both groups, but as far as the magnetostimulation group is concerned that improvement was statistically significant.

Todd et al. [15] evaluated the influence of magnetotherapy on patients with chronic varicose ulcers. The authors applied therapy with the following parameters: the frequency 5 Hz, and the magnetic induction – 6 mT. The duration of the treatment was two weeks, 15 minutes daily for 5 days per week. The researchers divided their patients into two groups. After the treatment, it was observed that in the group where the magnetotherapy was applied, chronic varicose ulcers were healed faster than in the control group.

The influence of the magnetostimulation on chronic feet ulcers was as well the object of interest of Sarma et al. [16]. In the studied group, the authors applied therapy with the following parameters: the frequency 0,95-1,05 Hz, and the magnetic induction 2400 nT. That therapy was added to the pharmacological treatment in the study group. The authors observed that the therapy reduced the size of the wounds by more than 40% in 89% of the patients and more than 89% in 33% of the patients in the study group. The authors claimed that the therapy is effective while treating chronic wounds.

Summary

All clinical studies showed that different kinds of physical therapy such as the magnetostimulation, the magnetotherapy, and the high voltage therapy accelerate the process of wound healing. Unfortunately, the application of physical therapy in order to improve the wound healing process is still limited.

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