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PHYSICAL THERAPY IN BONE FRACTURES – FACTS AND MYTHS

Krystyna Hejdysz[1]
Paweł Sip[1]
Piotr Jastrzębski[2]
[1]Clinic for Rehabilitation, University of Medical Sciences, Poznań, Poland.

[2]Graduate Entry Medical School, University of Limerick, Ireland

SUMMARY

Introduction

Emergency Departments and Surgical Departments deal with fractures on a daily basis. Surgical treatment and immobilization are used. Physical therapies are used to aid the healing process. The focus of the study was on physiotherapeutic treatments utilizing electrotherapy, magnetotherapy, heat therapy, phototherapy and acoustic waves, the application of which has been discussed in available scientific articles. The presentation of this paper has been dictated by the existing discrepancies in appropriateness of the use and effectiveness of physical therapy, which is now a subject of an extensive discussion among physicians rehabilitation physicians and physiotherapists themselves.

Aim

The aim of this paper is to present a current and evidence based knowledge of physical therapy use in bone fractures, with concurrent presentation of facts and myths referring to therapeutic process.

Materials and methods

Medline, Pubmed and Cochrane databases were used for the search of relevant scientific papers.

FIZYKOTERAPIA W ZŁAMANIACH – FAKTY I MITY

Krystyna Hejdysz[1]
Paweł Sip[1]
Piotr Jastrzębski[2]
[1]Klinika Rehabilitacji, Uniwersytet Medyczny im. K. Marcinkowskiego w Poznaniu, Poznań, Polska
[2]Graduate Entry Medical School, University of Limerick, Irlandia

STRESZCZENIE

Wstęp

Szpitalne oddziały ratunkowe oraz oddziały chirurgiczne każdego dnia notują przypadki złamań kostnych. Stosuje się leczenie chirurgiczne i unieruchomienie. By wspomóc proces leczenia wykorzystuje się zabiegi fizykalne. W pracy uwagę skupiono na zabiegach fizykoterapeutycznych z zakresu elektroterapii, magnetoterapii, ciepłolecznictwa, światłolecznictwa i fal akustycznych, których zastosowanie zastało omówione w dostępnych artykułach naukowych. Zaprezentowanie niniejszej pracy zostało podyktowane istniejącymi rozbieżnościami co do słuszności stosowania i skuteczności fizykoterapii, co jest dziś tematem szerokich dyskusji wśród lekarzy rehabilitacji medycznej i samych fizjoterapeutów.

Cel

Celem pracy jest przedstawienie popartej doniesieniami naukowymi, aktualnej wiedzy na temat zastosowania fizykoterapii w przypadku złamań kostnych, z jednoczesnym wskazaniem faktów oraz mitów dotyczących procesu terapeutycznego.

Materiały i metody

Do niniejszego artykułu wykorzystano doniesienia zamieszczone w bazach Pubmed i MEDLINE. Przy wyszukiwaniu literatury z lat 2002–2017 użyto słów kluczowych

Results
The analysis of the presented articles can indicate a positive impact of physical therapy on bone healing.

Conclusion
Based of the available literature it can be concluded that physiotherapeutic treatments are recommended in cases of damage to the bone tissue.

Keywords: physical therapy, fracture treatment, physical agents, bone fracture

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„fizykoterapia", „leczenie złamań", „zabiegi fizykalne", „złamania kości".

Wyniki
Analiza przedstawionych artykułów może świadczyć o pozytywnym wpływie zabiegów fizykalnych na proces gojenia kości.

Wnioski
Po analizie literatury przedmiotu można stwierdzić, że zabiegi fizykoterapeutyczne są zalecane w przypadkach uszkodzenia tkanki kostnej. Ze względu na niewystarczającą w tym zakresie liczbę randomizowanych prac badawczych powinno przeprowadzać się dalsze postępowania kliniczne z wykorzystaniem coraz bardziej zaawansowanych dziś metod diagnostycznych i narzędzi pomiarowych.

Słowa kluczowe: fizykoterapia, leczenie złamań, zabiegi fizykalne, złamanie kości

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Introduction
At the moment, there is not enough available data regarding epidemiology of fractures in adult males and females. However, the tendency to change the frequency of fractures in different age groups is observed (Court-Brown *et al.* 2017). The epidemiology of fractures is mainly based on the systematic acquisition, collection and analysis of data from individual departments such as hospital emergency departments, surgical and orthopedic departments (Aitken *et al.* 2012). Nowadays, fractures due to falls occur even more frequently than in XX century. This is a result of increased life expectancy, social and economic changes, obesity and life-style diseases such as diabetes mellitus (Court-Brown *et al.* 2014, Court-Brown *et al.* 2017).

Depending on a type, fractures may be treated surgically or if it is possible using conservative management (Mandell *et al.* 2017). One of the conservative management methods is appropriate physical therapy with immobilization (Buza J.A., Einhorn T. 2016).

Physical Therapy
According to the World Confederation for Physical Therapy, physical therapy is treatment that utilizes biophysical and electrophysiological types of energy for assessment, treatment and prevention of injuries, functional activities decrease and barriers to participate in social life, to sustain and optimize state of health.

The aim of physical agents is to reduce pain and inflammation, restore balance in soft tissues tone after injury by reducing tension in their fibers, nourish peri-articular tissues by increasing blood supply, treatment of postoperative wounds and scars and improving general health (Włodarczyk *et al.* 2012).

Bone tissue

Bone fracture is a partial or total discontinuation of bone continuum differentiated by cause, injury mechanism, fracture progression, and severity of injury. Symptoms of bone fracture are pain and decreased range of motion in joints (Kruczyński and Szulc 2015).

Chemically, bone tissue is composed of composite materials, the ossein-forming organic components, thanks to which the bone is elastic and the inorganic components, calcium and phosphate salts (dihydroxyapatites), thanks to which the bone is hard. Elasticity and hardness are features that contribute to bone strength. External forces affecting bone tissue with an intensity exceeding the strength of its structure can lead to damage and loss of the bone continuity (Abueidda *et al.* 2017).

Aim

The aim of this article is to present the current theoretical and practical knowledge based on available scientific data regarding physical agents that are used in bone fractures.

Method

PubMed, MEDLIN and Cochrane databases were used for the purpose of this article. Keywords "physical therapy", "fracture treatment", "physical therapy", "bone fracture" were used for the search of literature from 2002 to 2017.

Results

Facts and myths

Electromagnetic field PEMF reduces bone healing time – FACT

Electromagnetic field regulates proteoglycan and collagen production. Studies have shown higher saturation of the cancellous bone (Nelson *et al.* 2003).

Hanneman *et al.* conducted a randomized, 30-year study of the efficacy of PEMF in the treatment of fractures. A total of 737 patients were examined. The results show that the time of bone healing was significantly shortened in the case of non-operative fractures and fractures of the upper limbs (Hanneman *et al.* 2014) (Figure 1)

Figure 1. Electromagnetic field therapy.

Magnetotherapy reduces the risk of osteoporotic fractures – FACT

Through piezoelectric phenomena, magnetotherapy improves bone mineralization (Hanneman *et al.* 2014, Bayat *et al.* 2017, Sieroń *et al.* 2003). According to Pisula-Lewandowska the most effective is the use of a triangular magnetic field, 15mT induction, 10 Hz frequency for 12 weeks three times a day. Therapy should be continued once a week for 5 months (Pisula-Lewandowska 2014) (Figure 2).

Figure 2. Osteoporotic fracture of the spine 61-years-old man, back pain after lifting the flower-pot (Stäbler and Ertl-Wagner 2008).

Magnetotherapy cannot be used in a person with a metal implant within a joint – MYTH
Magnetotherapy is one of the few treatments that does not generate heat and does not lead to internal tissue overheating (Głąb *et al.*, 2014). In people who have a metal implant within the fracture most of the physiotherapeutic treatment is prohibited, therefore, magnetotherapy is a very safe and effective alternative (Aaron *et al.* 2004, Głąb *et al.* 2014) (Figure 3).

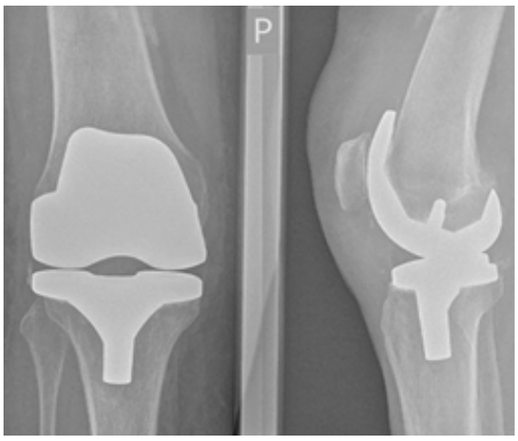

Figure 3. Knee endoprosthesis.

Magnetotherapy is one of the first treatments that can be used before the plaster cast is removed – FACT
The magnetic field, unlike other forms of energy, is the only one that passes through all the structures of the system. Energy in remaining treatments is absorbed at a cera tain depth of tissue (Sieroń *et al.* 2006). When wearing a plaster cast, the entire range of physiotherapeutic treatments is contraindicated. Magnetic field application should begin immediately after plaster cast is placed (Sieroń *et al.* 2006) (Figure 4).

Shock wave stimulates osteogenesis – FACT
Extracorporeal shock-wave therapy (ESWT) leads to the stimulation of the osteogenesis process and accelerates the process of angiogenesis (Dias dos Santos *et al.* 2015, Sztuce 2015). Studies have shown increased bone density and its strength, along with accelerated regeneration of the trabecular

Figure 4. Immobilization with plaster cast.

and cortical bone. The improvement of bone healing was observed in 70% of subjects after one treatment with a wave energy of 0.47mJ/mm2 and 2000 impulses (Sztuce 2015, Kieves *et al.* 2015). Alkhawashi showed a 75.5% effectiveness of shock wave therapy in people with no union in the tibia and the femur. According to the author, the failure of therapy was due to extensive fracture fissure and the presence of previously undiagnosed infections (Alkhawashki 2015). Buza *et al.* reviewed 10 randomized studies involving 924 patients. Improvement of bone union was achieved in 76% of the patients (Buza *et al.* 2016). Birnbau *et al.* confirm the effectiveness of the wave therapy, but suggest that doses in the treatment of fractures should be refined (Birnbau *et al.* 2002). It is important not to start the procedure before hematoma disappears, as it may exacerbate bleeding (Sztuce 2015) (Figure 5).

Shock wave causes significant pain reduction – FACT
An important problem in patients after factures is pain, which slows down the recovery (Cheng *et al.* 2015). A low-energy shock wave damages the sensory fibers, resulting in the release of neuropeptides. Thanks to these compounds, the process of re-innervation in inflamed site is inhibited. Consequently, this results in a long lasting analgesic effect. It leads to normalization

Figure 5. Shock-wave therapy.

of muscle tone (Cheng *et al.* 2015, Sztuce 2015, Khosrawi *et al.* 2017, d'Agostino *et al.* 2015). Stokłosa suggests that a shock wave of 8Hz and penetration of up to 40 mm should be applied (Stokłosa 2009). (Figure 6).

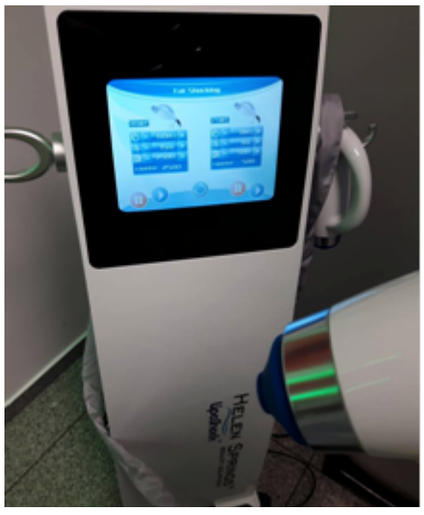

Figure 6. Shock-wave therapy equipment.

Biostimulatory laser facilitates callus formation – FACT

Low-level laser therapy (LLLT) is a biophysical form of therapy that, by complex mechanisms, accelerates formation of callus (Medalha 2016, Pisula-Lewandowska 2012). It enhances the synthesis of collagen, proteins and RNA, and stimulates the formation of osteoblasts. Under the influence of its action, changes in the potential of cell membranes and secretion of neurotransmitters are observed. In addition, the dissociation of hemoglobin, phagocytosis and ATP and prostaglandin synthesis are improved. Thanks to this diversified effect, laser therapy accelerates healing of wounds and facilitates the formation of callus (Shakouri *et al.* 2008, Pisula-Lewandowska 2012). Shakouri *et al.* conducted a study showing that after 5 weeks of laser therapy the bone density was more than 2 times greater in the study group than in the control group (Shakouri *et al.*, 2012). The effectiveness of laser therapy is noticeable in people with osteoporosis. Pisula-Lewandowska suggests that a dose of 6 to 12 J/cm² should be used. The maximum daily dose cannot exceed 200J (Pisula-Lewandowska 2012) (Figure 7).

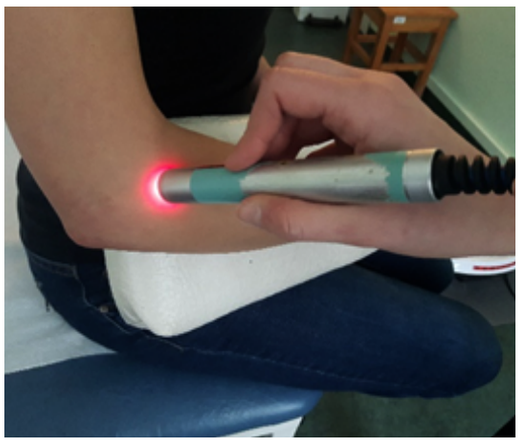

Figure 7. Low-level laser therapy treatment.

The healing time of fresh fractures is reduced by the use of low-intensity pulsed ultrasound – FACT

In treatment of delayed bone healing, LIPUS ultrasound is highly effective (Buza *et al.* 2016, Leighton *et al.* 2017). It is characterized by low intensity and lack of overheating effect. It affects the production of osteocalcin and organic phosphatase which accelerate tissue regeneration and wound healing in the acute and subacute period (Buza *et al.* 2016, Leighton *et al.* 2017). Lee *et al.* report that bone healing time is significantly reduced due to ultrasound treatment, even by 12 months. (Lee *et al.*

2017). In addition, researchers claim that ultrasound is a safe, non-invasive method of accelerating the healing of new fractures of the tibia, radius, pelvis and metatarsal bones (Buza *et al.* 2016, Lee *et al.* 20017, Leighton *et al.* 2017).

Figure 8. Low-intensity pulsed ultrasound treatment.

Electrostimulation accelerates bone healing – FACT
Electrical stimulation is a commonly used bone healing aid (Allem *et al.* 2016). In the study, bone healing was increased by 35% (Allem *et al.*, 2016). Zorlu *et al.* confirm the effectiveness of electrostimulation and report that it is as effective as ultrasound (Zorlu *et al.* 1998). Zimmermann *et al.* in their study report that electrostimulation is highly effective in treating pelvic fractures (Zimmermann *et al.* 2012) (Figure 9).

Figure 9. Electrical stimulation treatment.

Heliotherapy increases the synthesis of vitamin D3 in the body affecting the bone mineral homeostasis – FACT
The 2005 study found that 92% of healthy young women in Central and North Europe had very low levels of vitamin D. Daily dosage of Vitamin D3 in a fair-skinned person is generated during a 5–15 minute exposure between 10 and 15 o'clock (Dawson-Hughes *et al.* 2010, Pisula-Lewandowska 2014, Sieroń 2006). The effectiveness of heliotherapy in fractures has not been researched in the last 20 years (Figure 10).

Figure 10. Heliotherapy.

CRET therapy accelerates healing of damaged tissues and regeneration of bone tissue – FACT
CRET therapy is one of the newer forms of physical therapy. For the first time its effectiveness has been presented and described in 2013 (Kuźma *et al.* 2014). Its operation is based on 448kHZ radiofrequency current which activates extracellular ions. This improves their penetration through the cell membrane and dramatically accelerates cellular metabolism. In the study, accelerated bone healing was observed (Kuźma *et al.*, 2014) (Figure 11).

Overheating treatments such as paraffin are recommended for bone fractures – MYTH
Treatment with paraffin is characterized by a strong overheating and anti-inflammatory effect. It improves microcirculation and

Figure 11. CRET therapy.

causes localized muscle relaxation (Pisula-Lewandowska 2014). As a consequence, this leads to a great overheating of the body, which in the case of fractures or osteoporosis can exacerbate the disease and make bone bones difficult (Pisula-Lewandowska 2014, 2011) (Figure 12).

Figure 12. Treatment with paraffin.

Microcurrents accelerate tissue regeneration, shorten wound healing time and bone healing – FACT

MENS currents work at the cellular level. As a result of subthreshold stimuli, stimulation of tissue healing processes is induced. Protein and ATP synthesis is increased with accelerated amino acids transport (Dudek *et al.* 2012). As a consequence, microcurrents cause a significant reduction in inflammation and accelerate the formation of the callus (Sztuce 2015, Dudek *et al.* 2012) (Figure 13).

Figure 13. Microcurrents Electrical Nerve Stimulation therapy.

Conclusions

After analysis of the literature, it can be stated that physical agents can are recommended in cases of bone tissue damage. Due to insufficient number of randomized trials in this area, further clinical trials should be conducted using increasingly advanced diagnostic methods and measuring tools.

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Author responsible for correspondence:
Krystyna Hejdysz
Clinic for Rehabilitation,
University of Medical Sciences
28 Czerwca 1956 No 135/147
61-545 Poznań
Poland
krystynahejdysz@gmail.com

Autor odpowiedzialny za korespondencję:
Krystyna Hejdysz
Klinika Rehabilitacji
Uniwersytet Medyczny w Poznaniu
28 Czerwca 1956 r. nr 135/147
61-545 Poznań
Polska
krystynahejdysz@gmail.com