



REVIEW ARTICLE- THE IMPORTANCE OF MAGNOTHERAPY IN FUNCTIONAL REHABILITATION, IN A SUB-ANALYSIS FOR PAIN

Veterinary Science

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ABSTRACT

Pain is a complex multi-dimensional experience with extreme impact in quality of life of all animals. The management of pain through medication and functional rehabilitation is of great interest in the current days. This review intends not only to elucidate important concepts as pain physiology and trigger points but also to clarify the clinical use of magnotherapy as an adjuvant modality of pain management in functional rehabilitation in companion animals.

KEYWORDS:

Magnotherapy, Pain, Functional Rehabilitation, trigger point

Introduction

Pain is inevitable, acting as an essential protection mechanism against aversive stimulus to human beings and others animals. However, in some cases, it becomes an incapacitating, continuous and grievous sensorial experience³⁶.

In 1979, the International Association for the Study of Pain (IASP), defined pain as "an unpleasant sensory and emotional experience, associated with actual or potential tissue damage, or described in terms of such damage"³⁹.

Pain is a sensation that, in spite of being crucial to survival, could compromise the physiological and mental status of the organism¹⁰.

1. Pain and Nociception

It's important to make a clear distinction between pain and nociception.

Nociception is the term that designates the process where the organism detects a pain stimulus, transmitting that electric signal to the Central Nervous System (CNS)³⁹.

Pain is a complex multi-dimensional experience, involving sensory and affective (emotional) components¹⁴.

Based on this last premise, it is assumed that the multidimensional pain experience is a consequence of the involvement of three systems: Nervous, Endocrine and immune system⁴⁸, in which, the disruption among this systems, constitutes the major cause for the arising of pain⁵.

2. Physiology of Pain

A good way to understand the physiology of pain is by following the nociception signal pathway from its transduction in the peripheral nervous system (PNS) to it's perception in CNS¹⁴.

Nociception's pathway (Figure 1), which not only includes nociceptors but also other important structures, consists in five events: Signal Transduction; Signal Transmission; Modulation; Projection of electric signals; Perception⁸.

3. Classification of pain

Pain must be primarily classified (Figure 2) based on tissue origin,

which is defined as Somatic or Visceral Pain⁸.

Somatic Pain comes from highly sensitive tissues, as skin, muscles, articulations and periosteum and it's described as localized and pulsed, being many times preceded by the fight and flight reflex²². Visceral Pain comes from internal organs, it is poorly localized and gives sometimes the sensation of internal burn⁸.

After the distinction between somatic and visceral pain, it's important to categorize the duration of the painful process and gravity of damage tissue, being crucial differentiate acute and chronic pain¹⁶.

Acute pain happens after a painful nociceptive stimulus, initiating a behavioral and physiological answer, to protect the damaged spot and promote the regeneration of the tissue. It's subcategorized in Physiological and Pathological pain^{16;22;36}.

Physiological Pain comes as an answer to potential tissue damage. Pathological Pain implies the presence of actual tissue damage¹³. It's subcategorized in Inflammatory and Neuropathic Pain¹⁶.

Inflammation that appears after tissue damage persists until the regeneration of the tissue. The substances that result from this process are designated as "inflammatory soup". The inflammatory soup changes the chemical environment and sensitized the nociceptors²¹.

Neuropathic pain is the consequence of damage neurological structures, as peripheral nerves, spinal cord or central nervous system³¹.

Inflammatory and neuropathic pain are the major cause for the sensitization of PNS and CNS and the appearing of chronic pain²¹. The Chronic Pain persists even after the elimination of aversive stimulus and regeneration of damaged tissue, being a consequence of PNS and CNS sensitization¹⁴. Nowadays, it's also described as a pain process that overcomes the tissue regeneration expected time⁴².

Apparently, chronic pain doesn't have any biologic or survival advantage to the organism, it tends to be debilitating to the patient and sometimes doesn't even answer to multimodal pain

approaches^{8,36}.

4. Trigger Points

Trigger Points (TP) are defined as painful sites in the skeletal muscle, associated with hypersensitivity and tension in the muscle band⁵⁰.

TP are characterized by sensory, motor and autonomic expressions⁷. The most evident expressions of pain appear during the palpation of TP, where the animal often vocalizes and tries to avoid contact with the manipulator, since these signs may be increased due to sensitization of the PNS and the CNS⁵⁶.

It's still possible that the animal shows signs of muscle weakness without the occurrence of muscle atrophy, decreased joint amplitude, inhibition of muscle contraction and postural changes⁵.

4.1 Trigger Points Pathophysiology

Borg-Stein and Simons concluded that a damaged motor plate will result in an increased release of acetylcholine in neuromuscular junction, leading to depolarization of muscle fibers and shortening of the sarcomere². This leads to local hypoxia and ischemia, as well as the liberation of inflammatory mediators, which sensitize nociceptors, causing pain¹⁷.

Through electromyography, it's possible to detect any changes in the electrical neuromuscular activity, designated as endplate noises, these being particular characteristics of the TP process origin⁴⁹.

4.1.1 Trigger point in orthopedic diseased

Orthopaedic patients can easily developed myalgia and muscle dysfunction, because of mechanical stress upon the skeletal muscle system⁵².

Postural changes and compensatory movements that occur in orthopaedic patients are one of the possible etiologies for the appearing of TP¹⁷.

4.1.2 Trigger point in neurological diseased

Neurological patients can equally develop TP, normally in neuromuscular junctions, due to inflammation of peripheral nerves or spinal cord segments⁵⁶.

4.2 Treatment and diagnosis of Trigger Points

Palpation is the ideal method for diagnosing TP, although some experience is required, and a few researchers advocate that the result depends a lot from individual interpretation of the manipulator¹⁷. Treatment can be done by non-invasive techniques like Laser IV, ultrasounds or massages⁷, or even invasive techniques like acupuncture³.

5. Pain Evaluation

Painful sensation is somehow subjective and individual, being hard to evaluate in humans and presenting itself as an even more arduous challenge to evaluate in animals¹.

Tachycardia, tachypnea, hypertension, mydriasis and hyperthermia are signs that emerge as consequences of such neuroendocrine change⁵⁸ which tend to remain present in chronic pain, associated with distress⁴¹.

Skeletal muscle pain and neuropathic pain are normally associated with gait disorders, muscle stiffness, body tension and postural changes⁵⁸.

The concept of pain becomes more nebulous when referring to its chronicity. Chronic pain isn't a mere consequence of acute pain; it's a maladaptive painful process that causes stress, as well as physiologic and behavioural imbalances²⁷.

The evaluation of the animal's behaviour and well-being becomes more important in chronic pain, being the tutor's opinion crucial in

the assessment of the animal's clinical progression⁴⁴.

Some multidimensional scales have been developed, such as the Glasgow, Melbourne or Colorado pain scales^{57,58}. Although practical, the big majority of these scales are only useful for post-surgery acute pain⁴¹. The only exception is the Colorado State University canine chronic pain scale, that in spite of lacking scientific approval, can be a useful tool in clinical daily practice⁵⁸.

6. Functional Rehabilitation

Nowadays, physiotherapy and rehabilitation are indispensable for a fast and efficient recovery of both neurological and orthopaedic patients, as well as in other branches like preventive and sports medicine³⁹.

Functional Rehabilitation aims, by non-invasive means, to restore, maintain and promote functionality, wherever there is any kind of movement related disorder⁴⁵.

6.1 Modalities for pain management

The primary goal of any rehabilitation protocol is to maximize the functional recovery of the patient and to improve its musculoskeletal condition and well-being¹⁵.

The basis of a functional rehabilitation protocol consists in locomotor training, like hydrotherapy or treadmill, and postural training, like kinesiotherapy³⁷. However, a successful protocol equally depends on non-invasive modalities as complementary therapeutic⁴⁷, which are summarized in Table 1.

Massage	Systematic manual approach, where it is necessary to exert pressure and movement in soft tissues, skin, tendons and muscles ⁷ . Decrease local edema, as well as tissue adhesions and muscle spasm and stimulate muscle flexibility, nutrition and the elimination of metabolic waste ¹⁸ .
Thermotherapy	Thermotherapy appeals to the use of superficial heat and cold, with the intention of reducing pain and edema and increasing muscle flexibility ¹¹ .
Laser therapy	Laser Therapy is a modality that uses electromagnetic radiation in shape of photons ³⁵ . Class IV Laser has the biggest wavelength, close to 980 nm and intensity of 1 to 15 W, allowing to reach high tissue depth, but with risk of causing burns ^{6,35} . This benefits analgesia by increasing a local and systemic circulation of B- endorphins, reducing inflammation and improving tissue healing ¹² .
Electrotherapy	Electrotherapy is a modality that consist in the application of an electric current of low to medium frequency (<250 Hz), in an effort to stimulate the sensory or motor nerves, leading, correspondingly, to a pain reduction or muscle contraction stimulation ²⁵ . The two most used forms of electrotherapy are Neuromuscle Electrical Stimulation (NMES) and transcutaneous electrical nerve stimulation (TENS).
Ultrasounds	The ultrasounds allow to focus in biological tissues, with wave frequencies of 20000 HZ, producing deeper heat than thermotherapy ³⁷ .

Table 1- Non-invasive modalities of complementary therapeutics during a functional rehabilitation protocol

1. Magnotherapy

The original concept of magnetism goes back to the beginning of the first civilizations, and although its widely usage for therapeutic goals in the past, only in the last century have scientists started to uncover its benefits³³.

The Functional Rehabilitation is a recent area of medicine with a progressive development of new therapeutics, which allows faster recoveries and improved well-being²⁶.

In Human medicine, magnetic fields can be used for diagnosis methods, like magnetic resonance, or as therapeutic modalities, like Pulsed electromagnetic field therapy of low frequency (PEMF-LF)⁴⁰.

8. Low frequency pulsed electromagnetic fields (PEMF-LF)

PEMF-LF method consists in the application of low frequency electromagnetic fields that stabilizes the electric potential of nerves and other tissue's cells, normalizing ion and nutrients flux to the cells^{16,19}.

This modality uses pulsed electromagnetic fields that mimic the body's electromagnetic waves¹⁶.

It is a non-invasive, easy handling method, useful in skeletal muscle system disorders, pain management, tissue regeneration and increasing general well-being³⁰.

Many clinical trials suggest positive results and benefits from using this modality, though its action mechanisms are not well enlightened³³.

Sisken et al. (1995) found that the use of PEMF-LF in mice with sciatic nerve injury, during 3 to 6 days 4 to 10 hours/per day, increased nervous regeneration in 22% of the cases⁵¹. After that Szajkowski et al. (2014) examined the influence of the spatial variable magnetic field on neuropathic pain after tibial nerve transection in 64 mice, 5 days a week during 20 minutes, for 28 days, concluding after histological and immunohistochemical analysis, that the nociceptive sensitivity of healthy rats was not changed following the exposition to the spatial magnetic field of the low frequency, but the use of extremely low-frequency magnetic fields of minimal induction values decreased pain in rats after nerve transection⁵⁴.

Regarding to inflammatory pain, Kanat et al. (2013) using a randomized controlled single-blind follow-up study evaluated the effect of PELM-LF in humans with handosteoarthritis, in the tested group, that received 25 Hz, 450 pulse/s, 5–80 G, during 10 days and 20 min/day, magnotherapy showed better results in pain management, function and quality of life scores, than in the control group³⁰.

In addition to human clinical trials, Pinna et al. studied the effects of pulsed electromagnetic field (PEMF) on pain relief and functional capacity of dogs with osteoarthritis (OA) when compared with firocoxib therapy. Patients were randomly assigned to two groups: twenty five client-owned dogs were treated with PEMF once a day for 20 sessions, and fifteen dogs (control group) were treated with 5 mg/kg of firocoxib once daily for 20 days. The results showed decreased clinical signs of OA during the treatment in both groups, however in PEMF group the effects were sustained until the end of the study, whereas in the control group the progress tended to return to baseline values after the end of therapy⁴³.

Many clinical trials suggest positive results and benefits from using this modality, though its action mechanisms are not well enlightened³³.

8.1 Pulsed electromagnetic fields as therapeutic modality

The electromagnetic intensity is measured in Gauss (G) or Tesla (T) ($1 \text{ T} = 10^4 \text{ G}$) and the frequency in Hertz (Hz)²⁹.

The biological answer to the electromagnetic fields depends on the chosen parameters. It is known that there are two intensity windows that can be used with beneficial effects, 15-20 mT (150-200 G) or 45-50 mT (450-500 G)^{28,29,30}.

The gap frequency of 0,5-5 Hz is useful for reducing inflammation and general pain, and 5-20 Hz is used for muscle tonification and tension reduction, both during a period of 30 minutes to 1 hour a day¹⁶. The number of days recommended for therapy is not well defined.³⁰

8.1.1 PEMF-LF biologic effects

All atoms, elements and cells produce balanced electromagnetic fields. If that energetic activity ends, life ceases to exist^{4,10}.

Healthy cells have a normal electric charge of -70 to -100 mV due to, the ionic flux changes in the cell's membrane⁴⁶. Any cell damage could change the ionic flux and compromise homeostasis⁷. Nowadays, it is assumed that the primary target of PEMF-LF is cell membrane⁴³.

The interaction between electromagnetic fields of PEMF-LF and the cell membrane's channels, change ions' flux, like Na^+ or Ca^{2+} , normalizing transmembrane potential, signal transduction and promoting homeostasis, making this explanation the basis theory of PEMF-LF biologic effects^{30,40}.

8.1.2 PEMF-LF neuropathic pain

Apparently, the transmembrane potential stabilization effect by PEMF-LF reduces muscle tension and neuropathic pain^{23,38}.

A clinical trial conducted in mice involving tibial nerve injuries showed signs of neuropathic pain reduction after the exposure to PEMF-LF⁵⁴. Another recent study proved that electromagnetic fields produced by PEMF-LF increase nervous fibers' regeneration and conductivity⁵³. In this study, Mert et.al (2006), studied the influence of pulsed magnetic on nerve regeneration in a model of crush injury of the sciatic nerve of rats. They used electrophysiological recordings and ultrastructural examinations, to determine the influence of PEMF-LF exposure and concluded that PEMF application for 38 days accelerated nerve conduction velocity, increased compound action potentials (CAP) amplitude and decreased the time to peak of the CAP. Moreover PEMF improved both morphological and electrophysiological properties of the injured nerves. Corrective effects of PEMF on sensory fibers may be considered an important finding for neuropathic pain therapy.³²

8.1.3 PEMF-LF inflammatory pain

The effect of PEMF-LF in inflammatory response pathways is still unknown³⁴.

A plausible explanation comes from a study that clarifies the effect of PEMF in an up-regulation of adenosine receptors, related to an increase of their functional activities in bovine chondrocytes and fibroblast-like synoviocytes⁵⁵.

Recently was postulated the hypothesis that the anti-inflammatory effect of PEMF-LF is a consequence of its action as a mediator on the gene expression involved in the acute and resolution phases of inflammation, inhibiting prostaglandin synthesis by lipoxygenase pathway²⁴.

8.2 PEMF-LF and well being

Human medicine studies admit that the use of PEMF-LF reduces fatigue, irritability and stress manifestations⁴⁰. It is believed that the analgesic effects from PEMF-LF are a consequence of the endogen opioid liberation from B-endorphins group, reducing pain and increasing general well-being^{43,46}. This issue remain as a field to explore in the veterinary species.

Conclusion

Understanding the complexity of pain remains a challenge even nowadays. The existence of co-adjuvant modalities in the field of the functional rehabilitation medicine is of higher interest, not only for the treatment success but also for well-being issues. Magnotherapy is a promising method of pain modulation although it lacks of clinical trial that can sustain its.

It is expected that in a close future non-invasive methods start to be use more frequently, because of the effort that many researchers make day by day to scientifically sustain these modalities. The ultimate goal will be the use of minimum drugs therapy in the pain management, mainly in areas where the alternatives are already a

reality, like in Functional Rehabilitation.

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