

*Review*

**CHRONIC PAIN AND PHYSICAL ANALGESIA:  
THE IMPACT OF PHYSICAL MODALITIES TO REDUCE PAIN**

**Ivet B. Koleva**

*Clinic of Physical and Rehabilitation  
Medicine  
University Hospital-Pleven*

**Corresponding Author:**

Ivet Koleva  
Department of Physical Medicine,  
Rehabilitation, Ergotherapy and  
Sports  
Medical University-Pleven  
1, St. Kliment Ohridski str.  
Pleven, 5800  
Bulgaria  
Phone: +359 888 20 81 61  
e-mail: [yvette@cc.bas.bg](mailto:yvette@cc.bas.bg)

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**Summary**

Current paper proposes personal opinions on some contemporaneous theories of pain and therapeutic concepts of analgesia, including physical analgesia. Millions of patients suffer from chronic pain. All modern scheduled drugs used for treatment of the persistent pain (opioids, NSAIDs, COX-2 inhibitors) are associated with limitations and side effects. Our purpose was to remind the wide public of the impact of physical modalities in pain management in adults. We explain different natural and preformed physical modalities, with effectiveness in clinical practice. The author formulates a conception of pathogenetical mechanisms of physical analgesia. Declared opinions and conclusions of the author are based on the traditions of Bulgarian rehabilitation school, on analysis of scientific literature (including electronic media), on our modest 20 years experience - clinical observations, scientific and applied investigations; and on the results from systematic interviews with in-patients (treated in the National Physical therapy and rehabilitation hospital (Sofia) and in the Rehabilitation Clinic of Pleven University Hospital) and with outpatients (of some Medical centers of Sofia and Pleven).

**Key words:** physical modalities, rehabilitation, pain, analgesia

The formulation of the gate-control theory [1] for explanation of pain deposited the base of a new epoch in the development of orthodox medicine. This was the introduction of the principle of “contra-stimulation” final effect reticence by stimulation of inhibiting systems or else, final effect stimulation by embarrassment of inhibiting systems. The science proved the existence of unsuspected reflectory relations and dependences between processes, apparently independent. There appear conditions for infringement of traditional therapeutic thinking and for formulation of a fundamentally new approach for creation of modern, or for explanation of existing anti-pain methods from the domain of electrology, thermo and cryotherapy, manual techniques, reflexology.

In our opinion, the anti-pain effect of physical modalities is very important, with a high level of efficacy. Physical analgesia has not side effects, and may be applied in combination with other therapeutic factors.

In the era of evidence-based medicine is important to precise details of correspondent therapeutic complex [2, 3, 4, 5], concerning applied physical modalities, methods and respective dosage.

**Pain** is one of the most frequent sensations, formed in the nervous system, with different individual characteristics. Pain is a subjective experience, defined by nociceptive activation; by changes in sensory nerves and paths, in cerebral centers regulators of stress, affections and motivation [6]. Different factors (physical, chemical, psychic) may influence pain sensation.

The biological significance of pain sensation is to defend the organism from noxious external influences (signal of attention). The pain informs the organism and causes a *reflex defensive reaction* of the individual.

Contrary to the medico-philosophical systems explaining pain by a metaphysical conflict between life and death, the French philosopher René Descartes formulates a new methodology oriented to the correct thinking and the system of knowledge. In his famous works "Discourse on the Method" (1637, in French) and "Principles of philosophy" (1644, in Latin) Descartes formulates the famous statement "*Cogito ergo sum*" (*I think, therefore I am*; or better, *I am thinking, therefore I exist*). In "Meditations on first philosophy" (1641, 1647) he explained the idea of the rational animal, the mind-body connection and of the defensive character of pain (baby fire, boy fire), including its capacity to unchain a reflectory reaction "*pulling on a thread*".

In nine volumes of the first didactic tractate on physiology "*Elementa physiologiae corporis humani*" (*Physiological elements of the human body*), the Swiss poet, scientist and Doctor Albrecht von Haller explain the difference between irritability and sensibility (1757-1766). Antoine-Laurent de Lavoisier, the father of contemporaneous chemistry, after experiments concluded that "*la respiration est donc une combustion*", that is, respiratory gas exchange is a combustion, like that of a candle burning and "life is a burning process". Slowly but definitively, in 19<sup>th</sup> century physiological sciences leave metaphysical speculations and target to the principles of physics, natural sciences and clinical medicine.

The Holland surgeon Willem Noordenbos [2] proposed the hypothesis for the multi-synaptic transmission of pain signal (1959): "*One-one*

*synaptic transmission must be the exception rather than the rule in the nervous system. Any nerve cell located in the anterior horn . . . could hardly be expected to synapse at higher level with one such similar cell only. It will probably send ramifications to many other locations, and in turn be acted upon by the ramifications of many other cells. . . Far from being a continuous chain of short neurons, these fibers must constitute links in an extremely complicated nerve net in which, within limits, everything synapses more or less with everything else."*

In 1965 the collaboration between two individual investigators the British physiologist Patrick Wall and the Canadian psychologist Ronald Melzack, generated the **theory of gate control**. Their common article "Pain Mechanisms: A New Theory" [1] was qualified like "*the most influential ever written in the field of pain*". Melzack and Wall suppose the existence of a controlling mechanism in the spinal medulla, which is closed in response to the normal stimulation of fast fibers of tactile sense, but is open if the slow fibers of pain perception transport numerous and intensive sensory signals. The gate is closed (and the pain transmission is interrupted) in case of a new stimulation of the fast fibers.

The scientific literature mentioned various contemporaneous theories for pain perception: *specific* (specific pain receptors nociceptors); *non-specific* (patterns theory pain perception depends on decoding, probably at spinal level, of temporo-spatial organization of patterns signals perceived by intensive stimulation of non-specific receptors). Most of authors support *combined theories*.

The following levels of pain perception are mentioned: *receptors* (nociceptors and free nerve terminals); *sensory roots*; *posterior columns of the spinal medulla*; *thalamus opticus*; *reticular formation*; *cerebral cortex*. In some cases (stress-analgesia) the psycho-emotional state of the individual is considered as very important.

There exist different types of pain: *acute and chronic (persistent) pain*; *nociceptive and neuropathic pain*; *others (central pain)* [7-13]. It is important to remember that the pain in clinical practice is generally combined with nociceptive and neuropathic components, and the latter usually prevails.

Some authors [13] consider that the combination of nociceptive (inflammatory hyperalgesia) and neuropathic mechanisms in

every individual case is the main cause for our therapeutic helplessness, as regard pain.

In the neuropathic type of pain, the direct irritation of the nociceptor (receptor) is not necessarily present. Neuropathic pain includes mechanisms of long-time potentiation (LTP) augmented expression of Na<sup>+</sup>, H<sup>+</sup>, Ca<sup>++</sup> channels in the peripheral sensory nerves, generating an ectopic excitation and augmented sympathetic activity [13]. The LTP-mechanism of neuropathic pain is the theoretical base for the therapeutic use of drugs with membrane-stabilization activity, some anti-depressants and sympaticolytics [14].

Probably, preformed physical modalities execute their influence exactly on a membrane level (plasmalema and neurolema). We consider that preformed factors control the algescic type of stimulation of nociceptors (closing ion channels and thus inhibing the generation of action potentials). Presumably, peloids and physiotherapy (kinesitherapy in Bulgarian nomenclature) regulate the hyperalgesic type of stimulation (reducing the probability of irritation of nociceptors by mechanical, chemical and thermal stimulation) [5, 15].

## Traditional methods for pain treatment

### Drug therapy

Traditionally, in clinical practice different medicaments are applied [3, 4, 5, 15-22].

*Opioid analgesics* = *opioids* (Morphine, Codeine, Fentanyl, Meperidine, Methadone, Propoxyphene, Levorphanol, Hydromorphone, Oxycodone hydrochloride, Oxymorphone, Pentazocine) have a lot of limitations due to their side effects and the high risk of addiction.

*Non-opioid analgesics* are steroids (corticosteroids) and non-steroidal anti-inflammatory drugs (classical NSAIDs salicylates, diclofenac, ibuprofen, naproxenic acid; and the modern COX-2 inhibitors) (Table 1). Some authors consider acetaminophen (Tylenol, the most common antipyretic drug used in the US) as belonging to this group too. The use should be very carefully evaluated (risks of gastrointestinal events, cardio-vascular side effects, heart failure, etc.). The dose titration is important.

*Adjuvant therapy* includes drugs that are not usually used for pain relief but may relieve pain in certain circumstances. When used to relieve pain, they are usually combined with other analgesics

**Table 1.** Non-opioid analgetics

NONSTEROIDAL ANTIINFLAMMATORY DRUGS)	
GROUPS	DRUGS ( <i>commercial name</i> )
<i>Salicylates</i>	Aspirin
	Choline magnesium trisalicylate
	Diflunisal Salsalate
<i>COX-2 inhibitors (Coxibs)</i>	Celecoxib
	Valdecoxib
<i>Other NSAIDs</i>	Diclofenac
	Etodolac
	Fenoprofen
	Flurbiprofen
	Ibuprofen
	Indomethacin
	Ketoprofen
	Ketorolac
	Meclofenamate
	Mefenamic acid
	Meloxicam
	Nabumetone
	Naproxen
	Oxaprozin
	Piroxicam
Sulindac	
Tolmetin	

or non-drug pain treatments. This group includes: tricyclic antidepressants (TCAs like amitriptyline, clomipramine, desipramine, imipramine, maprotiline, nortriptyline, etc.); selective serotonin reuptake inhibitor (SSRI like fluoxetine); anticonvulsants (ACs like gabapentin, pregabalin, phenytoin, carbamazepine, clonazepam, divalproex, lamotrigine, topiramate, oxcarbazepine). The main effect of TCAs and SSRIs on pain is explained by the blockade of norepinephrine and serotonin reuptake resulting in an increased availability of these transmitters in the synapses of the descending pain-modifying pathways. The main effect of ACs on pain is explained by bind to synaptic Ca channels resulting in reduced release of neurotransmitters responsible for afferentation of pain [21, 22].

*Local anesthetics* have different mode of application: *peroral* (e.g. the antiarrhythmic Mexiletine); *topical* (e.g. paravertebral blockade with lidocaine); *local* (local injection or application of crème containing Capsaicin).

*Local nerve destruction* is applied in some cases of pain (e.g. trigeminal neuralgia): *local injection of a nerve-destroying substance* (phenol), *nerve freezing* by cryotherapy, *nerve burning* by radiotherapy.

## Physical analgesia

In physical analgesia we apply different physical modalities [4, 5, 15-31]:

### Preformed modalities

*Low-frequency currents and low frequency modulated middle-frequency currents* (sinusoidal-modulated, interferential, Kots currents);

*Transcutaneous electroneurostimulation (TENS);*

*High-frequency currents* (diathermy, ultra-high frequency currents, decimeter and centimeter waves);

*Ultra-sound and phonophoresis with NSAIDs;*

*Low-frequency magnetic field.*

### Natural modalities

*Cryo-factors* (ice, cold packs, cold compresses);

*Thermo-agents* (hot packs, hot compresses);

*Hydro- and balneo-techniques* (swilling, rubbings, showers, baths, piscine); hydro and balneo-physiotherapy techniques (underwater massage, under water exercises, etc.);

*Peloidotherapy* (fango therapy, thermal mud, sea lye compresses);

*Physiotherapy techniques* - stretching, post-isometric relaxation, manual therapy (traction, mobilization, manipulation); massages (manual and with devices; peristal, connective tissue massage, etc.).

**Reflectory methods:** *electrotherapy, thermotherapy and physiotherapy in reflectory points and zones; acupuncture, laserpuncture, acupressure, etc.*

### Mechanisms of physical analgesia

In physical medicine, we applied the principles of gate-control theory of Melzack & Wall [1] for central nociceptive influence. Investigations of Gacheva [32, 33, 34] have demonstrated that selective electrostimulation of tactile A $\beta$ -nerve fibers (with high velocity of conduction) provokes a preliminary stimulation of suppressive neurons, that inhibit tardily occurring nociceptive stimuli of A $\delta$  and C-fibers (with lower conduction velocity). It is assumed that a closer suppressive transfer mechanism exists at spinal level. At the peripheral level, direct anti-adaptation electrostimulation of the receptors probably provokes a hyperpolarization with an increase of the sensibility of nociceptors. A direct low frequency electrical stimulation of the A $\delta$  and C fibers may have an analgesic effect.

We propose our own theory to explain the mechanisms of action of physical modalities on nociceptive and neuropathic pain - we introduced

the notion *physical analgesia* or *anti-pain effect of physical modalities* [5]. Our hypothesis is based on the traditions of Bulgarian neurorehabilitation school, on analysis of scientific rehabilitation literature (including electronic media), on our modest 20-year experience (1986-2008) - clinical observations, scientific and applied investigations [5, 17, 26-28]; and on the results from systematic interviews with in-patients (treated in the National Physical Therapy and Rehabilitation Hospital, Sofia and in the Rehabilitation Clinic of Pleven University Hospital) and with outpatients (of different Medical centers of Sofia and Pleven).

The physical complexes used may provoke an analgesic effect by the following mechanisms (Fig.1):

*By influencing the cause for irritation of pain*

Probable mechanisms of action  
of pre-formed and natural physical modalities

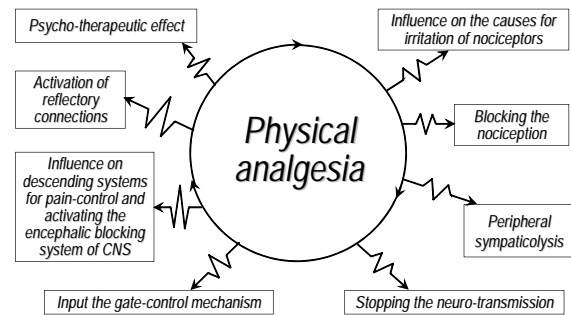


Figure1. Mechanisms of physical analgesia

*receptors* - a consequence of stimulation of circulation, metabolism and trophy of tissues (by low and medium frequency electric currents, magnetic field, ultrasound, He-Ne laser; massages; manual techniques);

*By blocking nociception* (low frequency currents, including transcutaneous electrical nerve stimulation or TENS; lasertherapy);

*By peripheral sympaticolysis* (low frequency currents like dyadinamic currents, peloids);

*By stopping the neural transmission (by C and A $\delta$  delta fibers) to the body of the first neuron of general sensibility (iontophoresis with Novocain in the receptive zone the region of neuro-terminals);*

*By input of the gate-control mechanism* (TENS with frequency 90-130 Hz and interferential currents with a relatively high

resulting frequency - 90-150 Hz);

By activation of the reflexory connections: cutaneous - visceral, subcutaneous-connective tissue-visceral, proprio-visceral, periostal-visceral and motor-visceral (classic manual, connective tissue and periostal massage, post-isometric relaxation and stretching-techniques);

By influence on the pain-translation in the level of posterior horn of the spinal medulla - using the root of activation of encephalic blocking system in the central nervous system (increasing the peripheral afferentation) and influence on the descending systems for pain control (TENS with frequency 2-5 Hz and interferential currents with low resulting frequency 1-5 Hz, acupuncture and laserpuncture; reflexory and periostal massage, zonothrapy, acupressure, su-dgok massage; preformed factors in reflexory zones /palms of hands, plants of feet, paravertebral points; zones of Head, of Mackenzie, of Leube-Dicke, of Vogler-Krauss);

By influence on the psychic state of the patient - the “doctor” drug and the “procedure” drug.

During last years, the development of physical medicine has proven the existence of some reflexory connections in the human body, based on the theory of the metameric structure of the embryo during the intra-uterine development. In physical analgesia, we apply the following groups of reflexory connections: *cutaneous-visceral, subcutaneous-connective tissue-visceral, proprio-visceral, periostal-visceral and motor-visceral* (Fig.2).

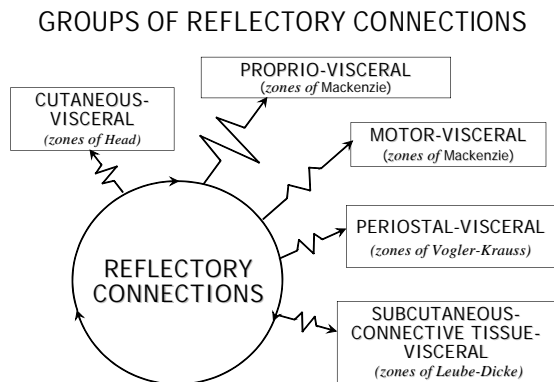


Figure 2. Groups of reflexory connections

The construction of a complex physical and rehabilitation programme is needed, because the mechanism of action of different procedures is diverse (Fig.3). This opinion is in agreement with

modern tendencies in drug treatment of neuropathy (during the last ten years). Moreover, contemporaneous studies prescribe a combination of symptomatic and pathogenetically oriented therapy [21].

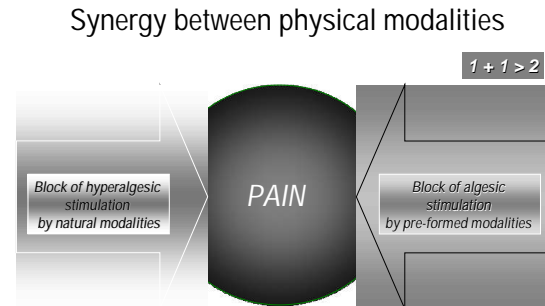


Figure 3. Synergy between physical modalities

Physical modalities have an effect on the interstitium modulating the intern compartments (milieu interieur of Claude Bernard) and this way creating an optimal medium for the influence of medicament substances. This is the theoretical base for therapeutic application of a combination of drugs and physical modalities. The synergy between different physical modalities is the logical base for prescription of a complex rehabilitation program [1, 13].

In conclusion we should not underestimate the use of methods of physical analgesia in clinical practice, which can improve the quality of life of patients and accelerate their returning to work and social activities.

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