

Physical Therapy Modalities and Rehabilitation Techniques in the Treatment of Neuropathic Pain

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Abstract

Neuropathic pain is an important problem because of its complex natural history, unclear etiology, and poor response to standard physical therapy modalities. It causes severe disability unrelated to its etiology. The primary goal of neuropathic pain management is to investigate the underlying cause, to make the differential diagnosis, to eliminate risk factors, and to reduce pain. The physician should also be aware of functional, and psychological conditions of the patient. Therefore, a multimodal management plan in neuropathic pain is essential. In this article, we aimed to reflect a diverse point of view about various physical therapy modalities and rehabilitation techniques. For this purpose, we searched articles about physical therapy modalities and rehabilitation techniques in PubMed database and presented various studies according to their relevance. New rehabilitation techniques seem promising however there is a requirement for more randomized controlled trials with larger patient groups. In this review, we suggest that physical therapy modalities and rehabilitation techniques are very important options and must be considered with pharmacotherapy.

Keywords: Physical therapy modalities; Rehabilitation techniques; Neuropathic pain; Treatment

Neuropathic pain can be defined as a primary lesion or a functional dysfunction in the nervous system. It usually doesn't have a specific cause and responds poorly to the treatment. It takes a long time and increase gradually, and may lead serious disability [1]. There are many causes of neuropathic pain which can be classified according to etiology, and localization [2] (Table 1). As it is well known, neuropathic pain affects the quality of life, decreasing physical functionality and activities of daily living, and creating severe difficulties in both professional and private life. It also causes psychological problems resulting in sleep disorders, anxiety and depression. There are also some consequences associated with neuropathic pain like deterioration in sexual and marital life and family relationships which lead to social isolation. These problems increase over time, which in turn worsen the pain causing a circulus vicious. Neuropathic pain also has a bad impact on the economy such as considerable loss in working days, disability and increasing healthcare costs [3]. Therefore, neuropathic pain must be approached as a big health problem that have to be resolved as quickly and as efficiently as possible.

At the beginning of the treatment of neuropathic pain, pain must be defined and goals of treatment must be established. Co-morbidities and psychosocial factors, which can be related to pain, should also be evaluated. It is important to determine an underlying cause of neuropathic pain and the functional status of the patient. As a result, a target- based treatment algorithm must be planned and executed step by step. In a well-designed management plan of neuropathic pain; pharmacotherapy, physical modalities, rehabilitation techniques, cognitive- behavioral therapy/ psychotherapy/ relaxation therapy methods and invasive procedures should all be taken into consideration. In pharmacological treatment, European Federation of Neurological Societies (EFNS) guideline suggests the usage of antiepileptic drugs like gabapentin and pregabalin, antidepressants like duloxetine, venlafaxine and tricyclic antidepressants as first line drugs [4]. As a second line drug, weak opioids such as tramadol are offered. Namaka et al. [5] also advocates topical antineuralgics like capsaicin and lidocaine as an addition to first line drugs.

Physical Therapy Modalities

Physical therapy modalities include pain modulators like hot and cold packs, ultrasound, short wave diathermy, low frequency currents

(TENS, diadynamic currents, interferential currents), high voltage galvanic stimulation, laser and neurostimulation techniques like deep brain stimulation and transcranial magnetic stimulation (Table 2). Hot and cold applications can be used together as in contrast baths. Sometimes fluidotherapy or whirlpool can also be chosen for this purpose. In all these superficial heat agents should not be applied in high degrees, due to possible risk of increase in pain. Although these

Central Causes of Neuropathic Pain	Peripheral Causes of Neuropathic pain
<ul style="list-style-type: none"> • Compression myelopathy due to spinal stenosis • HIV myelopathy • Multiple sclerosis pain • Pain of Parkinson disease • Myelopathy after ischemia or radiation • Pain after stroke • Pain due to posttraumatic medulla spinalis injury • Syringomyelia 	<ul style="list-style-type: none"> • Acute and chronic inflammatory demyelinating polyradiculoneuropathy • Alcohol induced polyneuropathy • Chemotherapy induced polyneuropathy • Complex regional pain syndrome • Entrapment neuropathies • HIV sensory neuropathy • Idiopathic sensorial neuropathy • Tumour infiltration of nerves • Neuropathy of nutrition deficiency • Painful diabetic neuropathy • Phantom pain of extremity • Postherpetic neuralgia • Plexopathy after radiation • Radiculopathy (cervical, thoracic, lumbosacral) • Neuropathy because of toxic exposure • Trigeminal neuralgia • Posttraumatic neuralgia • Peripheral nerve injury

Table 1: Main causes of neuropathic pain.

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Physical Modalities	Indications
Heat and Cold applications Fluidotherapy Whirlpool	Chronic pain
Massage	Spinal Cord Injury
Transcutaneous Electrical Nerve Stimulation (TENS)	Spinal Cord Injury Acute, subacute and chronic postoperative pain Radiculopathy Diabetic Neuropathy
Transcranial Magnetic Stimulation (TMS)	Spinal Cord Injury Stroke Brachial Plexus Lesions Trigeminal Nerve Lesions
Cortical Electrical Stimulation (CES)	Spinal Cord Injury

Table 2: Physical therapy modalities used in neuropathic pain and their main indications.

modalities have been found effective in chronic pain, there is a definite need of studies which support their effectiveness [6]. In general, deep heating agents like ultrasound and short wave diathermy are not recommended in the treatment of neuropathic pain. They are helpful especially in joint contractures, and adhesions. It increases flexibility of collagen fibers and circulation of connective tissues which help functional restoration. It may provide to decrease neuropathic pain. Massage is also not recommended. In AIDS patients with neuropathic pain, massage therapy has been applied but there have been no significant changes on pain intensity [7]. There is another study that has been investigated the role of massage in spinal cord injury patients. While the study claims that massage appears as one of the effective ways of therapy, it does not specify the type of pain [8].

Pieber et al. [9] has evaluated the effectiveness of different types of electrotherapy. In this review, the studies which involve largest groups are usually about transcutaneous electrical nerve stimulation (TENS) in addition to other studies with smaller groups that investigate other techniques such as electromagnetic neural stimulation, pulse and static electromagnetic field application and high frequency external muscle stimulation. Possible action mechanisms of electrotherapy have been suggested to be local release of neurotransmitters such as serotonin, raised levels of ATP, release of endorphine and its own anti-inflammatory effects. Dorsal column activation is another mechanism of electrotherapy. It has been shown that low frequency currents increase microcirculation and endoneural blood flow. Electrotherapy can also be effective in correcting the disrupted microcirculation in diabetic polyneuropathy and increase oxidative capacity in muscles via metabolic effect.

TENS is one of the best modalities that has been shown to be effective in the treatment of neuropathic pain [10]. It is suggested that TENS activates central mechanisms to provide analgesia. Low frequency TENS activates μ -opioid receptors in spinal cord and brain stem while high frequency TENS produces its effect via δ -opioid receptors. European Federation of Neurological Societies (EFNS) has published a guideline about the use of therapeutic electrical neurostimulation techniques in chronic neuropathic pain [11]. The guideline suggests that the effectiveness of TENS depends on the intensity, frequency, duration and the number of sessions. McQuay et al. [12] have published a review about the use of TENS in outpatient conditions for non-specific chronic pain which suggests it is effective in chronic non-specific pain. A randomized controlled trial which is done by Akyuz et al. [13] has also shown the efficacy of TENS in acute, chronic and postoperative pain. Another study, investigating the effect of different TENS applications compared to placebo in 11 radiculopathy patients, TENS has been found effective when compared

to placebo [14]. Cheing et al. [15] found high frequency TENS is significantly effective in reducing the hypersensitivity of the hand. In a randomized controlled study, low frequency TENS (<2 Hz) and placebo (4 weeks, 30 mins daily) have been compared in patients with diabetic neuropathy. Eighty-three percent of the patients in the treatment group have defined sudden decrease in pain and discomfort [16]. Forst et al. [17] compared the effects of low frequency TENS and placebo TENS with a randomized controlled trial and showed that VAS and NTSS-6 scores have improved significantly in the treatment group. Acupuncture type TENS (0-4 Hz) has been found more acceptable when compared to high frequency TENS due to increased sensation of numbness but there is not sufficient evidence [11]. As a result, TENS can be effective in the treatment of painful peripheral neuropathy. However, inadequate study designs and short follow-up durations still prevent us to comment on TENS objectively. There is need for more randomized, double blind studies done with larger patient groups.

Laser is another physical therapy agent that can be used in the treatment of neuropathic pain. Very low level of laser has been shown effective in patients with neuropathic pain [18]. When very low laser therapy is applied, it decreases pain and inflammation, in addition to improving functional ability. In rats, low level laser therapy decreases the level of hypoxia induced factor 1- α (HIF 1- α), which is an important modulator in inflammation and released after chronic constrictive nerve injury [19]. However, other studies that study the effectiveness of laser therapy in neuropathic pain are also done in rats [20,21]. Therefore, there is not enough evidence to suggest that it is effective in neuropathic pain of humans.

Neurostimulation techniques including transcranial magnetic stimulation (TMS) and cortical electrical stimulation (CES), spinal cord stimulation (SCS) and deep brain stimulation (DBS) have also been found effective in the treatment of neuropathic pain. Lefaucheur et al. [22] investigated 60 patients with chronic unilateral neuropathic pain caused by one of the following lesions: thalamic stroke, brainstem stroke, spinal cord lesion, brachial plexus lesion, or trigeminal nerve lesion. Transcranial magnetic stimulation was applied 3 weeks apart in two sessions, with a 10 Hz frequency. The patients' pain level was assessed with visual analog scale (VAS). Thirty-nine patients reported a decrease in pain depending on the localization and cause of pain. Capel et al. [23] have done a randomized, placebo- controlled study and evaluated the effects of CES in 27 patients with spinal cord injury. 14 patients received CES for 2 hours, two times in a day, for four days while 13 patients received placebo CES at the same protocol. Pain was assessed with VAS and McGill Pain Questionnaire but other functional related factors like depression, anxiety, analgesic usage were also monitored. In this study, patients receiving CES reported decrease in pain intensity and the need for pain medication. But in both groups there were no significant functional improvement. Another randomized placebo controlled study was done by Tan et al. [24] in 38 spinal cord injury patients who suffered from chronic neuropathic and musculoskeletal pain for at least 3 months. CES was applied to 18 patients for 21 days at a maximum of 100 microampers. 20 patients received placebo. The patients in CES group have reported a decrease in pain intensity immediately, and this decrease didn't change over time. However, there was not a statistically significant difference in between groups. Although there are many studies that have been done about neurostimulation techniques, they are far from giving us a definite result with patient groups being so small and mainly include the patients with spinal cord injury. There is need for research in the efficacy of neurostimulation techniques in other causes of neuropathic pain.

Rehabilitation Techniques

Rehabilitation is also an essential part of treatment in neuropathic pain (Table 3). The main aims of rehabilitation are to decrease pain and amount of medication, improve dysfunction, increase quality of life and physical activity and bring the patient's self-esteem back. Although one of the major parts of rehabilitation methods are therapeutic exercise, there are no sufficient evidence supporting this idea in the treatment of neuralgia. Many kinds of therapeutic exercises have already been used in the rehabilitation program such as conditioning, strenghtening and stretching exercises. Kuphal et al. [25] developed a neuropathic pain model in rodents by making a peripheral nerve injury in their sciatic nerve and showed that 25 days of exercises in water and swimming decreased pain. In this study, extended exercises in water and swimming have been shown reducing edema, inflammation and peripheral neuropathic pain in this animal model.

The purposes of psychotherapy are to treat emotional, behavioral or mental dysfunction, remove negative symptoms such as anxiety or depression, modify or reverse problem behaviors, help the individual cope with situational crises such as bereavement, pain, or prolonged medical illnesses, improve the individual's relationships, manage conflict or enhance positive personality growth and development. In a study done by Turk et al. [26] psychosocial treatment approaches, cognitive behavioral methods and the prevalence of emotional stress have been investigated and the effectiveness of psychological treatment have been evaluated. It showed that psychosocial support increases the efficacy of treatment. We should add psychosocial management programs to our standart therapy regimens in neuropathic pain. Primary goal of cognitive behavioral therapy (CBT) is to find and correct the negative, irregular and irrational thoughts that have become automatic by being repeated. Automatic thoughts come into mind when a person experiences a new thing or recalls a past event. In persons with depression and anxiety, negative automatic thoughts are experienced more often. The use of CBT is gradually increasing in neuropathic pain. Especially in elderly patients, relaxation techniques, the accurate planning of activity-rest cycles, cognitive reconstruction, meditation and distraction techniques can be used [27]. Relaxation therapy is a process that focuses on using a combination of breathing and muscle relaxation in order to deal with stress. Relaxation therapy is useful in decreasing anxiety, autonomic hyperactivity and muscle tension. Their adaptability for use at home and in other environments is another advantage. Progressive muscle relaxation, imaging, controlled breathing or listening to relaxation tapes have been started to be used in chronic pain while there is still not enough evidence for its effects on neuropathic pain. There is no clear evidence about the effectiveness of acupunture on neuropathic pain as well. Cha et al. [28] investigated the healing effect of acupunture inneuropathic pain induced in rats and found out that acupunture is effective in the treatment of neuropathic pain. Rapson et al. [29] applied electroacupunture to 36 spinal cord injury (SCI) patients with neuropathic pain 5 times a week for 30

minutes and suggested that pain intensity decreased after therapy and there were not any side effects.

It is now well known that in various cases of chronic pain like phantom limb pain and chronic low back pain, the organization of primary somatosensory cortex changes [30]. Mirror therapy and graded motor imagery are rehabilitation procedures developed with the hope of correcting this disorganization and thus decrease the pain. Mirror therapy is one of the rehabilitation methods that is widely used in patients suffering from neuropathic pain. In mirror therapy, the patient puts his affected limb into mirror box and keeps the unaffected side in front of the mirror. Unaffected limb in front of the mirror makes simple movements, patient imagines doing same movements with the affectedlimb. Although the pain may increase at the time, the patient tries to tolerate it. This method has been used in patients with stroke, phantom limb pain and complex regional pain syndrome (CRPS) and found effective in increasing upper extremity functionality [31]. During these studies, decrease in pain accompanied functional improvement. Therefore, studies have been designed to further investigate the effect of mirror therapy in neuropathic pain. McCabe et al. [32] did a study on 8 patients with CRPS type 1, in which mirror therapy have been applied. They found that it was effective in decreasing painin the patients who has the condition less than 8 weeks, while it was effective in reducing only stiffness in patients who had this condition for less than a year. However, in cases of CRPS lasting more than one year, it was not effective. In another randomised controlled study with 22 patients with amputated limbs, 4 weeks of mirror therapy were compared with covered mirror therapy (sham mirror therapy) and mental imagery [33]. There was a signifigant decrease in VAS in mirror therapy group compared with the others. In a similarly designed study done by Cacchio et al. [34] 24 patients with stroke were given 4 weeks of mirror therapy, sham mirror therapy and mental imagery. There was also a significant difference only with mirror therapy. Graded motor imagery (GMI) is a comprehensive program designed to sequentially activate cortical motor networks and improve cortical organization in three steps: laterality training, imagined hand movements, and mirror visual feedback [35]. There is one randomized controlled study done by Moseley [36] in CRPS type 1 patients which received GMI for 6 weeks, 2 weeks in each step, and compared with conventional physical therapy and medication. The study was done with 51 patients and showed significant decrease in pain in GMI group compared with other groups. However, a study by Johnson et al. [37] failed to show the effectiveness of GMI in CRPS patients. Instead, in this study, one patient has even reported an increase in pain intensity. Though mirror therapy and GMI are promising new ways of rehabilitation in the treatment of neuropathic pain, there is definitely need for more evidence.

Moseley GL [38] has done another interesting study that uses visual feedback through creating a visual illusion and compares its effectiveness with other experimental therapies like guided imagery and watching another person walking. This study also based on the principle of disorganization of primary somatosensory cortex. In this study, 5 paraplegic patients with SCI were taken and first, the three different therapies mentioned above were applied. In visual illusion, the patients' body from waist-above were reflected in a mirror and the legs of the patients were blocked. Instead, an image of a man walking on a treadmill were reflected where the patients' legs were supposed to be. The patients were also encouraged to move their body accordingly. The pain, foreignness and heaviness levels were all measured by VAS and there were all decreased in visual illusion technique compared to others. After this, 4 patients recieved visual illusion therapy for 15 days consecutively, their pre-task pain and the duration of pain relief all

Rehabilitation Techniques	Indications
Cognitive behavioral therapy	Elderly patients with neuropathic pain
Relaxation Techniques	Chronic Pain
Acupunture	Spinal Cord Injury
Mirror Therapy	Phantom Pain Complex Regional Pain Syndrome (CRPS) Stroke
Graded Motor Imagery	Stroke
Visual Illusion	Spinal Cord Injury

Table 3: Rehabilitation techniques used in neuropathic pain and their indications.

increased during this 15 days. This study also shows there is much area for improvement of these kind of problems and many techniques can be developed using visual feedback.

As a conclusion, rehabilitation programs must be emphasized and combined with pharmacotherapy in daily practice. Physical therapy modalities such as superficial and deep heat agents, analgesic currents and laser are also not sufficient in the treatment of neuropathic pain when applied alone. We hope that the importance of new rehabilitation techniques will increase in time and they will have a larger part in neuropathic pain treatment.

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