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Research Article

Neuropathic Pain and Spasticity Response to Traditional Acupuncture after Spinal Cord Injury

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Abstract

Introduction: One of the most relevant disabilities is caused by spinal cord injury (SCI). Typical causes of spinal cord damage are trauma, disease, or congenital disorders. Tetraplegia is a paralysis results in the partial or total loss of use of all limbs and torso; paraplegia is similar but does not affect the arms. Pain and spasticity are common sequelae of SCI [1]. Both pain and spasticity can have a late onset and develop slowly over time after SCI, and once developed, they often become chronic.

In this paper we have provided to assess the effectiveness of acupuncture for treating SCI sequelae and summarize the potential mechanisms of acupuncture therapy.

Method: We considered 30 patients with diagnosis of tetra or paraplegia after SCI complicated by neuropathic pain and spasticity. Neurologist trained in medical acupuncture conducted the therapeutic treatments. A specific set of acupuncture points was used in all sessions. Participants were treated for 8 sessions of acupuncture over 4 week's period. Pain and spasticity were evaluated with Numeric Raiting Scale (VAS) (2) and the Modified Ashworth Scale [3] at the beginning of the first, the fourth an eighth treatment session.

Results: 28 patients (93%) showed improvement in pain intensity and spasticity after two weeks of acupuncture treatment. The therapeutic effect continued until the eighth week of treatment. However, 15 patients (53,5%) reported an increase in spasticity and pain 2 months after acupuncture sessions.

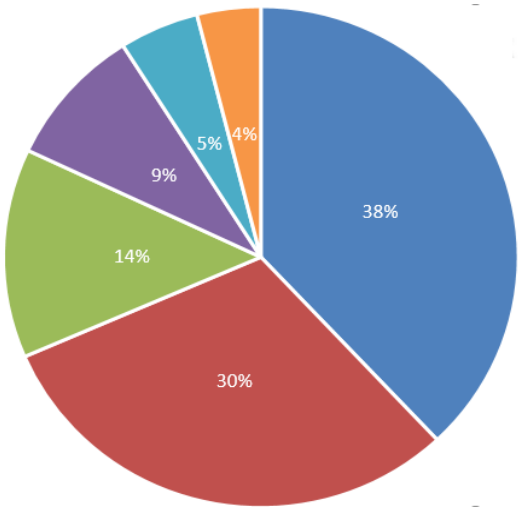
Conclusions: Acupuncture sessions using defined acupoint set reduced pain intentensity and *spasticity i*n patients with SCI.

Keywords: acupuncture; pain spasticity; spinal cord injury

Introduction

According to the World Health Organization the term 'spinal cord injury' refers to damage to the spinal cord resulting from trauma (e.g. a car crash) or from disease or degeneration (e.g. cancer). [4] Traumatic spinal cord injuries most commonly occur as a result of motor vehicle and motor-bike accidents, followed by falls. Sport, in particular, water-based activities and work-related injuries are also common, with a further small but increasing contribution from a gun, knife or war-related injury. [5,6] (**Figure-1**)

Common Causes of Spinal Cord Injury (2016)



- Vehicular / Automobile Accidents 38%
- Falls 30.5%
- Violence (Primarily From Gunshot Wounds) 13.5%
- Sports Injury 9%
- Medical / Surgical Complications 5%
- Miscellaneous / Other Causes 4%

Figure 1: *Causes of traumatic spinal cord injury. Source: The National Spinal Cord Injury Statistical Center*

Tetraplegia, also known as quadriplegia, is a paralysis caused by illness or injury that results in the partial or total loss of use of all limbs and torso; paraplegia is similar but does not affect the arms. The loss is usually sensory and motor, which means that both sensation and control are lost [7]. The rehabilitation process following a spinal cord injury normally begins in the acute care setting. The clinical outcomes of SCI depend on the severity and location of the lesion and may include partial or complete loss of sensory and/or motor function below the level of injury. A primary goal of rehabilitation is to restore, to the greatest possible extent, the physical functioning of an individual after illness or injury.

Knowledge of possible complications during the acute phase is important because they may be life-threatening and/or may lead to prolonged rehabilitation.

The range of conditions following SCI can be categorized into neurological consequences and resulted from the injury itself, following interruption and decentralization of central nervous system and may be regarded as sequel to the injury. [8] Example are neurogenic pain or spasticity; the latter being part of the upper neurone syndrome. Neuropathic pain is present in 50–60% and spasticity in about 70% of individuals living with a SCI. (9-10) Central neuropathic pain shares many features with spasticity and has even been termed 'sensory spasticity'. [11] Both pain and spasticity can have a late onset and develop slowly over time after SCI, and once developed, they often become chronic. Neuropathic pain is defined as 'pain caused by a lesion or disease of the somatosensory nervous system. [12]

Neuropathic pain following SCI includes at- and below-level SCI neuropathic pain, where at-level pain may consist of both peripheral and central neuropathic pain, while below-level pain is a central neuropathic pain condition. [13] Studies have found that patients with spinal cord injury who suffer from pain have less life satisfaction than do patients in whom pain is well controlled; this may also affect the patients' general outlook on life [14,15].

Spasticity has been defined as 'a disordered sensorimotor control resulting from an upper motor neuron lesion, presenting as intermittent or sustained involuntary activation of muscles', and this broad definition of spasticity is adopted in the spinal cord injury musculoskeletal data set. [16]

Neurological consequences may interfere with the start of active rehabilitation, can slow down the achievement of outcomes during rehabilitation and sometimes lead to re-hospitalization

Life expectancies for patients with spinal cord injury continues to increase but are still below the general population. Patients aged 20 years at the time they sustain these injuries have a life expectancy of approximately 35.7 years (patients with high tetraplegia [C1-C4]), 40 years (patients with low tetraplegia [C5-C8]), or 45.2 years (patients with paraplegia) [17]. Individuals aged 60 years at the time of injury have a life expectancy of approximately 7.7 years (patients with high tetraplegia), 9.9 years (patients with low tetraplegia), and 12.8 years (patients with paraplegia).

Originally the leading cause of death in patients with spinal cord injury who survived their initial injury was renal failure, but, currently, the leading causes of death are pneumonia, pulmonary embolism, or septicemia. Heart disease, [18-19] subsequent trauma, suicide, and alcohol-related deaths are also major causes of death in these patients [20-21]. In persons with spinal cord injury, the suicide rate is higher among individuals who are younger than 25 years.

There are many treatments for functional recovery from injury and the related complications that result from SCI; these include surgery [22], prescription drugs [23], behavioral therapy [24], physical therapy [25], and supportive treatment [26]. There are also a variety of treatments used for the secondary complications of SCI, such as intermittent catheterization for bladder dysfunction, analgesics for pain, and others [27]. Treatment options for spasticity are effective and include oral medication (baclofen, tizanidine), intrathecal baclofen, and rarely, surgical rhizotomy or myelotomy.

These treatments tend to be administered over long periods of time, and because of the potential complications of treatment, there has been an increased interest in alternative medical treatments, including acupuncture and other related therapies (moxibustion and acupressure) [28].

Acupuncture is an important part of Traditional Chinese Medicine, which has been used for more than 4000 years to prevent and treat a variety of diseases. Even though the technique was first developed in China, it is now practiced by thousands of clinicians worldwide and has become one of the most frequently used complementary medicine therapies among SCI patients. Many researchers have found acupuncture to be effective in a large number of patients for not only nociceptive condition but also for neuropathic pain [29,30,31,32,33]. The effect of acupuncture on spasticity has been proven by several studies, Zhang et al. concluded that the nanometer acupoint mounting method through defined acupoints can significantly alleviate myospasms complicated by spinal injury, compared with the non-acupuncture group [34]. Another Chinese study also proved that acupuncture combined with Western medicine could improve SCI-induced spasticity after spinal cord injury, compared with treatment with Western medicine alone [35]. It is important to advance knowledge on people with SCI and strengthen the evidence base for prevention, support and care of people with SCI. In this paper we have provided to assess the effectiveness of acupuncture for treating post-SCI complications and summarize the potential mechanisms of acupuncture therapy for SCI.

Material and Method

Acupuncture has been administered to 30 SCI patients, aged between 16 and 80, treated at the Spinal Unit of Maugeri IRCCS Foundation. Patients were recruited consecutively from January 2019 to December 2019. Spinal cord injuries were classified as complete and incomplete by the American Spinal Injury Association (ASIA) classification [36]. The ASIA scale grades patients based on their functional impairment from A to E, where A represents the greatest impairment and E represents the normal condition. Neurologist trained in medical acupuncture conducted the therapeutic treatments. During the procedure, a hair-thin needle is inserted into the skin at distinct acupoints (**Table1).** Participants were treated for 8 sessions of acupuncture over a 4 week period. After insertion, needles were left in place for 30 minutes and were not manually or electrically stimulated. Needles were inserted to a depth of 15 to 30 mm. A specific set of acupuncture points was used with all participants: 5TB *Waiguan,* 41 GB *Linqi.* 20 GB *Fengchi,* 34 GB *Yinglingquan,* 4 GI *Hegu,* 3 LV *Taichong,* 36 ST *Zusanli.* **We** have focussed on inserting needles into fixed *anatomical locations* (**table 1).** At the beginning of the first, fourth an eighth treatment session, each participant was asked to describe the quality and location of pain and spasticity: an operator evaluated VAS [2**]** and Modified Ashworth [3] scale respectively.

Acupuncture Point	Location
GB 41 Zulinqi	Posterior to the 4th metatarsophalangeal joint, in the depression lateral to the tendon of m. extensor digiti minimi of the foot.
TH 5 Waiguan	On the dorsal aspect of the forearm, on the line connecting SJ 4 and the tip of the elbow, 2 cun above the transverse crease of the wrist between the ulna and radius.
GB 20 FengChi	At the top of the sternocleidomastoid muscle which runs from the back of the head down to the front of the shoulders at the clavicle.
GB 34 YangLingQuan	In the depression anterior and inferior to the small head of the fibula.
GI 4 Hegu	On the dorsum of the hand, between the first and second metacarpal bones, at the midpoint of the second metacarpal bone and close to its radial border.
LV 3 Taichong	On the dorsum of the foot in a depression distal to the junctions of the 1st and 2nd metatarsal bones.
ST 36 Zusanli	On the finger breadth lateral to the lower border of the tuberositas tibiae 3 cun below the knee joint

Table 1: *Acupoints*

Results

At the time of the acupuncture treatment, all patients were hospitalised. Thirty patients presented a traumatic spinal cord injury. Median age was 58 years in men and 69 years in women. Patients in acute phase of disease were 12. Patients distribution among ASIA categories was well balanced (14 patients were ASIA A or B). Acupuncture may be effective in treating a subgroup of patients who have pain and spasticity after traumaic SCI. Sixty-five percent of the present study sample reported moderate to significant pain relief immediately after the course of 16 treatments and 25% of the sample continued to report pain relief at 2-month follow-up.

Our data provide preliminary evidence indicating that the subgroup reporting spasticity relief after acupuncture. Forty-six percent of the present study sample reported moderate to significant spasticity relief immediately after the course of 16 treatments and 5% of the sample continued to report spasticity relief at 2-month follow-up. Patients with incomplete injuries appear to do better than those with complete ones.VAS scale evidenced a reduced pain intensity in 64,4% patients with acute SCI and 30% with chronic SCI. Fifty - seven percent of acute SCI patients reported spasticity relief and 30% of chronic SCI reported the same result. Spasticity responds better in acute incomplete SCI compared to chronic; the percentage change is equal to 31,5%..

In term of safety no serious adverse events related acupuncture were reported in anyone of the 30 patients.

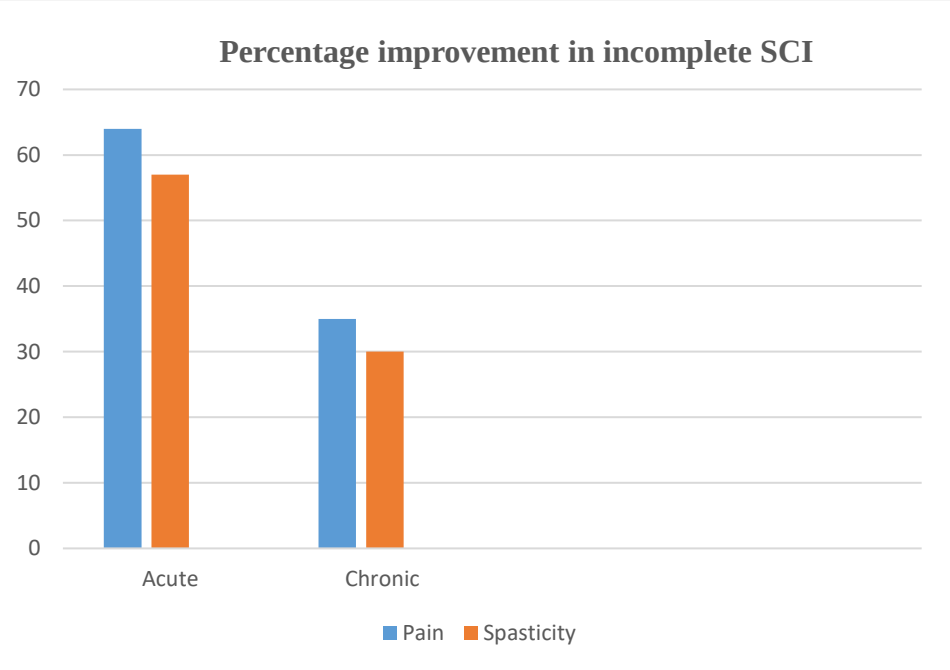


Figure 2: *Pain and Spasticity improvement after acupuncture treatment in incomplete acute and chronic spinal cord injury*

Discussion

Our data provide preliminary evidence indicating that the subgroup reporting neuropatic pain and spasticity relief after acupuncture. Patients with incomplete injuries appear to do better than those with complete ones. This result might explain because the pathway to the central nervous system is still intact. Acute SCI evidenced better results than chronic SCI patients.

Despite the fact that response to acupuncture was not effective in the long term it is still encouraging that 65% of partecipants reported moderate to significant pain and 46 % to spasticity relief immediately after treatment.

Several theories about the mechanism of acupuncture may explain why neuropatic pain relief after acupuncture. One suggests that the insertion of acupuncture needles stimulates the release of endorphins. [37] Given that central pain is more refractory to conventional treatment [38], this finding suggests that acupuncture may provide a viable treatment alternative for some individuals with this kind of pain.

The mechanism of the effect of acupuncture on spasticity is still unclear. It is widely accepted that acupuncture can reduce pain. Acupuncture therapy could break the pain-spasm-pain cycle and relax muscles by controlling pain [39]. The threshold of pain receptor is increased after location stimulation [40-41]**.** However, the mechanism cannot explain all causes because spasticity is not always painful and the link between spasticity and pain is not clearly established. SCI can trigger neuroplasticity that potentially promotes recovery from the injury but it also may have deleterious consequences. Neuropathic pain and spasticity are multifactorial and complex consequences of maladaptive neuronal plasticity after SCI**.** [1]. Following an initial impact after spinal cord injury (SCI), there is a cascade of downstream events termed 'secondary injury', which culminate in progressive degenerative events in the spinal cord. These secondary injury mechanisms include, but are not limited to, ischemia, inflammation, free radical-induced cell death, glutamate excitotoxicity, cytoskeletal degradation and induction of extrinsic and intrinsic apoptotic pathways [42] Different aspect of pain and spasticity, and injury characteristics may reflect different underlying mechanisms. [1] *Decrease oxidative stress, inhibition of inflammation and neuronal apoptosis, regulation of the expression and activity of endogenous biological mediators, and increase regenerative stem cell production are the possible mechanism of* acupuncture therapy for SCI. McCouch proposed another aetiological mechanism: the distruption in the balance between excitatory and inhibitory inputs to motoneurons observed during spasticity. Enhanced excitability of motoneurons and interneurons and axonal sprouting are the most likely mechanisms involved in spasticity [43]. Management of spasticity can include physical exercise, medication, and electrostimulation [44]. Evidence from experiments in humans and animal models of spasticity demonstrated that alterations in the excitability of numerous excitatory and inhibitory spinal pathways occur after SCI. The pathogenesis of spasticity resulting from SCI is multifactorial and extend beyond the stretch reflex. It also depends on the type, site, and duration of injury. The alteration in excitability of various inhibitory pathways has historically been studied the most, with less focus until recently on the alterations in excitability of motoneurons and interneurons themselves. This latter alteration appear to play critical role in the manifestation of spasticity after SCI [45]. The enhancement in excitability of motoneurons is most likely involved in pathophysiology of spasticity following SCI. Acupuncture therapy may regulate the activity of spinal motor neurons by decreasing the hyperexcitability of gamma and alfa motor neuron and/or increasing the inhibition of interneurons. Fink et al. [46] and Lee et al. [47] found that after the first acupuncture treatment, H/M ratios decreased immediately as compared with controls. The improvement in H/M ratio may be associated with decreased excitability of *alfa* motor neurons. Yu et al. [48] found that acupuncture on the antagonist muscle of the spastic muscle could prolong the mean H-reflex recovery time, which may be caused by the increased inhibition of interneurons. The use of complementary and alternative medicine (CAM) to relieve pain for the patients with SCI has been assessed in several studies. As in our survey, CAM was used as a supplementary rather than an exclusive treatment. In Pannek's study 73% of the SCI patients reported the use of CAM for chronic pain [49]. Acupuncture was the most frequent technique (28% of the participants), with a pain relief that lasted for weeks in 19% of the users [50]. A meta-analysis showed positive results for the use of acupuncture for pain in SCI [51]. The percentage of SCI patients seeking help for their chronic medical conditions by CAM is

high. Therefore, a comprehensive care of SCI patients should not be limited to the various forms of conventional treatments, but should include CAM procedures as well.

Conclusion

Acupuncture seems to be a potential therapeutic intervention for SCI pain and spasticity. Neurological complication of SCI may interfere with the start of active rehabilitation, can slow down the achievement of outcomes during rehabilitation and sometimes lead to re-hospitalization. The possibility to use acupuncture sessions complementary to the individual rehabilitation program (PRI) in SCI can be useful to perform activities of daily living without shooting and burning pain, spasms and increased muscle tone. There are several limitations to the described study. These findings must be replicated in a longer term study that has a larger sample, including a nonacupuncture control group. Further researches are needed in this direction to develop valid and reliable instruments to assess the health status in people with SCI.

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Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research authorship and/or publication of this article.

Patient consent

Obtained.
The study was approved by the Ethics Committee of our Centre and all patients provided written informed consent before study treatment.

Provenance and peer review

Not commissioned; externally peer reviewed.

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