META-ANALYSIS

Meta-Analysis on the Recovery Effect of Acupuncture Combined With Rehabilitation Therapy in Spinal Cord Injury Patients

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ABSTRACT

Objective • To explore the recovery effect of acupuncture combined with rehabilitation therapy on muscle spasms in patients with spinal cord injury through a systematic review of meta-analysis methods.

Methods • Use "acupuncture," "electronic-acupuncture," "spinal cord," "spasm," and "paraplegia" as keywords, CNKI, Google, Wanfang, VIP, sci-hub, Web of Science, PubMed, and other Chinese or English databases were searched. To collect the domestic and foreign research on acupuncture combined with rehabilitation for muscle spasms in patients with spinal cord injury. Preliminary screening was conducted, and data extraction and quality evaluation were carried out on the included literature, including publication time, sample size, treatment methods, recovery effects, etc. According to the literature, the influence of acupuncture combined with rehabilitation therapy on muscle spasms in patients with spinal cord injury and related indices was analyzed. The search period was from January 2018 to June 2023, and the selected research results were tested by RevMan5.3 software and data consolidation for consistency. The methodological quality of the included studies was assessed using the Newcastle-Ottawa Scale (NOS).

Results • A preliminary literature search yielded 172 papers. 53 papers from sci-hub, 71 papers from HowNet, 36 papers from Wanfang, and 12 papers from VIP. Finally, 10 articles that met the criteria were included, including 594 patients. According to different treatment methods, the literature about acupuncture combined with rehabilitation therapy for muscle spasms in patients with spinal cord injury was analyzed for consistency, and data were merged. It was concluded that acupuncture combined with rehabilitation The clinical curative effect of the experimental group of patients is higher than that of the control group MD=5.31, 95%CI (2.94, 7.81), Z=5.64, $P < .001$; the clinical effective rate of the experimental group is higher than that of the control group. The improvement of the clinical spasticity index (CSI) score index of the patients in the experimental group was better than that of the control group MD = -3.09, 95%CI (-4.51, -1.67), Z =4.28, $P < .001$; the MAS score of the patients in the experimental group The improvement was better than that of the control group MD =-0.76, 95%CI (-1.16, -0.38), Z=8.13, $P < .001$; the improvement of Barthel index (BI) in the experimental group was better than that of the control group MD=9.81, 95%CI (7.84,11.71), Z=12.71, $P < .001$; no adverse events were reported in the experimental group and the control group.

Conclusion • This study shows that acupuncture and rehabilitation are more effective than other therapeutic methods in the treatment of muscle spasms after spinal cord injury, and more randomized controlled trials are needed to verify this in the future. (*Altern Ther Health Med.* [E-pub ahead of print.])

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INTRODUCTION

Spinal cord injury (SCI) is a serious disease with high disability and high mortality, and its incidence is increasing yearly with the development of society and the economy. Factors causing spinal cord injury include traffic accidents, falling from heights, violent blows, sports injuries, etc. SCI causes neuronal death, axonal degeneration, and

demyelination, resulting in motor, sensory, and sphincter dysfunction at the corresponding segment.[1] According to the data of the National SCI Statistical Center (National Research Center) in the United States, due to the lack of effective SCI treatment methods, only about 1% of SCI patients can fully recover, which not only brings huge psychological and psychological pain to the patients themselves and their families and social burden,[2-3] it is also a huge challenge.

Spasticity is the most common complication of SCI, which mostly occurs two months after the injury, and 65%-78% of patients with long-term SCI for more than 1 year develop spasticity. Spasticity is characterized by abnormally elevated muscle tone accompanied by hyperreflexia of the extremities.[4] In the process, violent convulsions and muscle twitches can cause unbearable pain. Appropriate spasticity can delay muscle atrophy, maintain joint stability, prevent the formation of venous thrombosis in the lower extremities, and, at the same time, improve the daily activities of patients.[5] However, if there is a severe spasm, it will also cause symptoms such as joint contracture deformity and limb pain, which will have a great impact on the patient's normal life and rehabilitation training. Severe spasticity seriously affects the quality of life and rehabilitation after SCI, but its treatment is not perfect.[6] Limb spasticity refractory to muscle relaxants can be treated surgically, but its long-term efficacy is uncertain.[7] Although muscle spasms after SCI have a great impact on the quality of life and rehabilitation training of patients, its pathogenesis is still unclear. After spinal cord injury, the adaptive changes of motor neurons, the excitability of interneurons, the regulation of sensory input to the motor output of the spinal cord, and the changes of signal molecules in nerve conduction are the possible causes of spinal cord injury. The descending conduction pathway of the spinal cord is damaged after spinal cord injury, and the spinal cord circuits located below the level of injury undergo a series of adaptive changes. Increased motor neuron excitability is an important cause of muscle spasms after SCI.[8,9] Mainly manifested in: Recombinant Potassium Chloride Cotransporters 2 (KCC2) transporter function decline, ion channel changes on the cell membrane, intracellular current increase, 5-hydroxytryptamine (5-HT) receptor activity and number changes.[10] In the electrical activity of the spinal cord, interneurons perform a key function, not only transmitting information from the same segment to another segment but also from one segment to another. In the production and conduction of tonic reflex, excitatory amino acids are the main neurotransmitters in various spinal cord injury pathways. After SCI, the content of excitatory amino acids in the body increases significantly, manifesting as excitotoxicity.[11]

Studies have found that after SCI, the inhibitory effect of type Ia afferent nerves on motor neurons decreases, and the connection strength between type Ia afferent nerves and motor neurons increases, which may be an important reason for muscle spasm after SCI.[12] Under normal physiological conditions, the metabolism of ions, amino acids, free radicals, and their products in the human body is always in the process of balance. After SCI, due to the blockage of this pathway, self-ischemia and hypoxia are caused, microcirculation is damaged, a large amount of metabolic waste accumulates, and free radicals increase rapidly, resulting in more serious damage after SCI. After SCI, the first cells to enter the damaged area are neutrophils.[13] During this phase, neutrophils fight off bacterial infection, but their production of lysosomal enzymes and free radicals breaks down the connective tissue matrix, leading to tissue destruction. The macrophages then move into the injured area and damage the tissue. In the hyperacute stage of spinal cord injury, surgical methods such as steel nails, plates, and repair can be used to reduce the compression on the spinal cord and maintain the stability of the spine.[14,15]

However, as time goes by, the damage to the spinal cord will become more and more serious, and in the end, it will even cause irreversible damage. There are various methods of surgical treatment. In clinical practice, compared with traditional decompression, pedicle screws internal fixation can not only help the fracture site to be reset but also effectively avoid broken screws, loose screws, and posterior fractures. Convex deformity, etc.[16] For early-stage SCI patients, methods such as vertebral fractures, spondylolisthesis reduction, and extramedullary decompression can be used to reduce nerve damage. The rehabilitation training of SCI patients is still a difficult, slow, and gradual process.[17] For SCI patients, the sooner, the better. With the continuous development of rehabilitation technology and the participation of rehabilitation engineering technology, a large number of clinical experiments have shown that rehabilitation can improve the patient's physical function to the greatest extent and compensate for the lost function so that the patient's daily life, social interaction and The ability to work and so on has been improved to the greatest extent. Some researchers have found through animal and clinical experiments that rehabilitation training can promote the endogenous regeneration of nerve and muscle tissue,[18] effectively inhibit the formation of glial scar, improve the inhibitory microenvironment of nerve and muscle tissue, and restore its function. At present, electric and magnetic stimulation techniques have been widely used clinically, and the curative effect is positive, which has been recognized by the majority of patients.[19] In recent years, novel therapeutic strategies have been proposed through neuroplasticity to injury, remodeling of neural pathways, activation of neurons, and alteration of the microenvironment. In traditional Chinese medicine, spinal cord injury is attributed to the two deficiencies of "du" and "pivot". Therefore, the treatment of most spinal cord injuries is mainly based on acupuncture and moxibustion.[20]

Yu Jiansong et al.[22] divided 200 SCI patients into two groups and combined rehabilitation training with acupuncture. Acupuncture and moxibustion selected Du points, and acupoints were allocated according to syndromes and supporting evidence. The exercise ability and self-care ability of the acupuncture group were better than those of the

rehabilitation training group. There is a significant improvement. Rong Shanshan et al.[23] used acupuncture at points such as "Du Meridian" and "Jiaji Point" to greatly improve the motor, walking, and sensory functions of SCI patients, which has greater advantages compared with the traditional therapy group, indicating that acupuncture " "Du Vessel" and "Jiaji Point" have a better effect on improving the motor function of SCI patients. Acupuncture is widely used clinically for the rehabilitation of SCI patients due to its advantages of simple operation, convenience, low price, good curative effect, and few side effects.[24,25] At the same time, with the rapid development of rehabilitation medicine, rehabilitation after spinal cord injury has attracted more and more attention.

However, there is still no systematic research report on the clinical effect of the combined application of the two. This study intends to conduct a systematic study on the application of acupuncture and rehabilitation training in limb convulsions after SCI on the basis of the previous research and use the Meta-analysis method to analyze the efficacy and safety of acupuncture and rehabilitation training on limb convulsions after SCI sex is evaluated.

RESEARCH OBJECT AND METHOD

Research object

A Meta-analysis was carried out by searching the English literature on acupuncture combined with rehabilitation therapy for spinal cord injury patients with muscle spasms published in the past five years in various databases as the research object. Computer retrieval is carried out by combining subject words and free words. Search CNKI, Google, Wanfang, VIP, sci-hub, Web of Science, PubMed, and other English-language or English-language databases. The retrieval time was from January 2018 to June 2023. English search terms: Subject terms "Acupuncture", "electroacupuncture", "spinal cord", "spasticity", "paraplegia" and free words. Randomized controlled trials are included first, followed by controlled clinical trials and cohort studies. Languages are limited to Chinese and English. All patients were diagnosed with spinal cord injury by pathological examination, and the race and nationality of the patients were not limited.

Inclusion criteria

1. Clinical randomized controlled trials are used; 2. Patients who have been diagnosed with spinal cord injury and muscle spasms after spinal cord injury are used as the test subjects. 3. A combination of acupuncture moxibustion and rehabilitation can be used as the intervention method; 4. The treatment plan of the control group can adopt other methods except acupuncture combined with exercise; 6. The motor assessment scale(MAS) is used to evaluate the patient's treatment, its therapeutic effect, and its therapeutic effect. Only final trial data were included together with the evaluation of multiple treatment cycles.

Exclusion criteria

1.Comparing the curative effects of acupuncture and physical therapy; 2. Acupuncture-based, or acupuncture-based, supplemented by functional rehabilitation training; 3. There are no relevant indicators and data in the literature; 4. Acupuncture, needle knife, pricking Bloodletting, and plum-blossom acupuncture; 5. For patients who are not suitable for conventional therapy, such as patients with serious complications or other serious diseases, as well as consciousness and cognitive dysfunction, and pregnant women. 6. Only fragments of literature that are repeatedly published.

Literature screening and methodological quality evaluation of included studies

Two researchers independently screened the literature, extracted materials and data according to the inclusion and exclusion criteria, and cross-checked the results of the included studies. Disagreement or disputed data will be decided through discussion or by the third researcher. Data type: (1) General information, including author, nationality, publication time, research type, sample size, baseline conditions of research patients, intervention measures, outcome indicators, treatment methods, recovery effects, etc., as well as evaluation nodes and evaluation sites; (2) including effectiveness observation indicators: clinical spasticity index (CSI), Motor assessment scale(MAS) score, Barthel index (BI), Fugl-Meyer (FMA) motor function, clinical effect and adverse events; non-randomized research bias risk assessment method Newcastle-Ottawa scale (NOS) to assess the quality of included non-randomized controlled studies. The MINORS scoring standard was used to evaluate the quality of the included clinical studies.

Statistical processing

Meta-analysis was performed using RevMan version 5.3 software provided by the Cochrane Collaboration. Odds ratio (OR) was used for dichotomous variables, and weighted mean difference (WMD) or standardized mean difference (SWD) was used for continuous variables for efficacy analysis (limit and median. Continuous variables can be converted into weighted mean differences); all expressed with 95% CI. The χ^2 test was used to analyze the statistical heterogeneity among the studies, and the studies with good homogeneity ($P \geq .1$, $I^2 \leq 50\%$) used the fixed effect model; if there was heterogeneity in the included studies ($P < .1$, $I^2 > 50\%$), a random effects model was used.

RESULTS

The results and general characteristics of the included literature

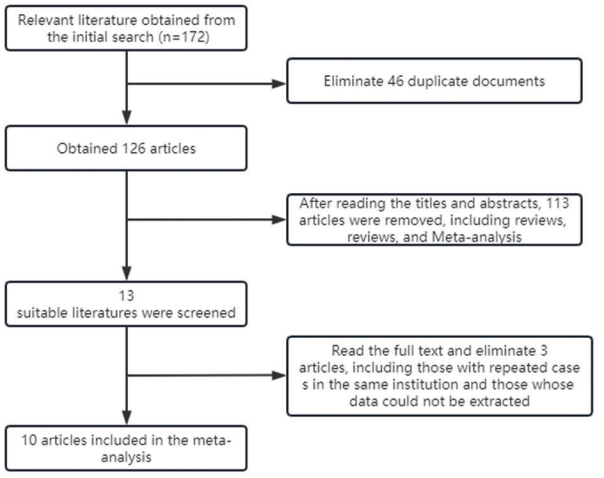
A preliminary literature search yielded 172 papers. 53 papers from sci-hub, 71 papers from HowNet, 36 papers from Wanfang, and 12 papers from VIP. This study used Endnote X9 software to delete 46 papers that were repeatedly published. First, Read the titles and abstracts of the remaining

Table 1. General characteristics of the included literature

Study	Number of people Test group/Control group	Comparability of baseline information	Methods of intervention		Outcomes	Healing period	Adverse event	Methods of Acupuncture
			Test group	Control group				
white crane, 2021	44/44	comparable	Rehabilitation training combined with acupuncture	Rehabilitation training treatment	MBI scale, MAS scale, CSI scale, ER	6 weeks	0	Deqi
Yu Jiansong, 2021	100/100	comparable	Routine rehabilitation exercise combined with acupuncture	Routine Rehabilitation Exercise Therapy	MBI scale, ER	2 months	0	Deqi/Twirl
Rong Shanshan, 2020	38/38	comparable	Conventional basic treatment and nursing combined with acupuncture	Routine basic treatment and care	MAS scale, ER	8 weeks	0	Deqi
yellow lotus. 2020	45/45	comparable	Conventional rehabilitation system therapy combined with electroacupuncture stimulation combined with local vibration therapy	Conventional Rehabilitation System Therapy Treatment	MBI scale, MAS scale, CSI scale, ER	8 weeks	0	Acupuncture
Tang Yizhou, 2021	30/30	comparable	Jiaji electroacupuncture combined with conventional therapy	conventional therapy	MBI scale, CSI scale, ER	4 weeks	0	Acupuncture
Yu Fangfei, 2018	40/40	comparable	Routine rehabilitation training combined with electroacupuncture stimulation therapy	routine rehabilitation	MBI scale, MAS scale, CSI scale, ER	4 weeks	0	Acupuncture
Wu Jinlong, 2021	42/42	comparable	Rehabilitation training combined with Du meridian electroacupuncture	Rehabilitation training treatment	MBI scale, CSI scale, ER	3 months	0	Acupuncture
Jiang Nan, 2020	35/35	comparable	BWST bundled motor function rehabilitation training combined with myoelectricity	BWST bundled motor function rehabilitation training treatment	MAS scale, CSI scale, ER	8 weeks	0	Acupuncture
Shanbin, 2018	20/20	comparable	acupuncture treatment	conventional rehabilitation	MBI scale, MAS scale, ER	12 weeks	0	Deqi
Xiong F, 2021	24/24/24	comparable	Tongdu Tiaoshen Acupuncture Combined with Conventional Rehabilitation	routine rehabilitation	MBI scale, CSI scale, ER	5 weeks	0	Deqi

126 papers, according to the inclusion and exclusion criteria, exclude 113 reviews, reviews, Meta-analysis, re-screen the full text of the 13 papers after screening, and exclude 2 of them from the same research institution that included repeated cases Papers with different topics, and 1 paper that could not extract relevant data on the effect of acupuncture combined with rehabilitation therapy on the recovery of muscle spasticity in patients with spinal cord injury. Finally, 10 papers were included in our meta-analysis.[21-23,26-32] The literature screening process is shown in Figure 1. The general characteristics of the included literature are listed in Table 1.

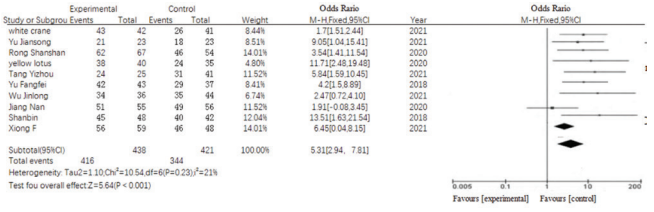
Figure 1. Literature incorporation process



Meta-analysis results

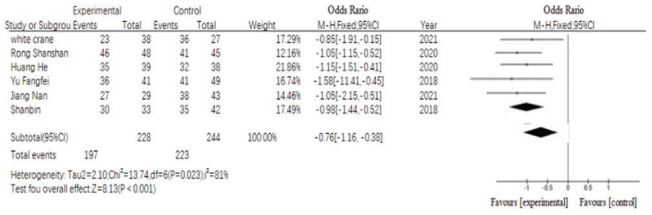
ER analysis of clinical efficacy. The 10 studies [21-23, 26-32] all reported clinical efficacy ER. Since the combined effect size of each study was not significantly heterogeneous (P = .23, I^2 = 21%), the fixed effect model was used for analysis. The results showed MD=5.31, 95%CI (2.94, 7.81), Z=5.64, and P < .001, suggesting that the experimental group had a more significant clinical effect on muscle spasm after spinal cord injury than the control group. See Figure 2.

Figure 2. Meta-analysis forest plot of the clinical effectiveness of acupuncture combined with rehabilitation therapy and other therapies



MAS scale analysis: Six studies [21,23,26,28,30,31] reported MAS. There was significant heterogeneity after the combined effect size of the included studies (P < .05, I^2 = 81%). Using the random effect model analysis, the results showed that compared with the control group, the improvement of MAS scores in the experimental group was better: MD=-0.76, 95%CI (-1.16, -0.38), Z=8.13, P < .001. See Figure 3.

Figure 3. Forest plot of meta-analysis of MAS scores of acupuncture combined with rehabilitation therapy and other therapies



Analysis of Spasticity Index (CSI) Score: Seven studies [21,26,27-30,32] reported the spasticity index (CSI) score, and there was significant heterogeneity in the combined effect size of the included studies (P < .05, I^2 = 88%). A random effects model was used. The results showed that the experimental group was better than the control group in reducing patients' CSI scores MD= -3.09, 95%CI (-4.51, -1.67), Z =4.28, P < .001. See Figure 4.

Analysis of MBI index of activities of daily living: Eight studies[21-22,26-29,31-32] reported MBI scores, and there was significant heterogeneity in the pooled effect sizes of the

included studies (P = .18, I^2 = 35%). A fixed-effects model was used for analysis. The results showed that the improvement of MBI score in the experimental group was better than that in the control group MD=9.81, 95%CI (7.84, 11.71), Z=12.71, P < .001; no adverse events were reported in the experimental group and the control group. See Figure 5.

Assessment of publication bias

Based on the Meta-analysis results of the above two groups, the Rev Man funnel plot was used to evaluate whether there was publication bias in each result. As shown in Figure 4, the funnel plot is basically symmetrical, indicating that no significant publication bias was seen. At the same time, the publication bias was quantitatively analyzed by using the method of calculating the safety factor. See Figure 6.

DISCUSSION

The spinal cord is an important part of the nervous system. If the spinal cord is damaged, the brain cannot regulate the sensory and motor functions of the limbs and organs below the level of the damaged spinal cord.[33] Spinal cord injury can be affected by a variety of reasons, such as spinal displacement and vertebral body damage.[34] In this study, combined with acupuncture rehabilitation therapy, the clinical effect of acupuncture rehabilitation on muscle twitching after spinal cord injury and its influence on limb function were discussed. It can be seen that the clinical effect of acupuncture rehabilitation therapy on the recovery of limb spasms after spinal cord injury is better than acupuncture treatment, and the clinical effect is better than acupuncture treatment alone.

Due to a variety of reasons, the spinal column is displaced, the vertebral body is damaged, and then the spinal cord is compressed into the spinal canal, resulting in spinal cord injury.[1] Spinal cord injury generally leads to sensory and motor abnormalities below the injured spinal cord, as well as sphincter function and autonomic dysfunction, while motor and sensory disturbances help to locate the level of spinal cord lesions. The spinal cord is an important structure of the nervous system. Its upper end connects to the medulla oblongata and descends along the medial side of the spinal canal, forming a spinal cord cone at the lower edge of the first lumbar vertebra. The gray and white matter within the spinal cord are primary centers for a variety of movements and sensations, as well as important reflex centers.[23] The spinal cord plays a role in communication between the brain, the limbs, and the body. When the spinal cord is damaged, the connection is interrupted, and the brain cannot regulate the sensory and motor functions of the limbs and organs below the level of the injured spinal cord, which leads to patients below the level of injury dysfunction and have a great impact on the physical and mental health of patients.[31] In traditional Chinese medicine, SCI belongs to the category of "atrophy syndrome". The "Internal Classics" defines and defines "atrophy" and puts forward that "all diseases in the five internal organs can cause impotence" and "the treatment of impotence should be based on the theory of Yangming." Atrophy syndrome generally manifests as weakness of limbs, difficulty in moving, muscle atrophy, inability to flex or extend joints, etc. Yiguan said: "There is another class, whose upper and lower body are all paralyzed, and their urine may be astringent, or enuresis." Insomnia." "Synopsis of the Golden Chamber. Lung impotence, lung abscess, cough, upper qi disease, pulse syndrome, and treatment" has a record that "those with phlegm in lung obstruction without coughing are enuresis and frequent urination", but the specific pathogenesis is not yet known. Therefore, its dialectical classification is very necessary. It is also mentioned in "Su Wen Zhizhenyao Dalun": "Disease of Shaoyin, disease of little Qi, weak bones, and poor intestines." The description of these materials cannot be compared with the current limb atrophy caused by spinal cord injury activity, accompanied by clinical manifestations of bladder and digestive tract dysfunction. Lower extremity spasticity is a common complication of SCI. Franz et al. came to a conclusion[13] that

Figure 4. Forest plot of meta-analysis of CSI score of acupuncture combined with rehabilitation therapy and other therapies

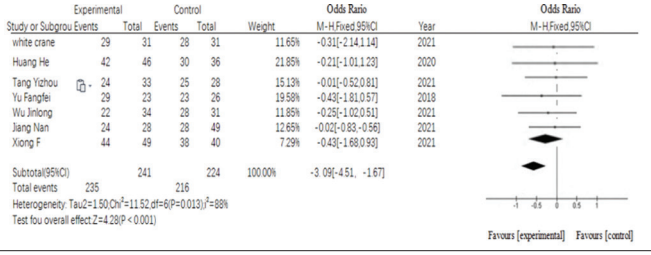


Figure 5. Forest plot of meta-analysis of MBI score of acupuncture combined with rehabilitation therapy and other therapies

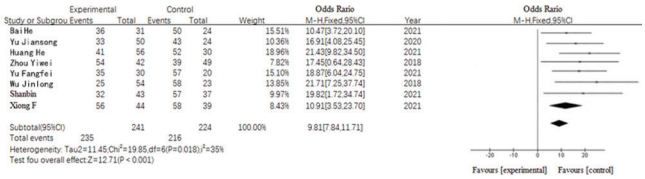
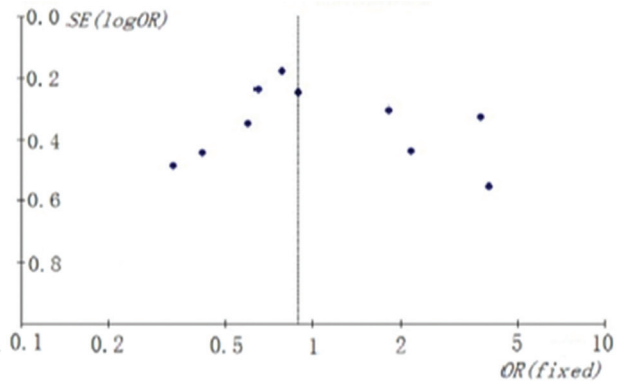


Figure 6. Meta-analysis of the effects of treatment methods on the recovery of muscle spasticity in patients with spinal cord injury



12% to 37% of SCI patients may develop lower extremity spasticity, and the incidence rate is relatively high. Lower extremity spasticity is mainly caused by disturbance of motor control after upper motor neuron injury.[14] The role of spasticity in patients is dual. Appropriate low-level limb spasticity can delay muscle atrophy and help patients stand up, but uncontrolled limb spasticity can lead to limb pain, heterotopic ossification, and difficulty walking.[7]

For patients with muscle spasms, if not treated in time, it will affect the improvement of the patient's muscle strength and muscle tone-dependent endurance and seriously affect the recovery and recovery of the patient. Currently, both acupuncture and rehabilitation training are effective methods for rehabilitating SCI patients. However, the concepts of acupuncture and rehabilitation are different, and there are many types. How to combine these two methods organically and clinically to get a better application is a problem we need to consider.[23]

Baihe[21] conducted research on the rehabilitation effect of acupuncture at Du Meridian and Jiaji Points on SCI patients. A total of 88 patients were collected and randomly divided into two groups, namely the rehabilitation training group and the acupuncture group. Based on this treatment observation group the results showed that patients who were treated with acupuncture and moxibustion had a more significant recovery effect, and its effectiveness far exceeded that of simple rehabilitation. This topic intends to use acupuncture rehabilitation therapy as a holistic therapy and adopts the Meta-analysis method to screen the database comprehensively from the aspects of the literature search database, search terms, inclusion criteria, exclusion criteria, etc. Acupuncture, rehabilitation therapy, or a combination of other therapies were compared in curative effect of limb twitching after spinal cord injury. The results suggest that acupuncture rehabilitation therapy has a better clinical effect on the recovery of limb spasticity after spinal cord injury than acupuncture therapy and has better clinical efficacy than acupuncture alone. At the same time, the research results of Yu Jiansong et al. 22 divided 200 SCI patients into two groups and combined rehabilitation training with acupuncture. Acupuncture and moxibustion selected Du points, and acupoints were allocated according to syndromes and supporting evidence. The exercise ability and self-care ability of the acupuncture group were better than those of the rehabilitation training group. There is a significant improvement. Rehabilitation training combined with acupuncture and moxibustion has a good clinical effect, and the results of this study are similar to them. CSI score, MBI score, and clinical effective rate were significantly improved. In the data collected in this study, there is no adverse reaction, which shows that the operation of acupuncture and moxibustion combined with rehabilitation treatment has good safety. Rong Shanshan et al.[23] used acupuncture at points such as "Du Meridian" and "Jiaji Point" to greatly improve the motor, walking, and sensory functions of SCI patients, which has greater advantages compared with the traditional therapy group, indicating that acupuncture " "Du Vessel" and "Jiaji Point" have a better effect on improving the motor function of SCI patients. The results of this study also highlight the good effect of acupuncture on patients, and the results of this study are similar. However, since the data in this study come from a small-scale randomized controlled trial, there is a certain degree of bias in the calculation of the effect size. Through the comprehensive analysis of multiple experimental results with the same results, the results show that the differences between the experimental results of different experimental results are more obvious. The specific treatment plan, selection of acupuncture points, specific rehabilitation operation methods, intervention timing, and follow-up evaluation were different among different studies, which may be the main reason for the heterogeneity.

Through investigation, we found that there are some urgent problems to be solved in clinical treatment research: (1) Although the current literature reports some characteristics of acupuncture and moxibustion treatment, there are also many reports that only briefly describe the efficacy indicators; there is no in-depth research on different disease types; (2) The outcome indicators are relatively subjective, such as the MAS scoring scale and the manual spasticity test, which are used to evaluate the four muscle groups, relying only on the resistance of joint passive movement As the basis of evaluation, the subjective feeling is not quantitatively accurate enough. For the evaluation of spasticity, factors such as the trigger of spasticity, relief of aggravating factors, severity, and distribution should also be considered. (3) The clinical research of acupuncture and moxibustion is complicated. The main feature of acupuncture and moxibustion is the diversification and personalization of selection and manipulation.[23] Under different conditions, there will inevitably be deviations; (4) the determination of the sample size is not specified in detail, and most of them are small-sample studies; (5) most of the studies do not have a follow-up after recovery, or the Results of follow-up were not clearly described.

Based on the previous research, this project intends to explore the clinical efficacy of acupuncture and rehabilitation therapy on muscle twitching after spinal cord injury and its influence on limb function by combining acupuncture and rehabilitation therapy with spinal cord injury as the starting point. However, limited by the number of samples, we need further multi-center, large-sample, high-quality clinical trials to confirm.

DATA AVAILABILITY

The simulation experiment data used to support the findings of this study are available from the corresponding author upon request.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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REFERENCES

1. Li Z, Wu F, Xu D, Zhi Z, Xu G. Inhibition of TREM1 reduces inflammation and oxidative stress after spinal cord injury (SCI) associated with HO-1 expressions. *Biomed Pharmacother*. 2019;109:2014-2021. doi:10.1016/j.biopha.2018.08.159
2. Anjum A, Yazid MD, Fauzi Daud M, et al. Spinal cord injury: pathophysiology, multimolecular interactions, and underlying recovery mechanisms. *Int J Mol Sci*. 2020;21(20):7533. doi:10.3390/

ijms21207533
3. Shi Z, Yuan S, Shi L, et al. Programmed cell death in spinal cord injury pathogenesis and therapy. *Cell Prolif*. 2021;54(3):e12992. doi:10.1111/cpr.12992
4. Lin S, Li Y, Lucas-Osma AM, et al. Locomotor-related V3 interneurons initiate and coordinate muscles spasms after spinal cord injury. *J Neurophysiol*. 2019;121(4):1352-1367. doi:10.1152/jn.00776.2018
5. Fauss GNK, Hudson KE, Grau JW. Role of descending serotonergic fibers in the development of pathophysiology after spinal cord injury (SCI): contribution to chronic pain, spasticity, and autonomic dysreflexia. *Biology (Basel)*. 2022;11(2):234. doi:10.3390/biology11020234
6. Theisen KM, Mann R, Roth JD, et al. Frequency of patient-reported UTIs is associated with poor quality of life after spinal cord injury: a prospective observational study. *Spinal Cord*. 2020;58(12):1274-1281. doi:10.1038/s41393-020-0481-z
7. Field-Fote E C, Furbish C L, Tripp N E, et al. Characterizing the experience of spasticity after spinal cord injury: a national survey project of the Spinal Cord Injury Model Systems centers. *Archives of physical medicine and rehabilitation*. 2022;103(4): 764-772. e2. doi:10.1016/j.apmr.2021.03.040
8. Guest J, Datta N, Jimsheleishvili G, Gater DR Jr. Pathophysiology, classification and comorbidities after traumatic spinal cord injury. *J Pers Med*. 2022;12(7):1126. doi:10.3390/jpm12071126
9. Hofstoetter US, Freundl B, Danner SM, et al. Transcutaneous spinal cord stimulation induces temporary attenuation of spasticity in individuals with spinal cord injury. *J Neurotrauma*. 2020;37(3):481-493. doi:10.1089/neu.2019.6588
10. Huang Q, Duan W, Sivanesan E, et al. Spinal cord stimulation for pain treatment after spinal cord injury. *Neurosci Bull*. 2019;35(3):527-539. doi:10.1007/s12264-018-0320-9
11. Iqubal A, Ahmed M, Iqubal MK, Pottoo FH, Haque SE. Polyphenols as potential therapeutics for pain and inflammation in spinal cord injury. *Curr Mol Pharmacol*. 2021;14(5):714-730. doi:10.2174/1874467213666201223111743
12. Todd KR, Lawrason SVC, Shaw RB, Wirtz D, Martin Ginis KA. Physical activity interventions, chronic pain, and subjective well-being among persons with spinal cord injury: a systematic scoping review. *Spinal Cord*. 2021;59(2):93-104. doi:10.1038/s41393-020-00550-z
13. Franz S, Schulz B, Wang H, et al. *Management of pain in individuals with spinal cord injury: Guideline of the German-Speaking Medical Society for Spinal Cord Injury*. GMS German Medical Science; 2019:17.
14. Huang H, Young W, Skaper S, et al; International Association of Neurorestoratology and The Chinese Association of Neurorestoratology. Clinical neurorestorative therapeutic guidelines for spinal cord injury (IANR/CANR version 2019). *J Orthop Translat*. 2019;20(20):14-24. doi:10.1016/j.jot.2019.06.005
15. Gant KL, Guest JD, Palermo AE, et al. Phase 1 safety trial of autologous human schwann cell transplantation in chronic spinal cord injury. *J Neurotrauma*. 2022;39(3-4):285-299. doi:10.1089/neu.2020.7590
16. Tsuji O, Sugai K, Yamaguchi R, et al. Concise review: laying the groundwork for a first-in-human study of an induced pluripotent stem cell-based intervention for spinal cord injury. *Stem Cells*. 2019;37(1):6-13. doi:10.1002/stem.2926
17. Zipser CM, Cragg JJ, Guest JD, et al. Cell-based and stem-cell-based treatments for spinal cord injury: evidence from clinical trials. *Lancet Neurol*. 2022;21(7):659-670. doi:10.1016/S1474-4422(21)00464-6
18. Arnold BM, Toosi BM, Caine S, Mitchell GS, Muir GD. Prolonged acute intermittent hypoxia improves forelimb reach-to-grasp function in a rat model of chronic cervical spinal cord injury. *Exp Neurol*. 2021;340(340):113672. doi:10.1016/j.expneurol.2021.113672
19. Fernandes S R, Salvador R, de Carvalho M, et al. Modelling studies of non-invasive electric and magnetic stimulation of the spinal cord. *Brain and human body modeling*. 2020;139-165.
20. Zeng YS, Ding Y, Xu HY, et al. Electro-acupuncture and its combination with adult stem cell transplantation for spinal cord injury treatment: A summary of current laboratory findings and a review of literature. *CNS Neurosci Ther*. 2022;28(5):635-647. doi:10.1111/cns.13813
21. He B. Effect of acupuncture combined with rehabilitation training on the rehabilitation effect of patients with incomplete spinal cord injury. *Guangming Traditional Chinese Medicine*. 2021;36(24):4220-4222.
22. Yu J, Liu Y, Feng W, et al. Clinical research on acupuncture combined with routine rehabilitation exercise for spinal cord injury. *New Chinese Medicine*. 2021;53(14):146-149.
23. Rong S, Wei S, Yi Y, et al. Effect of acupuncture on the rehabilitation of lower limb function in patients with limb motor dysfunction after incomplete spinal cord injury. *Zhejiang Journal of Traditional Chinese Medicine*. 2020;55(2):126-127.
24. Jiang K, Sun Y, Chen X. Mechanism underlying acupuncture therapy in spinal cord injury: A narrative overview of preclinical studies. *Front Pharmacol*. 2022;13(3):875103. doi:10.3389/fphar.2022.875103
25. Xu H, Yang Y, Deng QW, et al. Governor vessel electro-acupuncture promotes the intrinsic growth ability of spinal neurons through activating calcitonin gene-relatd peptide/α-calcium/calmodulin-dependent protein kinase/neurotrophin-3 pathway after spinal cord injury. *J Neurotrauma*. 2021;38(6):734-745. doi:10.1089/neu.2020.7155
26. He H, Xiang L, Wei C, et al. Effects of electroacupuncture combined with local vibration therapy on rehabilitation and serum BDNF and PDGF in patients with spinal cord injury complicated with lower limb spasticity. *Advances in Modern Biomedicine*. 2020;20(15):5.
27. Tang Y, Chong Z, Jiao C. etc. Clinical study on Jiaji electronic -puncture combined with conventional therapy in the treatment of 30 cases of muscle spasm after spinal cord injury. *Jiangsu Traditional Chinese Medicine*. 2021;53(8):48-51.
28. Yu F, Jia X, Li W, et al. Effects of electroacupuncture on motor function and excitability of cerebral cortex motor areas in patients with incomplete spinal cord injury. *Chinese Journal of Traditional Chinese Medicine*. 2018;59(21):1848-1852.
29. Wu J, Kun Y, Jin Y, et al. Clinical research on electroacupuncture of governor vessel combined with rehabilitation training for motor and sensory disturbance after spinal cord injury. *New Chinese Medicine*. 2021;53(18):131-134.
30. Nan J, Zhi L, Wang F, et al. Effects of key myoelectric acupuncture combined with BWST bundle motor function rehabilitation training on motor function recovery in patients with incomplete spinal cord injury. *Journal of Clinical and Experimental Medicine*. 2020;19(20):2228-2231.
31. Shanbin SUN, Yanju LI, Chong C, et al. Governor vessel-unblocking and mind-regulating acupuncture therapy for sensory and motor dysfunction after spinal cord injury. *World J Acupunct Moxibustion*. 2018;28(2):71-74. doi:10.1016/j.wjam.2018.06.006
32. Xiong F, Lu J, Pan H, et al. Effect of Specific Acupuncture Therapy Combined with Rehabilitation Training on Incomplete Spinal Cord Injury: A Randomized Clinical Trial. *Evid Based Complement Alternat Med*. 2021;2021:5671998. doi:10.1155/2021/5671998
33. Anjum A, Yazid MD, Fauzi Daud M, et al. Spinal Cord Injury: Pathophysiology, Multimolecular Interactions, and Underlying Recovery Mechanisms. *Int J Mol Sci*. 2020;21(20):7533. doi:10.3390/ijms21207533
34. McDonald JW, Sadowsky C. Spinal-cord injury. *Lancet*. 2002;359(9304):417-425. doi:10.1016/S0140-6736(02)07603-1