Zou Y et al. (2024) META-ANALYSIS OF EARLY INTEGRATED REHABILITATION TRAINING FOR MANAGING LIMB SPASTICITY IN ATHLETES POST-INJURY. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte vol. 24 (98) pp. 315-328.
DOI: https://doi.org/10.15366/rimcafd2024.98.021

ORIGINAL

META-ANALYSIS OF EARLY INTEGRATED REHABILITATION TRAINING FOR MANAGING LIMB SPASTICITY IN ATHLETES POST-INJURY

Yuting Zou[1*], Chaojin Luo[1], Deying Tian[1]

[1] Rehabilitation Medical Center, West China Hospital of Sichuan University, Chengdu 611130, Sichuan Province, China.
E-mail: Wanlisheng888@163.com

Recibido 21 de enero de 2024 **Received** January 21, 2024
Aceptado 21 de septiembre de 2024 **Accepted** September 21, 2024

ABSTRACT

Objective: To systematically assess the effectiveness of acupuncture combined with rehabilitation therapy on limb functionality in athletes experiencing muscle spasm post-spinal cord injury (SCI). **Methods:** We conducted a comprehensive search in PubMed, Cochrane Library, CNKI, VIP, and Wanfang databases up to October 2018 for clinical randomized controlled trials examining the combination of acupuncture and rehabilitation therapy for muscle spasm following SCI. A meta-analysis of the collected data was performed using RevMan 5.3 software, focusing on outcomes relevant to athletic rehabilitation. **Results:** Eleven studies, all conducted in China involving 715 participants, were included. The meta-analysis revealed significant benefits of the combined treatment approach. The experimental group exhibited a higher clinical response rate than the control group [MD = 5.02, 95% CI (3.05, 8.28), Z=6.34, P<0.001]. Improvements were also noted in the clinical spasticity index score [MD= -3.09, 95%CI (-4.51, -1.67), Z=4.28, P<0.001] and Ashworth score [MD= -0.84, 95% CI (-1.01, -0.67), Z=9.48, P<0.001], indicating better muscle spasm management. Additionally, improvements in the Barthel index suggested enhanced daily functioning [MD = 10.41, 95% CI (8.74, 12.09), Z=12.19, P<0.001]. No adverse events were reported in either group. **Conclusion:** The findings suggest that acupuncture in conjunction with rehabilitation therapy significantly enhances limb function and reduces spasticity in athletes with SCI. However, limitations in the scope of the studies reviewed necessitate further research with larger, multicenter trials to substantiate these results fully and optimize treatment protocols for athletic rehabilitation post-SCI.

KEYWORDS: early comprehensive rehabilitation training; limb spasm after spinal cord injury; Meta-analysis

1. INTRODUCTION

In the realm of sports, athletes are constantly pushing the limits of physical human performance, which invariably increases the risk of injuries, including severe ones such as spinal cord injuries (SCI). SCIs can be particularly devastating, often leading to complications like muscle spasm and limb spasticity, which significantly impede an athlete's ability to return to sport and maintain peak physical condition. Understanding and improving the rehabilitation processes for such injuries is crucial, not just for the immediate recovery, but also for the long-term health and career sustainability of the athlete. Muscle spasm and spasticity following SCI are common, presenting both challenges and setbacks in the rehabilitation journey of an athlete. Spasticity affects muscle control and can be painful, leading to decreased functional abilities and a prolonged recovery period. Traditional rehabilitation methods have been employed to manage these symptoms, but with varying degrees of success. There is a growing need to explore and validate complementary therapies that can enhance these outcomes, especially in a sports context. Acupuncture, a key component of traditional Chinese medicine, has shown potential benefits in managing various neurological symptoms, including those associated with SCIs like muscle spasm and spasticity. When combined with conventional rehabilitation therapies, acupuncture is thought to facilitate better management of spasticity, potentially enhancing recovery rates and improving quality of life. The physiological rationale behind acupuncture involves the stimulation of certain body points believed to modulate the nervous system, thereby reducing pain and muscular tension. Despite anecdotal successes, there is a scarcity of comprehensive, scientifically rigorous investigations into the effectiveness of integrating acupuncture with rehabilitation therapy specifically for athletes recovering from SCI. This gap highlights the need for a systematic evaluation through meta-analysis, which can synthesize existing data to provide clearer insights into the efficacy of these combined therapies in a sports rehabilitation setting. The primary objective of this study is to conduct a meta-analysis of randomized controlled trials that assess the impact of acupuncture combined with rehabilitation therapy on limb functionality in athletes who have experienced an SCI (Hasan, Atmuangkhwang, & Durand, 2022; Ketchum et al., 2022). By focusing on randomized controlled trials, the study aims to provide the highest level of evidence on the effectiveness of these combined therapies, potentially guiding clinical practices and athlete management strategies post-injury. This research is expected to contribute valuable information to the fields of sports medicine and athlete rehabilitation by clarifying the role and effectiveness of acupuncture alongside traditional rehabilitation methods. The findings could lead to enhanced protocols that are specifically tailored for athletes, helping them regain function

and return to their sports more effectively and safely post-SCI. Such insights are essential not only for clinicians and therapists but also for coaches and sports organizations aiming to provide the best care for their athletes.

2. The Study Objects and Methods

2.1 Study Object

Computer search combines subject words and free words. The registration database of Pubmed and Cochrane, CNKI database, Wanfang database and VIP database were searched. The search time is from its establishment to October 2018. Keywords "Acupuncture", "Electroacupuncture", "Spinal Cord Injuries", "Tics", "Spasm", "Spastici-", "Muscle Hypertonia", "Rehabilitation", "acupuncture", "acupuncture", "acupuncture" and free words. Chinese search terms: "electric needle", "spinal cord", "muscle tension", "paraplegia", "spasm", "rigidity".

2.2 Inclusion Criteria

① Clinical randomized controlled experiment; ② The study subjects were patients with a definite diagnosis of SCI, Concurrent muscle spasm after SCI; ③ The intervention method can be the combination of various acupuncture therapy and various rehabilitation therapy; ④ The treatment regimen of the control group, except for not including acupuncture combined with exercise therapy, Can be used for any other form of treatment; ⑤ With at least one of the following outcome measures: the clinical efficacy grade or score evaluated by the Ashworth scale (MAS) criteria, Clinical spasticity index (CSI) score, Barthel index score for activities of daily living (MBI index, and clinical response rate (ER) based on the above outcome measures. Experimental data with multiple course assessments were included for the last one.

2.3 Exclusion Criteria

① Non-clinical randomized controlled experiment; ② Comparison between the effects of different acupuncture or exercise therapy; ③ study on acupuncture therapy or combined functional recovery training as auxiliary treatment; ④ literature on relevant indicators and data; ⑤ experimental study on non-interventional acupuncture schemes such as acupoint injection, needle knife, collateral release, and plum needle; ⑥ patients with serious complications or other major diseases, consciousness disorders, cognitive impairment and pregnant women who are not suitable for established treatment.

2.4 Statistical Methods

The data from the included literature were tically analyzed by RevMan V5.3 software. odds ratio (Odds Ratio, OR) and 95%CI; mean difference (Mean

Difference, MD) and 95%CI; for continuity variables (Std.Mean Difference ， SMD ）。Study heterogeneity between chi-square test values and I^2 test: when P> 0.10 and I2 <50%, without combined effect size, the fixed effect model (Fixed Effect); when P <0.10, I2> 50%, the combined effect size was considered significant, then random effect model (Randomized Effect).

3. Literature Search Results

According to the search strategy, 880 articles were retrieved. After merging and removing all retrieved documents using Note Express software, 344 articles were obtained. 286 articles were excluded by reading the titles and abstracts. After excluding 47 articles after reading the full text, 11 articles were finally included (Fig 1).

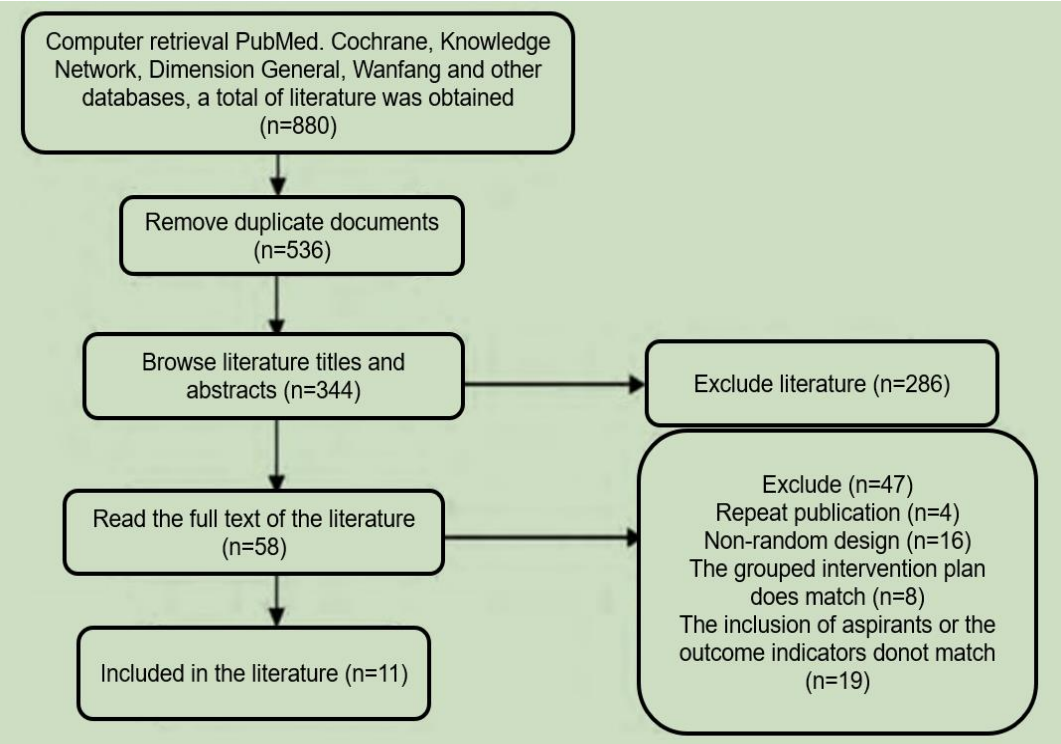

Figure 1: Flow chart of literature screening

3.1 Meta-Analysis Results

Seven studies reported clinical response rates, with a total of 482 patients enrolled. Given the combined heterogeneity of each study (P=0.25, I^2 =23%), a fixed effects model was used. The results showed that [MD=5.02,95%CI (3.05,8.28), Z=6.34, P <0.001] suggested that the clinical efficacy of the experimental group was greater than that of the control group after SCI. Subgroup analysis showed that the clinical response rate of patients in "acupuncture + rehabilitation + Western medicine" group was better than that of the control group [MD=6.89,95% CI (2.60,18.26), Z=3.88, P=0.0001]; the clinical response rate of patients in "acupuncture + rehabilitation + other" group

was better than that of the control group [MD =4.46,95%CI (2.49,7.99), Z=5.03, P <0.001]. In 3 studies, a total of 138 patients included a random effect model due to high heterogeneity after combined study effect sizes (P <0.1, I^2 =99%). The results showed that the experimental group was better than the control group in reducing the CSI score of patients [MD= -3.09,95%CI (-4.51, -1.67), Z=4.28, P <0.001]. After sensitivity analysis, 07,193 combined heterogeneities (P=0.50, I^2 =0%). The results of the Meta-analysis were relatively stable [MD= -3.99,95%CI (-4.07, -3.91), Z=92.86, P <0.001] (Fig 2-6).

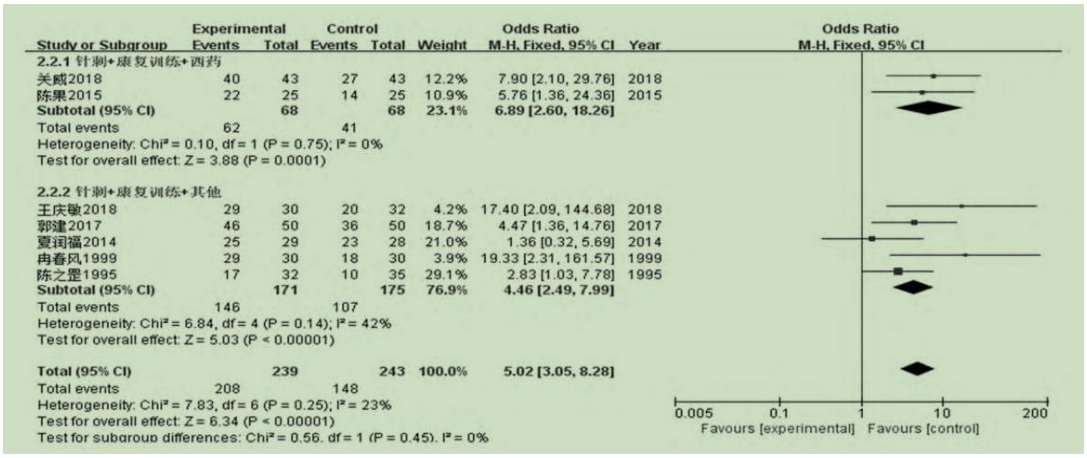

Figure 2: Meta-analysis forest plot

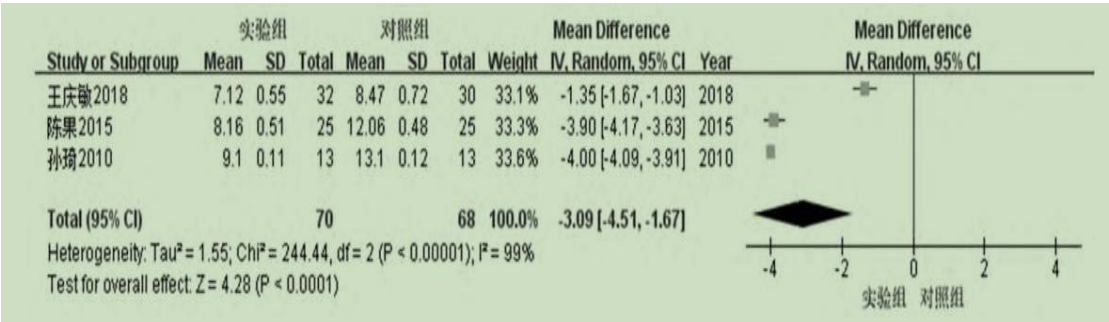

Figure 3: Acupuncture combined with rehabilitation therapy and other therapies CSI, meta-analysis of scoring forest plot (source of heterogeneity not excluded)

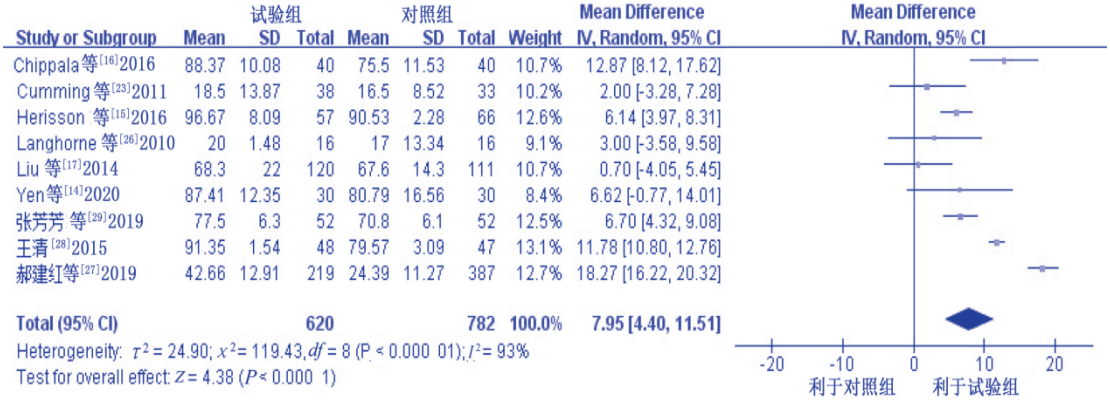

Figure 4: Meta-analysis of the two groups after 3 months of intervention

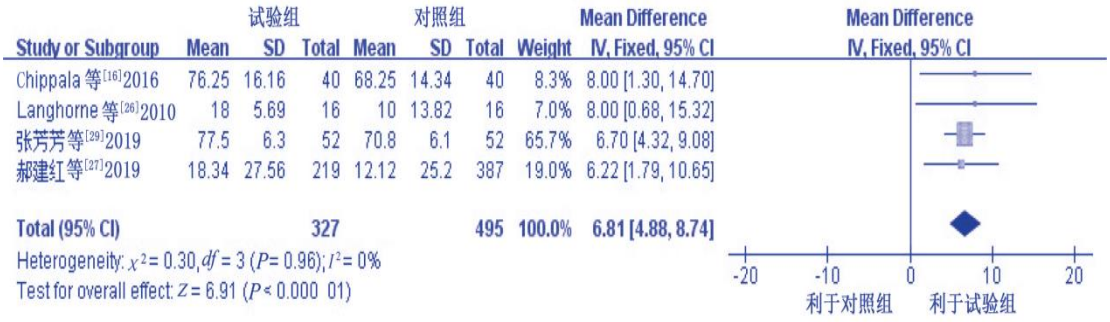

Figure 5: meta-analysis of two groups within 2 weeks of intervention

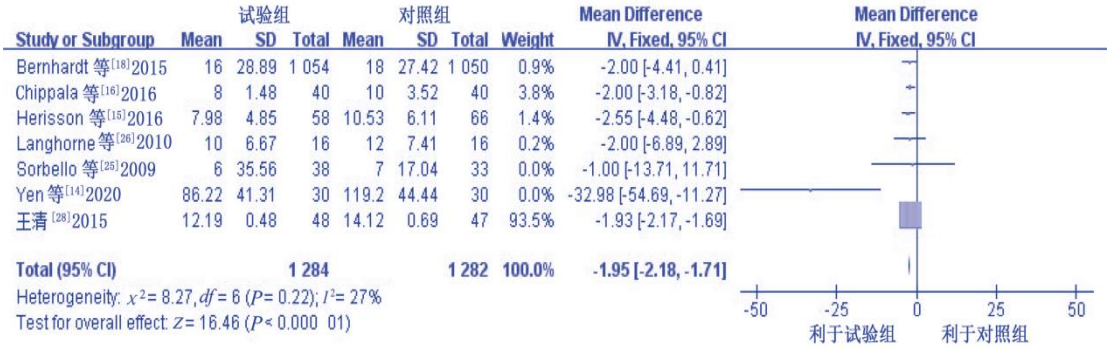

Figure 6: Forest plot of meta-analysis of hospitalization time of the two groups after intervention

4. Discussion

The incidence of spinal cord injury has increased significantly in recent years, seriously threatening the health of patients and bringing a burden to the family and society. With the development of surgical treatment of spinal cord injury, the disease mortality rate is significantly reduced, but it still has a high disability rate, poor recovery effect and low quality of life (Chang, Wang, Shen, Zhang, & Cai, 2023; Hu, Hu, & Hu, 2022; Lee et al., 2022; McNutt, Foreman, & Gotway, 2023). By understanding the individual needs of patients, the physical rehabilitation training of patients 'physical conditions, interests and hobbies, acceptance ability, so that the patients' confidence in rehabilitation is doubled and the rehabilitation effect is good, which is well received by doctors and patients (He et al., Journal of Qilu Nursing; "The influence of full Haiyan rehabilitation nursing combined with functional training on limb movement function and daily living ability of children after spastic cerebral palsy," 2022; Jiang, Jiang, Liu, & Yin, 2022; S. Xie, Wu, Chen, & Chen, 2022). The training content mainly includes the training of shoulder joint, hip knee joint and hand function, etc. In addition to the individualized rehabilitation training for patients, the observation group of this study also paid attention to the intervention of patients' families and helped patients to recover through comprehensive intervention (J. Li et al., 2022). Spinal cord injury is a common central nervous system disease for which muscle spasm is a major complication. Statistics show that the vast majority of SCI patients will have muscle spasm; if patients

with muscle spasm are not treated timely, it will inevitably affect the improvement of muscle tension and muscle tension dependence resistance, which will seriously affect the recovery and recovery of SCI patients. At present, acupuncture therapy and rehabilitation training are effective treatment methods for SCI patients. However, acupuncture therapy and rehabilitation have different concepts and various varieties. How to effectively apply them to the clinical practice is a problem that we should think about (Tang, Wei, & Li, 2022) (Lin, Chen, Liu, & Cao, 2023). Research for the first time with acupuncture combined with rehabilitation therapy as a whole treatment plan, by comparing it with other therapies, the system evaluation of acupuncture combined with rehabilitation therapy compared with other therapy (e. g., acupuncture therapy, rehabilitation therapy, and combined with other treatments) for the treatment of limb spasm after SCI randomized control experiment and Meta-analysis. The statistical results showed that through the combination of the two, the experimental group was better than the control group in terms of improving the MAS score, CSI score, MBI score and clinical response rate of the patients with concurrent muscle spasm after SCI. It is proved that with the combination of acupuncture and rehabilitation therapy, the overall treatment effect of improving limb spasm in SCI patients is better than the treatment plan in the control group, highlighting the importance and advantages of acupuncture and rehabilitation therapy and its treatment concept in the clinical rehabilitation treatment of SCI patients (Feng, Xu, Zhou, Jin, & Zhang, 2021; Jin, Zou, & Pan, 2021; Luo, Zheng, & Chen, 2021; "Meta-analysis of the efficacy of Xiang Ting, Jiang Yunlan, Yue Yuan, Lin Yuzhu, Liu Yue Traditional Chinese medicine fumigation in the treatment of limb spasm after stroke ", 2022). No adverse events were reported in the literature included in the institute, indicating that the operation safety of acupuncture combined with rehabilitation therapy was good. In this study, the effect size of many studies with the same outcome index was combined, and the heterogeneity between the effect sizes of some combined studies was found to be significant. The reason for the suspected heterogeneity may be caused by the differences between the included studies in the specific treatment plan, the choice of acupuncture points, the specific operation method of rehabilitation treatment, the time of intervention, and the time of follow-up assessment (H. Wu, Zhu, Liu, & Jiang, 2021). The heterogeneity between the studies decreased or even disappeared through non-susceptibility analysis and subgroup analysis, and the conclusion after data analysis showed that the study conclusion was relatively stable. It must be noted that, Due to the following conditions, The outcome of this study should be viewed with caution: the generation of the randomization scheme in ① part of the study is unclear, There may be semi-random experiments to be included; ② Study cannot conduct allocation concealment, The end result may be the risk of human intervention; ③ None of the included studies described the implementation of the evaluator blindness; ④ The choice and reporting of study outcome measures are not uniform, Specific values of the primary outcome measures were not reported in

some studies, There is a risk of an incomplete outcome; ⑤ Studies differ in the inclusion criteria and intervention protocol, The study is limited; ⑥ All the included literature have been published, And the grey literature was not included in the conditions, There may be a publication bias. Spinal cord injury is a severe traumatic injury that leads to a variety of motor, sensory and sphincter dysfunction that damage the corresponding segments. Some studies have found that compared with those who started rehabilitation training only 3 months after injury, the inpatient rehabilitation time and functional recovery score are significantly shorter within 3 months after injury (Zhang, Ma, & Xu, 2021). By exploring the interventional timing of rehabilitation treatment for SCI patients, it was found that rehabilitation of patients within 2 weeks after injury could effectively reduce the incidence of complications and improve their ADL (F. Wu et al., 2021). It can be seen that it is very important for SCI patients to carry out rehabilitation exercise as soon as possible. One of the main purposes of spinal cord injury rehabilitation is to transfer and transfer the patient. Once the patient's vital signs are stable, rehabilitation function training should be started as soon as possible to keep the paralyzed limb in a good functional position, and passive movement should be performed to maintain the joint range of motion and avoid joint contracture and deformity. Early rehabilitation training for patients with SCI can effectively improve motor function, reduce complications and improve quality of life ("The influence of Qu Yanfang's characteristic rehabilitation nursing on the rehabilitation of hemiplegia spasm after stroke," 2021). In this study, the observation group patients began systematic rehabilitation training after admission is stable, the control group began systematic rehabilitation training in the recovery period, the results showed that the BI and FIM scores are significantly higher, but the observation group is significantly better than the control group, indicating that the system effective rehabilitation training of spinal cord injury, and the early rehabilitation training can further promote the recovery of motor function and daily living activities. Spasticity (spasticity) is a syndrome of abnormal increase in muscle tension caused by excessive activity of the stretch reflex, which often occurs during the damage of the descending motor conduction bundle. Muscular spasticity (muscle spasticity) is one of the common complications in paraplegia patients with spinal cord injury (spinal cord injury, SCD. It is reported that 12% to 37% of SCI patients have spasticity, and 40% of patients affect rehabilitation treatment because of spasticity, of which more than 25% have severe spasticity. Because spasticity often can lead to limb swelling pain, joint contracture, deformity, and then affect the ability to walk and maintain posture in the wheelchair, and increase the incidence of heterotopic ossification and fracture, seriously affect the daily life and rehabilitation treatment effect. This article focuses on the current occurrence mechanism and clinical treatment of muscle spasticity after SCI. Muscle tone is a stretch reflex that is completed by the γ loop. The pyramidal tract, extrapyramidal system, brainstem reticular structure and cerebellar system all regulate muscle tone (Ask, Xu, Guo, Zhao, & Cao,

2020). In the anterior horn of the spinal cord, the inhibitory effect of pyramidal tract on muscle tension; the extrapyramidal tract has both inhibition and excitation; the mesh structure of the brain stem plays a certain role in regulating the muscle tone and is an important basis for maintaining the posture; the cerebellar system mainly excited muscle tone, and the muscle tone is low in cerebellar lesions. The increased muscle tone is mainly caused by the weakening or disappearance of the normal inhibition of muscle tone after pyramidal tract and extrapyramidal lesions. The pyramidal tract is composed of giant pyramidal cells in the motor area of the cerebral cortex and its neuraxis, and is the main structure to complete voluntary movements. Bilateral pyramidal tract lesions or wider lesions can cause paraplegia or spastic paralysis of the limbs, after which muscle spasm can occur with the increase of muscle tension (G. Wu, Feng, Tian, & Jin, 2020) (Gormley et al., 2022). For most patients, spasticity develops slowly and usually develops after spinal cord suppression (W. Xie & Wang, 2020). Wiesen danger suggested that the slow formation of spasticity is well demonstrated by the denervation structure at the level of the spinal cord. These compensatory responses are characterized by long-term changes in synaptic transmission. Lateral bud formation from the intact backbone fibers can be found in the degenerated synaptic region. Neuronal receptor hyperactivity is a compensatory response to the loss of synaptic afferent impulses. The formation of all these mechanisms takes some time and, often, coincides with the timing of spasticity formation after an acute injury ("The influence of Cao Yan's comprehensive rehabilitation nursing therapy on the recovery degree of muscle spasm in hemiplegic limb caused by stroke ", 2020). However, recent findings have questioned the above explanation. Although over activity of γ motor neurons is seen in some cases, changes in the activity background of motor neurons and interneurons may be a more important factor. Changes within the spinal cord may be the most important factor for attenuated motor neuron inhibition in γ. Loss of function of the descending corticospinal fibers would most likely lead to reductions in inhibitory interneuron activity. There is evidence that the tendon organ (I. Afferent) activated inhibitory interneurons activity decreases, and normal inhibition of some γ motor neurons from the tendon organs may disappear when muscle tone is increased. It has also been shown that workers are regulated by γ aminobutyric acid (GABA) interneurons. Less presynaptic inhibitory activity at the afferent terminals, which would cause α motor neurons to produce more than beyond the normal muscle pulling excitatory effect. The clinical manifestations of muscle spasm after SCI are increased muscle tone, tendon hyperreflexia, paroxysmal spasm, and myotonia. Spasticity can affect the voluntary movement, because of the phenomenon of speed dependence, normal activity will trigger excessive stretch reflex activity, making the muscle tonic. The most commonly affected muscle groups are the forearm flexulator or quadriceps lower limbs. Sometimes the stretch reflex is periodically activated and is called clonus. Muscle spasm has both positive and negative effects on the patients,

which is beneficial to the patient: ① should be performed at least 2 times a day, 20min each time. Using 30% to 40% zero-load treadmill exercise, the gastrocnemius extension reflex decreased, the standing period decreased, and the walking stability was enhanced. The spasticity suppression method of reflex, such as joint movement of distal lower limb muscle can extend dorsiflexor of toe, induce dorsiflexion, knee flexion, hip flexion and external rotation of toe and foot joint; joint movement of upper limb extensor muscle, such as the extension of finger joint flexor, can induce elbow extension and external rotation of shoulder joint, and then reduce muscle tension. Muscular spasm in SCI patients is associated with distraction reflex hyperactivity that occurs after upper motor neuron injury. Lestrained muscles can reduce hyperactive reflex activity and help relieve spasticity. Passive or active training and stretching exercises (including standing or splinting therapy) are key to the short-term and long-term management of spasticity. Standing training with inclined bed or standing cabinet can play a good distraction effect on hip flexors, knee flexors and ankle flexors, thus inhibiting the occurrence of spasm. Standing training was performed twice daily for 30 to 45 min each time. Cold therapy also has a role in relieving muscle spasm. The early effect of skin cooling is usually triggering spasticity. Given the short duration of cold therapy to reduce spasticity (1 to 2 h) and the long ice application time (15min or longer), it should not be performed daily, but can be used in combination with other therapies. Spa DT has a full-body electric bath, Hubbard bath, walking bath, water sports pool training and water walking training. Various ways of hydrotherapy, especially water exercise therapy, can help to improve the residual muscle strength, exercise function and self-care ability of SCI patients, in a short time to relieve muscle tension, expand ROM, relieve muscle spasm, reduce numbness, swelling, pain and other symptoms. Hydrotherapy is a treatment to relieve spasticity rather than a radical cure, which has obvious effect on SCI rehabilitation (B. Li et al., 2022). Wax therapy has the function of relaxing spastic muscles, relieving pain and promoting blood circulation, and should be used before exercise therapy.3.3 Neurological block therapy. Barlophoenol has poor lipid solubility, and it is difficult for bacloophenol in the blood to cross the blood-brain barrier after oral administration, so the dose of oral bacloophenol is large. Intrathecal injection of baclophenol can directly inject the drug into the cerebrospinal fluid, so that the drug dosage is significantly reduced, but the efficacy is greatly improved. According to other literature reports, C9-11, the use of spinal placement of a chloride chloride pump is still effective. Pump and catheter implantation are simple and have few complications, and long-term intrathecal injection of baclophol through the implantation procedure is a non-destructive, safe, effective method with low incidence of infection. However, the treatment cost is relatively expensive, so its application is limited. The complications of this therapy include muscle weakness, hypotension, dizziness, and dysarthria, but they are relatively rare. As an N-type calcium channel blocker, intrathecal injection is more often used to treat chronic pain. Calcium channels are

necessary for presynaptic neurotransmitter release, but the mechanism by which calcium channel blockers treat spasticity remains unknown. Ridge-way et al reported that the spasm of two patients. Side effects include memory loss, intermittent confusion and other DaJ. Soni et al reported that intrathecal morphine treatment for spasticity in SCI patients achieved good results. In patients with SCI, intrathecal injection is ineffective, which can achieve good results. The botulinum toxin (botulinum toxin, BTX) BTX is a very strong exotoxin produced by clostridium botulinum in the anaerobic environment. According to the antigenicity of toxins, it can be divided into eight types: A, B, C, C, D, E, F and G. BTX-A is a neurotropic toxin that acts on the brain nerve nucleus and peripheral neuromuscular joints after intestinal absorption, and has no DSJ inhibitory effect on the central nervous system and brain stem. BTX-A consists of A single polypeptide chain, intramuscular injection, through the selection of proteolysis process and activation, lysis for two different molecular weight fragments, heavy chain carboxyl terminal first and presynaptic membrane associated protein (SNAP25) of cholinergic nerve terminals, the amino end for channel formation area, and then light chain shift in the cell, through enzyme effect inhibiting the quantum release of acetylcholine vesicles, muscle denervation, muscle strength. When injecting BTX-A with insulated-needles, drugs should be injected as dense as possible. Animal studies have shown that BTX-A injected into the neuromuscular junction achieves the maximum block effect, reducing drug waste and improves efficacy. Electromyography examination will find a reduction or disappearance of the target muscle action potential, and pathological fiber atrophy. After injection, combined with exercise therapy, orthosis and other rehabilitation training effect is better. After the application of BTX-A, the symptom improvement lasts for the longest time of 4 months. Combined with physical therapy, manual extension training, brace and other auxiliary therapy, it can only help improve the degree of spasticity, not prolong the time of action, and the effect is maintained by relying on repeated injection. This method can change the physiological function of the neuromuscular joint and relieve the spasm. First of all, according to the anatomical position roughly determine the block point, the surface electrode anode fixed in the lateral body table, with the cathode near the block point to cause the location of the corresponding muscle maximum contraction is block point body projection point, with gentian purple identification, local disinfection, then use insulation injection needle connection electric stimulator cathode, along the identification point into the body, continue to look for block point in depth, with the minimum current can cause maximum contraction is the block point. About 1 to 2 ml was injected at each point. The effective duration of the phenol solution injection ranged from 6 to 9 months. Doxorubicin is an anthracycline antibiotic that is widely used as an anticancer drug. It can bind to DNA, and interfere with nucleic acid synthesis and mitosis, but it also can bind to RNA that interferes with protein synthesis. Muscle loss is permanent after DOX injection. The apparent reduction in muscle fibers after direct doxorubicin

injection means that a permanent cure of spasticity is of great potential. It is different from percutaneous injections of phenol and Botox, and the effect of the latter two is temporary, because the muscle fibers and neuromuscular joints can regenerate. Injection of doxorubicin in different doses can produce markedly different effects. Large doses produce large range of degeneration. In conclusion, based on the existing literature support, acupuncture combined with rehabilitation therapy can effectively improve the clinical symptoms and promote limb functional recovery in patients with concurrent muscle spasm after SCI, which is safe and feasible. However, due to the quality limitations of the included studies, more high-quality clinical studies with more centers and large samples need to be verified.

REFERENCES

Ask, L., Xu, H., Guo, Z., Zhao, H., & Cao, Y. (2020). Phlegm, and combined with rehabilitation training to treat 44 patients with limb spasm after stroke. *Western Traditional Chinese Medicine, 33*(12), 72-74.

Chang, J.-y., Wang, W., Shen, J.-l., Zhang, Y., & Cai, H.-f. (2023). Impact of sentinel lymph node biopsy through the axillary cribriform fascia approach on intraoperative indicators and postoperative complications. *Updates in Surgery, 75*(3), 757-767.

Feng, Q., Xu, H., Zhou, Y., Jin, J., & Zhang, J. (2021). Huang Changyu percutaneous acupoint electrical stimulation combined with mirror therapy in the rehabilitation care of patients with upper limb spasm after stroke. *Nursing Research, 35*(16), 2879-2883.

Gormley, M., Dabrowski, E., Delgado, M. R., Tilton, A., Christian, A., Evans, S. H., . . . Goldberg, J. (2022). Evaluating the Effectiveness and Safety of AbobotulinumtoxinA in Pediatric Lower Limb Spasticity (PLLS). *Archives of physical medicine and rehabilitation, 103*(12), e144.

Hasan, M. E., Atmuangkhwang, S., & Durand, J.-D. (2022). Range extension of Pomadasys andamanensis McKay and Satapoomin 1994 (Perciformes: Haemulidae) to Bangladesh, the north-eastern Bay of Bengal with the indication of a cryptic sibling species from Bali, Indonesia. *FishTaxa, 23*, 30-41.

He, J., Kou, Y., Yu, Y., He, Y., Yu, Y., & Hou, L. (Journal of Qilu Nursing). Application of clinical-rehabilitation-nursing full cycle management mode in patients with shoulder-hand syndrome after stroke. *Journal of Qilu Nursing, 28*(14), 7-10.

Hu, X., Hu, X., & Hu, Y. (2022). Clinical observation of the bladder by combined rehabilitation nursing treatment of limb spasm after stroke. *Modern distance Education of traditional Chinese Medicine in China, 20*(22), 157-159.

The influence of Cao Yan's comprehensive rehabilitation nursing therapy on the recovery degree of muscle spasm in hemiplegic limb caused by stroke (2020). *Medical Food Therapy and Health, 18*(11), 133 + 136.

The influence of full Haiyan rehabilitation nursing combined with functional training on limb movement function and daily living ability of children after spastic cerebral palsy. (2022). *Reflexology and Rehabilitation Medicine, 3*(10), 107-110.

The influence of Qu Yanfang's characteristic rehabilitation nursing on the rehabilitation of hemiplegia spasm after stroke. (2021). *Chinese Drug and Clinical, 21*(02), 356-358.

Jiang, J., Jiang, X., Liu, J., & Yin, J. (2022). The application of external shock wave therapy in patients with limb spasm after stroke. *General practice care, 20*(04), 501-503.

Jin, L., Zou, C., & Pan, H. (2021). Research progress of bilateral upper limb training in stroke patients. *Chinese Nursing Education, 18* (12), 1106-1110.

Ketchum, E. M., Downie, S. A., Esquenazi, A., Francisco, G., Verduzco-Gutierrez, M., Ifantides, K., . . . Ketchum, N. (2022). A Virtual Reality Platform to Facilitate Training on Treatment of Lower Limb Spasticity With OnabotulinumtoxinA. *Archives of physical medicine and rehabilitation, 103*(12), e68.

Lee, J., Chun, M. H., Ko, Y. J., Lee, S.-U., Kim, D. Y., & Paik, N.-J. (2022). Safety and efficacy of MT10107 in post-stroke upper limb spasticity treatment: A phase I randomized controlled trial. *Medicine, 101*(44).

Li, B., Yang, L., Yan, Y., Wu, B., Wang, T., Wei, D., . . . Xiao, W. (2022). The clinical effect of combined rehabilitation training in the treatment of limb spasm after spinal cord injury. *Journal of Jiangxi University of Traditional Chinese Medicine, 34* (06), 61-64 + 74.

Li, J., Mei, t., Wang, Y., Guo, J., Ren, B., & Feng, X. (2022). Li Ruiqing different acupuncture methods for the treatment of limb spasm after stroke patients. *Journal of Nursing, 29* (03), 1-6.

Lin, Y., Chen, Y., Liu, R., & Cao, B. (2023). Effect of exercise on rehabilitation of breast cancer surgery patients: A systematic review and meta-analysis of randomized controlled trials. *Nursing Open, 10*(4), 2030-2043.

Luo, Z., Zheng, L., & Chen, X. (2021). Clinical observation of copper needle scraping. *Practical Journal of Traditional Chinese Medicine, 37*(11), 1925-1927.

McNutt, M. C., Foreman, N., & Gotway, G. (2023). Arginase 1 deficiency in patients initially diagnosed with hereditary spastic paraplegia. *Movement Disorders Clinical Practice, 10*(1), 109-114.

Meta-analysis of the efficacy of Xiang Ting, Jiang Yunlan, Yue Yuan, Lin Yuzhu, Liu Yue Traditional Chinese medicine fumigation in the treatment of limb spasm after stroke (2022). *Hunan Journal of Traditional Chinese Medicine, 38*(01), 129-134.

Tang, L., Wei, Y., & Li, J. (2022). The impact of early rehabilitation care on children with viral encephalitis. *Journal of Qilu Nursing, 28*(03), 125-128.

Wu, F., Chen, Q., Huang, Y., Lin, H., Lin, H., & Gan, X. (2021). Observation of limb spasm in stroke patients. *Clinical Study of TCM, 13*(09), 33-35.

Wu, G., Feng, H., Tian, Y., & Jin, Q. (2020). The effect of traditional Chinese medicine nursing technology in the nursing of spastic hemiplegia patients after stroke *Heilongjiang Traditional Chinese Medicine, 49*(06), 347-348.

Wu, H., Zhu, X., Liu, F., & Jiang, Y. (2021). Pan Shuting Crisis management, permeable risk pre-control emergency care and good limb position training on the rescue and later rehabilitation of severe stroke. *Chinese Journal of Emergency Recovery and Disaster Medicine, 16*(07), 809-813.

Xie, S., Wu, Y., Chen, L., & Chen, Q. (2022). Analysis of the timing of rehabilitation nursing intervention on motor function and limb spasm in children with acute viral encephalitis. *General practice care, 20*(17), 2361-2363.

Xie, W., & Wang, Y. (2020). The clinical efficacy of TCM comprehensive rehabilitation program in the treatment of limb spasm after stroke. *Xinjiang Traditional Chinese Medicine, 38*(05), 16-17.

Zhang, D., Ma, H., & Xu, Z. (2021). massage combined with modern rehabilitation for the treatment of limb spasm after stroke. *Guangming Traditional Chinese Medicine, 36*(10), 1566-1571.