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REVIEW ARTICLE

Acupuncture treatment for spasticity after brain injury

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ABSTRACT

Spasticity after brain injury is a neurological sequela caused by damage to upper motor neurons. The primary symptoms are involuntary muscle activity, decreased muscle strength, and joint contracture. Acupuncture as a therapeutic method to regulate central nervous system function has been studied widely in recent years. Many clinical experiments have proved that acupuncture has positive effects on spasticity after brain injury. In this review, we discuss recent research of acupuncture treatment and the need for large randomized controlled trials.

1 Introduction

Brain injury is a type of upper motor neuron injury caused by stroke, hypoxia, trauma, and other origins. It is easy to identify the sequelae of the nervous system, such as spasm, language disorder, dyskinesia, and even hemiplegia. In 2005, according to results of pathophysiology and clinical experience, spasticity was defined as "sensorimotor disorder caused by the damage of upper motor neurons, showing intermittent or persistent involuntary muscle activity" [1]. This definition focuses on the less severe features of upper motor neuron syndrome, while ignoring the decline of muscle strength and activity ability and the changes to joint and soft tissue.

Spasticity after brain injury is a neurological sequela caused by damage to upper motor neurons. In clinical practice, the spastic state after brain injury is manifested as dyskinesia such as persistent hypertonia, increased stretch reflex, and hypertonic tendon reflex caused by brain-derived central injuries such as stroke, hypoxia, and craniocerebral trauma. In the recovery of spasticity after brain injury, the reconstruction of neural circuit is the main treatment, whose recovery depends on the remodeling of neuronal synapses. Therefore, the key to treatment is to improve the plasticity of neuronal synapses [2]. The commonly used treatment for spasm after brain injury are drug treatment, surgical intervention, and physical therapy, but the long-term high treatment costs have become an economic burden for patients and society. Long-term treatment may lead to poor patient compliance, which significantly

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reduces the effects of treatment. In addition, drugs and surgical treatment have potential adverse reactions [3–5]. Therefore, it is critical to discover convenient clinical applications and low-cost treatments to improve the function of patients after brain injury. In this review, we summarize the therapeutic methods and future research goals of acupuncture treatment for spasticity after brain injury.

2 Acupuncture method

Acupuncture point selection is recorded in ancient Chinese medical books and records. Its theoretical support is acupoint selection based on syndrome differentiation, acupoint selection based on time, and acupoint selection based on pain [6]. The acupuncture point selection method is generally a method of continuously innovating and improving the knowledge system based on the theoretical knowledge proposed by predecessors and clinical experience to provide more clinical point selection for later generations and promote the development of acupuncture theory.

2.1 Traditional needling

2.1.1 Tendon insertion method

"Acupuncture at pain points" is the basic principle for acupoint selection in meridian sinew. In the ancient book *Miraculous Pivot, Wei Qi Disorder*, there is a record saying that "tendon disease has no yin or yang, and no left or right, where the disease is waiting" [7]. In terms of acupuncture and moxibustion, the *Miraculous Pivot* records the methods for treating muscle paralysis and clonus such as "scalding and grabbing the needle", "restoring acupuncture and moxibustion", and "closing qi". In Jin Therapy, Huang & Huang [8] focused on the establishment of rehabilitation treatment systems such as "foci at tender points", "tendon nodes", and "method of detecting foci through tendons". Among them, the four therapies of "manipulation, acupuncture, cupping, and adjuvant chemotherapy" have significant effects on the treatment of spastic state and related diseases. Xue [9] combined the long needle and the round needle to form a long round needle and performed the closing and restoring needling at the muscle boundary and periosteal point, completing the dual functions of cutting and separation, and achieving significant therapeutic effects on muscle stiffness and limb spasm. Li et al. [10] performed row needling according to the trend of 12 meridian sinew and had significant effects on the treatment of limb spasm, facial spasm, varus pedis, and other conditions.

In recent years, related studies [11–13] have shown that acupoint selection through tendon insertion usually focuses on key points, such as elbow selection in the upper limb, knee selection in the lower limb, and tenderness points on both sides of tendon muscle group, and always adheres to the basic principle of using pain as the tender point.

2.1.2 Scalp acupuncture

Records of scalp acupuncture treatment of various diseases can be traced back to the "Neijing", which is the Internal Canon of Medicine. Contemporary clinical workers who use scalp acupuncture to treat brain injury have unique acupuncture manipulation and acupoint selection systems. The efficacy of scalp acupuncture in the treatment of brain diseases has been confirmed by many approaches. Using macroscopic analysis, scalp acupuncture can stimulate nerves, relieve spasm, and expand blood vessels. Microscopically, the functional state of the cerebral cortex is affected by the

bioelectricity generated when the scalp is stabbed, which causes the pulses of the second nerve cell of nerve fibers to be changed and then transmitted to the peripheral nerves to play a regulatory role. This process can cause positive changes in the nerves next to the stimulation points, thus better controlling the muscles in the spasmodic area. "The head is the shrewd mansion" and "qi comes from the brain" are findings from which we can draw the conclusion that all types of activities of the human body are controlled by the brain. Scalp acupuncture therapy thus can achieve the purpose of refreshing and adjusting the sea of marrow.

According to the literature, most researchers [14–16] selected acupoints from the midline of the vertex, the anterior oblique line of the vertex-temporal, and the posterior oblique line of the vertex-temporal, so that the paracentral lobular region of the cerebral cortex plays an irreplaceable role in the adjustment of muscle control. Based on interactive scalp acupuncture, Qi et al. [17] found that the therapeutic effect of combining proprioceptive neuromuscular facilitation (PNF) technology with scalp acupuncture was superior to using PNF technology alone. Sun et al. [16] enrolled 90 patients with spastic paralysis of the upper limb after brain injury. They divided them into an observation group treated with acupuncture for regulating mind and relieving spasm, and a control group treated with routine acupuncture. The experimental results showed that scores of 42 patients in the 2 groups improved after treatment compared with patients in the same groups before treatment and the improvement in the observation group was more significant. Xu et al. [15] evenly divided 40 randomly selected patients with hemiplegic spasm after brain injury into a control group and an observation group. The observation group was treated with scalp acupuncture combined with rehabilitation training, whereas the control group was treated with simple rehabilitation only. The results showed that both therapies could improve the spastic state of patients with hemiplegia after brain injury in the spastic stage, but the therapeutic effect of scalp acupuncture combined with rehabilitation was the most significant in improving the kinetic energy of movement and daily life. Therefore, attention should be given to the application of scalp acupuncture in the rehabilitation of patients with spasm after brain injury to improve the clinical efficacy and relieve spasm in time. Another researcher [18] attempted to treat 90 patients with spasticity after brain injury by scalp acupuncture that Baihui penetrated Taiyang together with acupoint catgut embedding in Yangming meridian and the connecting line from Baihui to Taiyang was selected. The needle tip was penetrated from Baihui to Taiyang, and three needles were evenly inserted into each side in a relay manner, and the therapeutic effect was also significant.

2.1.3 Abdominal acupuncture

The umbilical cord is the initial nutrition channel and the most meticulous regulation system of "information reserve" before the human body is formed. The embryo is formed by the mother's transmission of qi and blood essence through the umbilical cord. In this process, the umbilical cord is not only a conveyor for supplying nutrition, but also collects and stores information to timely regulate and control the output and supply of substances from various tissues and organs. Therefore, the Shenque meridian regulation system in the abdomen is formed in the embryonic stage, serving as the mother system of our meridian system. Abdominal acupuncture is an acupuncture treatment system that

regulates systemic disorders by stimulating the abdominal acupoints, based on the regulatory system of Shenque meridians and collaterals and the traditional abdominal acupoints as the main frame. From the root cause of spasticity after brain injury, abdominal acupuncture therapy can play a specific regulatory role.

Feng et al. [19] divided 60 patients with stroke into 2 groups and compared their clinical efficacy with different layered abdominal acupuncture. They concluded that the efficacy of abdominal four-gate acupoints was better than that of rheumatism acupoint-pointing. A comparative analysis of the total effective rates in the upper and lower limbs was performed using a modified Ashworth scale. The fluctuation of upper limb data was not significant, and the total effective rate after lower limb acupuncture was significantly higher than before acupuncture. Xu et al. [20] randomly divided 90 patients with stroke into 2 groups for observation and comparison of the efficacy of abdominal acupuncture combined with staged exercise therapy and simple exercise therapy. In abdominal acupuncture, the acupoints of Guanyuan, Huaroumen, Shangfengshi, Wailing, and Xiafengshi were selected. Through the analysis of big data results, it was found that the more comprehensive therapy could greatly improve the motor function of patients. Zhang et al. [21] enrolled 300 patients with hemiplegia and spasm after brain injury for control treatment and analysis. The acupoints of the four limbs were selected as the control group, whereas the acupoints of the four limbs and nape abdominal acupuncture were selected as the observation group. The control group was Jianyu, Binao, Quchi, Shousanli, Waiguan, Hegu, Huantiao, Futu, Yanglingquan, Zusanli, Chengshan, Juegu and Taichong. The observation group was given nape abdominal acupuncture on the basis of the control group, and Fengfu, Dazhui, Fengchi, Tianzhu, Bailao, Huaroumen, Tianshu, Wailing, Zhongwan and Guanyuan were taken. It indicated that nape abdominal acupuncture not only could relieve spasm, reduce spasm index, and improve the degree of neurological functional recovery, but that it also had a positive regulatory effect on pathological neural activity.

2.1.4 Through needle

Penetration acupuncture is a technique with a wide stimulation range and strong effect of dredging qi and blood. In this approach, the yin and yang meridians are mutually penetrated by connecting them through acupuncture, so that yin and yang oppose each other, restrict each other, and repel each other. This method thereby harmonizes yin and yang and makes the body contribute to the dynamic balance of yin and yang.

Liu et al. [22] compared the yin and yang meridians of limbs, and concluded that the clinical symptoms and the total effective rate were significantly improved in the yin and yang penetration of the acupuncture group without an increased incidence of adverse reactions. Wang et al. [23] used penetration acupuncture to treat 42 patients with lower extremity spasm after brain injury. They concluded that penetration acupuncture of tibialis anterior and extensor digitorum longus pulp can eliminate or relieve pain, and prevent joint contracture and muscle atrophy. Penetration acupuncture thereby gradually improved the patients' control over ankle joints; resolved gait and balance problems; promoted recovery of motor function and improved sensory function; improved quality of life; and enabled patients a more productive return to society.

2.2 Traditional acupuncture combining other traditional Chinese medicine therapies

2.2.1 Warm needle

Warm needle therapy primarily utilizes warm effect, acupuncture analgesia, and illumination effect to exert responses on nerves and blood vessels. Studies have shown that warm needling can significantly improve spasm [24–26]. Neurologically, warm needling can reduce the excitability of the peripheral nerves in the affected area; help the affected area to restore blood vessel function; regulate plasma osmotic pressure; strengthen the metabolism of local tissues; and improve blood circulation, which are all conducive to alleviating muscle spasm. In traditional Chinese medicine, it is believed that the etiology and pathogenesis of spasm are due to qi-deficiency and blood stagnation and meridian blockage, whereas warm needles warm meridians, dredge collaterals, and regulate qi and blood [27]. Li et al. [28] reported to treat patients with spastic hemiplegia after brain injury through warm needling combined with rehabilitation training. They compared the results that warm needling could not only help patients maintain normal activities (excitement and inhibition) of the central nervous and peripheral nervous systems, but also block the transmission of pain, and thus effectively relieve the pain. The heat generated from burning of Folium Artemisiae Argyi is transferred to the deep part of the tissue along the needle, thereby effectively promoting microcirculation [29]. Shi [30] used the Yin meridian acupoint warm needle therapy to treat 86 patients with joint spasm after brain injury. Added Quchi, Chize, Shaohai, Neiguan, Daling, Yangxi through Yanggu, Weizhong, Weiyang, Xiguan, Jiexi through Qiuxu, Taixi, Kunlun, Yanglingquan. At the end of the treatment, data such as Barthel Index scores were used for comparison, and big data analysis showed that outcomes in the observation group were superior to those in the control group.

2.2.2 Fire-needle

Fire-needle has the effects of warming meridians, dredging collaterals, and expelling wind and cold. Clinical practice has shown that fire-needle therapy has a significant therapeutic effect for patients with spasticity after brain injury. However, little is known about this therapeutic mechanism in modern science.

Wang et al. [31] used fire-needle acupuncture to treat patients with spastic hemiplegia after brain injury, and the results showed that the muscle tension of the upper limb in the fire-needle group was significantly lower than that in the conventional acupuncture group, indicating that fire-needle therapy could improve the motor function of the affected limb and the quality of life. Deng et al. [32] selected specific acupoints for treatment based on the therapeutic principles of regulating qi and blood and warming yang for ventilation. The results showed that the effect was superior to that of basic acupuncture manipulation.

2.3 Modern acupuncture integrating Chinese and Western medicine

2.3.1 Needle-knife method

Needle-knife therapy is a method to loosen the muscle adhesion or joint contracture under the closed condition through the four steps of fixed point, orientation, pressure separation, and penetration. To date, there have been many methods, such as longitudinal dredging; transverse stripping; lifting and thrusting cutting; and spalling of bone surface.

Ren et al. [33] developed cutting correction, muscle stimulation, and nerve contact stimulation based on the original needle-knife

therapy. Cutting correction can directly promote the balance of spasmodic and antagonistic muscles. Muscle stimulation eliminates or reduces spasms by increasing the frequency of muscle contraction and relaxation, thereby inhibiting abnormal postural reflexes. Nerve stimulation refers to the inhibition of nerves to eliminate or relieve muscle spasm. Clinical cure rates showed that the cure rates of all types of needle-knife therapy for various diseases were above 80%. Ding et al. [34] used small needle-knife therapy to treat 40 patients with post-stroke spasticity, and each patient received three treatments of needle-knife therapy. The acupoints involved were the origin of the scalp clip muscle, the origin of the trapezius muscle, the nuchal ligament, the levator scapulae stop point, the triceps brachii stop point, the adhesion scar of anterior fascia of elbow joint and aponeurosis of biceps tendon, the origin of carpometacarpal ligament, and the origin of sartorius muscle. After treatment, the recovery rate and the total effective rate of patients in the needle-knife group were significantly higher than those in the control group, and the difference was statistically significant.

2.3.2 *Acupoint injection*

Acupoint injection is a method for treating diseases by injecting liquid drugs into acupoints. It can combine acupuncture stimulation with drug properties and acupoint penetration to exert its comprehensive effects. Acupoint injection has been widely used for most indications of acupuncture treatment, including the treatment of patients with spastic state after brain injury.

Jing [35] used acupuncture combined with drug acupoint injection to treat 86 patients with muscle spasm. The control group in this study included 43 patients undergoing conventional acupuncture. The results were quantified using Diagnostic Efficacy Standards for Diseases and Syndromes. No adverse reaction was observed in patients in either group. Three patients (6.98%) in the acupuncture combined with drug acupoint injection treatment group and 11 cases (25.58%) in the conventional acupuncture control group experienced recurrence. There was a significant difference in recurrence rate between the 2 groups. The results showed that bilateral injection of drugs at Zusanli could achieve both drug and acupuncture effects and reduce the recurrence rate of spasm.

2.3.3 *Electroacupuncture*

Electroacupuncture is a therapeutic method of treating diseases by applying (sensing) trace current waves of human bioelectricity onto needles and giving strong stimulation to acupoints. For patients with spastic state after brain injury, electroacupuncture has had a significant clinical effect. However, due to the low level of consciousness of patients, the risk of using electroacupuncture is high, which can lead to adverse reactions in severe cases.

Wang et al. [36] adopted the method of integrated traditional Chinese and Western medicine to treat 36 cases of vegetative spasm after brain injury with the combination of electroacupuncture and Western medicine. This treatment method not only indicated that electroacupuncture had the effect of promoting wakefulness but also enhanced the nerve's control over muscle through its strong stimulation. Cao et al. [37] adopted scalp and body acupuncture to treat 26 patients in a vegetative state combined with spasm. Among them, 18 patients were cured, 7 patients showed improvement, and 1 patient was effective but inapparent. Based on the application of electroacupuncture, Li [38] found that the therapeutic effect of the combination of Western medicine and electroacupuncture could improve

the limb activity function, balance ability, and exercise tolerance. Guo et al. [39] explored electroacupuncture in relieving spasm in animal experiments, including acupoint selection of Yanglingquan and Quchi, and showed that electroacupuncture could stimulate synapses in the cerebral cortex to remodel expression of proteins and genes. The experimental results showed that electroacupuncture could improve motor function and alleviate spasm. However, according to a study conducted outside China [40], electroacupuncture can lead to adverse events, such as diseases of the central and peripheral nervous systems, skin and accessory diseases, and systemic diseases. Moreover, some nonspecific reactions were considered serious adverse reactions. Adverse events associated with electroacupuncture include skin pigmentation, syncope, spasm, implantable cardioverter-defibrillator shock or pacemaker dysfunction, and peripheral nerve injury.

3 Theoretical mechanism research

3.1 Traditional Chinese medicine

Acupuncture is an approach based on the basic theory of traditional Chinese medicine to treat diseases by inserting acupuncture into the body. In traditional Chinese medicine, qi represents vitality or energy. Qi can stimulate each meridian and organ with appropriate intensity and simultaneously stimulate the acupoints located in the meridians and organs. Therefore, acupuncture can be applied to acupoints on meridians and collaterals to change the flow of qi, thus keeping the body healthy. The etiology and pathogenesis of spasm in traditional Chinese medicine is expounded in the ancient book of traditional chinese medicine *Suwen*. After food entered the stomach, it was digested to transport the light and clear parts of essence (which could be converted into the parts of qi and blood needed by the human body after digestion, basically understood as nutritional components) to the liver, which then transported, distributed, and nourished the essence in the tendons. Muscle strength was strong when the liver was full of blood. On the contrary, the body's yin and yang imbalance, liver and kidney yin deficiency, liver and blood deficiency, and tendon loss of nourishment could result in spasm. Acupuncture and moxibustion, conversely, can balance yin and yang, relax tendons and activate collaterals, and harmonize the functions of zang-fu organs, to make yin and yang become secret, dredge meridians, and nourish tendons, thereby achieving the effects of relieving spasm [41–44].

3.2 Western medicine

Research on anti-spasm mechanisms of acupuncture focuses primarily on the effect of acupuncture on spasm-related neurotransmitters and receptors, that is, to relieve spasm by increasing the expression of inhibitory neurotransmitters or reducing the expression of excitatory neurotransmitters [45, 46]. Studies have shown that acupuncture promotes the recovery of damaged neurons and advanced central functions in brain tissue by reducing the expression levels of inflammatory factors and regulating cell signal transduction, thereby establishing a normal spinal reflex mechanism and relieving muscle spasm [47, 48]. In addition, acupuncture has a regulatory effect on the inhibitory neurotransmitter γ-aminobutyric acid (GABA) and other spasm-related neurotransmitters and their receptors. For example, γ-motor neuron regulates the excitability of spinal nerves, and its activity can be inhibited by presynaptic inhibition triggered by GABA and receptors. Meanwhile, acupuncture can increase the concentration of GABA in cerebrospinal fluid through stimulation, thereby relieving

spasm [49, 50]. In addition, acupuncture has been proved to protect the central neurons by improving the blood supply to the cerebral ischemic area and promoting the proliferation of central nervous cells, thereby achieving the functional remodeling of the central nervous system [51–53], which is crucial for strengthening the central control of the lower motor neurons, regulating muscle tension, and relieving muscle spasm.

4 Summary and prospect

4.1 Summary of current treatments

The spastic state is primarily manifested as increased muscle tension and decreased muscle strength. On the basis of the findings reported above, difficulties in the spastic state after brain injury are manifested as inability to move independently, micro-consciousness, and inability to provide timely feedback. The pathogenesis is that the damaged senior center cannot inhibit the basic reflex of the junior center, resulting in spasm. In clinical experience, acupuncture therapy can promote the treatment of spasm after brain injury and prevent patients from losing muscle strength, muscle atrophy, and joint contracture due to long braking time during bed rest. Acupuncture has the function of stimulating nerves. It can make patients relieve spasm as soon as possible, improve the muscle tension of the four limbs, and enhance the rehabilitation ability of patients through strong stimulation to acupoints. After acupuncture treatment, various functions improve to different degrees in a short time.

4.2 Future development direction and prospect

In recent years, more experts have become aware of the limitations of single acupuncture treatment and use more comprehensive rehabilitation methods to treat spasticity after brain injury, with significant efficacy. However, there is no comprehensive and systematic standard for the evaluation of spastic state, and there are different standards for the assessment of curative effect. Therefore, it is necessary to promote and implement experimental high-quality research programs to investigate the potential effects of acupuncture and generate evidence that supports clinical application. In experimentation studies, more effort should be made to improve the quality of trial methods to improve internal effectiveness. For example, there should be uniform inclusion criteria, determination of sample size, randomized treatment allocation, appropriate use of blind allocation, minimization of evaluation bias, and use of widely accepted and commonly used standard validated outcome measures (e.g. Glasgow Coma Scale, Barthel Index, and others) to ensure effectiveness, reliability, and comparability. Trials should include long-term follow up at specific time points, especially for rehabilitation studies, to determine the long-term effects of treatment (including survival, disability, and quality of life). The existing data show that since there are only few randomized controlled trials and a small number of volunteers, the potential side effects of acupuncture in the treatment of spasticity after brain injury and subsequent rehabilitation have not been revealed. In addition, the sustainability of long-term effects is not clear, and the universality and theoretical nature of the trial results are very limited. Although acupuncture can be used in experimental studies, it is still not recommended as a standard procedure in clinical practice for the treatment of spastic states after brain injury. Therefore, the design of strict randomized controlled trials with large sample sizes to provide reliable evidence and avoid conclusion bias is necessary to confirm the

efficacy of acupuncture in both the acute and rehabilitation stages. Clarifying the therapeutic scheme of acupuncture, including the selection of acupoints and stimulation volume, will provide substantive evidence to prove the effectiveness of acupuncture in treating spasticity after brain injury.

Conflict of interests

The authors report no conflict of interests in this work.

References

[1] Liu J, Zhang L, Yu YB. Surgical treatment of adult cerebral derived limb spasm (in Chinese). *Chin J Neurosurg* 2013, **29**(2): 204–207.

[2] Guo B, Wang PH, Huang LX, et al. Effects of electroacupuncture, modified Shaoyao Gancao Decoction and the combination of acupuncture and medicine on the ultrastructure of hippocampal synapses and plastic proteins in a rat model of post-stroke limb spasm (in Chinese). *J Tradit Chin Med* 2021, **62**(2): 1–6.

[3] Halpern R, Gillard P, Graham GD, et al. Adherence associated with oral medications in the treatment of spasticity. *PM R* 2013, **5**(9): 747–756.

[4] Santamato A, Panza F, Ranieri M, et al. Efficacy and safety of higher doses of botulinum toxin type A NT 201 free from complexing proteins in the upper and lower limb spasticity after stroke. *J Neural Transm (Vienna)* 2013, **120**(3): 469–476.

[5] Gracies JM, Brashear A, Jech R, et al. Safety and efficacy of abobotulinumtoxinA for hemiparesis in adults with upper limb spasticity after stroke or traumatic brain injury: a double-blind randomised controlled trial. *Lancet Neurol* 2015, **14**(10): 992–1001.

[6] Yang WB, Chen Y. Literature study on acupoint selection methods (in Chinese). *J Changchun Univ Trad Chin Med* 2017, **33**(2): 328–331.

[7] Zhu ZS, Liu FM. Discussion on "Jie Jie" theory in *Lingshu* (in Chinese). *Chin Acup Moxib* 2014, **34**(11): 1087–1088.

[8] Huang JW, Huang Y. Clinical exploration and application of Chinese meridian tendon therapy (in Chinese). *Chin Acup Moxib* 1997, **17**(6): 413–414.

[9] Xue LG. Discussion and exertion of meridian-tendon theory (in Chinese). *Chin Acup Moxib*, 1997, **17**(11): 698–699.

[10] Li CM, Wu ST. The clinical application of meridian sinew acupuncture (in Chinese). *J Clin Acup Moxib* 1999: 41–42.

[11] Feng GY. Clinical observation on treatment of limb spasm in apoplectic hemiplegia by sinew acupuncture (in Chinese). *J Prakt Tradit Chin Med* 2015, **31**(2): 140.

[12] Liu WY, Yue ZH, Lei F, et al. Effects of acupuncture at tendons combined with modified Shaoyao Gancao Decoction on limb spasm after stroke (in Chinese). *Rehab Theory Pract China* 2018, **24**(3): 323–327.

[13] Huang G, Huang RC, Hong RQ, et al. Effects of muscle-tendon acupuncture on spasticity of hemiplegic limbs after stroke (in Chinese). *Liaoning Med J* 2018, **32**(3): 17–19.

[14] Zhang Q, Wang Y, Ji G, et al. Standardization of rehabilitation program for post-apoplectic limb spasm treated by Tongjing Tiaoxing tuina and scalp acupuncture with physical therapy. *Medicine: Baltimore* 2020, **99**(21): e20368.

[15] Xu YH, Wang JH, Li HG, et al. Effects of scalp acupuncture combined with rehabilitation training on motor function and activity of daily living of patients in post-stroke spastic stage (in Chinese). *Chin J Rehab* 2015, 30(2): 120–121.

[16] Sun XG, Zhang JX, Jing W, et al. Clinical observation on spasmodic paralysis of upper limb after stroke treated with acupuncture of regulating mind and relieving spasm (in Chinese). *Shanghai J Acup Moxib* 2018, **37**(2): 149–153.

[17] Qi LL, Han ZX, Zhou YX, et al. Effects of interactive scalp acupuncture combined with PNF technology on upper limb function of spastic hemiplegia after ischemic stroke (in Chinese). *Chin Acup Moxib* 2018, **38**(3): 234–238.

[18] Lei HS, Li T, Dai JM, et al. Clinical observation on treatment of spastic hemiplegia after stroke with scalp acupuncture at Baihui (GV20) penetrating the Sun and acupoint catgut embedding in Yangming meridian (in Chinese). *Hebei J Tradit Chin Med* 2018,

40(4): 506–510.

[19] Feng LM, He MS. Comparison of clinical effects of layered abdominal acupuncture on limb spasm after stroke (in Chinese). *Guangming TCM* 2016, **31**(12): 1765–1767.

[20] Xu M, Chen XH, Liu R. Abdominal acupuncture combined with staged exercise therapy in the treatment of 47 cases of hemiplegic spasm after stroke in recovery stage (in Chinese). *Shaanxi Tradit Chin Med* 2017, **38**(9): 1281–1283.

[21] Zhang ZL, Zhao SH, Ji XQ, et al. A randomized controlled trial of abdominal acupuncture in the treatment of spastic hemiplegia after stroke (in Chinese). *Tianjin J Tradit Chin Med* 2014, **31**(1): 8–13.

[22] Liu DL, Jiang DY, Chu XF. Observation on the efficacy of penetration acupuncture at acupoints of Yin and Yang meridians in the treatment of spastic paralysis after stroke (in Chinese). *Shaanxi Tradit Chin Med* 2016, **37**(8): 1068–1069.

[23] Wang K, Liu JX, Yang E, et al. Effect of penetrating needling combined with rehabilitation training on the function of later limbs after stroke (in Chinese). *Shanghai J Acup Moxib* 2013, **32**(7): 539–541.

[24] Yang L, Tan JY, Ma HL, et al. Warm-needle moxibustion for spasticity after stroke: a systematic review of randomized controlled trials. *Int J Nurs Stud* 2018, **82**: 129–138.

[25] Chen JZ. Warm needle moxibustion treatment of spastic paralysis after stroke clinical study. Master Dissertation, Guangzhou University of Chinese Medicine, Guangdong, China, 2011.

[26] Hu N, Jin GY. Observation on the efficacy of moxibustion in improving post-stroke spasm pattern (in Chinese). *Liaoning J Tradit Chin Med* 2013, **40**(5):1000–1001.

[27] Liang C, Cui JM, Xu B. Clinical study on the treatment of knee osteoarthritis with warm needle moxibustion and novel knee joint moxibustion box (in Chinese). *Chin J Tradit Chin Med* 2016, **31**(8): 3344–3347.

[28] Li F, Chen JS, Tu M, et al. Efficacy analysis of warm-needle moxibustion combined with rehabilitation training in the treatment of spastic hemiplegia after stroke (in Chinese). *J Clin Acup Moxib* 2019, **35**(2): 14–17.

[29] Gao JY, Jia CS, Shi J, et al. The efficacy of acupuncture combined with warm moxibustion box moxibustion in the treatment of pseudobulbar paralysis after stroke and its effects on cerebral blood flow and blood rheology (in Chinese). *J Hebei Tradit Chin Med Pharmacol* 2018, **33**(2): 34–37.

[30] Shi YZ. Clinical study on the treatment of post-stroke joint spasm mainly by warm needling on Yin meridian acupoints (in Chinese). *Med Inf* 2018, **31**(2): 137–138.

[31] Wang N, Li ZF, Wu HH. Clinical effect of fire-needle therapy on spastic hemiplegia after stroke (in Chinese). *Acup Res* 2015, **40**(4): 304–308.

[32] Deng Y, Liu Y. Clinical observation of milli-fire needle in the treatment of spastic hemiplegia after stroke based on the therapeutic principle of regulating qi and blood, warming yang and ventilation (in Chinese). *Sichuan Tradit Chin Med* 2017, **35**(1): 186–189.

[33] Ren YL, Ren XF. Needle-knife therapy in the treatment of spastic disease (in Chinese). *Chin Med Mod Distance Educ China* 2010, **8**(10): 46–47.

[34] Ding M, Feng H, Jin CX, et al. Clinical effect of small needle-knife therapy on spasticity after stroke (in Chinese). *Chin Med Herald* 2018, **15**(3): 155–158.

[35] Jing RH. Clinical observation of intractable diaphragmatic spasm treated with acupuncture and drug acupoint injection (in Chinese). *J Prakt Tradit Chin Med* 2018, **34**(5): 557–558.

[36] Wang SX, Jun H, He X, et al. Xingshen Kaiqiao acupuncture therapy for persistent vegetative state after cerebral trauma (Report of 31 cases) (in Chinese). *J New Tradit Chin Med* 2000, **32**(7): 26–27.

[37] Cao WS, Xiong ZY. Observation on the efficacy of electroacupuncture in promoting the awakening of persistent vegetative state in 26 cases (in Chinese). *Chin Acup Moxib* 2003, **23**(9): 511–512.

[38] Li YH. Evaluation of the efficacy of electroacupuncture combined with Tizanidine in the treatment of spastic hemiplegia after stroke (in Chinese). *Clin J Tradit Chin Med* 2018, **30**(12): 2272–2274.

[39] Guo B, Wang PH, Huang LX, et al. An experimental study of electroacupuncture at Quchi (LI 11)–Yanglingquan (GB 34) in alleviating the plasticity of synaptic structure in spastic brain of rats with stroke (in Chinese). *Chin J Rehabil Med* 2020,

35(7): 787–793.

[40] Park JH, Lee JH, Lee S, et al. Adverse events related to electroacupuncture: a systematic review of single case studies and case series. *Acupunct Med* 2020, **38**(6): 407–416.

[41] Liu DY, Ren JW. Acupuncture combined with Bobath therapy in treating post-stroke spastic paralysis: A systematic review and meta-analysis (in Chinese). *J Guangzhou Univ Tradit Chin Med* 2019, **36**(12): 1967–1974.

[42] Zhang Y, Ma TM, Bai ZH, et al. Meta-analysis on the therapeutic effect of acupuncture at meridian sinew for spastic paralysis after stroke (in Chinese). *Acup Res* 2017, **42**(2): 178–182.

[43] Yang H, Li J, Li YH, et al. Re-evaluation of acupuncture treatment for spastic paralysis after stroke based on systematic review (in Chinese). *Chin J Evid-Based Med* 2019, **19**(10): 1233–1239.

[44] Yu C, Shen B, Xu SW. Systematic evaluation on treating spastic paralysis after stroke by acupuncture (in Chinese). *Clin J Chin Med* 2016, **8**(22): 12–15.

[45] Liu CM, Li RQ, Song XL, et al. Effect of catgut implantation at acupoints on GABA(B) and mGluR1 expressions in brain stem of rats with spasticity after stroke. *J Tradit Chin Med* 2014, **34**(5): 566–571.

[46] He T, Yan CQ, Zeng XH, et al. Effects of acupuncture on amino acid content in striatum and spinal cord of rats with post-stroke spasm (in Chinese). *China J Tradit Chin Med Pharm* 2015, **30**(9): 3105–3107.

[47] Wang S, Zhang J. Study on the effect of acupuncture at different meridian points on the content of serum cAMP and cGMP in rats with hemiplegic spasm after stroke (in Chinese). *Chin J Tradit Med Sci Tech* 2012, **19**(1): 54–55.

[48] Wang S, Hu YH. Study on the effect of acupuncture at different meridian points on the expression of PKC in the brain of rats with hemiplegic spasm after stroke (in Chinese). *Chin J Tradit Med Sci Tech* 2012, **19**(6): 519–521.

[49] Wang JX, Ma LX, Yang Y, et al. Study on the mechanism of acupuncture in the treatment of post-stroke limb spasm (in Chinese). *Glob Tradit Chin Med* 2019, **12**(3): 470–475.

[50] Kakinohana O, Hefferan MP, Nakamura S, et al. Development of GABA-sensitive spasticity and rigidity in rats after transient spinal cord ischemia: a qualitative and quantitative electrophysiological and histopathological study. *Neuroscience* 2006, **141**(3): 1569–1583.

[51] Li J, He JJ, Du YH, et al. Electroacupuncture improves cerebral blood flow and attenuates moderate ischemic injury via Angiotensin II its receptors-mediated mechanism in rats. *BMC Complement Altern Med* 2014, **14**: 441.

[52] Hong JC, Wu GW, Zou YL, et al. Electroacupuncture promotes neurological functional recovery via the retinoic acid signaling pathway in rats following cerebral ischemia-reperfusion injury. *Int J Mol Med* 2013, **31**(1): 225–231.

[53] Kahles T, Brandes RP. Which NADPH oxidase isoform is relevant for ischemic stroke? The case for nox 2. *Antioxid Redox Signal* 2013, **18**(12): 1400–1417.

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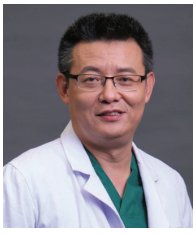

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