

Research Progress of Acupuncture Treatment of Neurogenic Bladder after Spinal Cord Injury

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Abstract: Neurogenic bladder (NB) mainly occurs in patients with spinal cord injury (SCI). The pathological basis of NB is the occurrence of lesions in the urination control center, which requires systematic treatment. Western medicine has many treatment methods for this disease, which can alleviate the symptoms of the disease. However, the radical effect is not ideal and there are many adverse reactions. In comparison, acupuncture can improve the residual urine volume of NB patients and regulate the related indexes of urodynamics. There are many kinds of acupuncture therapies, such as simple acupuncture and moxibustion, which can comprehensively improve the therapeutic effect and obtain a better disease prognosis. Therefore, this article elaborates on the pathogenesis of SCI complicated with NB, the treatment mechanism, and treatment methods of acupuncture and moxibustion to provide a reference for clinical treatment.

Keywords: Acupuncture; Spinal cord injury; Neurogenic bladder

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1. Introduction

Patients with spinal cord injury (SCI) complicated with neurogenic bladder (NB) will have symptoms such as dysuria, urinary incontinence, or urinary retention, and even induce renal failure and increased mortality. Currently, the conventional therapy of NB is intermittent catheterization combined with bladder function exercise, electrical stimulation, and drug surgery. However, this therapy has certain limitations and side effects and the clinical treatment effect is not ideal. Acupuncture is a unique treatment method of traditional Chinese medicine (TCM). It facilitates individualized treatment based on the symptoms and signs of patients and has a wide range of applications with minimal side effects^[1]. Furthermore, there are many methods of acupuncture and moxibustion for the treatment of SCI complicated with NB. It is necessary to analyze the advantages of each therapy and make rational choices to ultimately improve the effectiveness of treatment.

2. The pathogenesis of SCI complicated with NB

2.1. TCM pathogenesis

TCM classifies the disease as “enuresis” or “retention of urine.” It is believed that the disease is located in the

bladder and governor's vessel, and the pathogenesis is related to the spleen kidney, and lung ^[2]. The spinal cord is located in the middle of the body. After the onset of SCI, the governor's vessel is damaged and the operation of yang qi is blocked, resulting in abnormal bladder gasification function, followed by abnormal urination and NB. This results in abnormal water metabolism, leading to abnormal urination. Therefore, the principle of treatment of SCI complicated with NB is to dredge collaterals and remove blood stasis to warm the spleen and kidney.

2.2. Mechanism of Western medicine

After the onset of SCI, the function of the advanced central nervous system is abnormal, and its ability to regulate and control body signals is impaired, resulting in low and irregular urethral sphincter function and detrusor function. This results in urinary retention, urinary incontinence, and other manifestations, and easily leads to urinary tract infection and even renal damage. Combined with the location of NB, it can be divided into the subsacral type (the lesion is located in the lower motor neurons), the suprasacral type (the lesion is located in the upper motor neurons), and the mixed type. Subsacral NB will cause the loss of detrusor reflex function of patients, with symptoms of urinary retention and dysuria. The suprasacral NB will increase the reflexivity of the bladder detrusor, reduce its urine storage capacity, and cause urinary incontinence or frequent urination.

3. The mechanism of acupuncture treatment of SCI complicated by NB

3.1. Improve the physiological function of the injured spinal cord

Neural stem cells (NSCs) have complex differentiation potential and can self-renew. They are produced from nerve tissues and can be converted into neurons and astrocytes under certain conditions, thereby restoring the physiological function of damaged spinal cord segments. The impaired function of NSCs in SCI patients will significantly increase the content of excitatory neurotransmitters and reactive oxygen species in the body and will increase the actual level of pro-apoptotic factors, thereby increasing the number of neuron deaths. Acupuncture can improve the specific expression level of the nerve growth factor in the spinal cord, avoid rapid apoptosis of cells, and facilitate the proliferation of NSCs in the spinal cord. Hence, it can alleviate the degree of SCI, reshape the damaged spinal cord function, and play a protective role in bladder function ^[3].

3.2. Regulating the specific expression of neurotransmitters

The parasympathetic and sympathetic nerve endings will continuously release a large number of neurotransmitters to strengthen the frequency of information exchange between target cells and neurons, thereby regulating the effective relaxation and contraction of the urethral sphincter and improving the regulation ability of the detrusor muscle. Adenosine triphosphate-sensitive potassium channel (KATP) plays an important role in the contraction and excitation of the detrusor muscle. After the channel is effectively activated, it is directly involved in the occurrence or progression of bladder lesions, hence it will affect bladder function ^[4]. The release of adenosine triphosphate (ATP) in SCI patients is significant, which has a selective effect on purinergic receptors outside the cell and acts as a neurotransmitter. Acupuncture can regulate the secretion process of spinal cord neurons, avoid the rapid release of ATP, affect its specific binding process with spinal cord neurons, and interfere with the signal pathway to prevent excessive bladder activity.

3.3. Enhancing the physiological function of bladder detrusor

Bladder activity is affected by detrusor contraction function and relaxation function. If the bladder is damaged, the smooth muscle function will be reduced. If the detrusor is abnormally contracted, the urination function is

impaired, and the cell structure or tissue morphology of the detrusor is abnormal, which eventually affects the urination function. Acupuncture can moderately relax the smooth muscle cells of patients, avoid the fibrosis reaction of the detrusor, avoid cell structure damage, and prevent the continuous contraction of the detrusor caused by SCI [5]. Therefore, acupuncture can enhance the function of the detrusor and improve its coordination with the urethral sphincter to reconstruct the storage and urination performance of the bladder.

3.4. Characteristics of acupoint selection in acupuncture treatment of SCI complicated with NB

Yang *et al* collected the clinical literature of SCI complicated with NB treated by acupuncture and moxibustion in the CNKI database from 2010 to 2019 and evaluated the regularity of acupoint selection [6]. The results showed that 54 articles involved topics related to 10 meridians and 47 acupoints. In the application frequency of meridians, the bladder meridian of foot-taiyang was up to 120 times, and the conception vessel was 112 times. In the application frequency of acupoints, Zhongji acupoint was up to 35 times, and Guanyuan acupoint was 31 times. It can be seen that the principle of acupuncture and moxibustion for the disease is to select acupoints along meridians and local acupoints. At the same time, it is necessary to select acupoints dialectically according to the patient's condition.

4. Specific methods of acupuncture treatment of SCI complicated with NB

4.1. Simple acupuncture

The principles of acupoint selection for simple acupuncture of SCI complicated with NB covers several aspects. The first would be the distal and proximal acupoints. The far and near acupoints can regulate the function of nerve fibers and avoid their obvious inhibition. The commonly used acupoints are Sanjiaoshu, Sanyinjiao, Zhongji, Yinlingquan, and Bladder Shu (bilateral). The back-shu points combined with front-mu points were selected. This kind of acupoint matching method can gather the qi of the five viscera and six organs, and treat the pathogenesis of unfavorable bladder gasification. The liver, kidney, spleen, triple energizer, and bladder acupoints can be selected to combine with the Zhongfu or Zhongji acupoint to improve bladder function. The baliao point is also selected, which is located on the bladder meridian of the lumbosacral region and corresponds to the pelvis. It is the main treatment point for urinary system or reproductive system diseases. Acupuncture at this acupoint can prevent the above system diseases, dredge meridians, and collaterals, and have a stimulating effect on nerve roots. It can regulate the relaxation and contraction regularity of the detrusor or sphincter, and then reduce the residual urine volume of the bladder. The selection of dialectical acupoints based on syndrome differentiation and reasonable acupoint selection can ensure the effectiveness of treatment. For example, patients with kidney yang and kidney essence deficiency can choose the method of regulating stilts, dredging the governor's vessel, and benefiting the marrow. After acupuncture and moxibustion, this method can alleviate the damage to bladder function or the decrease of pelvic floor muscle strength caused by SCI and improve motor sensory function. If the patient's yin and yang are damaged and they are bedridden for a long time, it is necessary to choose abdominal acupoints like Jiaji acupoints and bladder meridians acupoints to supplement qi and nourish the kidney, dredge meridians, and dredge collaterals. At the same time, it can regulate the functions of the liver, kidney, and spleen, and achieve easy urination. Liao *et al.* conducted a study in rats with SCI complicated with NB, where acupuncture was performed at the Changqiang and Sanyinjiao acupoints for 20 minutes, once a day for 7 days [7]. The results showed that the bladder pressure and capacity of acupuncture at Changqiang acupoints were lower than those of Sanyinjiao acupoints, and bladder compliance was higher than that of Sanyinjiao ($P < 0.05$). This showed that acupuncture at the Changqiang acupoint improved the bladder

function of SCI complicated with NB and improved the urination ability.

4.2. Electroacupuncture treatment

Electroacupuncture is an effective combination of electroacupuncture and simple acupuncture. It aims to improve the patient's experience with acupuncture treatment and effectively stimulate their nervous system to improve the curative effect. This therapy can improve the nerve function of cells and accelerate the electrical conduction velocity of damaged nerve cells via electrical and physical stimulation at specific acupoints. In addition, electroacupuncture can utilize density waves to regulate the metabolic rate of damaged tissue, improve blood circulation at the site, and prevent inflammatory edema. Electroacupuncture has a significant stimulating effect on multiple efferent nerves of spinal nerve roots, which can control multiple movement processes of the bladder sphincter and improve bladder function. Electroacupuncture waves can be subdivided into intermittent, dilatational, and continuous. The treatment frequency of the three waveforms was 0.02–80 Hz. Among them, the density wave was most similar to the human bioelectricity, which can significantly control the urethral closure pressure, urethral control length, and abdominal pressure. The intermittent wave will significantly increase the patient's bladder pressure and the continuous wave may cause neuromuscular fatigue. Therefore, during the treatment period, it is necessary to reasonably select the waveform according to the actual needs of the patient. Jiang *et al* took bladder comprehensive training (control group) and bladder comprehensive training with electroacupuncture (observation group) for patients with SCI complicated with NB [8]. The observation group took Sanyinjiao (1 to 1.5 inch), Guanyuan (1 to 1.5 inch), and Zhongji (1 to 1.5 inch), connected to the electroacupuncture therapeutic apparatus, and performed continuous wave treatment. The needle retention time of each point was 25 min, once a day, for 4 weeks. The results showed that the total effective rate of the observation group (76.0%) was higher than that of the control group (52.0%) ($P < 0.05$). This indicates that electroacupuncture treatment improved the therapeutic effect of the patients.

4.3. Warm acupuncture treatment

Warm acupuncture is a product of ordinary acupuncture combined with moxibustion. During the needle retention period, a moxa velvet will be placed on the needle and lit to penetrate the skin through the thermal sensation generated by combustion, thereby generating thermal stimulation on the acupoints. It has a regulatory effect on plasma osmotic pressure and bladder blood vessel perfusion. This therapy can dredge the collaterals and analgesia, warm the meridians, and improve bladder function. Yuan *et al.* took bladder function training and intermediate frequency therapy for SCI patients with NB, including drinking water plan, intermittent catheterization, pelvic floor muscle training, and intermediate frequency therapy, as the control group [9]. The observation group was combined with warm acupuncture and moxibustion treatment, Baliao points were selected and punctured to 20–30 mm, and the method of lifting, thrusting, and twisting was adopted to mugwort stick after obtaining the qi. This was carried out 20 min each time, once a day, for 4 weeks. The results showed that the total effective rate of the observation group (88.24%) was higher than that of the control group (67.65%), and the urination status and urodynamic indexes of the observation group were better than those of the control group ($P < 0.05$). It can be seen that warm acupuncture at the Baliao point restored the patient's bladder function and relieved the abnormal urination function. Sun believed that NB patients after SCI have a long course of disease and poor curative effects, which is considered a stubborn disease in TCM [10]. After years of painstaking research on Wuwei Han bamboo slips and Dunhuang medicine, he found that high-dose spreading moxibustion after warm acupuncture and moxibustion benefited the bladder meridian and governor's vessel. The selected area is the bladder meridian and governor vessel patrol site from Mingmen to the Baliao area, which can further

assist the warming effect. With this, the yang qi becomes sufficient, the triple energizer is smooth, the bladder gasification is strengthened, the waterway is coordinated, and the urination ability is improved.

4.4. Combined acupuncture

Combined acupuncture and moxibustion is an effective combination of TCM, Western medicine rehabilitation therapy, and acupuncture therapy, including electroacupuncture and other therapies. In his study, Sun *et al* took bladder function training (control group), bladder training training + electroacupuncture (electroacupuncture group), and the above therapy + hyperbaric oxygen therapy (combined group) for patients with SCI complicated with NB^[10]. Electroacupuncture was performed on Baliao points, and the empirical compatibility of bladder shu points, Sanyinjiao points, Zhongji points, and Yinlingquan points was performed. The deficiency syndrome was combined with the Qihai point, Sanjiaoshu point, Shenshu point, and Pishu point, the reinforcing method was used for acupuncture, and the electroacupuncture instrument was connected. The results showed that the urodynamic indexes, urination frequency, and urination volume of the combined group were better than those of the other two groups, and the urodynamic reflexes of the electroacupuncture group were better than the control group ($P < 0.05$). It was seen that the effect of electroacupuncture was better than that of conventional bladder function training, and the effect was better after combined with hyperbaric oxygen therapy, which provides a new idea for the treatment of the disease by combining TCM and Western medicine. Huang *et al.* carried out ordinary acupuncture and acupuncture + cake-separated moxibustion for patients with this disease^[11]. The results showed that the residual urine volume of the bladder in the combined treatment was lesser than that in the ordinary acupuncture, the lower urinary tract symptom score was lower, and the total effective rate was higher, indicating that the combination of various acupuncture and moxibustion methods can reduce the residual urine volume of the patients, disease symptoms, and the curative effect is definite. He implemented acupuncture and Buyang Huanwu Decoction for this disease^[12]. The results showed that the urodynamics, urination, quality of life, and total effective rate of combined treatment were higher than those of conventional treatment ($P < 0.05$). It was also seen that the combination of acupuncture and medicine effectively improved the quality of life of patients, improved the urodynamics and urination of patients, and had an excellent curative effect. The author believed that acupuncture and moxibustion can effectively improve bladder function, but acupuncture and moxibustion treatment require a certain amount of time, thereby increasing the risk of recurrent urinary tract infections and bladder hyperplasia. Combined TCM can effectively reduce the risk of complications. According to the patient's urinary condition, treatment can be carried out according to the treatment idea of TCM of stranguria. The recommended drug concoction consists of Bixie, Xianhecao, and Smilacaceae.

5. Issues and prospects

Acupuncture has obvious advantages in the treatment of SCI complicated with NB, such as strong economy, easy operation, high safety, and minimal complications. However, the research on the treatment of acupuncture and moxibustion for the disease generally lacks objectivity, systematicness, and a short research time. Furthermore, the relevant standards for the evaluation of the curative effect are not standardized, so the comparability of the research is not ideal. Therefore, in future research, it is necessary to extend the research time of the patients, carry out large sample and multi-center research, and follow up the treatment effect of the patients for a longer period. According to evidence-based medicine, a set of therapeutic benchmarks has been established. Subsequently, a comprehensive analysis of the effectiveness of acupuncture and moxibustion in the treatment of the disease is crucial to providing the best treatment for affected patients.

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Disclosure statement

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