

Application of Neuromuscular Electrical Stimulation Therapy in Stroke Rehabilitation

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Abstract: Stroke has a high incidence and disability rate, posing a heavy burden on patients, families, and society. Neuromuscular electrical stimulation (NMES) is a safe and effective rehabilitation treatment method that is increasingly being used in stroke rehabilitation therapy. This article reviews its current application status in treating various aspects such as limb swelling and spasms after stroke, explores its mechanism of action, clinical efficacy, and limitations, and provides a reference for clinical application.

Keywords: Neuromuscular electrical stimulation; Stroke; Rehabilitation therapy

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1. Introduction

In the current medical field, stroke is an extremely common and highly harmful sudden cerebrovascular disease that has received widespread attention. Its series of characteristics, such as high incidence, high mortality, and high disability rates, have made it one of the major public health issues in the 21st century, having a profound and heavy impact on society and many families^[1]. In terms of the specific situation in China, the number of stroke patients is quite large. According to relevant statistical data, among people aged 40 and above in China as of 2019, the number of those who have had or are currently suffering from stroke reached approximately 17.04 million. This astonishing figure undoubtedly highlights the severe epidemic situation of stroke in China^[2]. Moreover, it is worth noting that the prevalence of many risk factors that can induce stroke is also becoming more evident. Stroke can easily lead to nerve function damage, which can cause varying degrees of disability in patients, thereby severely affecting their daily self-care abilities. This phenomenon is well-known in the industry^[3]. Although rehabilitation training is widely used in clinical practice, there are significant limitations in relying solely on it for treatment in terms of relieving muscle spasms and improving limb function. These limitations manifest as a lengthy treatment cycle and difficulty ensuring patient compliance, which greatly affects the rehabilitation effect^[4]. Currently,

neuromuscular electrical stimulation therapy (NMES) is a physical therapy with a mechanism of action to enhance muscle contraction that exhibits high application potential in stroke rehabilitation therapy ^[5]. A thorough analysis of the specific application of this therapy in stroke rehabilitation treatment is of profound significance for optimizing patient prognosis and improving their quality of life.

2. Treatment of limb swelling after stroke

Neuromuscular electrical stimulation (NMES) therapy plays a significant role in the rehabilitation of stroke patients. As a type of low-frequency electrical therapy, it utilizes the electrical excitability of nerve cells to stimulate the muscles of the limbs, thereby effectively promoting the recovery process ^[6]. Specifically, NMES is administered by precisely placing electrode pads at corresponding points on the body. The electrical current induces muscle contraction through two pathways: directly causing muscle contraction or indirectly stimulating nerves to achieve muscle contraction. This creates a muscle pump effect, which elevates venous blood pressure, promotes blood flow toward the heart, effectively reduces local blood stagnation in the limbs, and ultimately achieves the goal of reducing swelling ^[7]. For example, when using NMES combined with pneumatic therapy to treat hand swelling after a stroke, one electrode pad is placed on the palm, and the other is placed on the trapezius muscle for a 20-minute session. Within 1 to 2 weeks after such treatment, there is a significant reduction in hand swelling and a noticeable improvement in the range of motion of the metacarpophalangeal and interphalangeal joints, highlighting the remarkable effectiveness of this therapy in treating limb swelling after stroke ^[8].

3. Treatment of spasticity after stroke

After a stroke, damage to the upper motor neurons often leads to spasticity, resulting in abnormally increased muscle tension. This manifests as muscle stiffness and limited joint movement, which can significantly impact patients. If not managed properly, their gait and daily activities can be severely disrupted ^[9]. Among the various clinical treatments for spastic hemiplegia after stroke, neuromuscular electrical stimulation (NMES) plays a crucial role as a commonly used physical therapy in Western medicine. It utilizes pulsed currents to stimulate the nerves controlling the muscles, enhancing the electrical excitability of nerve cells and promoting muscle contraction ^[10]. According to Zhang Zhengyang's research, after 8 weeks of treatment, the BBS and FMA scores of both patient groups improved compared to before treatment, and the observation group showed more prominent results ^[11]. This fully demonstrates that the combined treatment of reducing yin and nourishing yang acupuncture with neuromuscular electrical stimulation can effectively improve balance and motor functions in patients with spastic hemiplegia after stroke.

4. Treatment of shoulder pain and shoulder joint subluxation after stroke

Shoulder pain and shoulder joint subluxation are common occurrences after a stroke. Their mechanisms are associated with factors such as muscle weakness around the shoulder joint, joint capsule laxity, and pain. Between 32.0% and 81.0% of hemiplegic patients are prone to shoulder joint subluxation, often accompanied by limited range of motion and pain, which severely affects their quality of life ^[12]. Furthermore, the incidence of shoulder pain caused by soft tissue issues is as high as 74.8%. This type of shoulder pain not only impairs joint and limb function but also impacts sleep and psychological well-being ^[13]. Wang Yuanyuan et al. conducted a study using

rehabilitation therapy combined with NMES for treatment ^[14]. The results showed that the total effective rate of treatment and the FMA score in the observation group were higher than those in the control group, with a greater range of shoulder joint motion and a lower VAS score. This suggests that adding NMES to conventional rehabilitation therapy can significantly improve the treatment effectiveness for patients with shoulder joint subluxation after a stroke. Stimulating muscle contraction around the shoulder joint enhances muscle strength, improves joint stability, effectively reduces pain, and further improves the range of shoulder joint motion and upper limb motor function.

5. Treatment of swallowing disorders after stroke

In the early stage of stroke, about 34.4% of patients will experience swallowing disorders, and within 30 days, aspiration pneumonia caused by swallowing disorders is often the main factor leading to patient death ^[15]. NMES stimulates the pharynx and muscle groups related to swallowing by using low-frequency pulsed currents, which is very beneficial for the repair and reconstruction of the swallowing reflex arc, thereby improving patients' quality of life and rehabilitation effects ^[16]. Liu Yiyi's observation group experiment involved placing the negative electrode of the device on the upper edge of the hyoid bone and the middle position of the line connecting the maxilla to the hyoid bone ^[17]. Each round of electrical stimulation lasted for 4 seconds, with an intensity of 5–25 mA and a frequency of 30–80 Hz. After each round, there was a 5-second rest. At the same time, patients were instructed to swallow quickly during the electrical pulses, for 15 minutes each time, twice a day, for 30 days. The results showed that the observation group had higher hyoid-larynx complex mobility indicators and lower swallowing function scores compared to the control group. This suggests that combined NMES rehabilitation therapy can promote the recovery of mobility and effectively improve swallowing function.

6. Treatment of aphasia after stroke

Aphasia can be classified into various types such as motor, sensory, and conductive based on the location of brain damage, with motor aphasia being the most common ^[15]. Currently, clinical treatment for patients primarily with motor aphasia relies on basic medications and nursing care. Although this approach can restore language function and improve neurological function to some extent, it often fails to meet patients' expectations. Studies have shown that combining neuromuscular electrical stimulation with conventional basic medication and nursing care in the treatment of post-stroke aphasia patients yields significant results, improving both language function and quality of life ^[18]. Meanwhile, research has also found that using this method to treat patients with motor aphasia can enhance clinical efficacy, further optimize language and neurological functions, and improve quality of life, even leading to improvements in hemorheology ^[19].

7. Treatment of limb dysfunction after stroke

After a stroke occurs, the patient's central nervous system is damaged, which severely affects their ability to control their limbs, leading to decreased muscle strength and disuse atrophy, ultimately resulting in limb dysfunction ^[20]. A study targeted patients with these limb dysfunctions by first implementing rehabilitation training interventions, followed by further treatment combined with a neuromuscular electrical stimulation system ^[21]. The results showed that after the combined intervention, the patients' MAS scores were significantly lower than

those when only rehabilitation training was performed. This indicates that the combination of these two treatment methods can effectively reduce muscle spasms and significantly improve patients' muscle strength levels. This is due to the unique advantages of the neuromuscular electrical stimulation system, which can simulate the facilitation techniques used in exercise therapy, precisely control the affected limbs, and design targeted inhibitory measures based on actual reflex conditions. This effectively reduces the incidence of limb spasms and provides strong support for functional recovery in stroke patients^[22].

8. Treatment of urinary incontinence after stroke

Urinary incontinence is a common and troublesome issue for patients after a stroke, falling under the category of neurogenic urinary incontinence. Statistics show that approximately 40%–60% of stroke patients hospitalized will experience this condition^[23]. Currently, treatment methods for urinary incontinence primarily include bladder management, dietary adjustments, and pelvic floor muscle training^[24]. A study involving 74 patients with post-stroke urinary incontinence revealed that combining acupuncture and neuromuscular electrical stimulation of the bladder region resulted in better outcomes in the observation group compared to the control group, specifically in terms of slow muscle fibers and integrated fiber amplitude^[25]. Additionally, the observation group had lower ICI-Q-SF scores and higher I-QOL scores. These findings suggest that the integration of acupuncture and neuromuscular electrical stimulation of the bladder region in the treatment of post-stroke urinary incontinence can significantly enhance the strength and endurance of pelvic floor muscles, improve coordination among muscle groups, effectively alleviate symptoms of urinary incontinence, and enhance patients' quality of life in daily activities.

9. Conclusion and prospects

NMES is a safe and effective rehabilitation treatment that exhibits broad application prospects in the field of stroke rehabilitation therapy. It can improve various complications, effectively promote the recovery of patients' neurological function, and thereby enhance their quality of life. However, NMES treatment is not flawless. There are still limitations in selecting treatment parameters, planning treatment regimens, and evaluating treatment effects, which require further exploration. It is foreseeable that with the continuous advancement of technology and the deepening of clinical research, NMES will play a more critical role in the process of stroke rehabilitation therapy.

Disclosure statement

The author declares no conflict of interest.

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