

Research Status of Abnormal Gait in Children with Spastic Cerebral Palsy

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Abstract: Cerebral palsy is one of the most common disability factors in children. The incidence rate is increasing year by year. Spastic cerebral palsy accounts for about 60%-70% of all types of cerebral palsy. Most CP patients will experience abnormal gait during rehabilitation, which will seriously affect the self-care ability and mental health of children with spastic cerebral palsy. At present, the cause and mechanism of brain injury in children with cerebral palsy are not clear, so effective etiological treatment can not be carried out. The author summarizes the treatment of abnormal gait in children with spastic cerebral palsy in Chinese and Western medicine in the past five years, in order to provide reference for further optimizing the treatment scheme and promoting the rehabilitation of cerebral palsy.

Keywords: Spastic Cerebral Palsy, Abnormal Gait, Overview

1. Introduction

Cerebral palsy is a series of symptoms caused by non progressive brain injury during the development of fetus or infants, such as dyskinesia, abnormal posture and limited activity [1]. A meta-analysis on the prevalence of cerebral palsy in children aged 0-6 years in China in 2021 showed that the prevalence of cerebral palsy in children in China was 0.23%, which is now close to the international average of 0.215% [2]. The cause of cerebral palsy is still unclear, but many high-risk factors related to cerebral palsy have been gradually found in clinic, including premature delivery, low birth weight infants, neonatal asphyxia, and ischemic hypoxic encephalopathy and so on. Some scientific studies believe that [3], the neurological symptoms and changed muscle structure and function of children with cerebral palsy show different degrees of defects, that is, muscle weakness, limited growth and shortening of muscle and tendon units, high muscle tension and reduced spasm and selective motor control, which affect the walking function of patients with spastic cerebral palsy. How to correct abnormal gait is not only an urgent problem for clinical workers, but also one of the most concerned problems for the families of children. The methods to improve gait abnormalities of children with cerebral palsy in recent years are summarized as follows:

2. Primary coverage

2.1. Exercise therapy

2.1.1. Application of rehabilitation robot

In the early stage of research, rehabilitation robots were used in the fields of stroke, spinal cord injury and brain injury to help them establish normal gait. At present, they have been gradually used in the field of cerebral palsy as supplementary and alternative treatment. Yin Zhenglu [4] used the lower limb rehabilitation robot system developed by lokohelp group in Germany to treat 12 patients with cerebral palsy. Compared with before and after treatment, the walking speed, FAC grade and BBS score of the robot group were significantly improved compared with those before treatment, and the degree of improvement was better than that of the control group. Zheng Hongchao [5] used the children's version of lower limb rehabilitation robot to treat 35 children with cerebral palsy. After treatment, the scores of aom and BBS of children increased, and the test group was higher than the conventional group, and the satisfaction of parents of children in the test group was higher. In clinical practice, the training effect of patients is often not ideal because of non-standard or inappropriate training methods, resulting in abnormal walking patterns that are difficult to be corrected. As a new rehabilitation treatment method, rehabilitation robot assisted walking training is easier to be accepted because it not only allows patients to continuously repeat full cycle compound actions, but also allows patients' brain motor center to strengthen the control of lower limb motor ability. Moreover, the rehabilitation robot has an intelligent

anti spasm mode, which can adapt to the current physical condition of patients, It can reduce muscle tension spasm, improve walking ability, make patients have better enthusiasm and active participation, and play an important role in improving neural plasticity and motor control ability. Although robot assisted gait training has been widely used in children with cerebral palsy, it has not been popularized in the rehabilitation treatment of cerebral palsy due to the lack of research on the optimal intervention frequency and duration.

2.1.2. Whole body vibration training

Whole body vibration (WBV) training has been more and more widely used in recent years. It is mainly used in sports and mass sports, rehabilitation physiotherapy, aviation, beauty medicine, etc. It mainly uses the vibration table to generate mechanical vibration waves according to the set vibration frequency and amplitude, stimulate the body to cause muscle vibration, and make the neuromuscular system adjust and adapt, So as to improve its function. Meng Wenbin et al. [6] selected 38 children with spastic cerebral palsy aged 1-3 years to explore the effect of whole-body vibration training on lower limb motor function of children with CP. the gross motor function test scale-88 (gmfm-88) and Berg Balance Scale (BBS) were used to evaluate the gross motor function and balance function of children before and after treatment. The results show that WBV training can improve the gross motor and balance function of children, it can effectively improve the abnormal gait of children with cerebral palsy. Yan Shanzhong [7] intervened children with spastic cerebral palsy on the basis of routine rehabilitation treatment and combined with whole-body vibration training. After 12 weeks, the walking and motor ability were compared. The results showed that the effect of standing, walking, running and jumping, posture control, mobility and walking speed was better than that of routine rehabilitation treatment, and the physical operation level had no significant impact. Research shows that whole body vibration training stimulates proprioceptive receptors through external mechanical vibration. Rapid muscle contraction and relaxation can activate the core muscle group, so as to alleviate limb spasm, enhance muscle strength and improve core stability. Compared with traditional treatment and rehabilitation methods, WBV training equipment has the advantages of simple operation and high acceptability. It has been popularized and applied in children's rehabilitation institutions at home and abroad to varying degrees, but the relevant high-quality clinical research and evidence-based basis are insufficient, and it has not been popularized in the rehabilitation treatment of children with cerebral palsy in China. In the future, we can study different types of cerebral palsy and set up whole-body vibration training with different parameters to observe the long-term and short-term effects.

2.1.3. Virtual reality training

Virtual reality (VR) is to generate a 3D simulation scene with the help of computer programming, immerse users in the virtual scene by wearing corresponding auxiliary equipment, and establish a human-computer interaction mode. It was first proposed in the 1980s. Han Jing et al. [8] searched the relevant literature on the clinical randomized controlled trial of virtual reality rehabilitation training and conventional rehabilitation training in the treatment of lower limb motor dysfunction in children with cerebral palsy, and finally included 14 literatures for systematic evaluation and analysis. The results show that virtual reality rehabilitation training combined with conventional rehabilitation training can more effectively promote the rehabilitation of lower limb motor function in children with cerebral palsy, it is more effective than simple routine rehabilitation training. Wang Yali [9] found in the study of virtual reality technology training on the balance function and gross motor function of CP children that the BBS score and gmfm-88 score of the experimental group after intervention were higher than those of the control group, The results show that rehabilitation training based on virtual reality technology can improve the balance function and gross motor function of children with cerebral palsy, and promote the recovery of walking function of children with cerebral palsy. Cho et al. [10] through a small sample randomized controlled trial, confirmed that VR simulated rehabilitation training for children with cerebral palsy can significantly improve gross motor function, and confirmed that sensory feedback plays a positive supporting role in the rehabilitation of children. More importantly, VR technology makes the body mass evenly distributed in the lower limbs by improving the limb symmetry, enhances the muscle strength of the lower limbs, increases the stability of children when standing, improves the ability to adjust posture, improves the stability of dynamic posture, and finally improves the walking ability of children.

2.2. Physical therapy

There are a variety of physical therapy methods commonly used in patients with cerebral palsy, and have been widely used in the rehabilitation of cerebral palsy, including various forms of electrical

stimulation therapy, biofeedback therapy, phototherapy, water sports, spa, etc., which can effectively alleviate muscle spasm, reduce muscle tension, and have a good auxiliary effect on children with spastic cerebral palsy. Yun Guojun et al. [11] found that the use of extracorporeal shock wave can alleviate muscle spasm, reduce the tension of hamstring and triceps of lower leg in children with CP, and improve the crouching gait of children. Yang Guangxian et al. [12] combined with deep muscle stimulation therapy on the basis of conventional rehabilitation therapy, can not only reduce muscle tension and improve the walking speed and stride of children with spastic diplegia, but also improve the mobility of hip and knee joints of both lower limbs during walking, reduce the plantar flexion angle of ankle, and improve the gait of children with spastic diplegia. Cheng Hui [13] applied intramuscular patch to improve exercise efficiency, improve abnormal gait and improve walking efficiency by establishing correct action mode. Studies have shown that [14], EMG biofeedback therapy can better improve the dorsiflexion of feet and improve the pointy foot gait of children with spastic cerebral palsy. Pu et al pointed out that the biofeedback system can not only detect the pointy foot gait of children with cerebral palsy in the real environment, but also potentially improve the effect of training and rehabilitation and correct the pointy foot gait [15]. Studies have shown that [16], rhythmic auditory stimulation can activate auditory center and brain motor area, control lower limb muscles, cooperate with rhythm training, adjust gait mode, effectively improve children's gait speed and step length, and increase lower limb joint activity, and different frequency and training time will affect its intervention effect.

2.3. Medication

At present, there is no specific drug for the treatment of cerebral palsy at home and abroad. The commonly used drug treatment in clinic is mainly to nourish nerves and relieve spasticity, such as ganglioside, mouse nerve growth factor, brain protein hydrolysate, etc. Studies have shown that monosialotetrahexose ganglioside commonly used in clinic can repair damaged nerves, promote their reconstruction and improve brain injury [17]. In terms of relieving spasm, type A botulinum toxin is more representative. Xu Huan et al. [18] believe that after grasping the treatment dose and comprehensively considering the condition, type A botulinum toxin can significantly alleviate the muscle spasm of children with cerebral palsy, improve the standing and walking function, reduce the number of steps, increase the step length, and improve the limb motor function and quality of life. Studies have shown that a series of plaster combined with botulinum toxin injection may obtain better curative effect [19]. Tang Qingsong [20] included 7 studies in the meta-analysis of the effectiveness and safety of botulinum toxin injection in the treatment of horseshoe foot deformity of spastic cerebral palsy, including 576 patients, 360 cases of botulinum toxin A and 116 cases of placebo. The results show that local intramuscular injection of botulinum toxin A can reduce the muscle tension of spastic muscles, alleviate the degree of muscle spasm, and improve joint mobility and gait, It has the advantages of quick effect, small local side effects and strong selectivity. As for the choice of oral drugs, foreign studies have shown that the prescriptions and doses of oral drugs given by doctors in clinic are different, but baclofen and bapentin are used more frequently [21]. At present, although many drugs can improve the local symptoms of children with cerebral palsy, it is still necessary to further formulate the standardized treatment scheme of drug prescription according to the best evidence and consensus of clinical experts.

2.4. Orthopaedic AIDS and surgical treatment

With the continuous progress of modern rehabilitation medicine, orthopedic AIDS support treatment plays an extremely important role in CP rehabilitation. Clinically, CP children often use knee ankle foot orthosis and thermoplastic plates made according to the plaster model of the affected foot. It has the characteristics of good fitting, comfortable, light and easy to clean. It has been widely accepted by children and their parents. Huang Yanfang [22] wore ankle foot orthosis on the basis of routine rehabilitation training. After 6 months of follow-up observation on the rehabilitation effect, muscle strength improvement and gait of children with cerebral palsy in the two groups, it was found that wearing ankle foot orthosis can not only effectively improve the rehabilitation training effect, but also improve the muscle strength of children with mental, motor function, independence Gait has a certain promoting effect. After years of clinical practice, selective posterior rhizotomy (SPR) has been recognized as the most accurate operation to alleviate spasticity of cerebral palsy. Yu Jianglong et al. [23] used the three-dimensional gait analysis system to record the parameters of 12 children with cerebral palsy after SPR before operation, 6 months after operation and the normal control group. The results showed that after 6 months after operation, the grading score of large motor function grading system (GMFM) and the spastic state score of modified Ashworth scale were significantly improved, and the postoperative gait frequency The percentage of time in the initial stage decreased significantly, and the percentage of time in the step

length and stride stage increased significantly, indicating that SPR can significantly improve the motor ability of children with cerebral palsy.

In recent years, the emergence of new rehabilitation treatment methods also provides new ideas for the rehabilitation treatment of cerebral palsy. LV Renhua et al. [24] discussed the effect of neuromuscular activation technology on the walking ability of hemiplegic patients and found that it is not only conducive to improving the gross motor function, balance and walking function of children, but also can stimulate the active participation of patients, which is an interesting training. The core content of neuromuscular activation technology is a technical system that can activate "dormant" or inactivated muscles, reconstruct normal movement mode, promote the central nervous system's control of movement through high-level neuromuscular stimulation with the help of suspension movement system, and restore the function of inactivated deep muscles. It is an efficient motor unit for retraining muscles. Studies have shown that [25], the movement mode of children can also be improved by improving the sensory motor system. A German scholar proposed to use sensory motor insole (SMI) to improve the walking ability of children with CP. the mechanism is to change the muscle activation mode by changing the sensory input and proprioceptive input of plantar skin, so as to adjust the muscle tension of lower limbs Motor activity and motor coordination, reduce excessive internal and external rotation of lower limbs, and improve children's abnormal spastic gait.

2.5. TCM Treatment

Traditional Chinese medicine has a long history in the treatment of cerebral palsy. It mainly plays the role of Supplementing Qi and blood, relaxing meridians and collaterals, promoting blood circulation and removing blood stasis, and regulating the balance of yin and Yang, so as to improve the circulation of children's lower limbs, so as to effectively improve the walking function of children with cerebral palsy. At present, TCM treatment includes acupuncture, acupoint catgut embedding, acupoint injection, massage, external use of traditional Chinese medicine, etc. Traditional Chinese medicine acupuncture therapy "brain and abdomen four needles" [26] can improve the surface electromyography and three-dimensional gait time-space parameters of children with spastic cerebral palsy, better positively adjust and improve the muscle strength of lower limbs during walking, and there are no serious adverse reactions. It is effective in clinical cooperation with conventional rehabilitation treatment. This method is used to find the support phase, swing phase, step length the stride was significantly higher than that before treatment, and the double support phase was significantly lower than that after treatment. After treatment, the support phase, swing phase, step length and stride of the observation group were significantly higher than that of the routine group, and the double support phase was significantly lower than that of the routine group. Fang Qian et al. [27] not only accurately corrected the force lines of pelvis and lower limbs, improved the stability of support phase and swing phase, but also significantly prolonged the step length by using the "belt leading and air guiding" massage method. Lan Ying [28] selected 60 patients with spastic cerebral palsy with foot drop for acupoint catgut embedding treatment, selected JieXi, xiajuxu and Zusanli as the main points, and selected the corresponding matching points according to the accompanying symptoms. After continuous treatment for 3 months, the gross motor function, muscle strength and active foot dorsiflexion angle were tested and statistically analyzed, It is found that acupoint catgut embedding can effectively improve spastic state level gross motor ability, improve muscle strength and correct foot drooping gait in children with cerebral palsy. Zhang guanfei [29] adopts the treatment method of traditional Chinese medicine fumigation and washing combined with rehabilitation training. The drugs are combined with *Caulis Spatholobi*, *Ligusticum chuanxiong*, *Tougu* grass, *Polygala tenuifolia*, *Acorus tatarinowii*, *Astragalus membranaceus* and *angelica*, 30g of white peony and *Shenjin* grass, all ground into powder, put them into medicine bags, and use the traditional Chinese medicine fumigation and washing therapeutic instrument for fumigation and washing treatment, once a day, six times a week and two months as a course of treatment. Research shows that traditional Chinese medicine fumigation combined with comprehensive rehabilitation treatment can effectively increase the joint activity of children with spastic cerebral palsy. Through three-dimensional gait space-time analysis, it can reduce the step size, stride, gait speed and swing phase, shorten the support phase, enhance the walking ability of children, and treat gait disorders. Zeng Yiyi [30] and others explored the effect of improved acupoint catgut embedding technology on the improvement of pointy foot gait of spastic cerebral palsy. On the basis of comprehensive rehabilitation therapy, Naoqing, Yanglingquan and Chengshan acupoints were taken for acupoint catgut embedding treatment with improved acupoint catgut embedding technology. The rehabilitation evaluation results showed that the pointy foot score, foot dorsal flexion angle and CSI score of CP children after treatment were better than those of the control group, It shows that this method can effectively improve the ankle range of motion and pointed foot degree of children with spastic cerebral palsy, correct abnormal gait and improve their walking ability, and the

effect is better than that of simple comprehensive rehabilitation treatment. Due to the complex condition and long course of cerebral palsy, it is difficult to obtain the maximum curative effect only by traditional Chinese medicine. Clinically, it is a comprehensive treatment of traditional Chinese medicine combined with modern rehabilitation training.

3. Epilogue

The treatment of abnormal gait in cerebral palsy is a long-term and complex process, which is difficult to completely restore the normal walking function. At present, there is still a lack of specific drugs for the treatment of CP. modern rehabilitation treatment mostly adopts exercise therapy or training, sensory integration function training, orthopedic AIDS, etc., but these treatment methods have great limitations. The effect of single treatment is not ideal, and comprehensive treatment must be adopted.

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