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Research Progress on Intellectual Disability in Children with Cerebral Palsy

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Abstract: Cerebral palsy refers to a non progressive brain injury syndrome caused by various reasons during the early stages of brain development in infants from before birth to one month after birth. In recent years, with the rapid development of medical technology, the improvement of neonatal rescue technology, the development of perinatal medicine and the change of people's living habits, the incidence rate of cerebral palsy worldwide has also increased year by year with the significant increase of neonatal survival rate. Among them, intellectual disability, as one of the important factors affecting the growth and development of cerebral palsy, has a serious impact on the growth and development of children with cerebral palsy. Intellectual disability not only limits the cognitive ability, social interaction, and learning potential of children, but also has a profound impact on their daily self-care ability. This article reviews the latest developments in research on pediatric cerebral palsy in recent years, aiming to provide a comprehensive overview of intellectual disabilities in children with cerebral palsy from the perspectives of etiology, pathogenesis, and treatment methods. The goal is to provide more scientific and systematic theoretical support and practical guidance for the treatment of intellectual disabilities in children with cerebral palsy, promote further standardization and optimization of clinical practice, and provide useful references for the comprehensive rehabilitation and improvement of their quality of life.

1. Introduction

Cerebral palsy (CP), also known as cerebral palsy. It refers to central motor disorders caused by non progressive brain damage or abnormal brain development due to various reasons during the early stages of brain development in infants from before birth to one month after birth[1]. Cerebral palsy is mainly manifested as central motor disorders and postural abnormalities, and may also be accompanied by intellectual disabilities, epilepsy, sensory and perceptual disorders, language communication disorders, and mental and behavioral abnormalities. It is one of the main diseases

that cause motor disabilities in children. According to domestic and foreign reports, the prevalence of cerebral palsy ranges from 1.4 ‰ to 3.2 ‰, with a prevalence of 2.46 ‰ among children aged 1-6 in China.[2] Research has found that over 70% of children with cerebral palsy currently have varying degrees of intellectual disability[3]. In recent years, with the continuous progress in the fields of medicine and education, research on intellectual disabilities in children with cerebral palsy has gradually deepened, but there are still many urgent problems that need to be solved[4].

Cerebral palsy is a common pediatric neurological disorder with complex etiology and long treatment duration. Intellectual disability, as one of the important clinical manifestations of cerebral palsy, seriously affects their quality of life and social adaptability[5], and also requires long-term care from caregivers. In view of this, the author provides the following review on the etiology, pathogenesis, and treatment methods of intellectual disabilities in children with cerebral palsy, hoping to provide reference for clinical research on the treatment of intellectual disabilities in children with cerebral palsy.

2. Etiology and pathogenesis

2.1 Traditional Chinese Medicine's understanding of the etiology and pathogenesis of cerebral palsy in children

In traditional Chinese medicine, there is no specific disease name for "cerebral palsy in children", but rather it is classified under the categories of "five delays", "five softness", "relieving the skull" and other diseases[6]. Cerebral palsy with intellectual disability is classified as "dementia" in traditional Chinese medicine. These conditions are related to delayed growth and development in children, which may be caused by congenital or acquired factors, mainly involving abnormal brain nerve development, affecting motor function and intellectual development [7].

The causes of cerebral palsy in children mainly include congenital and acquired factors, among which:

Congenital factors mainly include: (1) Insufficient innate endowment: parental deficiency of essence and blood, giving birth to a child at an advanced age, leading to congenital deficiency of essence and blood in the fetus, and loss of cerebral spinal cord. As stated in the *Golden Mirror of the Medical School: Preschool Heart Method*: The syndrome of "Five Delayed Children" is mostly caused by parents' weak qi and blood, congenital deficiency, which leads to weak muscles and bones, difficult walking, slow tooth growth, and inability to sit stably when the child is born, all of which are manifestations of kidney qi deficiency. (2) Inappropriate adjustment of pregnant women during pregnancy: Due to improper adjustment of diet, daily life, emotions, improper medication treatment, or unsuccessful abortion, the fetus is damaged, and the brain and spinal cord are injured.

Acquired factors include: (1) difficult childbirth and birth injuries: Difficult childbirth and birth injuries that occur during the delivery process may lead to blood stasis and phlegm obstructing the brain meridians, affecting the normal function of the brain marrow. (2) Postpartum asphyxia or illness: Neonatal asphyxia, fever, poisoning, or brain trauma can also lead to blood stasis, toxicity, and brain damage. The brain is the home of the primordial spirit. If the brain marrow is not filled or damaged, the spirit will lose its hearing, leading to symptoms such as intellectual disability, slow response, unclear language, weak chewing, and limb weakness.

Traditional Chinese Medicine believes that the main pathogenesis of cerebral palsy in children is dysfunction of the internal organs and imbalance of the circulation of qi, blood, and semen. The onset of cerebral palsy is closely related to the three organs of the liver, spleen, and kidneys. Deficiency of the liver and kidneys leads to empty brain marrow, deficiency of the spleen and kidneys leads to loss of muscle and muscle nourishment, and weakness of the liver and spleen results in symptoms such as limb rigidity and spasms; Phlegm and blood stasis obstruction is also

one of the important causes. Excessive phlegm and dampness can obscure the clear orifices, prolong the course of the disease, obstruct the meridians, block the brain meridians, hinder the circulation of qi and blood, and cause the brain to lose nourishment.

2.2 Research on the etiology and pathogenesis of cerebral palsy in children by Western medicine

The research on the etiology of cerebral palsy in children by Western medicine is shown in Table 1.

Table 1: Research on the etiology of cerebral palsy in children by Western medicine

Category	Pathogeny
Prenatal factors	Maternal factors: infection, poisoning, malnutrition, exposure to radiation, genetic factors, etc
	Fetal factors: chromosomal abnormalities, congenital metabolic diseases, etc
Birth factors	Premature birth: Immature development, susceptible to brain damage
	Suffocation: cerebral hypoxia ischemia
	Labor injury: mechanical injury during childbirth
Postnatal factors	Neonatal diseases: convulsions, respiratory distress syndrome, aspiration pneumonia, sepsis, meningitis, etc
	Hyperbilirubinemia: Elevated serum bilirubin levels in newborns may lead to bilirubin encephalopathy

The pathogenesis of cerebral palsy mainly involves damage and dysfunction of brain nerve cells. Specifically, it includes the following aspects:

(1) Degeneration and necrosis of cortical neurons in children with cerebral palsy: Cortical neurons in children with cerebral palsy may undergo degeneration and necrosis, leading to a decrease in the number, disorder, degeneration, and proliferation of glial cells at various levels of the cerebral cortex[8].

(2) Abnormal brain development: Early embryonic developmental abnormalities may lead to premature birth, low birth weight, and increased risk of perinatal hypoxia and ischemia, which further affect normal brain development.

(3) Brain hypoxia and ischemia: Regardless of whether it is before, during, or after childbirth, any occurrence of hypoxia and ischemia in the brain can lead to damage to nerve cells and subsequently trigger cerebral palsy[9].

In summary, the etiology and pathogenesis of cerebral palsy with intellectual disabilities in children in Western medicine involve multiple factors, including brain nerve cell damage and functional impairment caused by various factors before, during, and after childbirth [10]. When preventing and treating cerebral palsy in children, it is necessary to comprehensively consider various factors and develop personalized treatment plans. Meanwhile, continuous in-depth research on its etiology and pathogenesis can help improve treatment outcomes and enhance the quality of life for affected children.

3. Traditional Chinese Medicine treatment methods

The traditional Chinese medicine treatment methods for infantile cerebral palsy mainly include acupuncture and moxibustion, moxibustion, massage, acupoint injection, acupoint catgut embedding and traditional Chinese medicine treatment, which have certain effects on the treatment of cerebral palsy. At present, more and more scholars are adopting comprehensive therapy to treat

pediatric cerebral palsy, which has the advantage of recombining and integrating various means to make them work together. Many studies have also shown that this has the advantages of faster efficacy, no side effects, lower cost, better long-term effect, and fewer adverse reactions compared to any single treatment method.

3.1 Acupuncture and moxibustion treatment

Acupuncture and moxibustion is mainly used to treat infantile cerebral palsy by dredging channels, harmonizing qi and blood, and stimulating brain function [11]. Head points such as Baihui, Sishencong, Dazhui, Yamen, etc. are often selected as the main points for acupuncture and moxibustion treatment. According to the specific condition of the child, shoulder, Quchi and other auxiliary points can also be selected for acupuncture [12]. Alternatively, electroacupuncture therapy, meridian flattening therapy which using a meridian flattening device to perform low-frequency pulse targeted treatment on the corresponding meridians, ear acupoint therapy, helium neon laser acupoint irradiation, etc. can all help improve the symptoms of children with cerebral palsy. Yang Dongmei et al. [13] divided 180 children with cerebral palsy into three groups for comparative observation: acupuncture combined with Hei Xiaoyao San treatment (60 cases), simple acupuncture treatment (60 cases), and simple traditional Chinese medicine treatment (60 cases). The main acupuncture points were selected from Si Shen Cong, Ben Shen, Bai Hui, and Shen Ting, while the auxiliary acupuncture points were selected from the lower limb motor and sensory areas, foot movement and sensory areas, etc. Conventional needle insertion and application of the method of tonifying and purging were performed. The results showed that the total effective rate of the combination group was 91.4%, which was higher than the 78.2% of the simple traditional Chinese medicine group and the 80.4% of the simple acupuncture group ($P<0.05$). It can be seen that acupuncture and moxibustion treatment can improve the motor function, cognitive ability and language ability of children with cerebral palsy, stimulate their own rehabilitation potential, promote the recovery and regeneration of the nervous system, and has high safety.

3.2 Moxibustion treatment

Moxibustion, as a traditional Chinese medicine therapy, uses dry and pure mugwort leaves to make mugwort sticks, mainly targeting the Du meridian points such as Dazhui, Shuzhu, and Yaoyang Guan [14]. It is combined with the Hand and Foot Yangming Meridian points to unblock the Yang meridian, and regulates qi and blood through warm stimulation of acupoints, playing a certain auxiliary therapeutic effect. This method is suitable for relieving muscle tension and spasms, and can help improve the motor function and intellectual development of children with cerebral palsy. Jiao Yuxiang et al. [15] treated 42 children with cerebral palsy with moxibustion at acupoints of the Du meridian, including Zhiyang, Dazhui, Yaoshu, Yaoyangguan, Xuanshu, Jinsuo, and Mingmen, combined with physical therapy, scalp electroacupuncture, and body acupuncture. The total effective rate was 92.9%. Specifically, moxibustion can promote the smooth flow of meridians and harmonize qi and blood, thereby adjusting the functions of nerves and organs. It may have a certain rehabilitation effect on children with cerebral palsy and intellectual disability [16]. However, the therapeutic effect of moxibustion may vary among individuals and requires long-term adherence to treatment to see significant results. Therefore, when performing moxibustion treatment, it is necessary to follow the guidance of a professional physician and closely monitor the reactions and changes in the patient's condition.

3.3 Massage therapy

Tuina follows the meridians and muscle groups, often using techniques such as palm root massage, pinching, thumb tapping, and pressing. Depending on the patient's different conditions, constitution, age, and existing obstacles, different massage techniques, relaxation techniques, and stimulation techniques are selected and applied in coordination with each other. Harmonize qi and blood, balance yin and yang, unblock meridians, regulate organs [17], and achieve the goals of relieving muscle spasms, improving circulation, and increasing joint mobility. On the basis of action training, Ye Jingyan et al. [18] combined massage therapy to treat 31 children with cerebral palsy (study group), and compared it with 31 children treated with simple action training therapy (conventional group). One finger Zen pushing method was used for spastic cerebral palsy children, pressing method was used for tense involuntary movement cerebral palsy children, pressing method was used for hypotonia cerebral palsy children, and pressing method was used for ataxia cerebral palsy children. The results showed that after treatment, the gross motor function score, Fugl Meyer motor function assessment scale score, and intellectual development index score of the study group were higher than those of the conventional group ($P<0.05$). Tuina can promote the circulation of qi and blood, smooth joints, correct contractures, and improve neurological function [19], but further standardization and normalization of Tuina treatment effects and techniques are still needed.

3.4 Other Traditional Chinese Medicine therapies

In addition, a large number of studies have shown that traditional Chinese medicine therapies such as Chinese medicine, Chinese medicine patches, Chinese medicine fumigation, and acupoint embedding have significant therapeutic effects on pediatric cerebral palsy. Professor Wang Xuefeng [20] comprehensively discussed the medication rules and mechanisms of action of Huangqi Guizhi Wuwu Tang as the base formula for the treatment of children with CP through clinical modifications. He also elaborated on the authenticity of tracing the source from traditional medical works and the scientific nature of core drugs from a modern medical perspective. Wang Hui et al. [21] explored that the traditional Chinese medicine meridian application method improved lower limb motor function in children with spastic cerebral palsy. The observation group had higher gross motor function, TIS, and BBS scores than the control group. In addition, Zhang Hui et al. [22] used traditional Chinese medicine meridian application combined with comprehensive rehabilitation training to adjust the lower limb motor function of children with spastic cerebral palsy, while improving their quality of life to a certain extent. Zhang Hewei et al. [23] pointed out that traditional Chinese medicine fumigation, as a characteristic treatment method of traditional Chinese medicine, has the advantage of treating cerebral palsy in children. It can directly reach the lesion, regulate the organs, and have a therapeutic effect on the disease. Zhou Yu et al [24]. believe that acupoint thread embedding has a long-term therapeutic effect of "replacing needles with threads", which can improve the excitability and conductivity of acupoints, activate corresponding brain areas, stimulate the establishment of new synapses and neural circuits in the cerebral cortex, improve cell metabolism, enhance the compensatory function of the body, and play a role in stimulating yang qi, warming meridians, and promoting qi and blood circulation, that is, "promoting the pulse", thus achieving "harmony between blood vessels and benefits, where the spirit resides".

In summary, there are various methods of traditional Chinese medicine treatment for pediatric cerebral palsy, all of which have shown certain therapeutic effects. However, it should be noted that the effectiveness of traditional Chinese medicine in treating pediatric cerebral palsy may vary depending on individual differences. Therefore, personalized treatment plans should be developed based on the specific condition and constitution of the child during the treatment process. At the same time, the treatment of pediatric cerebral palsy with traditional Chinese medicine should be

combined with modern rehabilitation theory to form a comprehensive rehabilitation treatment method that combines traditional Chinese and Western medicine, in order to improve the treatment effect. At present, children with cerebral palsy are often treated with comprehensive therapy, that is, acupuncture and moxibustion, massage, acupoint therapy, traditional Chinese medicine treatment and other means are reorganized and integrated to play a role together. Comprehensive therapy can fully leverage the advantages of various treatment methods, improve treatment effectiveness, and reduce side effects. Related studies have shown that comprehensive therapy has advantages over any single treatment method, such as fast efficacy, no or minimal side effects, low cost, and good long-term effects.

4. Current status of modern medical treatment for children with spastic cerebral palsy

4.1 Drug therapy

At present, there is no specific drug for treating pediatric cerebral palsy in clinical practice. The treatment mainly focuses on drugs that promote nerve repair and improve cerebral circulation, which have a positive effect on the treatment of pediatric cerebral palsy. The drugs used to treat spastic cerebral palsy mainly include Botulinum toxin A (BoNT-A), monosialotetrahexosylganglioside, and mouse nerve growth factor. BoNT-A can alleviate muscle spasms, reduce muscle tone, correct limb spasms and posture abnormalities, and is an ideal drug for treating spastic cerebral palsy [25]. Western medicine treatment has a quick effect on improving patients' cognitive and executive functions, as well as memory. However, adverse drug reactions are common, and long-term use can lead to liver and kidney damage.

4.2 Surgical treatment

In the situation where traditional medicine and conventional modern therapies cannot effectively solve muscle spasms in children, surgical methods have emerged. Surgical methods include selective spinal nerve transection, carotid sympathetic nerve network dissection, activation conduction surgery, etc. It is an individualized treatment plan developed for different factors in patients after comprehensive evaluation. Surgery can improve patients' rigidity and reduce muscle spasms, but it has certain trauma and many postoperative complications. Therefore, research hotspots should be focused on improving surgical methods and reducing complications, and the importance of long-term functional rehabilitation training after surgery should be emphasized to patients from beginning to end [26].

4.3 Transcranial magnetic therapy

Low frequency repetitive transcranial magnetic stimulation induces electrical currents in brain tissue by placing a special magnetic field in the head, stimulating neurotransmitter activity and central nervous system excitation to repair nerve cell damage and improve neural development. It is suitable for various brain structural injuries and neurological disorders [27]. Low frequency repetitive transcranial magnetic stimulation stimulates the frontal and temporal cortex, promotes neural connections in the brain, improves language input and output functions, promotes information transmission in various brain regions, improves neural function development, and ultimately promotes intellectual development and enhances intelligence levels [28]. Transcranial magnetic stimulation can also activate dormant brain cells, delay brain cell apoptosis, enhance brain cell activity, promote brain structural repair, control the progression of intellectual disability, and improve intellectual level [29].

4.4 Rehabilitation therapy

Rehabilitation therapy is of great significance for improving intellectual disability in children with cerebral palsy.Bobath method, Vojta method, Rood method, occupational therapy and other rehabilitation treatment methods all improve abnormal movement patterns, increase joint mobility, and promote the establishment of normal movement patterns by inhibiting primitive reflexes and abnormal postures. It can effectively promote the recovery of limb function and sensory function in children with spastic cerebral palsy, improve their self-care ability, improve their neurological and psychological status and quality of life, and facilitate the development of their intelligence [30].

4.5 Stem cell therapy

In recent years, stem cell therapy has been rapidly developing as a treatment for various neonatal diseases. Multiple animal experiments and clinical studies have shown that stem cell transplantation is safe and effective for treating cerebral palsy. Stem cells have self-renewal ability and multi-directional differentiation potential, which can differentiate into neurons, astrocytes, oligodendrocytes, etc., helping to repair damaged neural networks and rebuild or improve neural function [31]. Clinical cases have confirmed that stem cell therapy effectively improves the motor coordination and cognitive abilities of children with cerebral palsy.

4.6 Comprehensive treatment

In actual treatment, Western medicine usually adopts comprehensive treatment measures based on the specific condition of the child. For example, combining drug therapy, surgical treatment, and rehabilitation therapy to maximize treatment effectiveness. At the same time, Western medicine also emphasizes the importance of early intervention and continuous treatment to maximize the intellectual development and neurological function recovery of children.

Although modern medicine has made some progress in the treatment of intellectual disabilities in children with cerebral palsy, there are still many challenges. In the future, with the continuous development of science and technology and the deepening of research, new therapies such as stem cell therapy are expected to provide more effective and safer treatment options for children with cerebral palsy. At the same time, it is also necessary to strengthen research on the rehabilitation treatment of intellectual disabilities in children with cerebral palsy, in order to further improve their quality of life and social adaptability.

In summary, the research on intellectual disabilities in children with cerebral palsy in modern medicine is a constantly developing and improving field. Through the application of comprehensive treatment methods and the exploration of new therapies, we are expected to provide better treatment and rehabilitation services for children with cerebral palsy.

5. Conclusions

In summary, cerebral palsy in children is a common cause of lifelong disability. Currently, most treatment methods aim to improve patients' function and activity participation, while minimizing factors that worsen the condition. Although modern medicine has made significant progress in preventing and improving brain damage, there is currently no cure for cerebral palsy. Therefore, early detection and treatment should be achieved, and the principle of timely, long-term, and formal treatment should be adhered to. Clinical trials have shown that the above-mentioned therapies can benefit children with cerebral palsy. At present, with the vigorous development of the medical industry, although there are numerous treatment methods, each has its limitations. Single therapy

often means slower efficacy and longer treatment cycles, which increases the economic and psychological burden on families. Moreover, a single treatment method can easily cause children's tolerance to the therapy and reduce its effectiveness. The combination of traditional Chinese medicine and western medicine is a relatively successful treatment method today. Traditional Chinese medicine methods, such as acupuncture and moxibustion, massage and Chinese medicine, have unique advantages in the treatment of mental retardation of children with cerebral palsy. The physical therapy, drug therapy and rehabilitation training of western medicine also provide new means for treatment. Through the integrated treatment of traditional Chinese and Western medicine, advantages can be complemented and treatment effectiveness can be improved, bringing new hope and opportunities for the treatment of intellectual disabilities in children with cerebral palsy. The feasibility of combining traditional Chinese and Western medicine to treat intellectual disabilities in children with cerebral palsy has been widely recognized. Although there are currently numerous comprehensive therapies and various therapies are used in combination, there is no clear consensus on which combination of therapies can achieve the best therapeutic effect. Meanwhile, the treatment of intellectual disabilities in children with cerebral palsy is a complex and lengthy process that requires joint efforts from parents and doctors. During the treatment process, parents should closely monitor the changes in the child's condition and communicate with doctors in a timely manner, so that doctors can adjust the treatment plan according to the condition. At the same time, parents should also provide sufficient care and support to their children, helping them build confidence in overcoming the disease. Therefore, breakthroughs in the treatment of pediatric cerebral palsy should not be limited to the emergence of new methods, but should also focus on the combination of existing therapies, constantly combining, exploring, and innovating in order to continuously promote the progress of cerebral palsy treatment.

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