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Research Article

The Effects of Electrical Stimulation on Gross Motor Function in Children with Spastic Cerebral Palsy: A Review Article

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Abstract

Cerebral Palsy (CP) is the most common childhood disability in children. The child's motor development and functioning are affected by variety neuromuscular and musculoskeletal impairments. Both of upper and lower extremities motor function are important for many daily life activities. For example, children who has good fine motor function and who can sitting independently can manipulate the objects by using upper extremities and can realize transfer activities. Therefore, she/he can play effectively in daily life. Children who can play will be happy and independent in daily life activities. Spasticity is the most common problem in children with CP and can interfere with daily life activities. Children who have spastic CP constrained in daily life activity, participation and recreational activities. Working on gross motor skills helps to gain strength, increase postural control, to achieve motor milestones and to become independent in daily life activities. In treatment program, physical therapist used different approach, like, exercise programs (stretching, strengthening, aerobic exercise…), electrical stimulation, neurodevelopmental approaches, virtual reality, constrained induced movement therapy. Neuromuscular Electrical Stimulation, Functional Electrical Stimulation and Threshold Electrical Stimulation commonly used for this reason. There is a few evidence on positive effects of electrical stimulation applied in children with CP. This review study was planned to investigate the effects of electrical stimulation on gross motor function in children with CP.

Introduction

Cerebral Palsy (CP) is most common a disorder affecting movements and posture resulting from damage to the developing brain. The prevalence of CP is 2-3 per 1000 live births [1]. CP is non-progressive disorder, but, disability is progressive. Neuromuscular and musculoskeletal impairments are affect child's functioning and daily life activities. The severity of symptoms can vary significantly. Although primary symptoms are motor, gait and posture problems, sensory impairments, speech difficulties, learning disabilities, emotional and behavioural challenges, joint problems, epilepsy, nutritional deficiencies, are also seen [1,2]. Some children only have minor problems while others may be severely disabled. Delays in motor skill milestones, and movement ability are most common problem in children. Motor developmental problems are holding head up, rolling over, sitting, crawling and walking. Spasticity, muscle stiffness and exaggerated reflexes can cause delay in motor skills. Spasticity is the most common movement disorder, occurring in 80% of children with cerebral palsy. Many children with spastic CP have difficulty in mobility tasks [2, 3]. Gross motor skills are important to enable children to perform physical activities and daily activities, such as sitting, play activities, sporting skills. Delay in gross motor development cause most important problems in daily life activities and functional performants in children with cerebral palsy. Sitting independently is an important ability for many functional activities in daily life. Children who cannot sitting independently cannot manipulate the objects by using upper extremities, and some functional activities like transfers will be very difficult. Therefore, children with spastic CP have limitations and late development to perform daily life activities including sitting, standing, walking and running. Working on gross motor skills helps to gain strength, increase postural control, to achieve motor milestones and to become independent in daily life activities [4-7]. There is no cure for CP, but treatment can improve life quality for the patients. There is a few evidence for treatment and interventions to improve gross motor function in children with spastic CP. Several different types of approaches are used for children with CP. Common treatment modalities include muscle strength exercises, neurodevelopmental approaches, ankle–foot orthoses, strength training, physical therapy exercise, strengthening, fitness training, and constraint therapy, treadmill training, serial casting, splinting, and virtual reality [2,8,9]. Electrical stimulation is one of the physiotherapy modality commonly used to improve muscle strength (antagonist muscles) and to decrease muscle tone (spastic muscles). Electrical stimulation has been used successfully in adults with hemiplegic patients and children with spastic cerebral palsy to correct foot drop, to improve standing balance and gait function, increase muscle strength, reduce muscle spasticity, and to improve movement control. Evidence to support the effectiveness of some electrical stimulation methods (such as, functional electrical stimulation, neuromuscular electrical stimulation, and transcutaneous electrical nerve stimulation) in children with spastic CP has been increasing over recent years. Common outcome measurements used to evaluate the effectiveness of electrical stimulation have been focused mainly of the International Classification of Functioning, Disability and Health levels on body structure and function, activity limitation and social partition which include range of motion, walking ability and gait function, motor function, self-care ability, functional mobility, postural control, motor learning [10-15].

There are various forms of electrical stimulation methods in the literature. Neuromuscular electrical stimulation (NMES) is the application of an electrical current of sufficient intensity to elicit muscle contraction. It is most common type of therapeutic electrical stimulation used to decrease muscle spasticity and to strengthen the antagonist muscle of the spastic muscles. NMES has been used to improve gross motor function skills in children with CP. In the literature, there is a lot of study shown that positive effects of NMES on muscle strength and gross motor function in children with CP [15-18]. Second application is Threshold Electrical Stimulation (TES). TES or therapeutic electrical stimulation is described as the delivery of low-intensity electrical stimulation to targeted spastic muscles during sleep at home. This stimulation is not intended to cause muscle contraction. TES is well accepted by the parents and has no known negative side effects. Several studies on its positive effects in children with CP have been published [19-22].

The other therapeutic stimulation is Functional Electrical Stimulation (FES) [23, 24]. FES, as a treatment option in children with CP has several benefits. It may be use to improve gait function, muscle strength in lower extremity (for example, m. Tibialis anterior, m. Quadriseps femoris,) to improve motor control, postural control and to decrease muscle spasms [25]. Evidence to

support the effectiveness of FES in children with cerebral palsy has been increasing over recent years. In a study Pool et al., found that daily functional electrical stimulation (FES) applied during walking activity is effective in improving self-perceived performance and satisfaction of individually identified mobility performance problems in children with CP. In the same study, authors stated that FES could increase daily life activity performance, community mobility and active recreational abilities by improving functional skills after treatment programs [14]. Postans and Granat reported on their study the effects of FES applied during walking, on gait in spastic CP. 8 children with CP included in the study. At the end of the study, clinically significant improvements occurred in three of the eight children [26]. Determined a question: what is the effect of FES on the participation domain of the International Classification of Functioning Disability and Health? In their study. Their aim were to investigate the effects of FES on walking ability in children with spastic CP. They concluded that FES is a feasible and suitable therapy method for children with spastic CP in terms of walking performance and it seems to have positive effects on kinematic data's [27] reported that FES treatment improved children's propulsive capability and positively influenced their mobility in their single case follow up study [28]. studied that to determine the orthotic and therapeutic effects of daily community applied FES to the ankle dorsiflexors in a randomized controlled study. They found that the improvements in community mobility and balance skills and spasticity are evident for up to six weeks post treatment. At the end of the study, they suggest that FES applied during every day walking activities to improve gait mechanics as well as to address community mobility in children with unilateral spastic CP [29] reported that electrical stimulation can be an effective interventions, when used functionally (like FES), to increase gait function and correct asymmetrical walking patterns in children with spastic CPm [30] performed a systematic review examining the effects of several functional electrical stimulation modalities on lower extremity muscles strength and gait function. They were tried to find an answer to their question, which is "is functional electrical stimulation an alternative for orthotics in patients with cerebral palsy? A literature review" in a literature review study. They conducted computerized database search from inception 6/2016. Fifteen studies were met the inclusion criteria. At the end of the study, they concluded that the quality of most current study was poor, most included a small number of children with CP. They recommended that controlled investigations with larger numbers of participants are needed to fully determine efficacy of FES and establish how to achieve a longer-lasting benefit, and need a longer follow up studies investigating patient compliance. They stated that also controlled investigations are warranted to determine the orthotic and therapeutic efficacy of FES [31]. Performed a randomized controlled study using TES. They evaluated the effects of low-amplitude TES on antagonists of spastic muscles in the legs improves ambulatory performance, muscle strength, activities of daily living, and neurological function in children with spastic CP. They have found no significant effect of TES on ambulatory function in children with CP, although, in the same study the parents of the most children (11 of 12 children) stated that TES had a significant effect [22] studied the effects of TES as a randomized double-blind placebo-controlled clinical study (treatment and placebo groups) in children with spastic CP. They were applied TES for 12 months. Stimulation was applied to the quadriceps femora's and tibia is anterior muscles. The authors reported that there was no significant difference between the groups, but, there was increase in quadriceps area [32]. In their study, Steinbok et al. studied that the effects of TES applied overnight on children with spastic CP who had undergone selective dorsal rhizotomy. They applied TES for treatment group for 1 years. On the other hand, the control group received no TES. The authors concluded that significant improvement in gross motor function for the treated group with TES [33]. In their study, Chan et al. studied as a randomized controlled study, the effects of NMES on the triceps surae muscle in improving gait and function in children with spastic CP. At the end of the study, they concluded that applied NMES of the triceps surae muscle had a positive effect on gait and function. The standing and walking performance of the children were increased [34]. Reported the effectiveness of NMES on gross motor function in children with CP as a systematically review study. Six randomized controlled study were included in the meta-analysis. They stated that NMES might be used as adjuvant therapy to improve sitting and standing function in children. The evidence was found as low quality [15]. Similarly, Pool et al., aimed to determine the effectiveness of NMES-assisted gait on muscle stregth and volume in children with unilateral spastic CP as a randomized controlled study. At the end of study, they concluded that eight weeks of daily NMES-assisted gait training increases muscle strength and gait function [35].

Recommended for the future research study

NMES, FES and TES have positive effects on gait and function in children with spastic cerebral palsy (especially in children with spastic hemiplegia and diplopia who have potential to walking ability). On the other hand, in literature studies stated that further studies employing more rigorous study designs (especially randomized controlled study) and follow-up, larger sample sizes, and homogeneous patient groups are required to support the effects of electrical stimulation on gross motor function and activity limitation in children with CP. From the current evidence, more studies support the potential role of FES as a alternative to conventional orthosis, but, it cannot be concluded that FES improve functioning at the activity and participation level. Low quality of evidence suggest that NMES can be improve activity level and participation domain. There is no guideline for the treatment intensity and stimulator settings to electrical stimulation in children with CP. Data on side effects and long- term follow up are limited. Future study should especially pay attention effects on domain activity and participation, patient compliance, satisfaction of the user, family needs, and side effects.

Conclusion

Electrical stimulation which using to as a functionally might be used as a adjunct treatment method to increase motor function and gait ability in children with spastic CP. However, further randomized controlled, adequate methodological quality, high sample size and long-term follow up are still needed.

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