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RESEARCH REPORT

Effects of combined Adeli suit and neurodevelopmental treatment in children with spastic cerebral palsy with gross motor function classification system levels I and II

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KEYWORDS
Adeli suit;
balance;
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Abstract *Background:* Children with cerebral palsy (CP) exhibit diverse gait patterns depending on their neurological deficits and musculoskeletal problems. The Adeli suit treatment (AST) has been proposed as an intensive exercise protocol in the management of CP.
Objectives: The aim of this study was to compare the effects of a 6-week programme of combined AST and neurodevelopment treatment (NDT) with those of NDT alone on Gross Motor Function Measure (GMFM), balance, and gait in children with CP.
Methods: Twenty children with CP of Gross Motor Function Classification System levels I and II were randomly assigned to one of the following two groups: (1) NDT or (2) AST/NDT. The participants were assessed using the GMFM, Pediatric Balance Scale (PBS), Timed Up and Go (TUG) test, and spatiotemporal gait parameters.
Results: The GMFM, PBS, and TUG test for both groups showed a statistically significant increase ($p < 0.05$). Three children were excluded. Compared to the NDT group ($n = 9$), the AST/NDT group ($n = 8$) demonstrated a significant increase in spatiotemporal gait parameters ($p < 0.05$).
Conclusion: These results provide evidence for the greater effectiveness of combined AST/NDT than NDT alone in improving spatiotemporal gait parameters but not GMFM, PBS, and TUG test.

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Introduction

Cerebral palsy (CP) is a group of permanent disorders associated with the development of movement and posture due to activity limitation that are attributed to nonprogressive disturbances that occur in the developing foetal or infant brain. Motor disorders with cerebral impairment are often accompanied by disturbances in sensation, perception, cognition, communication, and behaviour [1]. Additionally, several factors include pathophysiology impairment, limitations on functional and social activities, and physical asymmetry [2]. Particularly noteworthy is that low muscle tone trunk creates problems of safety and mobility, and leg muscle spasticity affects the mobility of the lower body and delays motor development that is essential for independent standing and walking [3].

Children with CP exhibit diverse gait patterns depending on their primary neurological deficits and secondary musculoskeletal problems; in comparison with healthy children, those with CP walk at a slower speed and exhibit asymmetries and decreased balance [4]. Balancing and walking abilities serve as useful indicators that correlate with the functional level of children with CP [5]. Balancing requires maintaining a state of equilibrium with minimal change in posture. It is composed of multiple movements that require walking, sensory-motor input, proprioceptive input, and joint and muscle coordination. It requires an orientation response that positions one's head and body in an upright position and an equilibrium reaction for recovery of one's posture [6]. The equilibrium reaction results in a reduction of bilateral body asymmetries and shifting of weight to the lower extremities [6,7]. Spasticity and muscle weakness are the main factors affecting gait abnormality in children with CP [8,9].

The treatment methodologies adopted for CP, such as neurodevelopmental treatment (NDT) [10], constraint-induced movement therapy [11], and functional electrical stimulation [12], require a long duration (>8 weeks) to demonstrate improved muscle strength. NDT promotes proprioceptive input and is aimed at reduction of spasticity as well as facilitating normal motor development and improved activities of daily living [13,14]. NDT focuses on the promotion of normal and suppression of abnormal patterns in motor disturbances caused by central nervous system damage, with the aim of improving posture and movements performed with abnormal muscle tone. NDT is effective in improving the patient's body alignment and functional level, which normalises posture through key point of control on the patient's body and handling [15].

Use of the Adeli suit treatment (AST) has been proposed as an intensive exercise protocol in the management of CP as well as other neuromuscular disorders. The suit was developed for maintenance of muscle tone in a weightless environment such as that of an astronaut [16]. AST is based on three principles: (1) working against resistive loads, increased proprioception, and realignment; (2) intensive daily physical therapy; and (3) active motor participation by the patient [17]. The suit is composed of a cap, vest, shorts, knee pads, shoes attached with auxiliary equipment, and a bungee cord that connects the auxiliary equipment. The pieces are laced together with bungee-type cords. The cords are adjustable to allow varying degrees of tension to different muscle groups. The bungee cords are positioned to keep the body properly aligned and to forcibly encourage movement within a normal range of motion [18]. In an attempt to reposition limbs to correct abnormal muscle alignment, the bungee cords are adjusted by therapists to mimic normal flexor and extensor patterns of major muscle groups [16]. In a previous study of 24 children with CP [Gross Motor Function Classification System (GMFCS) levels II—IV], improvement in Gross Motor Function Measure (GMFM) was reported over a 4-week period comprising of 5 days (2 h/d) per week with a total of 20 sessions; however, in order to justify the higher costs of the suit treatment compared with that of NDT, more clinical base studies are needed [16]. AST incurs additional hospital visits that increases treatment programme costs and time spent [16]. More information demonstrating the effective treatment of CP is needed in order to obtain more concrete generalisations about AST.

In this study, we aimed to compare changes in Gross Motor Function Measure-88 (GMFM-88), Pediatric Balance Scale (PBS), Timed Up and Go (TUG) test, and spatiotemporal parameters in children with CP, who were categorised into two groups based on the type of treatment received for a period of 6 weeks. Participants in one group underwent standard NDT alone, whereas those in the second group underwent both NDT and AST.

Methods

Design

This study was conducted using a single-blinded randomised controlled trial with a pretest/posttest design conducted for a period of 6 weeks. The participants were randomly divided into AST/NDT and NDT groups, using a free random allocation software (Isfahan University, Isfahan, Iran). Participants in the AST/NDT group underwent NDT (30 min/session, 2 sessions/d, 5 d/wk) and suit treatment (30 min/session, 5 times/wk); participants in the NDT group underwent exclusive NDT (30 min/session, two 2 times/d, 5 times/wk). Pre- and postintervention assessments of 6 weeks were conducted by the same physical therapist experienced in paediatric rehabilitation and unaware of each child's treatment.

Participants and estimation of sample size

Twenty children with CP participated in this study. The inclusion criteria were as follows: (1) diagnosis of CP; (2) 4—7 years of age; (3) GMFCS level I or II; (4) no orthopaedic surgery or spasticity-reduction intervention in the past 6 months; and (5) parental consent for allocation of their child to either group through randomisation [19]. The exclusion criteria according to the contraindications for AST were as follows: (1) hip dislocation or progressive scoliosis; (2) poorly controlled epilepsy; and (3) use of medications for treatment of spasticity. All participants participated in the intervention at a children's hospital in the Republic of Korea. Data were collected between February 2011 and