Therapeutic Interventions in Cerebral Palsy

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Abstract. Various therapeutic interventions have been used in the management of children with cerebral palsy. Traditional physiotherapy and occupational therapy are widely used interventions and have been shown to be of benefit in the treatment of cerebral palsy. Evidence in support of the effectiveness of the neurodevelopmental treatment is equivocal at best. There is evidence to support the use and effectiveness of neuromuscular electrical stimulation in children with cerebral palsy. The effectiveness of many other interventions used in the treatment of cerebral palsy has not been clearly established based on well-controlled trials. These include: sensory integration, body-weight support treadmill training, conductive education, constraint-induced therapy, hyperbaric oxygen therapy, and the Vojta method. This article provides an overview of salient aspects of popular interventions used in the management of children with cerebral palsy.
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Management of children with cerebral palsy requires an interdisciplinary approach that draws on the expertise of many specialists in different disciplines.[1,2,3] Numerous therapeutic interventions, including non-traditional or complementary and alternative medicine are used widely by families and professionals alike for their children with cerebral palsy.[4,5,6] Early intervention, interdisciplinary team approach, and family focused intervention strategies are essential. Traditional physiotherapy and occupational therapy have been shown to be efficacious in improving functional capabilities of children with cerebral palsy. Various other philosophies or approaches of treatment have been advocated. Most are based on personal observations and their usefulness has not been clearly established by well controlled studies. This article provides an overview of salient aspects of neurodevlopmental treatment, sensory integration, electrical stimulation, body-weight support treadmill training, conductive education, patterning, constraint-induced therapy, hippotherapy, hyperbaric oxygen therapy, acupuncture, and Vojta method. Although not within the scope of this article, other essential and integral components of management of children with CP include: braces, appliances, orthotics, various orthopedic interventions, speech and language therapy, treatment of spasticity, and general medical management of various associated problems.[1,2,3]

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TRADITIONAL PHYSIOTHERAPY AND OCCUPATIONAL THERAPY

Traditional physiotherapy used in children with cerebral palsy (CP) has been shown to improve muscle strength, local muscular endurance, and overall joint range of motion.[2,6,7] Physiotherapy is routinely used as a part of an interdisciplinary treatment approach for school-aged children with CP because it fulfils the need for certain degree of cooperation and active participation on the part of the child.[7,8] A program of progressive resistive exercises is used to improve muscle strength.[3,9] A program that uses low resistance and more repetitions will enhance local muscular endurance. The physical therapist carries out repetitive passive range of motion exercises to improve and maintain joint mobility. Passive, static, gentle stretches are performed on individual joints to decrease and prevent joint contractures. Such stretches should be performed within a pain–free joint range of motion. The physical therapist, working with the orthopedic surgeon and orthotist, also assists in designing and implementing exercises to improve balance, posture control, gait, mobility, and ability to transfer (for instance from bed to wheel chair).

Traditional occupational therapy is a recommended component of an interdisciplinary team approach to the treatment of children with CP.[10,11] Occupational therapist (OT) works with children with CP in improving fine motor abilities, especially the use of upper extremity in performing activities of daily living. OT has been shown to be effective in improving and maintaining adaptive fine motor activities of children with CP. In addition to focusing on specific fine motor movements, the OT also

works on organizing play areas, providing adaptive equipment for self care and learning, and to modify the learning environment to facilitate attention and information processing.

NEURODEVELOPMENTAL TREATMENT (NDT)

This therapeutic approach was developed by Berta and Karl Bobath in the 1940s, based on their personal observations working with children with cerebral palsy.[6,12] It is one of the more popular therapeutic interventions for the treatment of children with CP. There are thousands of trained therapists all over the world using this approach, who are trained at various NDT training centers and NDT courses.[6] The basis of NDT approach as conceptualized by Bobaths is that the motor abnormalities in children with CP are due to failure of normal development of postural control and reflexes because of the underlying dysfunction of the central nervous system.[4,12] The aim of the NDT approach is to facilitate normal motor development and function and to prevent development of secondary impairments due to muscle contractures and joint and limb deformities.

Originally, the Bobath approach used various techniques to inhibit and control abnormal tone, reflexes and movement patterns.[12] This was postulated to facilitate normal postural and righting reflexes, and movement patterns. The normal developmental sequence of child development is used as the underlying guiding principle. It was postulated that such normal therapeutic experience in automatic movements and reflexes will translate into the child developing normal tone and volitional movements with improved functional capabilities. With further experience, the Bobaths noted that there was a lack of such carry–over effects, and modified their approach so as to allow the child to take over more control of balance and movement, treat children in natural play environments, and not necessarily to follow rigid developmental sequence.

There is a wide variation in the expertise and training of therapists who use NDT approach with various modifications.[6] There are also significant differences in the NDT application in different countries. Typically, most sessions are of 1 hour duration each, and given at least 2 times per week.[12] Intensive NDT has been practised by some with 1 hour per day for 5 days per week and reported to be more effective.[13] The parents and caregivers are also trained to continue the therapy at home during daily activities and play. Various therapeutic aides such as orthotics and balls are used as necessary. NDT approach takes long–term view recognizing the need for continued intervention to maintain functional capabilities and prevent deformities and contractures. Although the effectiveness of NDT in CP has been questioned by some published reports, there are some studies suggesting its effectiveness.[4,7,12,13]

SENSORY INTEGRATION (SI)

The theory of sensory integration was originally developed by A. Jean Ayres in the 1970s.[14] The principles of SI theory are used by occupational therapists in developing treatment approaches for children with sensory processing difficulties, including CP. As conceived by Ayres, the SI model was developed to treat learning disabilities. SI theory is based on the hypothesis that in order to develop and execute a normal adaptive behavioral response, the child must be able to optimally receive, modulate, integrate, and process the sensory information.[14,15] Many children with learning disabilities, cerebral palsy and other neurodevelopmental disabilities have associated sensory difficulties. The SI approach attempts to facilitate the normal development and improve the child's ability to process and integrate sensory information (visual, perceptual, proprioceptive, auditory, etc).[14] It is proposed that this will allow improved functional capabilities in daily life activities.

As originally described by Ayres, the objective of SI approach is not to teach specific skills but "to enhance the brain's capacities to perceive, remember, and motor plan."[14] A therapeutic environment is created in which the child gains rich sensory motor experience. The therapist engages the child in challenging play activities in such a way, that the child is able to overcome the challenge, and adapts to subsequently face more challenging stimulus.[14,15] The therapist takes cues from the child's behavior and provides appropriate sensory–rich play–environment.

The occupational therapist works closely with other members of the interdisciplinary team, so that an appropriately challenging sensory-motor experience can be provided for the child in daily life settings and the functional capabilities can be monitored.

Three classic patterns of SI disorders have been proposed, namely, sensory modulation disorders, sensory discrimination disorders, and sensory–based motor disorders.[14] Such grouping is intended to guide formulation of specific intervention for homogeneous disorders. Overall, some studies find SI as a useful treatment approach in children with CP, while others do not find any functional benefit.[14,15]

ELECTRICAL STIMULATION

The goal of the electrical stimulation is to increase muscle strength and motor function. Electrical stimulation is provided by TENS (transcutaneous electrical nerve stimulation) unit which is portable, non-invasive and can be used in the home–setting by parents or the patient.[16]

Neuromuscular electrical stimulation (NMES) involves application of transcutaneous electrical current that results in muscle contraction.[16] NMES has been postulated to increase muscle strength by increasing the cross-

sectional area of the muscle and by increased recruitment of type 2 muscle fibers. Functional electrical stimulation (FES) refers to the application of electrical stimulation during a given task or activity when a specific muscle is expected to be contracting.[16,17]

Threshold electrical stimulation (TES) is also applied transcutaneously, is of low intensity, and does not elicit actual muscle contraction. TES is supposed to act by increasing the muscle blood flow and bulk.[16,18]

Typically, the electrical stimulation is used in children more then 4-5-years-old with diplegic or hemiplegic CP. Each session of NMES typically lasts from 15 to 30 minutes, with varying frequencies of half hour to upto 21 hours per week, for duration that ranges from 1 month to 1 year.[17] Electrical stimulation is typically used for lower extremity muscles. TES is generally give for 8-12 hours during sleep at home, and used for up to 1 year.[17,18]

There is evidence to support the use and effectiveness of NMES in children with CP. However, studies are limited by many confounding variables including concomitant use of other therapies, wide variation in methods of application, heterogeneity of subjects, difficulty in measuring functional outcomes and lack of control subjects.

BODY WEIGHT SUPPORT TREADMILL TRAINING

Stepping movements (or reflex stepping reactions) are normally present in newborns and infants, before the infant starts to bear weight, stand and walk.[8] In treadmill training, the child is supported in a harness on the treadmill in an upright posture limiting weight bearing.[8,19,20] The child then attempts to walk on the slowly moving treadmill, eliciting the stepping movements. Treadmill training, thus allows development of stepping movements needed for ambulation. Studies using 3-4 sessions per week lasting for 3-4 months have shown improvement in lower extremity movements and gait patterns in children with cerebral palsy.[8,20,21]

CONDUCTIVE EDUCATION

CE was developed by Peto in the 1940s.[4,6] It is based on the concept that children with motor disabilities learn the same way as those with no disability.[22] CE is carried out by trained "conductors" who use repeated verbal reinforcement to promote and facilitate intended motor activity by the child.[6,22] Participation in CE requires reasonable cognitive abilities to comprehend the verbal instructions. The idea is to develop independence in daily activities by the child by facilitating all aspects of child's development. The child is encouraged to participate and practice all daily activities to the best of his or her abilities.[22,23] CE is typically carried out in separate group sessions for school age children. The effectiveness of CE in improving functional capabilities of children with CP has not been established by any controlled clinical trials.[4,6,22,23]

PATTERNING

The concept of patterning is based on theories developed by Fay, Delacato, and Doman in the 1950s and 1960s.[6] Patterning is based on the principle that typical development of the infant and child progresses through a well–established, pre-determined sequence; and failure to normally complete one stage of development therefore impairs or inhibits the development of the subsequent stage.[4,6,24]

It was hypothesized that typical motor development can be facilitated in the brain injured children by passively repeating the sequential steps of typical development, a process called patterning.[4,6] Parents and other care givers are taught to carry out patterning at home. This approach is labor intensive and time consuming as it requires multiple sessions every day. Effectiveness of patterning has not been established and its use in children with CP is not recommended.[24]

CONSTRAINT-INDUCED THERAPY

Constraint-induced therapy is used to improve the use of affected upper extremity in a child with hemiplegic CP.[8,25,26] The normally functioning or stronger upper extremity is immobilized for a variable duration in order to force the use of the affected or weaker upper extremity over time. The efficacy of this approach has not been established, and adverse effects of prolonged immobilization of the normally developing upper extremity are a significant concern.[8,25,26]

HIPPOTHERAPY

Therapeutic horse-back riding has been shown to improve muscle tone, balance, and postural control in children with CP.[27,28,29,30] Children with CP enjoy horse riding and it also provides a setting for increased social interaction and psychosocial development.

HYPERBARIC OXYGEN THERAPY

Use of hyperbaric oxygen therapy (HBOT) in children with CP is based on the hypothesis that HBOT will increase the oxygen available to the neurons surrounding the injured area of the brain and revive these dormant neurons.[4,31,32] Additionally, HBOT is postulated to decrease brain edema by inducing cerebral

vasoconstriction. Typically, HBOT is administered at 1.75 atmospheric pressure, each session lasting about an hour, given 1-2 time per day for 5-6 days per week, initially for 40 treatments.[4,6,31,32]

Potential complications of HBOT include ear pain, bleeding from ears, tympanic membrane perforation, myopia, pneumothorax, and seizures.[1,32] At present, there is insufficient evidence to determine whether the use of HBOT improves the functional outcome of children with CP.[32]

ACUPUNCTURE

Acupuncture has been used in children with CP for over 2 decades. There is some evidence that acupuncture may be of benefit in some children with CP to reduce painful muscle spasms and overall motor function.[4,33,34]

VOJTA METHOD

Vojta approach is based on the observation that children with CP exhibit many of the reflexes seen in normal newborns.[4,6,8] According to Vojta, the persistence of these newborn reflex patterns in a child with CP interferes with postural development. It is postulated that with appropriate stimulation, the newborn reflex pattern can be provoked and activated in a child with CP, thereby facilitating the development of reflex locomotion.[4,6] No controlled studies are available supporting Vojta approach in the treatment of children with CP.[4,6,7,8]

CONCLUSION

Children with cerebral palsy can be optimally managed in a special center by a team of professionals from various disciplines. Because of the complexities of the management of children with cerebral palsy, a number of various therapeutics interventions have been used by professionals and families alike. The efficacy of only a few such interventions has been established by scientific research while many others have no established effectiveness in cerebral palsy management. The clinician involved in the care of children with cerebral palsy should be familiar with various interventions so that he or she can guide the families appropriately.

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