A REVIEW ON MUSCLE STRENGTH EXERCISES AND CHILDREN WITH CEREBRAL PALSY

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Abstract

Cerebral Palsy been described as a condition/disability that affected muscle tone, coordination, balance and speech. Muscle weakness is part of the motor syndrome and it contributes to limitations in motor ability and a common impairment in children with CP. This is why maintenance of muscle strength in terms of function is important when considering the amount and cost of the care that is needed throughout their daily living and also lifetime. Some past studies do revealed the important of physical activity because of the benefits of physical activity and exercises to overall health are well known especially to people with disabilities who are less likely to engage in physically healthy lifestyles compared with people without disabilities. This is because most inactive adults with disabilities exhibit increased severity of disease and reduced overall health and wellbeing and impairments such as weakness, muscle spasticity and deficient balance make it difficult for children with CP to participate in sport and play activities at a level of intensity sufficient to develop and maintain normal physical fitness levels. Weakness and muscle imbalance have been identified in children with CP, and that contributed to the weak walking gait. Children with CP also must be encourage to be active in strength training since

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there is no evidence exhibit that strength training causes an increase in spasticity. This will avoid them to have certain level of muscle weakness and will jeopardize their daily living and even their lifetime.

Keywords: ***muscle strength; muscle weakness; walking gait; strength training; children with cerebral palsy***

Introduction

Cerebral palsy (CP) been describes as "a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to nonprogressive disturbances that occurred in the developing fetal or infant brain" (Rosenbaum, Paneth & Leviton, et al. 2007). Cerebral Palsy (CP), with a prevalence of 2-3 per 1000 children, is the most common motor disability in paediatric rehabilitation. Because of their motor problems, children and adolescents with CP experience participation restrictions and limitations in physical activities. Physical activities (PA) been defined as all body movements resulting in an increased energy output from the resting position. Children and adolescents with CP show lower levels of PA compared to their healthy peers. Lower levels of PA contribute to a reduced physical fitness, which may increase the risk of developing secondary health problems such as pain and fatigue, cardiovascular disease and diabetes mellitus later in life. Moreover, PA is assumed to have a positive relation with health related quality of life and psychosocial functioning (Classen et al. 2011).

The primary impairments in CP are abnormal gross and fine motor function caused by abnormal motor control. These impairments lead to difficulty coordinating activities such as walking, feeding and speech, and often disrupt participation (Rosenbaum, Paneth & Leviton, et al. 2007).

The motor condition in CP may be spasticity, hypotonicity, or dyskinesia, with the added complication of the development of fixed deformity, and may change as the child develops (Badawi et al., 1998). Any assessment of interventions, therefore must take account of the type of disability, the severity of the condition and the age of the child. Spastic CP is characterized by a much-reduced capability of the skeletal muscles to stretch. The majority of CP cases are of the spastic diplegic type, where the term spastic refers to the manifestation of the movement disorder and the term diplegic refers to the distribution within the body, affecting mainly the legs (Albright *et al.*, 1993; Kuban & Leviton, 1994). Around 75% of all CP cases are spastic and around 50% of these are diplegic (Stanley *et al.*, 2000). Athetoid CP is much less common (around 10%) and has been attributed to a brief period of profound asphyxia at term, which damages the basal ganglia. This results in very unsteady movements of the head, arms and legs, necessitating support from others (Nelson & Ellenberg, 1978). Ataxic CP is a rare form (less than 5%), with low muscle tone and poor coordination in evidence. Children with ataxic CP look very unsteady and shaky with a wide-based gait. In mixed CP, the children have both the taut muscle tone of spastic CP and the involuntary movements of athetoid CP. This affects about 10% of children with CP. The type of CP is further described by reference to the number and location of the limbs involved such as monoplegia, hemiplegia, diplegia, triplegia and quadraplegia.

The cause of this condition has been controversial ever since 1843 when Little first described chronic encephalopathy in children (Rotta, 2002). In 1862 the link was made between the condition and abnormal delivery and until recently, it was considered that most cases of CP were the result of obstetric misadventure. However, careful epidemiological studies and brain imaging suggest that it frequently has antenatal antecedents and is often multi-factorial (Stanley et al., 2001; Kerr Graham & Selber, 2003). It is now considered that developmental and genetic factors are responsible for 90% of cases, with only 10% due to intrapartum disaster (Cook et al., 2002).

Cerebral Palsy and muscle weakness

As the focuses are more on the muscle weakness, there are many past studies do highlighted the relationship between CP and muscle weakness. As we already know that CP do affect the muscle tone. Although CP results from a static lesion, the manifestations of the disease change as the child grows, as abnormal biomechanical forces, immobility and overuse cause excessive stress on bodily structures and early joint degeneration (Murphy, Molnar & Lankasky , 1995). This may result in a decline in gross motor function during adolescence and early adulthood (Sandstrom, Alinder & Oberg, 2004). A decline in ambulatory ability may also lead to dependence on the walking aids, wheelchairs, handrails and others for assistance (Day, Wu, Strauss, Shavelle & Reynolds, 2007).

Muscle weakness is part of the motor syndrome of CP and it contributes to limitations in motor ability (Lin, 2004). Muscle weakness may contribute to deformity (Shortland , Harris, Gough & Robinson, 2002), osteoporotic fracture (Frost & Schonau, 2000), and less effective outcomes in treatment for spasticity and orthopaedic surgery (Goldstein, 2004). Muscle weakness, therefore, contributes to the production of deformity, pain, and functional loss.

Muscle weakness is a common impairment in children with CP (Brown et al 1991; Damiano et al 1995b, Wiley and Damiano 1998). Weakness has been attributed to incomplete recruitment or decreased motor unit discharge rates (Elder et al 2003; Rose and McGill 2005; Stackhouse et al 2005; Wiley and Damiano 1998), inappropriate coactivation of antagonist muscle groups (Elder et al 2003; Stackhouse et al 2005; Wiley and Damiano 1998), secondary (Rose et al 2006), and altered muscle physiology (Stackhouse et. al., 2005).

Muscle weakness is greater in children who are non-ambulant, i.e. those categorized as being in Level IV or V of the Gross Motor Function Classification System (GMFCS) (Palisano, Rosenbaum, Walter, Russell, Wood & Galuppi, 1997). Exercise opportunities are very limited in this population, and so muscle strength may be further reduced by disuse (Convertino, Bloomfield & Greenleaf, 1997). Loss of motor ability in early adulthood is a common outcome (Bottos, Feliciangeli, Sciuto ,Gericke &Vianello, 2001). As the majority of children with even the most severe forms of CP survive until adulthood (Evans, Evans & Alberman, 1990), maintenance of muscle strength in terms of function is important when considering the amount and cost of the care that is needed throughout their daily living and also lifetime.

Cerebral Palsy and strength training exercises

Spasticity in children with CP has long been regarded as a significant impairment causing motor dysfunction in CP (Andersson, Grooten, Hellsten, Kaping & Mattsson, 2003). With the improvement in medical techniques to decease spasticity, decreased muscle strength and abnormal muscular control are now recognized as key impairments impeding function (Damiano, Vaughan & Abel, 1995). Muscle weakness is present even in individuals with mild CP. It results from inactivity, as well as from primary and secondary impairments in the muscles and neurological pathways, and may be worsening by the neurosurgical and orthopaedic interventions to which this population is often exposed (Damiano, Dodd & Taylor, 2002). Until recently strength training was avoided clinically for people with CP. However, there is no evidence exhibit that strength training causes an increase in spasticity (Damiano, Dodd & Taylor, 2002; Dodd, Taylor & Damiano, 2002).

Problems of lower-extremity pain, back pain, and physical fatigue also have been reported in adults with CP (Schwartz, Engel & Jensen, 1999; Engel, Jensen, Hoffman & Kartin, 2003; Jahnsen, Villien, Stanghelle & Holm, 2003). It is possible that pain and fatigue play a role in causing further decrement of function and physical inactivity. Sandstrom and colleagues (2004) reported that one third of adults with CP deteriorated in function during adolescence and concluded that decreased functional ability and secondary musculoskeletal problems are common in adults with CP and that general health also can be impaired in association with these problems.

Regarding the muscular strength, there is little quantitative data on muscle strength (force-generating capacity) and functional status in adults with severe impairment. When people are evaluated by questionnaire or using tasks requiring effort, their comprehension is essential. For example, muscle strength is difficult to measure in people with severe CP because it is not easy for them to understand the task they need to perform. Therefore, an alternative method of quantitative muscle evaluation that can be performed without communication or effort would be beneficial. In general, limited activity leads to muscle weakness and atrophy. Although people with severe CP usually show muscle atrophy caused by palsy and limited activity, it is still possible that muscle thickness (MTH) measured by ultrasound imaging reflects muscle strength, at least to some extent. It has been proposed that quantitative ultrasonography is a potentially useful tool for studying skeletal muscle (Young, Stokes & Crowe, 1985; Sipila & Suominen, 1995; Sipila & Suominen, 1991; Sipila & Suominen, 1993; Sipila & Suominen, 1996; Abe, DeHoyos, Pollock & Garzarella, 2000). However, the difference in MTH for people with CP with different levels of motor function is not clear. Moreover, it is not understood whether MTH is influenced by age, body characteristics, and muscle spasticity in adults with CP.

Many evidence confirms that many people with CP are weak and that this weakness can be associated with difficulties performing everyday functional activities. Furthermore, recent reports have suggested that young people with CP may benefit from strength-training programs (Nicholas, Dodd & Graham, 2004).

Evidence is increasing that strength-training exercise for children with CP can improve muscle strength (Damiano, Vaughn & Abel, 1995; Tweedy, 1997; Morton, Brownlee & McFadyen, 2005) and motor ability (MacPhail HE, Kramer, 1995; Blundell SW, Shepherd RB, Dean CM, Adams RD, Cahill, 2003; Damiano & Abel, 1998; Andersson, Grooten, Hellsten, Kapling & Mattsson ,2003; Dodd , Taylor & Graham, 2003). Most of these previous studies, however, involved ambulant young children with CP using routine exercise methods such as weightlifting and circuit training. Older young people who are non-ambulant do not have the physical ability to perform routine exercises but they may be able to pedal independently when supported on a static exercise bicycle.

Correlation studies have demonstrated that muscle strength is related to activity in children with cerebral palsy. Ross and Engsberg (2007) reported a moderate correlation between strength and walking speed (r = 0.61) but little correlation between spasticity and walking speed (r =0.19) in children with cerebral palsy who ambulate. Damiano et al (2001) also found moderate to high correlations between strength and activity limitations (r = 0.70 to 0.83).

Several uncontrolled trials have reported increases in strength after training in children with cerebral palsy and that increased strength can translate into improved activity (Blundell et al 2003, Damiano and Abel, 1998, Eagleton et al., 2004, MacPhail and Kramer, 1995, Morton et al., 2005). Likewise, two randomised trials have reported increases in 1RM (repetition maximum) strength with training (Dodd et al., 2003, Liao et al., 2007) although with no clear carryover to activity. A recent systematic review (Mockford and Caulton, 2008) concluded that strength training was associated with moderate to large gains in both strength and activity. However, this review included uncontrolled trials, limiting the accuracy of the conclusions about the effect of strength training in children with cerebral palsy (Scianni et al., 2009).

At the activity level, strength training has led to improvements in ambulatory ability, including increased walking velocity (Palisano, Rosenbaum, Walter, Russell, Wood & Galuppi, 1997; Damiano & Abel, 1998) decreased energy expenditure during ambulation, (Damiano & Abel, 1998) and a more upright posture during stance phase in adolescents and adults Significant improvements in times for the Timed Up and Go test (TUG) and timed sit-to-stand have also been found(Palisano, Rosenbaum, Walter, Russell, Wood & Galuppi, 1997; Andersson, Grooten, Hellsten, Kapling & Mattsson, 2003).

There is qualitative evidence that strength training increases participation in school, leisure, social and family activities (Morton, Brownlee & McFadyen, 2005) but the effect of strength training on the participation levels of people with CP remains largely unknown. Although adolescents and young adults often show reduced function and participation, no study assessing strength training has spanned this age range. There is little research on fitness training, as distinct from strength training, for people with CP. Adolescents with spastic diplegic CP have poorer levels of cardiovascular fitness than the unaffected population (Murphy, Molnar & Lankasky, 1995) and poor physical fitness leading to impaired health and function is a major problem for children with CP (Sandstrom, Alinder & Oberg, 2004). Training produces improvements in cardiovascular fitness, physical endurance and peak aerobic power (Day, Wu, Strauss, Shavelle & Reynolds, 2007; Damiano , Vaughan & Abel, 1995). Case study reports have also found improved strength, gross motor function, gait efficiency, and self-perceived appearance following aerobic training (Damiano, Dodd &Taylor, 2002). Further study is needed to assess the benefits of fitness training on functional mobility and quality of life (Dodd, Taylor & Damiano, 2002).

Strengthening exercises have been routinely used in persons with orthopedic problems and athletes to increase force production or minimize muscle imbalance; however, such exercises have not been advocated for persons with CP despite identification of muscle weakness and restricted force production in this population (Guiliani, 1991; Corcos, 1991; Horvat, 1987; Kramer & MacPhail, 1994) Contemporary motor control research seeks to examine movement on several different levels with the assumption that many Merent subsystems, of whlch neurophysiology is only one aspect, contribute to the development of motor control. Gordon (1987) suggests that physical therapists have concentrated too long on the reduction of positive symptoms in central nervous system (CNS) disorders such as spasticity, while virtually ignoring the negative symptoms of weakness and loss of function.

After reviewing the scientific literature, Guiliani (1991) detailed that there is no evidence that strengthening exercises are detrimental in this population, and the literature indicated that these exercises may be beneficial (Leonard, 1990; Kolobe ,1990). Although the number of studies is very limited, strength has been shown to increase in CP through resistance exercise programs (Horvat, 1987; Healy, 1957; McCubbin & Shasby, 1985). Healy (1957) even compared isometric and isotonic exercise regimens in five boys with spastic diplegia, with each child performing a different type of resistive exercise on each leg. Comparable improvements were noted in strength and range of motion for both types of exercise. McCubbin and Shasby (1985) did examined the rate of torque development and the speed of movement of elbow extension in adolescents with CP who had participated in a 6-week program of isokinetic training versus a program of repetitive exercise in which subjects performed the same type and amount of motion but without resistance. They revealed that improvements in torque production and speed only in the isokinetic training group. They further noted that the effects of isokinetic training on neuromuscular performance of children with CP were similar to those found in children without CP. Horvat et.al., (1987) compared free weights and isokinetic training of equivalent intensity in an individual with CP and found that each method produced similar torque gains that were greater than those found in persons without CP and similar to those seen in deconditioned persons or those with primary muscle weakness (Damlano, Kelly & Vaughan 1995)

The importance of muscle strength in children with Cerebral Palsy

There is some evidence that children with CP are lack of muscle strength. Muscle weakness is a primary impairment in children with CP, as the diagnosis is dependent upon injury to a region of the brain responsible for movement. Some studies have revealed that muscle force production can be improved in children with CP (Damiano, Vaughan & Abel, 1995) and that improved strength can translate into functional gains (Damiano & Abel , 1998; Blundell , Shepherd, Dean, et al.2003; MacPhail & Kramer, 1995; Morton, Brownlee & McFadyen 2005; Thorpe, Reilly & Case 2005; Eagleton, Iams & McDowell, et al. 2004). The principles used for strength training, in terms of weight progression and specificity of training, are similar to those for people without disabilities. Preliminary information on safety and lack of adverse effects supports strength training in children with disabilities, including CP (Damiano , Dodd & Taylor, 2002). In particular, the concern that the performance of strengthening exercises will increase spasticity appears to be unfounded (Dodd, Taylor, Graham ,2003; MacPhail & Kramer, 1995; Morton, Brownlee & McFadyen,2005; Andersson, Grooten & Hellsten et al , 2003; Fowler, Ho, Nwigwe & Dorey, 2001).

Development of muscle strength can be adjusted through series of methods of training such as circuit training. Circuit training is a generalised conditioning program that increases muscular strength and endurance and improves cardiovascular fitness in the general population (McArdle, Katch & Katch, 2007). It combines low-resistance, high-repetition exercises aimed at improving muscular endurance with exercises that increase flexibility and cardiovascular fitness. Although circuit training is popular among adolescents and young adults without disabilities, and is offered in many community gymnasiums, its potential benefits for general health and community participation in people with CP have never been assessed.

Conclusion

The muscle weakness and imbalance are frequent clinical findings in children with spastic diplegia. Not only have children with CP been found to be weak, but reduced strength of the knee extensors has been shown to be related to diminished functional capacity in adolescents with CP, as evidenced by lower scores on the Gross Motor Function Measure and increased energy expenditure during gait in the weaker children (Kramer & MacPhail, 1994). Furthermore, it is possible to increase muscle strength in these children through traditional strength training programs. A causal link between resistance training and improved gross motor function, however, has not previously been established. Children with CP can posses some level of fitness if there can be exposed to the different type and modified of exercises. This will avoid them to have certain level of muscle weakness and will jeopardize their daily living and even their lifetime.

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