Review article

Effectiveness of resistance training exercises in spastic diplegia cerebral palsy: a review

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Abstract

Cerebral Palsy presents itself in a clinical form of spastic diplegia, where neurological sequels are predominant in the lower limbs and substantially affects the capacity to walk. Traditional methods of physiotherapy intervention emphasize the techniques of neurological rehabilitation at the expense of progressive resistance exercises.The goal of the present research is to fulfill a bibliographic review concerning the period of 1985 to 2012 about studies that investigated the effect of resistance exercises applied to cerebral palsy children carrying spastics' diplegia. The Scielo, MEDLINE, PubMed, EMBASE, CINAHL, Sports Discus, DARE, PsychInfo, ERIC, Ausport-Med, AMI, Cochrane and PEDro databases were used to conduct a literature search using keywords without restrictions. In this systematization, a search was conducted using the keywords: cerebral palsy, progressive resistance exercise, diplegia, gross motor function measure (GMFM). Literature have shown that the restrict capacity to generate force is as debilitating or more than it is the muscle spasticity, potentially causing more restriction to the movement than the spasticity itself. Children with normal motor development, as well as carrying spastic diplegia increase their capacity to generate strength when submitted to a resistive training, not only on lower limbs, but also on upper limbs. Furthermore, several studies have shown that diplegic cerebral palsy children improve their motor ability due to strength training, thought it still remains to be proved that strength training leads to a substantial change for the better allowing that there is ascension of category for functional capacity.

Keywords: cerebral palsy, progressive resistance exercise, diplegia, gross motor function measure (GMFM).

1 Introduction

Cerebral palsy (CP) is an unprogressive chronic encephalopathy that leads to neurological disorder (SCHOLTES, DALLMEIJER, RAMECKERS et al., 2008; SCHOEN, RICCI and OLIVEIRA, 2003; DAMIANO, DODD and TAYLOR, 2002; DARRAH, WESSEL, NEARINGBURG et al., 1999). By definition, the injury, which carries distinct etiologies, happens until the age of two years-old, interfering on the central nervous system (CNS) (DAMIANO, ABEL, ROMNESS et al., 2006; MOURA and SILVA, 2005; SÁ and SANTOS, 2004). Epidemiological studies, performed in developed countries, show the prevalence of 1.5 to 2.5 for each one thousand births (BECKUNG, CARLSSON, CARLSDOTTER et al., 2007; MORTON, BROWNLEE and McFADYEN, 2005).

Alterations of the reflexes and muscle tonus are neurologic sequels commonly found at CP which change directly both the movement as well as the posture control (ROMEO, CIONI, SCOTO et al., 2008; BEGNOCHE and PITETTI, 2007; PALISANO, ROSENBAUM, WALTER et al., 2007). This clinical Picture, in a short time, leads to structural and morphological alterations of the muscleskeleton system, such as muscle contractions and bone deformation (DODD, TAYLOR and DAMIANO, 2002; FLETT, 2003).

Spastic diplegia is highly prevalent in CP (SCHOEN, RICCI and OLIVEIRA, 2003; SOUZA and FERRARETO, 1998) whereby about 70% of children with diplegia have bilateral spasticity compromising the motor control of lower limbs, thougth they are able to walk (DAMIANO and

ABEL, 1998; DAMIANO, ABEL, ROMNESS et al., 2006). However, CP children's gait usually exposes exaggerated flexion, aduction and internal rotation of the hip, with excessive flexion of the knee and equinus foot (DAMIANO, KELLY and VAUGHN, 1995; TONER, COOK and ELDER, 1998).

Literature reviews have shown that the restrict capacity to generate force is as debilitating or more than it is the muscle spasticity, potentially causing more restriction to the movement than the spasticity itself (ROSS and ENGSBERG, 2007; SCHOLTES, DALLMEIJER, RAMECKERS et al., 2008). The weakness of the hip abductors and extensors muscles as well as the knee extensors result in decreased hip and knee joint movement in the sagital plane impairing the patient's gait (BERRY, GIULIANI and DAMIANO, 2004).

Minimizing the harmful effects of spasticity has been the rehabilitation focus for these patients (FLETT, 2003; NORDMARK, JARNLO and HAGGLUND, 2000). However, if one considers decreasing the strength as being the main problem, it would also be of great importance the strength training of these children (MORTON, BROWNLEE and McFADYEN, 2005; SCHOLTES, DALLMEIJER, RAMECKERS et al., 2008). Throughout decades, the rehabilitation of people affected by injury of the upper motor neuron had as main goal to minimize spasticity, taking into consideration that this was the major cause of motor dysfunction (DAMIANO, QUINLIVAN, OWEN et al., 2001; KANDEL, SCHWARTS and JESSELL, 2000; LUNDY-EKMAN, 2000). This paradigm considers the simultaneous action of the agonistic and antagonistic muscles (cocontraction) as being the cause of deviation of the movement instead of the weakness of the favorable muscles. Thus, the therapeutic focusing on inhibition of useless or ineffective patterns of movement, as preventive measure of abnormal posture and excessive muscle cocontraction became dominant (BEGNOCHE and PITETTI, 2007; FOWLER, HO, NWIGWE et al., 2001).

In conformity to Damiano, Kelly, and Vaughn (1995), orthopedics surgical procedures aiming to minimize muscle shortening caused by spasticity do not favor movement control. Instead, it is clearly shown the weakness of the compromised distal muscles. Clinical appraisals of patients submitted to distal stretching techniques of the tendons, known as tendontomy, report the appearance of post-operative weakness, mainly related with strength reductions of the anti-gravitation muscles (DAMIANO, DODD and TAYLOR, 2002; DAMIANO, QUINLIVAN, OWEN et al., 2001).

It is important to understand the progressive loss of the muscle strength, as this, together with spasticity, interferes directly with the motor rehabilitation strategies (SCHOLTES, DALLMEIJER, RAMECKERS et al., 2008; ROSS and ENGSBERG, 2007; DAMIANO and ABEL, 1998). The capacity the patient with CP has to generate strength is rarely evaluated and quantified, and consequently prioritized to the goals of a treatment (DAMIANO and ABEL, 1998; DAMIANO, VAUGHN and ABEL, 1995). However, some difficulties can arise when measuring the strength of children with CP, such as the capacity to understand and accomplish repeatedly the production of maximum effort, besides the variations of posture tests and coupling of the measuring equipment, usually a dynamometer (CROMPTON, GALEA and PHILLIPS, 2007; DAMIANO, DODD and TAYLOR, 2002).

The motor function is intrinsically connected to the capacity to generate strength and can be measured through functional scales, among which the most often used is the evaluation instrument denominated Gross Motor Functional Measure (GMFM), that is used in eighty-eight motor activities to achieve a numerical result corresponding to the percentage hit made by the patient. Efforts have been made aiming to understand how much the capacity to generate strength is connected with the functional capacity (PALISANO, ROSENBAUM, WALTER et al., 1997; RUSSEL and GORTER, 2005).

The goal of the present research is to fulfill a bibliographic review concerning the period of 1985 to 2012 about studies that investigated the effect of resistance exercises applied to CP children carrying spastics' diplegia.

2 Material and methods

The Scielo, MEDLINE, PubMed, EMBASE, CINAHL, Sports Discus, DARE, PsychInfo, ERIC, Ausport-Med, AMI, Cochrane and PEDro databases were used to conduct a literature search using keywords without restrictions. In this systematization, a search was conducted using the keywords: cerebral palsy, progressive resistance exercise, diplegia, gross motor function measure (GMFM).

3 Results

Damiano and Abel (1998) reported that in spite of fundamental importance in the normal motor control, the deficiencies of strength in the cerebral palsy child and the respective correlations with the motor capacity have been little investigated.

According to Darrah, Wessel, Nearingburg et al. (1999) and Taylor, Dodd and Damiano (2005), among the most used methods to increase the capacity to generate strength in the patients carrying CP one can cite the progressive resistance exercises, which effects can be noticeable not only in the improvement of the muscular performance but also on the gait established functional parameters, motor dexterity and conditioning (DAMIANO, DODD and TAYLOR, 2002).

As to MacPhail and Kramer (1995) and Russel and Gorter (2005) the instrument regarding quantity evaluation most indicated to be used for detection and measuring of changes on Gross motor function is the functional scale known as GMFM, which is based in an evaluation containing eighty-eight motor tasks graduated from 0 to 3 points. The tasks can be performed with the patient lying, seated, creeping, running or jumping, respectively denominated dimension (A, B, C, D and E). Scholtes, Dallmeijer, Rameckers et al. (2008) postulated that in order to determine the total points in GMFM, one has to add up the values obtained on each one of the dimensions, which can be displayed as percentage of the accuracy closely related to the total of tasks executed.

Damiano, Arnold, Steele et al. (2010) and Hamer, Alderson and LIoyd (2011) concluded that children with normal motor development, as well as carrying spastics diplegia increase their capacity to generate strength when submitted to a resistive training, not only on lower limbs, but also on upper limbs. However, Thompson, Stebbins, Seniorou et al. (2011) showed that CP children when compared with normal children show less capacity to generate strength in all muscle groups of the lower limbs, except for the hip extensors.

Studies have shown the benefits of strengthening exercises applied on CP patients. Isotonic, isometric, and isokinetic exercises have been utilized to faster increasing muscle strength and improvement of the motor function (BERRY, GIULIANI and DAMIANO, 2004; DAMIANO, KELLY and VAUGHN, 1995; FOWLER, HO, NWIGWE et al., 2001).

In a study, conducted by MacPhail and Kramer (1995), including seventeen CP children diagnosed with moderate motor impairment, the knee extensor torque (concentric and excentric) and the GMFM were evaluated before and after a strength training program. The results showed a significant increase of 10% in the knee peak torque and 13% in the GMFM scale (dimensions D and E). The motor skill improvement was maintained for 3 months after finishing the training program. However, Scholtes, Becher, Comuth et al. (2010) selected a group of 51 CP diplegic and hemiplegic patients, submitting them during 12 weeks to a progressive resistive concentric knee extension and hip abduction training. Shortly afterwards once finished the training they checked the results and concluded that there was an increase of about 12% at the pick torque, although there was no improvement on the motor function. The increase of the capacity to generate torque was maintained by 6 weeks at least. Similar study by Morton, Brownlee and McFadyen (2005) covering sample and training protocol just replacing the concentric exercises by isometric ones proved that 6 weeks of training are enougth to increase the capacity to generate knee joint extension torque, besides increasing the values obtained at the motor capacity tests.

Shortland (2009) submitted during a period of 6 weeks, 6 diplegic children with limited capacity to perform community gait with and without auxiliary devices to a protocol of resistive isometric exercise for 8 muscle groups of the lower limbs. The gait speed and pick torque showed significant increase, demonstrating that training of specific muscle groups, even considering the isometric way implies improvement in an antigravity and dynamic motor function. High correlation between strength and gait parameters as well as strength and motor capacity have been identified in a prospective study presented by Ross and Engsberg (2007) held with 97 diplegic children.

Although several studies have shown that diplegic CP children improve their motor ability due to strength training, it still remains to be proved that strength training leads to a substantial change for the better allowing that there is ascension of category for functional capacity. For example, in a study hold by Taylor (2009), 8 diplegic children, submitted to a 10 weeks, 4 times per week of progressive resistive training, presented significant improvement in gait kinematic parameters. However, neither of the active participants changed the respective functional capacity classification.

In as much as for elaboration of strength training protocols and appraisement, special alterations must be given to the movement speed, taking into consideration that spasticity is prone to increase in proportion to the increase of the movement speed. Damiano, Vaughn and Abel (1995) and MacPhail and Kramer (1995) showed, respectively, that the effects of strength training by diplegia CP children can be observed at the appraisement of the peak isokinetic torque performed at 30°/s, 60°/s and 90°/s and at 50°/s and 90°/s, due to being reliable for tests minimizing the effects of stretching reflexes and empowering the motor reply. However, Damiano, Quinlivan, Owen et al. (2001) showed that analyzing the peak isokinetic knee torque at the speed of 120°/s there is an involuntary decrease at the joint torque.

Knox and Evans (2002) and Nordmark, Jarnlo and Hagglund (2000) suggest that frequency and duration of training with progressive resistance exercise on diplegia patients are very variable. The motor function deriving strength training can increase up to 9 points on the GMFM scale at a short period of intervening from two to eight weeks. Likewise, it has been reported a change of 4 points at GMFM scale obtained only after two years of training (MacPHAIL and KRAMER, 1995; VOORMAN, DALLMEIJER, KNOL et al., 2007).

4 Conclusion

Cerebral palsy children carrying spastic diplegia increase their capacity to generate strength when submitted to a resistive training, not only on lower limbs, but also on upper limbs. Furthermore, several studies have shown that diplegic CP children improve their motor ability due to strength training, thought it still remains to be proved that strength training leads to a substantial change for the better allowing that there is ascension of category for functional capacity.

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