Addressing muscle performance impairments in cerebral palsy: Implications for upper extremity resistance training

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Abstract

Study design: Case study and literature review.

Introduction: Muscle performance consists of not only strength but also muscle power, rate of force development, and endurance. Therefore, resistance training programs should address not only the force-generating capacity of the muscle but also the ability to produce force quickly.

Purpose: To discuss the National Strength and Conditioning Association’s resistance training guidelines for youth as specifically related to optimal dosing for muscle strength versus muscle power. Dosing parameters of frequency, volume, intensity, duration, and velocity are discussed independently for strength and power.

Methods: We describe how resistance training principles can be applied to the upper extremity in CP through a case study. The case describes an individual with spastic CP, who has severe motor disability and is non-ambulatory, but has been able to perform resistance training focused on speed, power, and strength.

Discussion: Recommendations to optimize the dosing of this individual’s resistance training program are made.

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Introduction

Muscle performance represents the overall capability of a muscle to perform work and consists of the elements of strength, power, rate of force development, and endurance. Although muscle weakness has long been considered one of the primary impairments that contribute to activity limitation in children and adolescents with cerebral palsy (CP), other aspects of muscle performance have received less attention. Recent evidence suggests that other aspects of muscle performance, such as muscle power and rate of force development, are more impaired than strength and are related to activity limitations and functional performance.<sup>1</sup> Thus, these concepts will be discussed in this review.

Muscular strength refers to the maximum amount of force or torque that a muscle can generate. While weakness refers to a deficit in strength. Lower extremity muscle weakness is pervasive in CP with strength defects reported between 40% and 60% on average as compared to age-matched typically developing children. In addition, children with CP who are weaker tend to walk slower and have lower measures of gross motor function. Significant upper extremity and hand weakness has also been reported in children with unilateral or hemiplegic CP, with upper extremity and hand strength positively correlated with both unimanual and bimanual abilities. Because of the documented associations between strength and function in children with CP, muscle strengthening has become a standard component of therapeutic interventions. However, increases in strength as a result of strength training are not always associated with the desired improvements in functional abilities.

Despite the focus on muscle strength in past years, other measures of muscle performance must also be considered in the context of the performance of functional activities. Muscle power is the product of force and the velocity at which the force is produced and can be described as the ability to generate the greatest amount of force as fast as possible. While strength is only concerned with maximal force or torque, power involves both strength and the velocity of the movement. From the force-velocity curve, we know that less force can be produced concentrically at higher speeds as compared to slower speeds. However, in children with CP the ability to produce torque at higher speeds is even more impaired than those without neurological injury. Many daily activities, such as transfers, walking up steps, or moving from sitting to a standing