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Reliability and validity of the Trunk Impairment Scale in children and adolescents with cerebral palsy

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ABSTRACT

Standardized clinical tools are useful for treatment planning and evaluation, however clinical tools to assess quality in trunk movements in children with cerebral palsy (CP) are sparse. We have recently reported good intra- and inter-observer reliability of the Trunk Impairment Scale (TIS) in 5–12 year old children with CP. The aim of this study was to assess reliability in adolescents (13–19 years old), and to assess the construct validity in children and adolescents in the whole age spectrum from 5 to 19 years. Video recordings of 17 children with CP with Gross Motor Function Classification (GMFCS) level I–IV were analyzed by three observers on two occasions. For construct validity the TIS was compared with Gross Motor Function Measure (GMFM), in 37 children with GMFCS levels I–IV. Intraclass correlation coefficients varied between 0.82 and 0.98, and 86% of the kappa values varied between 0.61 and 1.00, suggesting high inter- and intra-observer reliability. The smallest detectable difference (SDD) of the TIS (scale range 0–23) varied between 2.55 and 3.82 for intra- and 4.07–8.23 for inter-observer observations. The high inter-observer SDD was partly due to consistently lower TIS scores by one observer. The correlation between the TIS total score and the dimension scores of the GMFM was high (Spearman's rho: 0.80–0.87), while decreasing GMFCS levels were associated with increasing total TIS score; both findings indicating good construct validity of the TIS. This study suggests that the TIS is a reliable and valid measure of trunk control for both children and adolescents with cerebral palsy.

1. Introduction

One of the key features in the definition of cerebral palsy (CP) is impaired control of posture (Rosenbaum et al., 2007). Control of posture is required in order to obtain balance, which may be defined as the ability to maintain, achieve or restore the center of mass relative to the base of support (Mancini & Horak, 2010). During development, the postural control system

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tries to achieve a stable vertical posture of the head and trunk against the force of gravity, to make a base for adequate sitting, reaching, standing, walking and feeding (Forssberg, 1999; Redstone & West, 2004). The control of the trunk movements plays a crucial role in these activities of daily life (Bertenthal & Von Hofsten, 1998; Kavanagh, Barrett, & Morrison, 2006; Ledebt & Bril, 2000; Patla, Adkin, & Ballard, 1999; Saavedra, Joshi, Woollacott, & van Donkelaar, 2009; Schmid, De Nunzio, & Schieppati, 2005; Van de Walle et al., 2012). Studies indicate that children with both mild and severe forms of CP have postural impairments (de Graaf-Peters et al., 2007; Heyrman et al., 2012), and many of the children with CP use sitting instead of standing position when performing tasks of daily life. Consequently, they spend more time in sitting than healthy children (Carlberg & Hadders-Algra, 2005). More knowledge about trunk control is of particularly importance when clinicians and researchers are planning and evaluating treatment in children with CP (Heyrman et al., 2012).

Despite its clinical importance, research on the specific characteristics of impaired trunk control in children with CP is rare. Trunk control in children with CP has been explored in studies of postural control (Heyrman et al., 2012). Such studies include assessment of the trunk as a single unit either in force platform studies (Ju, Hwang, & Cherng, 2012; Kyvelidou, Harbourne, Willett, & Stergiou, 2013; Liao, Yang, Hsu, Chan, & Wei, 2003), or in kinematic analysis (Coluccini, Maini, Martelloni, Sgandurra, & Cioni, 2007). In addition, muscle activation patterns of the trunk have been analyzed in electromyography studies (Bigongiari et al., 2011; Brogren, Forssberg, & Hadders-Algra, 2001; Hadders-Algra, van der Fits, Stremmelaar, & Touwen, 1999; Prosser, Lee, VanSant, Barbe, & Lauer, 2010; Roncesvalles, Woollacott, & Burtner, 2002). However, we are aware of only one study that have assessed trunk control in children with CP related to CP-subtype and to severity of gross motor impairment (Heyrman et al., 2012). In that study, Heyrman et al. speculated that the reason for lack of studies of trunk control might be due to the limited number of available clinical assessment tools (Heyrman et al., 2012).

Interventions proposed to improve trunk control in children with CP, include trunk targeted training (Butler, 1998), hippo therapy and horseback riding (Zadnikar & Kastrin, 2011), and adaptive seating (Ryan, 2012). However, due to lack of appropriate assessment tools (Ryan, 2012), and limited documentation of the measurement properties of existing tools, such studies should be interpreted with caution. Better documentation of existing assessment tools is therefore warranted (Saether, Helbostad, Riphagen, & Vik, 2013).

In a recent, systematic review of clinical balance tools in children and adults with CP (Saether et al., 2013), we found four clinical balance tools focusing on trunk control in children and adults with cerebral palsy. Among these tools the Sitting assessment for Children with Neuromotor Dysfunction (SACND) (Reid, Schuller, & Billson, 1996), the Trunk Control Measurement Scale (TCMS) (Heyrman et al., 2011), and the Trunk Impairment Scale (TIS) (Saether & Jorgensen, 2011) assess the quality of static and dynamic trunk control, while the Segmental Assessment of Trunk Control (SATCO) (Butler, Saavedra, Sofranac, Jarvis, & Woollacott, 2010) assesses the child's level of trunk control in one sitting position. The advantage of both the TIS and the TCMS compared with SACND is that both tools give more information about the dynamic trunk control, whereas compared with the TCMCS the TIS is less extensive and time-consuming.

In a previous study we found that the TIS had high intra- and inter-observer reliability in 5–12 year old children with CP (Saether & Jorgensen, 2011). The aim of the present study was to assess the construct validity of the TIS, and if the reliability of the tool would be equally good in adolescents with CP. We hypothesized that children with more severe gross motor impairments would have lower TIS scores, than those with less severe gross motor impairments, and that the TIS scores would be highly correlated ($\rho > 0.70$) with the Gross Motor Function Measure (GMFM) (Russell, Rosenbaum, & Lane, 2002).

2. Methods

2.1. Design

The present study is a reliability and validity study of the TIS including children and adolescents with CP with different gross motor function, according to the Gross Motor Function Classification System (GMFCS) levels. The TIS assessment was video recorded and the video scorings were used to assess intra- and inter-observer reliability. Construct validity of the TIS was evaluated by comparing the TIS total score with the different (GMFCS) levels (the ability to discriminate), as a classification of gross motor impairment, and the TIS total scores with the Gross Motor Function Measure (GMFM) (Russell et al., 2002). In this study, an expansion of our previous study of reliability in children 5–12 years old (Saether & Jorgensen, 2011), we have assessed reliability in adolescents 13–19 years old, and construct validity in the whole age group from 5 to 19 years.

2.2. Participants

Children, age 5–19 years old, able to sit on a bench without support, and to understand instructions were eligible for participation, and both children with CP, all subtypes within GMFCS level I–IV, as well as typical developing children were included. Children with no motor impairment were included in order to address the discriminative ability between children without apparent postural problems, and children with such problems (i.e. with CP). Children with CP were recruited from the neuro-orthopedic outpatient clinic at St. Olavs University Hospital (Trondheim, Norway), and children with no motor impairment were recruited from several mainstream schools. Exclusion criteria were surgical procedures, included botulinum toxin injections, performed during the preceding six months. Information about the diagnosis and classification of CP was provided by the physiotherapist responsible for the child's follow-up.