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Pre-operative walking activity in youth with cerebral palsy

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ABSTRACT

Background: No data are available regarding level of walking activity for youth with cerebral palsy (CP) before undergoing orthopeadic surgery. The goals of this study were to quantify pre-operative walking activity, and determine whether pre-operative values are different from previously defined levels of walking activity in youth with CP.
Procedures: This study retrospectively evaluated pre-operative walking activity in youth with spastic CP, GMFCS levels I–IV. Walking activity was monitored using the StepWatch™. Outcome variables included mean daily strides, percent of day active, and percent of active time at high activity. Differences between GMFCS levels were examined and comparisons were made to published data.
Results: Pre-operative walking activity data from 126 youth with CP were included. All variables demonstrated higher walking activity in youth at GMFCS levels I/II compared to those at GMFCS levels III/IV. When compared to previously defined walking activity levels, pre-operative walking activity was lower.
Conclusions: Walking activity among pre-operative youth with CP is significantly lower than published data for ambulatory youth with CP. Results suggest that youth with CP who are surgical candidates have less walking activity than youth with CP without surgical needs. Therefore this study should encourage the effort to collect and analyze individual pre-operative data for comparison and evaluation of post-operative functional recovery.

What this paper adds

No objective data are available regarding level of everyday walking activity for pre-operative youth with CP. This study quantifies pre-operative levels of walking activity, and determines that pre-operative values are different from previously defined levels of walking activity in youth with CP. Additionally, this paper provides a baseline walking activity level for future assessment of recovery in youth with CP following single event multi level surgery.

1. Introduction

Cerebral palsy (CP) describes a group of disorders of the development of movement and posture that are attributed to a non-progressive disturbance that occurs in the developing fetal or infant brain (Bax, Goldstein, Rosenbaum, Leviton, & Paneth, 2005). Prevalence of CP worldwide is approximately 2.11 per 1000 live births (Oskoui, Coutinho, Dykeman, Jetté, &

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Pringsheim, 2013), making CP the most common motor deficiency that causes disability in children (van Eck et al., 2008). Cerebral palsy makes up the largest diagnostic group treated in pediatric rehabilitation (Capio, Sit, Abernethy, & Masters, 2012).

Although CP is a non-progressive condition, progressive loss of physical function has been observed (Harvey, Rosenbaum, Hanna, Yousefi-Nooraie, & Graham, 2012; Opheim, Jahnsen, Olsson, & Stanghelle, 2009; Stevens, Holbrook, Fuller, & Morgan, 2010). To maintain or improve walking mobility, many youth with CP will have single event multilevel surgeries (SEMLS), including muscle tendon lengthenings, tendon transfers, re-alignment osteotomies, and joint stabilization procedures. The goal of SEMLS is to correct deformities and reduce the strain of walking. Easing the burden of walking is thought to allow improved mobility function and quality of life (Steele, Rozumalski, & Schwartz, 2015). In order to evaluate the effects of SEMLS, a variety of impairment level and capacity level gait measures have been utilized in clinical outcome studies (Mcginley et al., 2012; Rutz, Donath, Tirosh, Graham, & Baker, 2013).

Changes in gait quality have been examined in a laboratory setting, revealing improvements at the impairment level (kinematic and kinetic) and capacity level (gait speed) following surgery (Mcginley et al., 2012; Rutz et al., 2013). However, changes in everyday quantity of walking activity (WA) may be more revealing as a measure of mobility performance and are potentially more meaningful as indicators of decline, improvement or maintenance. Walking is an important activity of daily living that enhances independence, participation, and quality of life (Steele et al., 2015). Walking in a laboratory evaluates the quality of gait, however, quantity of walking in everyday life is an important part of mobility function and requires different measurement protocols. Measurement of everyday performance is now possible using WA monitors validated for youth with CP (Bjornson, Belza, Kartin, Logsdon, & Mclaughlin, 2007; O'Neil et al., 2015).

Walking performance following SEMLS for each GMFCS level can give insight into functional recovery. Stride counts for youth with CP have been studied and reported many times (Bjornson et al., 2007; Bjornson, Zhou, Stevenson, Christakis et al., 2014; Kuo, Culhane, Thomason, Tirosh, & Baker, 2009; Obeid, Balemans, Noorduyn, Gorter, & Timmons, 2014; Stevens et al., 2010; van Wely, Becher, Balemans, & Dallmeijer, 2012). Established counts are typically accepted as the representative WA level for youth with CP, with the Bjornson 2007 study having been referenced over one hundred times. However, there is question as to whether these established stride counts adequately represent walking activity levels for pre-operative youth with CP and provide an accurate baseline for functional recovery following SEMLS. In many cases, surgical intervention is offered when a decline in walking mobility is observed and it might be anticipated that pre-operative WA is lower than the established stride counts from the literature for youth with CP.

To our knowledge, no objective data are available regarding level of everyday WA for pre-operative youth with CP. Therefore the goals of this study were to quantify pre-operative levels of WA, and determine whether pre-operative values are different from previously defined levels of WA in youth with CP.

2. Material and methods

This institutional review board approved retrospective cross-sectional study evaluated pre-operative levels of WA in youth with spastic CP, GMFCS I–IV. Previous studies on the WA of youth with CP have only included GMFCS I–III, as these are considered the ambulatory classifications. However, youth at GMFCS IV may still maintain some functional walking ability, and WA among this group is pertinent to mobility outcomes. The WA monitoring coincided with a pre-operative gait analysis visit. Youth were referred for the gait analysis in anticipation of surgical needs, but surgery decisions were not made until after the gait findings were reviewed. All youth included in the WA analysis were recommended for surgery following their gait analysis.

As part of a pre-operative clinical gait analysis, youth were evaluated to establish a baseline WA level. Walking activity was monitored using a StepWatch (SW) (Modus: Washington, DC) worn on the right ankle. The SW was calibrated using a standard protocol, sent home for 8–14 days, and returned by pre-paid mail. The calibration protocol consisted of adjusting the sensitivity and cadence measures of the SW for a youth's gait pattern, having the youth walk 50–100 steps around the gait analysis laboratory while someone manually counted steps, and checking the SW step count against the manual step count. Accuracy of 90% and above was accepted. The calibration protocol was repeated until the accuracy was acceptable. Youth were instructed to wear the SW during all waking hours except when bathing or swimming. Patient data collection episodes were included in the present analysis if 1) there were at least three days with eight or more hours of wear, and 2) there was at least one weekend day and one weekday. Individual patient data was averaged over all usable days in the collection episode.

The SW monitor measures only the steps of one leg. Thus the outcome variables analyzed are stride counts and not step counts. Outcome variables analyzed included mean total daily strides, high intensity strides (>40 strides per minute), medium intensity strides (>15 strides per minute), low intensity strides (1–15 strides per minute), active minutes per day, high intensity active minutes per day, medium intensity active minutes per day, and low intensity active minutes per day. Active minutes per day were used to calculate the percent of the day spent active (1440 min equals 100%). The percent of active time that was spent at high intensity activity was calculated as high intensity active minutes per day divided by active minutes per day. The intensity cutoffs used were the default cutoffs for the SW monitors listed above. There may be different intensity cutoffs better suited for youth with CP, however, several studies have used similar intensity cutoffs to those used here (Bjornson et al., 2007; Bjornson, Zhou, Stevenson, & Christakis, 2014; Bjornson, Zhou, Stevenson, Christakis et al., 2014; Stevens et al., 2010; van Wely et al., 2012).