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Treadmill training in moderate risk preterm infants promotes stepping quality—Results of a small randomised controlled trial

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ABSTRACT

Infants at risk for neuromotor delay (NMD) are associated with premature birth and low birth weight. These infants frequently exhibit tone, posture, and movement abnormalities. Therefore, it is important to identify potential interventions to facilitate early motor development within this population. The purpose of this study was to examine the potential benefits of treadmill (TM) training in infants at risk for NMD. Furthermore, relationships between TM stepping performance and onset of walking have been suggested, and therefore, were also explored. Twenty-eight infants at moderate risk for NMD were randomly assigned to one of two groups: (1) TM training (experimental) ($N = 15$) or (2) control ($N = 13$). Infants in the experimental group were trained for 8 min/day, five days/week from study entry until walking onset. Monthly, 5 min of TM stepping performance were videotaped and analysed for infants in both groups to obtain frequency and quality of TM stepping. Groups were different in terms of TM stepping performance with experimental group displaying better stepping. However, they did not differ in age of walking onset (experimental = 15.1 months, control = 14.6 months). In both groups, frequency of TM stepping was significantly related to onset of walking. Findings suggest that TM training as implemented impact the quality of TM stepping, but did not significantly improve walking onset. Given the significant relationship between stepping and walking onset, the moderate affection of the population, the relative low intensity and lack of individualisation of the training, we suggest future research should further explore the impact of TM training on gait-related variables and include individualised, more intense, and prolonged training.

1. Introduction

Infants at risk for neuromotor delay (NMD) of non-genetic origin often display perinatal histories significant for prematurity and other related factors, such as low birth weight, brain abnormalities, respiratory difficulties, and multiparity (Spittle, Orton, Anderson, Boyd, & Doyle, 2012; Sutcliffe & Derom, 2006). From a motor perspective, these individuals may

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demonstrate abnormalities related to tone, movement, and posture (Molnar, 1985). Recent reports estimate the incidence of cerebral palsy (CP) amongst infants who were born prematurely or with low birth weight at five to fifteen percent (Spittle et al., 2012; Tin, Wariyar, & Hey, 1997; Vohr, Wright, Poole, & McDonald, 2005). Such rates suggest that a large proportion of infants, i.e. 85–95%, with perinatal risk factors experience deficits that are transient in nature or consistent with other developmental disabilities, such as Developmental Coordination Disorder (Davis, Ford, Anderson, & Doyle, 2007; Holsti, Grunau, & Whitfield, 2002).

Regardless of whether they receive a diagnosis, most of these infants will require early intervention to manage their deficits and promote motor development. Reviews of the literature surrounding the impact of early intervention on motor development in infants at risk for NMD have provided inconclusive results (Blauw-Hospers & Hadders-Algra, 2005; Brown & Burns, 2001; Spittle et al., 2012). However, programmes that are highly structured and have substantial parent involvement seem to have more favourable results (Hauser-Cram et al., 2001). Furthermore, ample evidence supports the value of task-specific training in therapeutic interventions (Alloway & Warner, 2008; Hubbard, Parsons, Neilson, & Carey, 2009). One intervention that meets these criteria is parent-implemented, task-specific treadmill (TM) training. This may be an attractive intervention tool because it specifically targets walking, a skill that is often delayed in infants at risk for NMD (Jeng, Chen, Tsou, Chen, & Luo, 2004; Jeng, Yau, Liao, Chen, & Chen, 2000). Further, the TM is believed to facilitate practice of functional leg movements (i.e. alternating steps) that are necessary for independent walking. Vereijken and Thelen (1997) found that daily TM training caused infants with typical development to increase their alternate stepping to the point where it was a dominant pattern despite being initially non-preferred.

To date, there is limited knowledge surrounding TM training in infants at risk for NMD (Valentin-Gudiol et al., 2011). However, the importance of alternating step practice provided by the TM has been documented in infants with certain paediatric disabilities. For instance, several studies have shown that TM training facilitates walking onset (Ulrich, Lloyd, Tiernan, Looper, & Angulo-Barroso, 2008; Ulrich, Ulrich, Angulo-Kinzler, & Yun, 2001) and improves quality of gait in infants with Down syndrome (DS) (Angulo-Barroso, Wu, & Ulrich, 2008; Wu, Looper, Ulrich, Ulrich, & Angulo-Barroso, 2007). It is widely known that infants with DS are typically characterised as having hypotonia and heightened ligamentous laxity. Whether the favourable results observed in DS can be replicated in infants with different neuromotor characteristics (ex. spasticity, hypertonia) of non-genetic origin remains unclear. Nevertheless, past studies concerning TM training in infants who are at risk for NMD have provided generally positive results. Davis and colleagues (Davis, Thelen, & Keck, 1994) demonstrated that premature low risk infants can produce alternating steps on a TM at 1, 6, and 9 months of age. Since then, Bodkin, Baxter, and Heriza (2003) have conducted a case study where they trained a premature infant with a grade III IVH on a TM. While they concluded that training may facilitate proper foot placement during stepping, it is important to note that the authors terminated TM training prior to the infant achieving independent walking. The latter two studies suggest that infants at risk for NMD are capable of producing TM steps and that TM training appears to be feasible in this population of infants. To our knowledge there is only one study that implemented a 6-week intensive TM training in infants with early diagnosis of mild CP at an average age of 22 months (Mattern-Baxter, McNeil, & Mansoor, 2013). This study found improvements in walking skills such as walking onset and increased speed in infants who received the TM intervention.

Further examination of the effects of TM training in infants at risk for NMD is warranted in order to determine if prolonged stepping practice up to the point of walking onset can both facilitate attainment of this skill and improve stepping performance. Given the limited evidence regarding the effects of TM training in infants at risk for NMD and the probably unfounded yet real clinical concern that this type of motor training could worsen spasticity, the target population for this trial was limited to less involved infants excluding high risk infants.

The research questions were:

1. Do infants at moderate risk for neuromotor delays who receive TM training demonstrate more alternating steps and superior quality of stepping on the TM relative to infants in the control group?
2. Will independent walking occur earlier in the TM training group than in the control group?
3. Is there a relationship between pre-walking onset TM performance and walking onset?

2. Material and methods

2.1. Participants

Participants were recruited via high-risk clinics of local hospital doctors who referred potential subjects. Each subject was checked against the inclusion and exclusion criteria, prior to the initial assessment. Forty-five infants were referred from the University Medical Centre's Neonatal Follow-up/Developmental Assessment Clinic (see Fig. 1 for flow of participants through the study). These infants were admitted to the clinic because of low birth weight (<1500 g), prolonged ventilator use, or neonatal neurological insults including intraventricular haemorrhage, periventricular leukomalacia, hypoxic-ischaemic encephalopathy, neonatal seizures, and other intracranial haemorrhage. The inclusion criteria for our study were: (1) moderate hypo/hypertonia or developmental delay when examined by their paediatrician; and (2) corrected age between 6 and 13 months; 6 months was considered the minimum age to produce 10 steps on the TM (see below), and 13 months the maximum age to warranty a minimum length of TM training. Exclusion criteria were congenital musculoskeletal deficits, or other neurological or genetic disorders (e.g. Down syndrome, spina bifida). Study procedures were approved by the Institutional