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Postural stability in children with hemiplegia estimated for three postural conditions: Standing, sitting and kneeling

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ABSTRACT

Postural control deficit is one of the most important problems in children with cerebral palsy (CP). The purpose of the presented study was to compare the effects of body posture asymmetry alone (i.e., in children with mild scoliosis) with the effects of body posture impairment (i.e., in children with hemiplegia) on postural stability.

Forty-five outpatients with hemiplegia and 51 children with mild scoliosis were assessed using a posturography device. The examination comprised two parts: (1) analysis of the static load distribution; and (2) a posturographic test (CoP measurements) conducted in three postural conditions: standing, sitting and kneeling. Based on the asymmetry index of the unaffected/affected body sides while standing, the children with hemiplegia were divided into two different postural patterns: a pro-gravitational postural pattern (PGPP) and an anti-gravitational postural pattern (AGPP) (Domagalska-Szopa & Szopa (2013). *BioMed Research International*, 2013, 462094; (2014). *Therapeutics and Clinical Risk Management*, 10, 113). The group of children with mild scoliosis, considered as a standard for static body weight distribution, was used as the reference group.

The results of present study only partially confirmed that children with hemiplegia have increased postural instability. Strong weight distribution asymmetry was found in children with an AGPP, which induced larger lateral–medial CoP displacements compared with children with scoliosis. In children with hemiplegia, distinguishing between their postural patterns may be useful to improve the guidelines for early therapy children with an AGPP before abnormal patterns of weight-bearing asymmetry are fully established.

1. Introduction

The term cerebral palsy (CP) refers to a group of postural and movement disorders that result from a non-progressive and permanent brain lesion that occurs during the development of the immature brain (Bax et al., 2005; Bleck, 1975; Rosenbaum et al., 2007; van der Heide & Hadders-Algra, 2005).

Children with CP often experience disruptions in postural control and subsequent postural instability, and most of them present atypical habitual body posture (Woollacott & Shumway-Cook, 2005). Asymmetric alignment in posture is especially characteristic in children with unilateral neurological lesions such as unilateral CP (spastic hemiplegia) (Bax et al., 2005).

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Furthermore, children with hemiplegia tend to have impaired coordination of movement, reduced between-limb synchronisation and less weight-bearing (WB) on the affected side, which can in turn cause problems with maintaining an upright WB position and gait (Bax et al., 2005; Woollacott & Shumway-Cook, 2005). Hemiplegia has also been associated with disruptions in postural control and subsequent postural instability (Bax et al., 2005; Woollacott & Shumway-Cook, 2005).

In our previous study, two asymmetrical postural patterns were described among children with hemiplegia: a pro-gravitational postural pattern (PGPP), which exhibited a tendency to overload the affected body side, and an anti-gravitational postural pattern (AGPP), which exhibited a tendency to underload the affected body side (Domagalska, Szopa, & Lembert, 2011; Domagalska-Szopa & Szopa, 2013, 2014). These studies provided evidence of strong correlations between WB asymmetry and both postural and gait patterns in children with hemiplegia, clearly showing that, despite apparent similarities, postural and gait patterns differed in children with hemiplegia. Therefore, it is important to investigate the effects of body posture impairment on postural stability control in children with hemiplegia, taking into account the differences in their postural patterns.

In the present study, the authors attempt to answer the question of whether the cause of deficits in postural stability in children with hemiplegia are indeed postural control deficits or disturbances resulting from features of brain damage, as well as the extent to which this is the result of body posture impairment, reflected by atypical postural patterns. The purpose of the present study was to compare the effects of body posture asymmetry alone (i.e., in children with mild scoliosis) with the effects of the body posture impairment (i.e., in children with hemiplegia) on postural stability. A group of children with mild scoliosis, considered as a standard of asymmetry of static body weight distribution, was used as a reference group.

The authors hypothesised that in all of the postural conditions: (1) children with hemiplegia would present greater WB asymmetry than those with scoliosis, (2) children with an AGPP would present greater WB asymmetry than those with a PGPP, (3) children with CP would exhibit poorer stability control compared with children with scoliosis, and (4) children with an AGPP would exhibit poorer stability control than those with a PGPP.

The confirmation of Hypothesis 3 could provide evidence that postural stability control in children with hemiplegia is the result of body posture impairment. The negation of Hypothesis 3 and confirmation of Hypotheses 1, 2 and 4 could indicate that postural stability control largely depends on static body weight distribution asymmetry and the body posture pattern in children with hemiplegia.

2. Methods

This study was approved by the local bioethical commission (NN-013-350/I/03/09). The subjects' parents provided their written, informed consent prior to the study.

2.1. Subjects

Forty-five children (17 girls and 28 boys) with hemiplegia (HS) were included in the study; 29 patients had right-sided deficits, and 16 patients had left-sided deficits. All of the participants with HS were independent outpatients of local paediatric rehabilitation centres and had Gross Motor Function Classification System (GMFCS) scores between I and II, indicating that they were relatively well-functioning patients. All of them had received a diagnosis of hemiplegia from a physician. The participants had a mean age of 9 years and 5 months old, ranging from 7 years and 4 months to 12 years and 2 months old.

The references group of children with mild scoliosis (references: Ref.) comprised 51 children (27 girls and 24 boys; range of lateral curvature, 11–20°; mean, 18°; mean age, 9 years and 2 months old; range, 7 years and 5 months to 12 years and 3 months [SD = 1.99]). All of these children were outpatients at a local centre for corrective gymnastics, and all of them had been diagnosed with scoliosis by a physician.

All of the subjects met the following criteria: (1) older than 7 years old (to minimise the incidence of unstable postural patterns); (2) had the ability to follow verbal directions; (3) had the ability to maintain sitting, kneeling and standing positions for 1 min without additional support; and (4) had no previous surgical procedures. The additional criteria for children with CP were as follows: (1) a diagnosis of hemiplegia; (2) no use of pharmacological agents and no spasticity management for 6 months before the evaluation. An additional criterion for children with scoliosis was mild scoliosis (angle of vertebral lateral curvature $<20^{\circ}$).

The exclusion criteria were as follows: a history of uncontrolled seizures or vestibular dysfunction.

2.2. Testing procedure

Our study comprised two interrelated parts

1 Analysis of the static load distribution (WB); and
2 posturographic testing (CoP measurements).

Conducted during (1) quiet stance, (2) sitting, and (3) kneeling with the eyes open. Finally, the participants' weights and heights were measured. A pressure measurement device (PMD) by Zebris Medizintechnik GmbH (Isny, Germany,) with an