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Characteristics of antigravity spontaneous movements in preterm infants up to 3 months of corrected age

Saori Miyagishima (PhD) (PT)[a,b,*], Tadayoshi Asaka (PhD) (PT)[c], Kaori Kamatsuka (MSc) (PT)[b], Naoki Kozuka (PhD) (PT)[d], Masaki Kobayashi (MD)[e], Risa Igarashi (MD)[e], Tsukasa Hori (PhD) (MD)[e], Yuko Yoto (PhD) (MD)[e], Hiroyuki Tsutsumi (PhD) (MD)[e]

[a] *Graduate School, Doctor Course of Medicine, Department of Pediatrics, Sapporo Medical University School of Medicine, Sapporo, Japan*
[b] *Division of Rehabilitation, Sapporo Medical University Hospital, Sapporo, Japan*
[c] *Department of Rehabilitation Science, Faculty of Health Sciences, Hokkaido University, Sapporo, Japan*
[d] *Department of First Division of Physical Therapy, School of Health Sciences, Sapporo Medical University School of Medicine, Sapporo, Japan*
[e] *Department of Pediatrics, Sapporo Medical University School of Medicine, Sapporo, Japan*

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ABSTRACT

Aims: We investigated whether spontaneous antigravity limbs movements in very low birth weight preterm infants were insufficient compared to those in term infants. The relationship between the quality of general movements (GMs) and antigravity limbs movements was also examined.
Methods: Preterm infants with very low birth weight without central nervous system disorders nor severe respiration disorders, and healthy term infants were recruited. The infants were set in a supine position. The distance between both hands and between both feet, and the height of both hands and feet from the floor were recorded at 1–3 corrected months for preterm infants, and at 1–3 months for term infants by a 3D motion capture system. The measurements were adjusted for body proportions. GMs in preterm and term infants were assessed similarly.
Results: Thirteen preterm and 15 term infants completed the study. In preterm infants, the distance between both hands and between both feet were longer, and the height of both hands and feet were lower than those in term infants in all measurements. In term infants, the height of both hands and feet increased as they developed, but no change was observed in preterm infants. In preterm infants with abnormal GMs, the distance between both hands was longer, and the height of both hands and feet was lower than that in those with normal GMs. There were no such differences between preterm infants with normal GMs and term infants with normal GMs.
Conclusion: Antigravity limbs movements in preterm infants within the first 3 month of corrected age were insufficient compared with those in term infants. Furthermore, no

* Corresponding author at: Division of Rehabilitation, Sapporo Medical University Hospital, Sapporo, Japan. South 1 West 16, Chuo-ku, Sapporo, Hokkaido, 060-8543, Japan.
E-mail address: saori305@sapmed.ac.jp (S. Miyagishima).

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improvement with development was observed in preterm infants. In addition, preterm infants with abnormal GMs showed worse antigravity limbs movements than preterm and term infants with normal GMs. The preterm infants with normal GMs could behave similar to the full term infants.

1. Introduction

Advanced perinatal intensive care has dramatically increased the survival of preterm infants, as recently documented in the survival of extremely low birth weight infants in Japan (Itabashi et al., 2007; Kusuda et al., 2006; Kusuda, Fujimura, Uchiyama, Totsu, & Matsunami, 2012). However, the long-term consequences of preterm birth are of public health concern and include neurodevelopmental difficulties such as poor motor and/or cognitive function (Kono, Mishina, Sato, Watanabe, & Honma, 2008; Kono, Mishina, Yonemoto, Kusuda, & Fujimura, 2011).

The neonatal intensive care unit (NICU) exposes the preterm infant to a non-optimal physiological environment and to invasive procedures and handling, which may cause pain and stress. In addition, frequent manipulations by attending staff could disrupt their rest activity cycles and sleep leading to chronic and prolonged stress possibly adversely influencing motor and/or cognitive function development (Als et al., 1994). To reduce neurodevelopmental risk, many preterm infants receive physical therapy interventions. Early intervention programs for preterm infants positively influence cognitive and motor outcomes during infancy, with the cognitive benefits persisting into pre-school age (Spittle, Orton, Anderson, Boyd, & Doyle, 2012).

Consequently, some characteristic features of preterm infants should be considered for their motor development. Motor behavior of the preterm infant prior term age is affected by the force of gravity, and their ability to control the position of the head, trunk and limbs is limited (Dubowitz, 1988). As a result, many preterm infants seem to continue less flexion posture with diminished antigravity movements even after term age (Drillien, 1972; Ferrari et al., 2001, 2007).

During their first few months spontaneous movements in preterm and also term infants involve general movements (GMs), characterized as gross movements of the entire body with no distinctive pattern or coordinated movement of body parts (Prechtl, 2001). They usually move their body and generate a variety of motor patterns, in the absence of any obvious external stimuli. These movements have reported to emerge at 9–10 weeks postmenstrual age (described as "fetal" or "pre-term" GMs) (Hadders-Algra, Klip-Van den Nieuwendijk, Martijn, & van Eykern, 1997). Then at around 36–38 weeks postmenstrual age, this "pre-term" GMs change into the more slow and forceful "writhing" GMs (Hadders-Algra et al., 1997). At around 2–3 months of age, the spontaneous movement patterns change qualitatively; small movements at moderate speed and variable accelerations of the neck, trunk, and limbs (described as "fidgety" quality) or powerful swiping and swatting arm movements begin to appear (Hadders-Algra & Prechtl, 1992; Prechtl & Hopkins, 1986).

Infants learn gross motor skills by performing such spontaneous movements in early infancy (Thelen, 1985). Therefore, the combination of diminished flexor tone with weaker antigravity power in preterm infants could weaken their spontaneous movement and ultimately impair the learning of gross motor skills.

Several observational studies have shown that spontaneous movements in preterm infants were smaller, of more limited repertoire and changed less frequently compared to those in term infants (De Vries, Erwich, & Bos, 2008; Kakebeeke, Von Siebenthal, & Largo, 1997; Van Schie et al., 2008). However, these studies did not include quantitative assessment from the point of view of antigravity movement. Some researchers have estimated early kicking movements of preterm infants using kinematic analysis (Geerdink, Hopkins, Beek, & Heriza, 1996; Heriza, 1988; Jeng, Chen, & Yau, 2002), but the movements' patterns they described were rather inconsistent, and their indicators were difficult to apply in the clinical situation.

In this study, we estimated antigravity limbs movement in preterm and term infants quantitatively using simple and reproducible indexes suitable for application in the clinical environment. The kinematic variables such as distance between both hands (or feet) and the height of both hands (or feet) from the floor were employed. In addition, we investigated the relationship between the quality of the GMs and quantitative antigravity limbs movements in preterm infants.

2. Methods

2.1. Participants

Preterm infants with birth weight of < 1500 g without central nervous system disorders (e.g. periventricular leukomalacia, intraventricular hemorrhage) and/or severe respiration disorders (e.g. severe bronchopulmonary dysplasia), and term infants with birth weight of >2500 g and born at term (37–42 week) without any perinatal events were recruited.

The participant was invited from the public in the Sapporo Medical University Hospital, Japan (e.g., distribution of instructions). The parents or caregivers who were interested in the study contacted the person in charge. After obtaining informed consent from them, an examination was performed for 18 preterm and 18 term infants. Data for 5 preterm and 3 term infants were not used for the analysis because of unsuitable behavioral states (crying, sleeping, or no movements during awake