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RESEARCH REPORT

Balance performance in children with unilateral and bilateral severe-to-profound-grade hearing impairment

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Abstract The objective of this study was to investigate the balance performance in a cohort of children with severe to profound grade hearing impairment. Twenty-eight children (14 girls) aged 6 to 11 years old who had unilateral (6) or bilateral (22) severe to profound grade sensorineural hearing impairment were assessed using the Bruininks—Oseretsky test of Motor Proficiency (BOT2), Pediatric Functional Reach Test (FRT), Pediatric Version of Clinical Test for Sensory Interaction of Balance (P-CTSIB), Test of Postrotary Nystagmus (PRN). Parental functional concern was also collected. Friedman test was used to compare the performances in the 5 subtests of BOT2. Spearman test was used to assess the correlation between balance subtest of BOT2 with the other administered tests. These children showed significantly worse performance in balance subtest as compared to the other 4 subtests in BOT2. Their balance performance (BOT2) was significantly correlated to the performance in P-CTSIB with vision absent, vision inaccurate, somatosensory inaccurate and vestibular accurate. Their balance performance was also correlated to their performance in bilateral coordination. The clinical implication is that balance assessments should be included as a routine procedure for early detection of dysfunctions in hearing impaired children, so as to guide the formulation of appropriate interventions.

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Introduction

Hearing loss is usually diagnosed early in life. Early intervention focusing on the development of communication skills is much emphasised. However, in this group of children, teachers and parents sometimes observe weak coordination, clumsiness, and balance deficits, which may affect their ability to function optimally within the environment and to interact with their peers [1,2]. Balance disorder in children is very often difficult to recognise. Children are not able to describe their symptoms and they just look clumsy. Routine screening usually does not include assessment of balance and motor function unless there are obvious neurological or orthopaedic concerns [3,4]. Therefore, early identification and remediation of balance and motor deficits are important.

Balance is maintained through the input of three signal systems, namely, visual, proprioceptive, and vestibular. Damage to any of these systems or an abnormality in the central nervous system (CNS) can cause balance problems [5]. The functional vestibular system comprises vestibulospinal and vestibulo-ocular systems. The vestibulospinal system contributes to the postural tone necessary for the emergence of early motor milestones. The vestibulo-ocular system contributes to visual stabilisation, acuity, and the development of visual spatial and perception abilities [6]. It is normal for persons of different age groups to have a certain amount of postural sway, but a child imitates the adult pattern of postural control by 7—10 years of age [3]. Balance skills and normal motor performance require an intact postural control system, which depends on sensory, motor, and integrative components [3,7].

Reports showed that vestibular dysfunction is common in children with sensorineural hearing loss, and morphological changes were found in the labyrinths of these children [2,8,9]. Children with hearing impairment and normal vestibular function performed like normal hearing peers on balance and dynamic motor tasks, whereas those with hearing impairment and concurrent vestibular dysfunction presented with balance problems [8,10,11].

Studies reporting motor and balance deficits in children with hearing impairment had been examined thoroughly. One study of 90 children, 8—10 years of age, with severe hearing impairment of various aetiologies, reported that that many, but not all, of these children presented with impaired static balance, e.g., balance during single-leg stand [12]. Another study reported impaired dynamic coordination (e.g., balance beam walking, skipping, hopping, and lateral hopping) in a group of 55 children, aged 6—10 years, with idiopathic hearing impairment [13]. Another study examined 200 children with hearing impairment of varying aetiology and reported deficits in object control (e.g., ball skills) and locomotor tasks (e.g., balance beam), mainly in those $<$10 years of age [14]. Butterfield and Ersing [1] reported that although no impairment of most motor skills was evident in 132 children aged 3—14 years with moderate to severe hearing impairment, deficits in static and dynamic balance skills (e.g., kicking, jumping, and hopping) were evident in the youngest children. Another study examined seven children aged 4—5 years with profound sensorineural hearing loss, and reported immature responses in static and dynamic balance, with a lack of proximal stability and delayed equilibrium responses [2].

De Kegel et al [15], who studied 23 children aged 6—12 years with moderate to severe hearing impairments, concluded that clinical balance tests and posturography offered different but complementary information, and recommended that both tests should be included in the assessment protocol of balance. Balance is a multidimensional concept; balance control does not rely on a single neural system and cannot be evaluated by a single test such as static and dynamic balance. Martin et al [16] studied 32 children with sensorineural hearing loss, and showed that motor performance was dependent on dynamic visual acuity and severity of hearing loss. Hartman et al [17] studied 42 deaf children with severe to profound hearing loss and concluded that they had a definite motor problem when compared to the normal population. These heterogenic results could be explained by the fact that different components of balance were tested with different assessment tools. Besides, different variables such as aetiology of hearing impairment, severity of hearing loss, and age of children at the time of testing might affect the results [4,18].

No similar study has been carried out in the Hong Kong population. The aim of this study was to investigate balance performance in children with unilateral and bilateral severe to profound sensorineural hearing impairment.

Methodology

A cross-sectional study was conducted. The study was approved by the Ethics Committee of the Department of Health, Hong Kong.

Participants

In 2009, all primary school-aged children, aged 6—11 years, who were diagnosed with unilateral or bilateral severe to profound sensorineural hearing impairment, were identified from the computer system of Child Assessment Service (CAS), Department of Health, Hong Kong. Children who had neurological, visual, or physical impairment in addition to their hearing impairment or those with IQ less than 80 were excluded. Patients and their parents were invited for a clinical assessment. Written consent was obtained from the parents.

Bruininks—Oseretsky Test of Motor Proficiency—Second Edition

The Bruininks—Oseretsky Test of Motor Proficiency—Second edition (BOT-2) was used to assess motor function. It is a norm-referenced test of a range of motor behaviours that allows comparisons to be made between actual performance and what may be expected from a child of the same age (4.5—18 years). It comprises five subtests, including balance, bilateral coordination, strength, upper limb coordination, and running speed and agility. We defined these children as having a problem in the specific gross motor area when they