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Vertigo and balance in children - Diagnostic approach and insights from imaging

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ABSTRACT

Common causes of vertigo and dizziness in childhood are vestibular migraine and associated syndromes (benign paroxysmal vertigo), unilateral vestibular failure due to labyrinthitis, positioning vertigo, and somatoform syndromes. Although the same spectrum of diseases as in adults can be found, the frequency differs widely. Further, balance disorders not related to vestibular function, like cerebral palsy, can present with dizziness. Vestibular function can reliably be addressed at the bedside by head impulses to test vestibulo-ocular reflex function, ocular motor testing of the central vestibular system, and balance tests for vestibulo-spinal function. Vestibulo-ocular reflex function can now be quantified by recording eye and head movements with high resolution video-oculography (256 Hz) and inertial sensors. Posturographic measures using artificial neuronal networks are used to classify dysbalance. Quantitative gait analysis further helps to distinguish balance disorders caused by e.g. sensory dysfunction or supraspinal disturbances. Recently, functional neuroimaging opened a view to the brain network for the control of posture and locomotion. From frontal cortex the locomotor signal is conveyed via the basal ganglia to the centers for locomotion and postural control in the brainstem tegmentum. The cerebellum is involved in sensory integration and rhythm generation during postural demands. To summarize, most syndromes causing dizziness, vertigo and imbalance can be diagnosed based on history and clinical tests. However, new data from neurophysiology and imaging help to understand the pathophysiology and the therapeutic principles in these disorders.

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1. Introduction

Vertigo and balance disorders are not uncommon in children. At school age the prevalence was estimated as 15% (at least one attack of vertigo over the last 12 month).[1] The spectrum of diagnoses is similar to adults, but the incidence rates are different (Fig. 1)

Between 25 and 50% of vertigo syndromes in children are related to migraine (e.g. vestibular migraine, benign paroxysmal vertigo of childhood). Somatoform disorders are a common cause for chronic vertigo in children >10 years. Some diagnoses well known in adults are increasingly recognized in children (e.g. vestibular paroxysmia). Clinical evaluation has a high impact as patient history not always helps. Neuronal circuits for ocular motor and vestibular function develop within the first year of life and can be tested reliably in toddlers. The head impulse test for vestibular ocular reflex function is an easy bedside and allows quantification when combined with eye and head movement recording. Other tests have been adopted from standard otoneurological examination. Sensory signals are differentially weighted during stance and locomotion. In highly automated gait patterns vestibular information is suppressed and the sensorimotor task is preferentially controlled by visual input. Recent functional MRI data show how human sensory control is modulated during standing, walking, and running. These finding are valuable for the planning and evaluation of physical therapy of children with gait and balance disorders (e.g. locomotor training in CP).

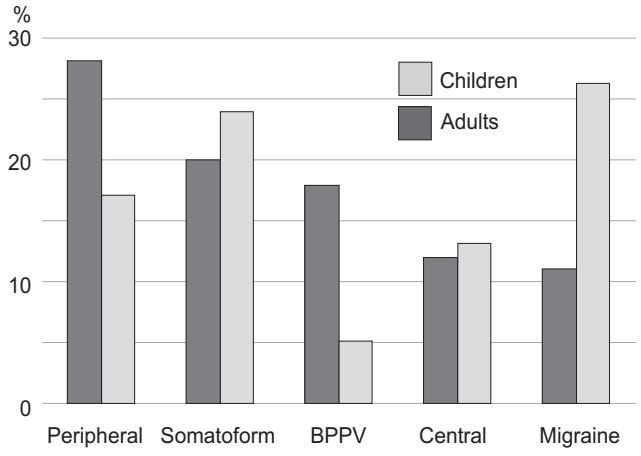

Fig. 1 – Relative Frequencies of vertigo syndromes in children and adults. Columns refer to 4470 adults (dark grey) and 214 children (light grey) seen in our dizziness unit. In children the most common diagnosis is migraine (27% vs. 11% in adults). Positioning vertigo (BPPV) is less common in children (5 vs. 18% in adults).

2. Vestibular testing in children

Clinical examination of peripheral and central vestibular function has to include ocular motor testing, head impulses, and balance tests. Neuronal circuits for ocular motor and vestibular function develop within the first year of life and can be tested reliably in toddlers.[2] The head impulse test for horizontal vestibulo-ocular reflex (VOR) function is a bedside test which can easily be performed.[3] Video-oculography systems with inertial sensors for the synchronized recording of head and eye velocity allow the quantification of VOR gains and are well tolerated.[4] Reponses to caloric irrigation of the ears have been successfully obtained in normal children as young as 1 year of age in several studies.[2] Rotational testing has some advantages over caloric testing if the goal is primarily to assess for the presence or absence of vestibular function. Small children are able to sit in an adult's lap during the rotational chair testing, and vertigo is less intense in rotational chair testing than during caloric testing. The investigator looks for optokinetic nystagmus during rotation. The vestibular response of the horizontal semicircular canal is best observed when stopping the chair after 5–10 rotations at constant velocity (about 180°/s). The quick phases of the vestibular nystagmus beat opposite to the direction of rotation (e.g. to the left after stopping a chair rotation to the right). The nystagmus duration should be symmetrical for left and right rotations. Caloric and rotational testing has been studied in normal, dizzy, and hearing-impaired children. Body sway can be quantified by posturography. Brain MRI should be considered in all patients presenting with subacute central vestibular signs.

3. Migraine related vertigo syndromes

Benign paroxysmal vertigo of childhood (BPV)[5] is the most common cause of episodic vertigo in children between 2 and 6 years of age. The prevalence was estimated as 2.6% for the population of children between 5 and 15 years of age.[6] The clinical presentation is characterized by short attacks of vertigo or dizziness (seconds to minutes) often associated with nystagmus and postural imbalance. In some cases nausea and vomiting go along with the attack. Cochlear symptoms (hearing loss or tinnitus) are not typical. The children do not show any signs of vestibular dysfunction between attacks. The frequency of attacks can differ widely. The disorder can manifest in the first two years of life and usually disappears spontaneously after the 6th birthday. There is an association with classical migraine for the positive family history and development of typical migraine later.[7] The