Bilateral Large Vestibular Aqueduct with Associated Hearing Loss

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History

A 3-year-old girl was presented to the hospital due to gradual hearing loss. She had been healthy and there was no history of head trauma or injury. Physical examinations were unremarkable. Pure tone audiometry (PTA) revealed a down-sloping curve and an asymmetrical severe high frequency hearing loss. Acoustic immitance examination showed a normal tympanogram and an absent acoustic reflex. A high resolution CT (HRCT) examination was requested to further investigate the cause of the hearing loss.

Diagnosis

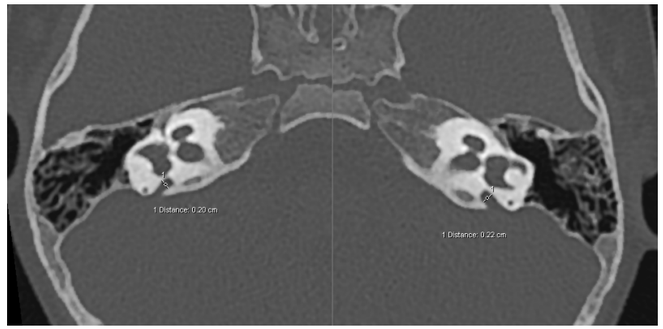
Axial CT images showed bilateral enlargement of the vestibular aqueduct (VA), measuring 2 mm in diameter at the right midpoint and 2.2 mm at the left midpoint, characterizing a large vestibular aqueduct (LVA). No other abnormalities of the ossicular chains, cochleas, and semicircular canals were seen in the mid- and inner ear on both sides.

Comments

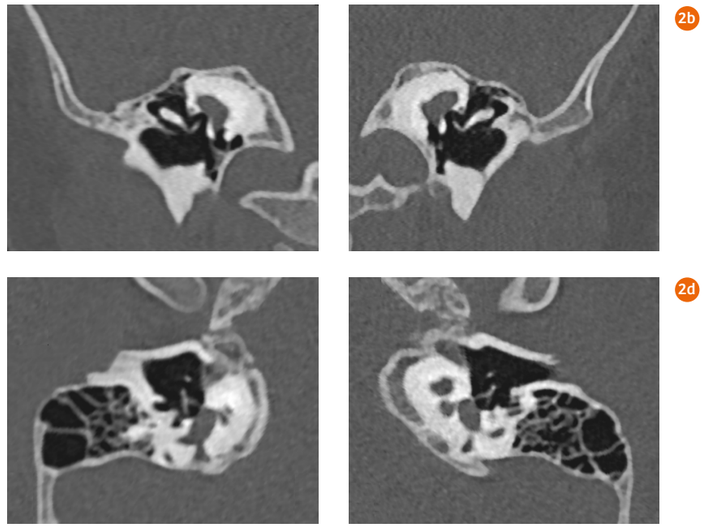
LVA is one of the most common malformations of the temporal bone associated with hearing loss in children. [1] It is defined as a midpoint diameter of >1.5 mm according to the Valvassori criterion. Identification of an LVA is important since its delayed onset and progressive nature offer a window of opportunity to prevent or retard the progression of hearing loss.[1] Treatment strategies such as careful selection of suitable hearing aid parameters or cochlear implantation could be of particular benefit during the critical period of speech and language acquisition in young children.[2] Computed tomography (CT) is the best radiological modality to image bony structures such as the vestibular aqueduct.[2] However, motion-free image acquisition needed for diagnosis may fail if the child is uncooperative during scanning. Traditionally, the child needs to be sedated prior to the CT scan. In this case, two previous CT scans – one without sedation and another with attempted sedation – were actually unsuccessful due to the impossibility of calming down the child. This scan was performed using SOMATOM Force, which provides higher temporal resolution and a wider detector. A sequential scan without table movement was performed to complete the acquisition in 0.25 s. The child was neither sedated nor still during the scan, nevertheless, motion-free high resolution images were acquired enabling a confident diagnosis. The tube voltage setting was lowered to 100 kV in order to reduce radiation dose. Combined with ADMIRE (advanced modeled iterative reconstruction), an effective dose of 0.21 mSv was achieved. This special scanning technique can be considered for routine applications.

Examination Protocol

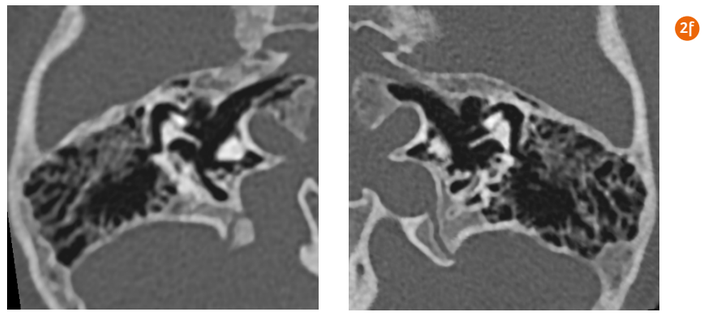
Scanner	SOMATOM Force		
Scan area	Mid and inner ears	**CTDIvol**	9.27 mGy
Scan mode	Sequential mode	**DLP**	53.4 mGy cm
Scan length	47.4 mm	**Rotation time**	0.25 s
Scan direction	Caudio-cranial	**Slice collimation**	192 × 0.6 mm
Scan time	0.25 s	**Slice width**	0.5 mm
Tube voltage	100 kV	**Reconstruction increment**	0.3 mm
Effective mAs	104 mAs	**Reconstruction kernel**	Hr59/Hr64 ADMIRE 3
Dose modulation	n/a		

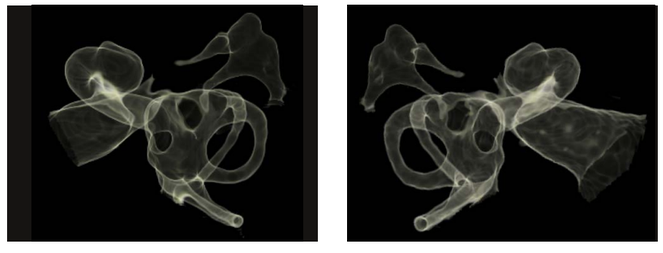


1 Axial images (0.5 mm) show bilateral enlargement of the VA, measuring 2.0 mm in diameter at the right midpoint and 2.2 mm at the left midpoint, characterizing an LVA.



2 MPR images (0.5 mm) show normal findings of the bilateral ossicular chains. Images are reconstructed with the kernel Hr59 on the left (Figs. 2a, 2c, 2e) and Hr64 on the right (Figs. 2b, 2d, 2f) which demonstrate higher spatial resolution.





3 Cinematic VRT images demonstrate bilateral normal ossicular chains, cochleas, and semicircular canals in three dimensions.

References
[1] Griffith A J, Wangemann P. Hearing Loss Associated with Enlargement of the Vestibular Aqueduct: Mechanistic Insights from Clinical Phenotypes, Genotypes, and Mouse Models [J]. Hearing Research, 2011, 281 (1-2):11-17.

[2] Mohamed M El-Badry et al. Evaluation of the radiological criteria to diagnose large vestibular aqueduct syndrome. International Journal of Pediatric Otorhinolaryngology 81 (2016) 84–91

In clinical practice, the use of ADMIRE may reduce CT patient dose depending on the clinical task, patient size, anatomical location, and clinical practice. A consultation with a radiologist and a physicist should be made to determine the appropriate dose to obtain diagnostic image quality for the particular clinical task.

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