Radiographic Evaluation of Children with Hearing Loss

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KEYWORDS

- CT temporal bone • MRI temporal bone • Childhood hearing loss
- Radiographic evaluation • Enlarged vestibular aqueduct • Common cavity deformity
- Mondini deformity

KEY POINTS

- High-resolution CT of the temporal bone offers excellent visualization of the osseous anatomy of the temporal bone, but has some limitations in the evaluation of soft tissue.
- MRI is associated with a higher cost and probable need for sedation, but offers excellent soft tissue detail and superior identification of intracranial pathology compared to CT.
- For children being considered for cochlear implantation, MRI is the recommended imaging study of choice.
- Enlarged vestibular aqueduct is the most common imaging finding. Findings are bilateral in up to 87% of patients and associated with cochlear malformation in 84%.

INTRODUCTION

Hearing loss is a common problem within the pediatric population, with 6 in 1000 children being diagnosed by the age of 18.[1] Over the past several decades, the universal screening of infants has been significantly expanded to evaluate 95% of newborns for hearing loss.[2] Through the implementation of early screening, the age of diagnosis has been reduced from the previous norm of 2 to 3 years of age, to the current level of 2 to 3 months.[3] As early detection has increased, focus has shifted to the diagnostic workup and the role of genetic, laboratory, and imaging studies. With this review, we seek to provide a guide for the use of imaging in pediatric patients with sensorineural, conductive, or mixed hearing losses. As such, we address the choice of

Disclosures: None relevant.

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Otolaryngol Clin N Am 48 (2015) 913–932
http://dx.doi.org/10.1016/j.otc.2015.07.003 oto.theclinics.com

imaging, findings, and clinical implications based on type of hearing loss at presentation. It is our hope that this format will present the most current information in a concise and more useful manner than cataloging imaging findings by Computed tomography (CT) or MRI.

Choice of Imaging

For a majority of the 20th century, temporal bone tomography was the only imaging modality available to clinicians. Using this technique, studies reported temporal bone abnormalities in up to 18% of typical deaf patients.[4] Despite the obvious limitations, plain films were used to identify congenital aplasia of the cochlea, glomus tumors, and temporal bone fractures.[5] Despite some utility, the use of plain films has been supplanted by more advanced (higher resolution) imaging.

The development of high-resolution CT of the temporal bone has allowed clinicians to dramatically augment the clinical history and physical examination and to arrive at more accurate and precise diagnoses. CT offers excellent visualization of the osseous anatomy of the temporal bone, but has limitations in the evaluation of soft tissues. These limitations are best exemplified by the lower sensitivity/specificity for the detection of acoustic neuromas compared with MRI, the inability to distinguish between soft tissue inflammation versus cholesteatoma consistently, and the inability to detect specific soft tissue lesions (eg, facial neuromas).[6] In practical terms, CT offers the advantage of short image acquisition times and the lack of need for contrast in the vast majority of clinical indications. These characteristics are important in the pediatric population, with the short study duration reducing the need for sedation and the associated potential complications.

MRI of the internal auditory canal (IAC) and temporal bone offers excellent soft tissue detail not afforded by CT. In the 1980s, contrast-enhanced MRI became the standard imaging modality for the detection of lesions of the IAC.[7] More recently, noncontrast fast spin-echo T2-weighted MRI and CISS (constructive interference) imaging protocols have been shown to possess adequate sensitivity and specificity to allow for IAC screening purposes.[8,9] As such, children with sensorineural hearing loss (SNHL), without suspicion of neoplastic, infectious or inflammatory processes, do not necessarily require intravenous contrast.[10] Published data suggest that MRI in the setting of pediatric SNHL workup should be extended to capture images that include the entire brain. Up to 20% of patients with SNHL have detectable intracranial findings, including gliosis, cortical dysplasia, brainstem hypoplasia, and cerebellar tumors.[11] As a balancing factor, the time required for MRI represents a relative disadvantage compared with CT. With MR studies requiring approximately 20 minutes to complete, sedation is required frequently in younger patients.[10]

Although the imaging modality used should be dictated primarily by clinical needs, it is important to acknowledge that other factors may influence decision making. Although the cost of MRI has decreased over recent years, it remains significantly more expensive than CT. For example, at our tertiary pediatric institution, a typical CT of the temporal bones (without contrast) incurs a charge of $1952. MRI is associated with a charge of $3178 without contrast and $3577 with contrast. In an increasingly cost-conscience health care environment, it has been suggested that CT may be a better initial choice in certain patient populations. However, patient safety is another highly relevant (if not more important) factor to consider. Recently, there has been a concerted effort to reduce the radiation exposure of children secondary to imaging studies. In a landmark study, Pearce and colleagues[12] followed 178,604 patients who underwent CT scans over a 24-year period in Great Britain. Use of CT in children delivering a dose of 50 mGy tripled the risk of leukemia,