

New MRI protocol enables imaging of fluid filled structures of the inner ear

Luke N. Ledbetter, MD
Associate Professor of Radiology
Director of Head and Neck Imaging Program
Department of Radiological Sciences
David Geffen School of Medicine at UCLA



Meniere's disease is associated with symptoms of fluctuating hearing loss, positional vertigo, aural fullness and tinnitus. These symptoms can range from mild to severe, with some patients at risk of injury from falls due to vertigo. Endolymphatic hydrops — too much fluid within the membranous structures that make up the endolymphatic spaces of the inner ear — causes the hearing and balance symptoms in Meniere's patients.


"Meniere's disease diagnosis and treatment decisions have been largely based on clinical presentation," states Luke Ledbetter, MD, associate clinical professor of radiological sciences. "Classically, we've not been able to image these endolymphatic spaces inside the inner ear." This is starting to change with the use of high-resolution delayed-intravenous-contrast MRI. UCLA was one of the first institutions working on this imaging technique and remains among a relative handful that offer it in clinical practice through its Meniere's MRI imaging program.

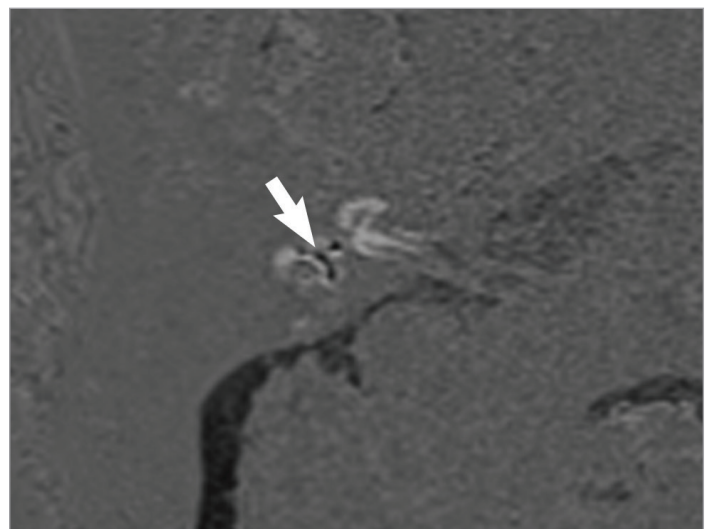
The membranous structures involved are very small — less than a millimeter in size. Conventional MRI studies cannot resolve the boundaries between the endolymphatic spaces and the surrounding perilymphatic spaces. Two developments that made the new imaging study possible are a better understanding of the dynamics of contrast along with technology advances in the imaging coils. Early attempts at imaging the endolymphatic spaces relied on intratympanic injection (through the eardrum) of contrast, followed by a 24-hour wait for the contrast to diffuse through the relevant structures. "Over time, we found out that we can instead give patients contrast intravenously — as we do for other MRI exams — and wait four hours for the contrast to get into these inner-ear structures," explains Dr. Ledbetter. The contrast spreads to the perilymphatic fluid, but not to the endolymphatic fluid. The endolymphatic structures — the utricle, saccule and cochlear duct — are thus revealed as dark areas against the bright perilymphatic fluid.

On the technology side, very small coils that sit like headphones on the patient's head are able to capture very-high-resolution images of very small structures. "If we try to look at these structures on a routine MRI, they all just look like fluid — we don't see the membrane separating perilymphatic from endolymphatic," explains Dr. Ledbetter. But with high-resolution delayed-intravenous-contrast MRI, neuroradiologists can now image the endolymphatic structures of the inner ear and reveal the changes in their size that result from the increased fluid pressure of endolymphatic hydrops. Not only can neuroradiologists visually confirm endolymphatic hydrops, they can also determine which structures are affected. UCLA neuroradiologists have found over the course of many such studies that abnormal imaging findings correspond well with patients' reports of their symptoms. "We find that with patients

who have just the hearing component, for example, we see hydrops in the cochlea but not in the utricle or saccule," reports Dr. Ledbetter. "With these imaging findings, we're breaking down sub-categories of patients and explaining the symptoms patients have with what we see on imaging."

For Meniere's disease patients who don't respond to conservative therapies, and whose symptoms are sufficiently debilitating, surgical intervention is often considered. In such cases, imaging that reveals the abnormal structures can be particularly valuable in helping to inform treatment decisions and guide invasive procedures. But high-resolution delayed-intravenous-contrast MRI has value for a broader range of Meniere's patients. "Otolologists often order conventional MRI of patients with hearing or balance symptoms to rule out things like a mass affecting one of the nerves," explains Dr. Ledbetter. "Our protocol includes the same type of images, so at the same time you rule out other causes, you get very specific information about what's going on in the endolymphatic spaces."

Dr. Ledbetter also points out that Meniere's disease symptoms of fluctuating hearing loss, aural fullness and vertigo can be hard to quantify. With the new imaging protocol, "there's an ability to be more accurate. We can narrow the diagnosis down to patients who have the anatomic changes that we were never able to see in the past." 



Normal patient Menieres subtraction image. The normal utricle containing endolymph is black (white arrow) and the surrounding perilymph is white.