

Physiologic Enhancement of the Labyrinth Measured with FLAIR

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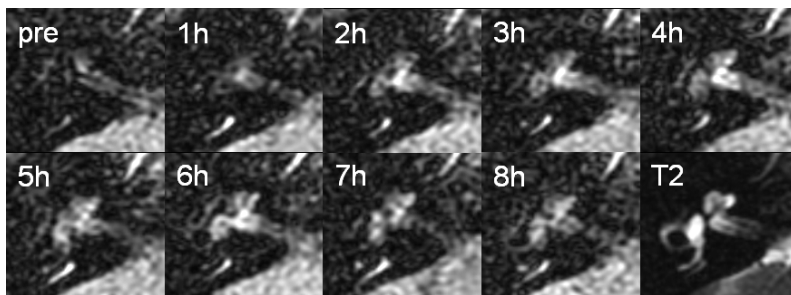
INTRODUCTION:

Normally, the fluid compartments of the inner ear do not enhance. Enhancement of the labyrinth is an indication of pathology, such as inflammation. Because FLAIR is more sensitive to alterations in the T1 of fluid than is routine T1 weighted imaging, FLAIR is particularly sensitive to leak of contrast into the labyrinth, and is a sensitive detector of intralabyrinthine pathology (1). In a number of cases, the physiologic enhancement of the labyrinth bilateral enhancement of the labyrinth was observed on clinical FLAIR imaging of the brain performed from 4-12 hours after injection of contrast (for MRI of the body) in patients with no known inner ear pathology (2). As this presumably reflected a normal physiologic process previously unreported in humans, we characterized the time course of enhancement in the labyrinth following injection of contrast in healthy volunteers.

MATERIALS and METHODS:

Subjects: Ten healthy volunteers were scanned under an IRB approved MRI protocol. **Data Acquisition:** MRI was performed at 1.5 T Signa (General Electric Medical Systems, Milwaukee, WI) using a quadrature transmit-receive head coil. 2D oblique axial fast FLAIR was performed using the following parameters: TR 11000 TE 140 TI 2200 ETL 22 FOV 22 cm MAT 320x256 384x256, 2 acquisitions and 2 NEX (time 6:40). In some cases fat saturation was applied. Intravenous contrast was injected at a dose of 0.1-0.3 mmol/kg. **Experiment 1:** FLAIR imaging was repeated every 15 minutes for up to 2 hours following injection of contrast (n=3). **Experiment 2:** FLAIR imaging hourly for up to 10 hours following contrast injection (n=7). Contrast (0.1-0.3mmol/kg Magnevist (Berlex, Canada)) was injected i.v. immediately following the precontrast baseline scan. The patient was allowed to exit the scanner between scans. However, receive and transmit gain settings were kept fixed, and care was taken to ensure uniformity of scan planes by performing multiple high resolution FIESTA scouts to allow the FLAIR images to be aligned along the plane of the lateral semicircular canal. **Experiment 3:** Two volunteers were able to return for single FLAIR studies the day following injection, and one of these returned for scanning 2 days following injection of contrast. **Analysis:** DICOM data was transferred to PACS. Circular ROIs were drawn on portions of the labyrinth to record signal intensity.

Figure 1. FLAIR images of inner ear obtained prior to and q1h after contrast. A T2 image is shown for reference.



hard to discern a clear peak (Figure 2). In experiment 3, contrast within the labyrinth persisted for 24 and even 48 hours following injection.

On early scans, contrast enhancement was most pronounced in the basal turn of the cochlea and anterior aspect of the vestibule near the modiolus (Figure 1). Also, the CSF in the fundus of the IAC enhanced on early scans. On later scans, the entire semicircular canal system enhanced. Within the vestibule, round filling defects were reliably observed in the expected location of the utricle and saccule, portions of the membranous labyrinth containing endolymph.

DISCUSSION: Accumulation of contrast in the labyrinth is a normal physiologic process that can be reliably demonstrated with delayed FLAIR imaging. FLAIR sensitizes fluid spaces to subtle alterations of T1 relaxivity, and hence the accumulation of gadolinium. This enhancement is very slow, and may not reach a peak until over 6 hours following injection of contrast. Because the fluid compartment is not highly perfused, contrast accumulates and does not wash out rapidly, and in fact, may be seen one to two days following injection. As the endolymph filled utricle and saccule appear to be present as "filling defects" the contrast accumulation appears to be confined to the perilymph, and excluded to some degree from the endolymph by the blood-cochlear barrier. Further investigation of this phenomenon should provide insights into labyrinthine fluid homeostasis in normal and pathophysiologic states such as Meniere's disease.

REFERENCES:

1. Butman JA, et al. FLAIR Imaging of the Inner Ear. 40th ASNR 2002;SE50
2. Butman JA, Physiologic Enhancement of the Labyrinth Demonstrated on Delayed FLAIR imaging 42nd ASNR 2004.
3. Counter SA, et al. Neuroreport 2000;11(18):3979-3983

RESULTS: In experiment 1, observation for two hours showed subtle evidence of labyrinth enhancement if at all. In experiment 2, observation was extended to over six hours. Delayed FLAIR imaging demonstrated reliable enhancement of the labyrinth with in all

of these cases. This enhancement persisted for the entire duration of the scan session (Figure 1). Enhancement appeared to plateau about 6 hours after injection, although it was

Figure 2.

Cochlear signal averaged across 4 subjects

