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Commentary

MR of the Temporal Bone

R. Nick Bryan[1]

MR imaging continues to make remarkable advances, often beyond our wildest dreams. As these advances occur, I am reminded continually of the importance of technology in determining how we practice medical imaging. It is obvious that most of the pertinent anatomy and diseases of the nervous system as well of those of the head and neck region primarily involve soft tissues. Only rarely do neurologic diseases emanate from bone; the major exception is diseases of the vertebral column that impinge on the spinal cord and nerve roots. Although some bony lesions occur in the head and neck, most diseases in this area arise in soft tissue, with the most common bony involvement being extension to bone of primary soft-tissue malignancies.

Despite this overwhelming importance of the soft tissues, most of the history of imaging the nervous system and the head and neck is dominated by bone imaging. This has been determined by technology, not by biomedical need. The earliest "modern" imaging technique—X-rays—provides detailed information about bone and calcified tissues but reveals little about soft tissues. Even advances in X-ray technique, such as pluridirectional tomography, allowed us to see only bone and calcium better. Because the soft tissues of primary interest could not be imaged directly by using conventional X-ray techniques, a variety of manipulations of soft-tissue contrast were devised. Pneumoencephalography, angiography, and soft-tissue pneumography were efforts to change the radiodensity of the soft tissues or to insinuate air between soft-tissue structures and thereby outline their interfaces. Despite extensive time, effort, and radiologic sophistication, imaging of the nervous system and the head and neck was quite primitive until the 1970s.

The dramatic change in neuroradiologic imaging occurred with the advent of X-ray CT. This critical combination of X-ray and computer technologies allows us to "see" the brain and most soft tissues of the head and neck for the first time. As this technology advanced, we could differentiate between gray matter and white matter and could delineate head and neck soft-tissue structures such as the salivary glands and vocal cords. The field of neuroradiology and head and neck imaging exploded as the result of this advance. This ability was so profound that it completely changed the practice of the clinical neurosciences and moved lesion localization from the bedside to the scanner.

However, important anatomic regions remain in which soft-tissue structures cannot be evaluated adequately with X-ray CT. In particular, the skull base, including the temporal bone, contains small soft-tissue structures surrounded by bone, which are a challenge to X-ray CT capabilities. Although X-ray CT remains the premier imaging technique for fine bony detail such as ossicular anatomy, soft tissues such as the membranous labyrinth within the temporal bone cannot be imaged directly by X-ray CT. Only the encasing bone is seen.

Imaging history is reflected by our approaches to imaging of acoustic neuromas, which obviously are soft-tissue lesions. Yet, historically we attempted to diagnose these by using X-ray film and pluri-directional tomography and looking for changes in the adjacent bone. The tumors themselves remained invisible. Even with X-ray CT, acoustic neuromas may not be visualized directly if they are small and intracanalicular. We continued to use bone information (enlargement of the internal auditory canal) or resorted to altering soft-tissue contrast by injecting air or radiopaque contrast material into

This article is a commentary on the preceding articles by Brogan et al. and Seltzer and Mark.

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the cerebellopontine angle in order to make the diagnosis. Obviously, we would have preferred to image the soft-tissue changes directly.

In the 1980s MR, with its significantly greater soft-tissue contrast, allowed us to identify many soft-tissue lesions for the first time. It has become the premier technique for imaging the brain and the head and neck because it is best at imaging soft tissues—usually our primary interest. However, MR has had numerous limitations in imaging soft tissues, particularly those related to spatial resolution and certain types of artifacts. The latter includes those due to motion and differences in tissue magnetic susceptibility. Initially, diagnoses of lesions such as intracanalicular acoustic neuromas were not particularly accurate when they were made on the basis of MR findings. The ability to detect such small lesions has increased steadily with improvements in MR spatial resolution, but the major advance in this area has been the development of MR contrast agents, particularly the gadolinium chelates. These agents increase the soft-tissue contrast of many small lesions so that the lesions become obvious when relatively routine scanning techniques are used. Small acoustic neuromas are diagnosed readily now because of the combination of MR and gadolinium contrast enhancement.

Despite these advances, until recently, even the highest resolution MR could not compete with X-ray CT in the evaluation of very small structures within the temporal bone, such as the facial nerve and labyrinth. However, two reports [1, 2] in this issue of the *AJNR* clearly show that the latest MR techniques are about to drive another nail into the coffin of X-ray CT.

Seltzer and Mark [1] used the combination of high-resolution partial saturation, spin echo, T1-weighted MR imaging with gadopentetate dimeglumine contrast enhancement to show previously invisible inflammatory changes in the soft tissues of the petrous bone, including the labyrinth, in patients with neuritis and/or labyrinthitis. We previously had no means of diagnosing inflammatory (or other pathologic) changes in these small, but important, soft-tissue structures. Inflammation and ischemic disease account for most cases of acute hearing loss and vertigo. Patients with these symptoms have been imaged routinely, but the studies generally did not show the cause, as radiologically demonstrable lesions such as acoustic neuromas account for a quite small percentage of such symptoms. Now we may be able to confirm the clinical diagnosis in addition to excluding other diagnostic possibilities.

The paper by Brogan et al. [2] illustrates the danger in using the term high resolution for any specific technique. Three years ago, high-resolution MR images were 5 mm thick. With new gradient-echo three-dimensional techniques, high resolution means 1 mm thick. Voxel sizes may be significantly less than 1 mm^3. In conjunction with this improvement in spatial resolution, development of appropriate pulse sequences that increase the signal intensity of soft tissues within the temporal bone allows exquisite soft-tissue detail with higher spatial resolution than is available with high-resolution X-ray CT. Small structures such as the vestibular aqueduct, tensor tympani muscle, subarcuate artery, and facial nerve [3] are shown clearly. Although only normal anatomy is shown in the paper by Brogan et al., the clinical implications are obvious, and I anticipate the diagnosis of small tumors of the petrous bone as well as of fistulas and anomalies.

In conclusion, MR continues to make dramatic advances, further eroding clinical indications for X-ray CT. However, optimism for MR must be balanced with practical realities. Careful attention to scanning detail is required. The appropriate selection of echo and repetition times and flip angles, the optimal use of surface coils, and selection of anisotropic imaging planes can be critical. Further evaluation of these techniques in the clinical arena, where sensitivity and specificity will be determined, is now necessary. I believe, however, that MR will become the primary imaging technique for soft tissues of the temporal bone (and other bony areas), just as it is now the primary imaging technique for larger soft-tissue structures.

REFERENCES

1. Seltzer S, Mark AS. Contrast enhancement of the labyrinth on MR scans in patients with sudden hearing loss and vertigo: evidence of labyrinthine disease. *AJNR* **1991**;12:13–16
2. Brogan M, Chakeres DW, Schmalbrock P. High-resolution 3DFT MR imaging of the endolymphatic duct and soft tissues of the otic capsule. *AJNR* **1991**;12:1–11
3. Tien R, Dillon WP, Jackler RK. Contrast-enhanced MR imaging of the facial nerve in 11 patients with Bell's palsy. *AJNR* **1990**;11:735–741