Temporal Lobe Injury in Temporal Bone Fractures

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Objective: To determine the incidence of intracranial injury, specifically in the temporal lobe, in patients with longitudinal fractures of the temporal bone.

Design: Prospective inception cohort.

Setting: University of Maryland Division of Otolaryngology–Head and Neck Surgery and the Maryland Shock Trauma Center, Baltimore.

Patients: Twenty-seven consecutive patients with unilateral or bilateral temporal bone fractures.

Main Outcome Measures: Evaluation of temporal bone and intracranial trauma using computed tomography (CT) and magnetic resonance imaging (MRI).

Results: Of the 27 patients enrolled in the study, 12 had the complete battery of MRI, CT, and physical and audiological examinations. In all 12 patients, MRI demonstrated adjacent middle cranial fossa meningeal enhancement. Results of non–contrast-enhanced CT and MRI demonstrated ipsilateral temporal lobe contusions in 6 of the 13 fractures for an overall incidence of 46%. In addition, MRI demonstrated 4 cerebral contusions not seen in the results of non–contrast-enhanced CT.

Conclusions: While high-resolution CT remains the criterion standard for evaluation of temporal bone fractures, MRI revealed a higher incidence of related temporal lobe injuries. Magnetic resonance imaging data may be valuable in preoperative evaluation of patients who require surgical intervention through a middle cranial fossa approach to document pre-existing injury and potential morbidity before retraction of the middle cranial fossa dura mater and temporal lobe.


The use of magnetic resonance imaging (MRI) to evaluate lesions of the temporal bone and cerebellopontine angle has evolved rapidly during the past decade. Gadolinium (Gd)-enhanced MRI has been found to be useful for many conditions, including acoustic neuroma,1 facial nerve schwannoma,1,2 Bell palsy,1,3 and surgical trauma of the facial nerve.1,3,5 Zimmerman et al6 conducted a retrospective study of the use of MRI in evaluating temporal bone trauma in patients with head trauma. They examined 40 patients with head trauma using both CT scan and thick-section MRI without gadolinium contrast. They concluded that CT scan remains the imaging technique of choice for evaluating ossicular injury and demonstrating temporal bone fractures. Orloff and Duckett7 used an animal model to study intratemporal facial nerve injury secondary to surgical trauma. They demonstrated great usefulness in MRI enhanced with gadolinium-diethylene-triamine-pentaacetic acid (Gd-DTPA) in surgical trauma. Also, they believed that this imaging technology may be useful in the evaluation of temporal bone fractures in humans. Haberkamp et al8 reported similar findings on the usefulness of Gd-enhanced MRI at the site of lesion testing in surgical trauma in patients with facial nerve injuries. In addition, they found that diffuse local enhancement, secondary to trauma, may obscure visualization of the facial nerve.

Controversy regarding the value of MRI in diagnosing disease associated with temporal bone trauma still exists. We attempted to define the role and usefulness of Gd-enhanced MRI in a prospective manner and to compare it with high-resolution CT scanning and clinical findings in temporal bone fractures.

RESULTS

Twelve patients with complete clinical and imaging evaluations had a total of 13 temporal bone fractures. Of the 12 patients, there were 9 males and 3 females, rang-
PATIENTS AND METHODS

All 27 patients enrolled in the study were admitted between November 1, 1992, and June 30, 1993, with clinical findings of temporal bone fracture, hemotympanum, and/or dysfunction of the cranial nerves VII and VIII secondary to trauma. All patients were evaluated using non–contrast-enhanced CT scans, and MRI scans were obtained when the patient gave informed consent for the study and when transport to the facility and the process of scanning would not compromise other aspects of the patient’s care. However, of the 27 patients, only 12 patients received the complete panel of clinical and imaging evaluation, consisting of history, physical examination, (including microscopic otoscopy), neurological assessment, audiometry, CT (head and dedicated temporal bone study) and MRI, and special analyses where appropriate. Computed tomographic scans were performed at 1.5-mm intervals in the axial plane and, when possible, coronal planes. Magnetic resonance imaging of the brain was supplemented by precontrast and postcontrast 3-dimensional T1-weighted spoiled gradient recalled thin-section images displayed axially and 2-dimensional coronal T1-weighted thin-section images centered on the internal auditory canal. Clinical evaluation was performed by a single examiner (R. M. J.). All images were read independently by 3 neuroradiologists. Clinical assessment and radiographic findings were compared (R. M. J.).

In 1996, high-resolution CT scanning remained the criterion standard for evaluating temporal bone fractures. In 1987, Zimmerman et al reported a retrospective evaluation of patients with head injuries who underwent thick-section MRI of the head. Of these patients, 7 had temporal bone fractures. The authors reported that routine MRI of the brain without Gd contrast was superior to CT scanning in the characterization and separation of hemorrhage from edematous mucosa in the mastoid air cells or cerebrospinal fluid within the middle ear and mastoid. Magnetic resonance imaging was more sensitive in showing additional intracranial traumatic lesions than non–contrast-enhanced CT of either the head or the temporal bone. Neither imaging technique was useful for demonstrating the facial nerve injury.

The history of the individuals revealed 7 patients with subjective hearing loss, 3 patients with vertigo, and no one with tinnitus. The results of the clinical examination of the head and neck of the patients revealed 3 patients with Battle sign, 2 with tympanic membrane perforations, 11 with hemotympanum, and 2 with ears suggestive of ossicular disruption. The results of the clinical assessment of the facial nerve showed 5 patients with clinically evident facial palsies: 1 with grade 5 and 4 with grade 6 according to the criteria of House. Audiometric testing results revealed conductive hearing loss in 10 patients (10–45 dB; mean conductive hearing loss, 18 dB). The conductive hearing loss in those patients with facial palsy was maximal for an intact ossicular chain (40 dB).

High-resolution CT scans of the temporal bone in 12 patients showed longitudinal fracture of the temporal bone in all cases; 1 patient had bilateral fractures. Disruption of the ossicles was noted in 2 fractures. Standard non–contrast-enhanced CT imaging showed adjacent temporal lobe contusions in 6 (46%) of the 13 fractures.

Magnetic resonance images revealed enhancement of adjacent structures and opacification of the temporal bone in all 12 cases. Focal meningeal enhancement adjacent to the temporal bone fracture occurred in 12 (100%) of the cases. The same ipsilateral temporal lobe contusions were demonstrated on MRI and CT scans. In addition, there were 4 contusions not adjacent to the temporal bone fracture that were not seen on the non–contrast-enhanced CT scans. Magnetic resonance images demonstrated 6 subdural hematomas, of which 4 were identified in CT scans (Figure).

The CT and MRI data are compiled in Table 1. Comparisons of the results of the imaging data are listed in Table 2. High-resolution CT examination was shown to be superior to MRI in delineating fractures and showing ossicular dislocation. Magnetic resonance imaging was more sensitive in showing additional intracranial traumatic lesions than non–contrast-enhanced CT scans. Magnetic resonance images demonstrated 6 subdural hematomas, of which 4 were identified in CT scans (Figure).

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The initial impetus for this study was to evaluate the usefulness of Gd-DPTA–supplemented thin-section MRI of the internal auditory canal and temporal bone for identification of the site of facial nerve injury in temporal bone fractures. Orloff and Duckert reported a series of experimental facial nerve contusions in an animal model. Images of the animals’ facial nerves were taken 1 to 9 days...
postinjury, and 8 of 9 facial nerves showed enhancement in the contused segment with Gd-DTPA-supplemented MRI. In our study, we were able to distinguish between the enhanced facial nerve and the adjacent middle ear mucosa and effusion. However, in evaluating the clinical usefulness of Gd-enhanced MRI in traumatic temporal bone injuries, we found that acute mucosal edema and blood obscured the course of the facial nerve throughout the temporal bone. This experience parallels that of Haberkamp et al, who reported 20 cases of surgically confirmed facial nerve injuries. Visualization of the nerve was often prevented by globally increased signal within the mastoid after temporal bone fracture or by dural enhancement postsurgery.

Although MRI did not prove useful for the evaluation of facial nerve injury in patients with temporal bone trauma, it brought to our attention a high correlation of temporal lobe injury associated with temporal bone fractures. These findings were independent of the mechanism of injury, and, except for the patient with a significantly reduced Glasgow Coma Scale score, there were no specific neurological findings suggestive of intracranial disease.

All patients were studied using non-contrast-enhanced CT at admission to the trauma center and subsequent MRI. Dural enhancement was the most common finding, occurring in all patients examined using Gd-enhanced MRI. Magnetic resonance imaging also delineated a total of 6 subdural hematomas and 13 cerebral contusions, often multiple in the same patient. Of the 6 subdural hematomas, 4 (67%) were found on non-contrast-enhanced CT scans, while 6 (46%) of the 13 brain contusions were demonstrated by non-con-
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The duration of the meningeal enhancement located on MRI is not known, but 1 patient who underwent an MRI 6 weeks postinjury continued to demonstrate enhancement great enough to obscure identification of the facial nerve. To delay taking images of the patient until the subacute period does not seem to improve the usefulness of MRI for identifying or localizing facial nerve injuries. In patients with functional hearing in whom surgical intervention is contemplated for facial nerve injury, the middle cranial fossa approach to the internal auditory canal and the perigeniculate region is required. Surgical approach through the middle cranial fossa requires retraction of the temporal lobe. Our data suggest a high incidence (46%) of temporal lobe contusion adjacent to the temporal bone fracture. The temporal lobe injury was subclinical in every case, and therefore would not be appreciated on physical or neurological examination of the patient. However, the retraction of the temporal lobe required for middle cranial fossa exploration could potentially exacerbate the temporal lobe injury. The clinician should also be aware of the potential development of problems in the central nervous system or the occurrence of seizures after surgical intervention that could falsely be attributed to the temporal bone exploration.

Magnetic resonance imaging may be a valuable preoperative assessment of patients who require surgical intervention through a middle cranial fossa approach to document pre-existing injury and potential morbidity. In all cases of facial nerve injury secondary to head trauma, caution should be exercised in manipulating potentially injured intracranial structures.

**CONCLUSIONS**

We have concluded the following from our study:

1. Magnetic resonance imaging of the acutely injured temporal bone reveals regional enhancement of the meninges and temporal lobe, representing acute contusion.
2. Enhancement in the acute stage of injury obscures visualization of the facial nerve.
3. Enhancement persists for prolonged periods (>6 weeks).
4. Data from this study have shown that MRI is slightly better than non–contrast-enhanced CT for diagnosis of temporal lobe injury in temporal bone fractures; this difference may be important in planning and treating facial nerve injuries through middle cranial fossa surgical approaches.
5. High-resolution CT scans of the temporal bone demonstrate osseous temporal bone anatomy but not intracranial injury.
6. Magnetic resonance imaging or non–contrast-enhanced CT may be of value if surgical intervention is contemplated.

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REFERENCES