MR Imaging with Topographic EEG Electrodes in Place

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Modern interventional neuroradiology procedures often require immediate feedback regarding the effects of induced alterations in cerebral blood flow. Although clinical feedback is helpful in many situations, there is an increasing reliance on real-time computed mapping of electroencephalographic data (CME). The procedures are also often done in stages with frequent interval feedback from other imaging studies, such as MR imaging, to assess brain parenchymal changes.

Unfortunately, the placement of the 30 or more scalp electrodes required for EEG monitoring is time-consuming and, once in place, these electrodes create severe image artifacts. We report here the use of nonferromagnetic EEG electrodes and wires that allow patients to be studied with MR imaging with the electrodes in place.

Materials and Methods

Patients referred for many neurointerventional procedures are first set up for computerized mapping of EEG. Thirty disk electrodes are applied with collodion according to the International 10–20 System with extra placements interpolated. The disks consist of gold-plated silver.* The wire leads are 1% cadmium, 99% copper alloy (copper development #C16200) with silver plating.† Solder joints are made of pure tin [1].

Although the electrodes and wires were visible on the radiographs, they were acceptable for angiographic studies (Fig. 1). Extensive metal artifacts from the electrodes and wires, however, rendered the CT scanning nondiagnostic.

The MR examination was performed after the electrodes and wires were in place, but not during actual CME recording. Spin-echo pulse sequences were obtained by using a head coil on a 0.3-T whole body MR imager. No artifacts were visible on any of the pulse sequences chosen (Fig. 2)

Discussion

With increasing applications of MR imaging there has been a growing emphasis on selecting metals for use with MR that do not cause alterations in magnetic susceptibility. Abrupt local changes in induced magnetic field (susceptibility) result in magnetic-field inhomogeneities that interfere with the gradient fields used in imaging. The resulting local geometric distortions and alterations in image intensity can completely obscure underlying anatomy and pathology [2–5].

Through the use of either high-nickel-content stainless steel

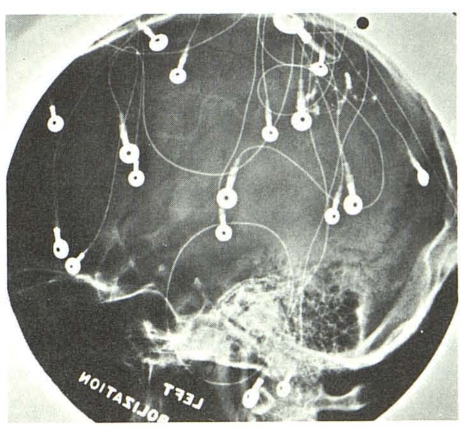

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Fig. 1.—Lateral postembolization scout view shows multiple CME electrodes in place.

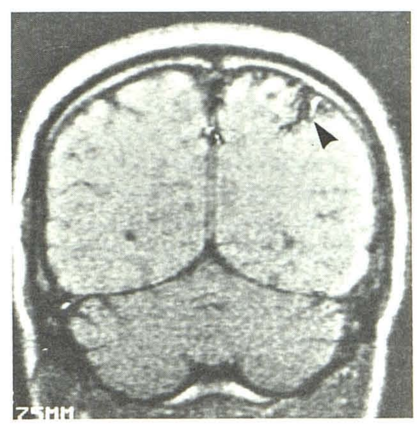

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Fig. 2.—Coronal T1-weighted image (SE 500/28) of same patient with electrodes in place. Flow void is present in residual nidus of AVM (*arrowhead*). There is no evidence of artifact from the electrodes. Artifact was also absent on a T2-weighted image (SE 2000/84) (not shown).

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alloys or nonferromagnetic metals, artifacts can be greatly diminished. Nickel reduces the ferromagnetic properties of the iron in the alloy by changing the highly susceptible form of alpha iron into less susceptible gamma iron. This decreases magnetic susceptibility differences between the alloy and surrounding tissues [4].

In this study we used silver-, gold-, and/or cadmium-based alloys, which are relatively nonferromagnetic for CME electrodes and wires. This preserves the high-performance properties of the recording electroencephalographic electrodes and connecting wires without producing significant artifacts on MR images. By using this design of wires we can now set up patients for continuous CME monitoring during staged angiographic or neurointerventional procedures with frequent MR follow-up examinations to assess parenchymal changes in the brain without having to remove the electrodes at each MR examination.

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