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Surface Coil MR Imaging of Orbital Blowout Fractures:
A Comparison with Reformatted CT

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Four patients with orbital blowout fractures were evaluated by surface coil MR imaging, and the resulting images were compared with computer reformatted CT scans. The surface coil afforded significant improvement in spatial resolution, resulting in better demonstration of the blowout fracture. Surface coil MR was found superior to CT in the assessment of fracture site, extent of prolapsed orbital fat, and muscle entrapment.

The application of MR imaging to the orbit has been challenged by several investigators. Most of the preliminary reports have been that MR imaging offers no more diagnostic information than does CT [1–4]. Since these studies were performed with conventional head coils as receivers, efforts to decrease pixel size and slice thickness were limited by the low signal-to-noise ratio.

By using surface coils as receivers, the signal-to-noise ratio can be improved significantly, permitting thinner sections and increasing spatial resolution comparable to CT. Recent studies on surface coil MR imaging of the orbit indicate that MR is superior to CT for imaging orbital lesions [5–7].

In this paper, we present surface coil MR findings in four patients with orbital blowout fractures and compare these with CT findings using computer reformation.

Subjects and Methods

Four patients, all men, with orbital blowout fractures diagnosed by plain radiography and CT were examined with surface coil MR. Polytomography was available in two cases. All of the patients had obvious trauma to the orbit. The fracture site of the orbit was the medial wall in one case and the inferior wall in the other three cases. CT and MR examinations were performed within a 2-day period in each case, and the time of MR examination after trauma varied from 2 to 45 days. Three patients underwent surgery.

CT was performed with a third-generation scanner. A 2-mm collimator was used and sections were obtained at 2-mm intervals in axial or coronal planes. Computer reformatted images in coronal plane, or oblique sagittal plane parallel to the axis of the inferior rectus muscle were obtained from the axial sections.

MR imaging was performed with a 0.5-T superconducting unit. The head coil was used for transmission only and a 10-cm-diameter surface coil was placed over the orbit to act as a receiver. T1-weighted spin-echo (SE) pulse sequence with a repetition time (TR) of 600 msec and an echo time (TE) of 35 msec or 45 msec was used. Each section was 5 mm thick with a 5-mm gap between adjacent slices. The sampling matrix was 256 × 256. All images were done multislice using two averages.

Initially, multiple images of coronal plane covering the entire orbit were obtained. Then, additional images of other planes were obtained—an axial plane along the course of the medial rectus muscle in the case of the medial wall fracture and an oblique sagittal plane parallel to the axis of the inferior rectus muscle in the three cases of the inferior wall fracture. All patients were asked to keep their eyes closed during the examination and to refrain from eye movement.

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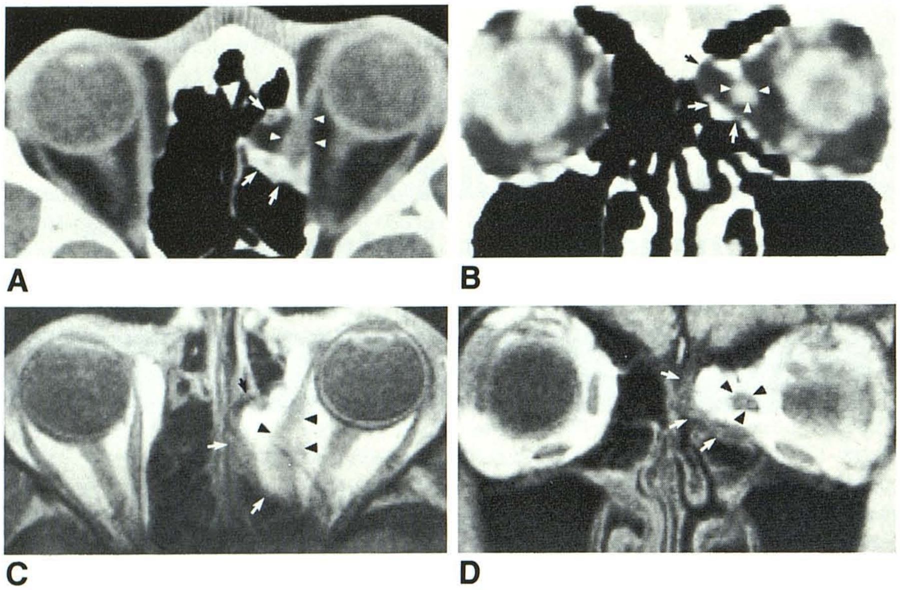

Fig. 1.—Case 1. Blowout fracture of medial orbital wall with muscle entrapment. Axial CT (*A*) and coronal reformatted CT (*B*) images show blowout fracture of medial orbital wall (*arrows*) and entrapment of medial rectus muscle (*arrowheads*) on left. Axial SE 600/35 (*C*) and coronal SE 600/35 (*D*) images show fracture (*arrows*) and muscle entrapment (*arrowheads*) with better detail because of bright signal from orbital fat.

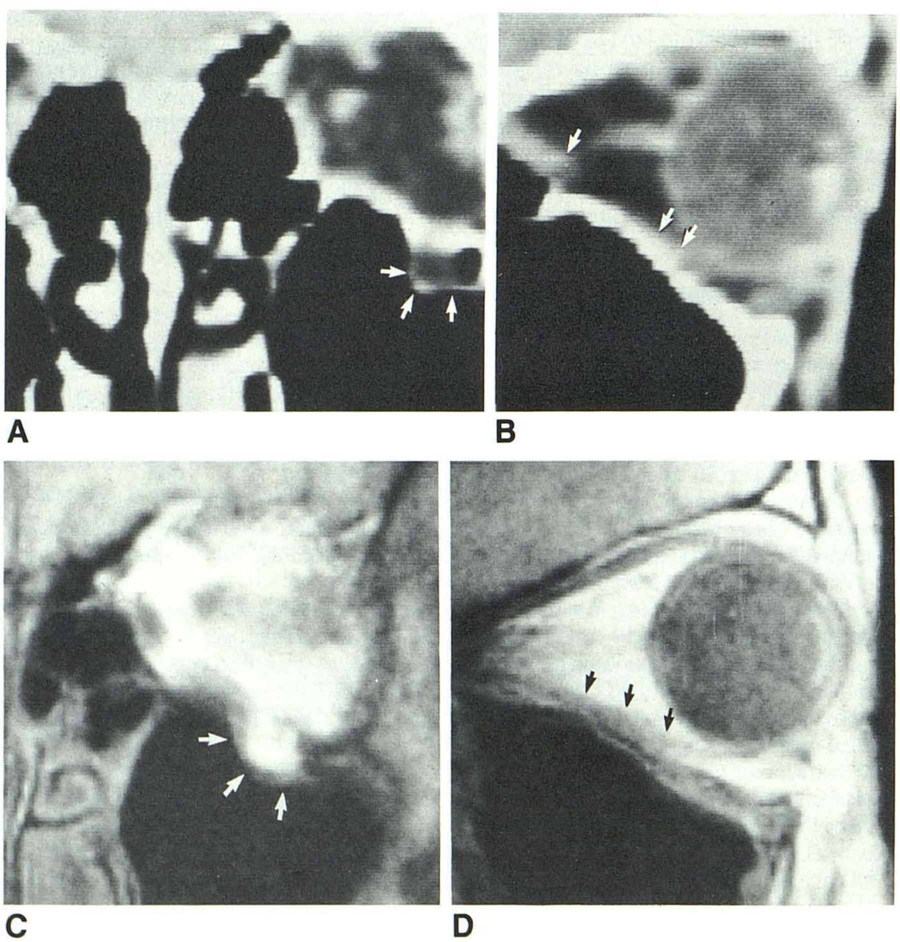

Fig. 2.—Case 2. Blowout fracture of inferior orbital wall without muscle entrapment. Coronal reformatted CT image (*A*) shows blowout fracture of inferior orbital wall on left (*arrows*), but oblique sagittal reformatted CT image (*B*) fails to show entire course of inferior rectus muscle (*arrows*). Coronal SE 600/35 image (*C*) shows fracture much better (*arrows*), and oblique sagittal SE 600/45 image (*D*) shows the muscle to be normal (*arrows*).

Case Reports

Case 1

A 30-year-old man was struck over the left eye. Diplopia with restricted lateral gaze was present, and a forced duction test was equivocal. CT revealed a fracture of the medial orbital wall, and entrapment of the medial rectus muscle was suspected (Figs. 1A and 1B). MR 5 days after the trauma showed the fracture and the prolapse of the orbital fat into the ethmoid sinus more clearly than CT did (Figs. 1C and 1D). Entrapment of the medial rectus muscle was also demonstrated on MR better than on CT. The left orbit was explored 2 weeks after trauma and muscle entrapment was confirmed.

Case 2

A 14-year-old boy was struck over the left eye. Diplopia with restricted upward gaze was noted, and a forced duction test was positive. CT revealed a fracture of the inferior orbital wall, but the entire course of the inferior rectus muscle could not be seen because of poor spatial resolution (Figs. 2A and 2B). MR 2 days after the trauma showed the prolapse of the orbital fat clearly and revealed a normal inferior rectus muscle (Figs. 2C and 2D). Surgery was performed 9 days after trauma and the inferior rectus muscle was found to be normal.

Case 3

A 24-year-old man was struck over the left eye. Although mild diplopia was present, extraocular motion was full range. A forced duction test was negative. CT revealed a relatively extensive fracture of the inferior orbital wall (Figs. 3A and 3B). Although there was an extensive herniation of the orbital fat, the course of the inferior rectus muscle was normal. MR 45 days after the trauma showed the lesion more clearly than CT did (Figs. 3C and 3D). Surgery was not performed because clinical symptoms were not serious.

Case 4

A 14-year-old boy was struck over the right eye. Diplopia with restricted upward and downward gaze was present, and a forced duction test was positive. CT revealed a fracture of the inferior orbital wall (Figs. 4A and 4B). Although the inferior rectus muscle showed downward kinking and an apparent discontinuity at the bone defect, actual herniation of the muscle could not be diagnosed. MR 2 days after the trauma clearly demonstrated the herniation of the muscle together with the orbital fat (Figs. 4C and 4D). The right orbit was explored 3 weeks after trauma and fixation of the muscle by the defect was confirmed.

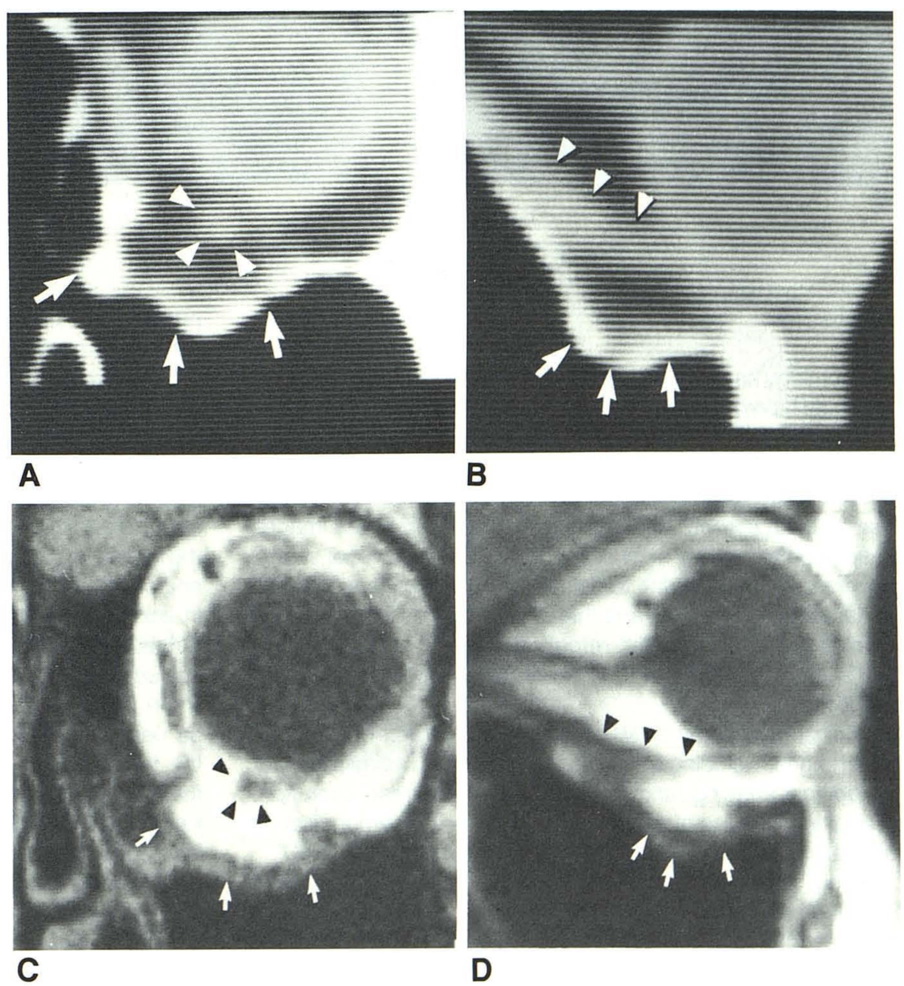

Fig. 3.—Case 3. Blowout fracture of inferior orbital wall without muscle entrapment. Coronal (*A*) and oblique sagittal (*B*) reformatted CT images show blowout fracture of inferior orbital wall on left (*arrows*). Inferior rectus muscle is intact (*arrowheads*). Coronal SE 600/35 (*C*) and oblique sagittal SE 600/45 (*D*) images show fracture (*arrows*) and muscle (*arrowheads*) clearly.

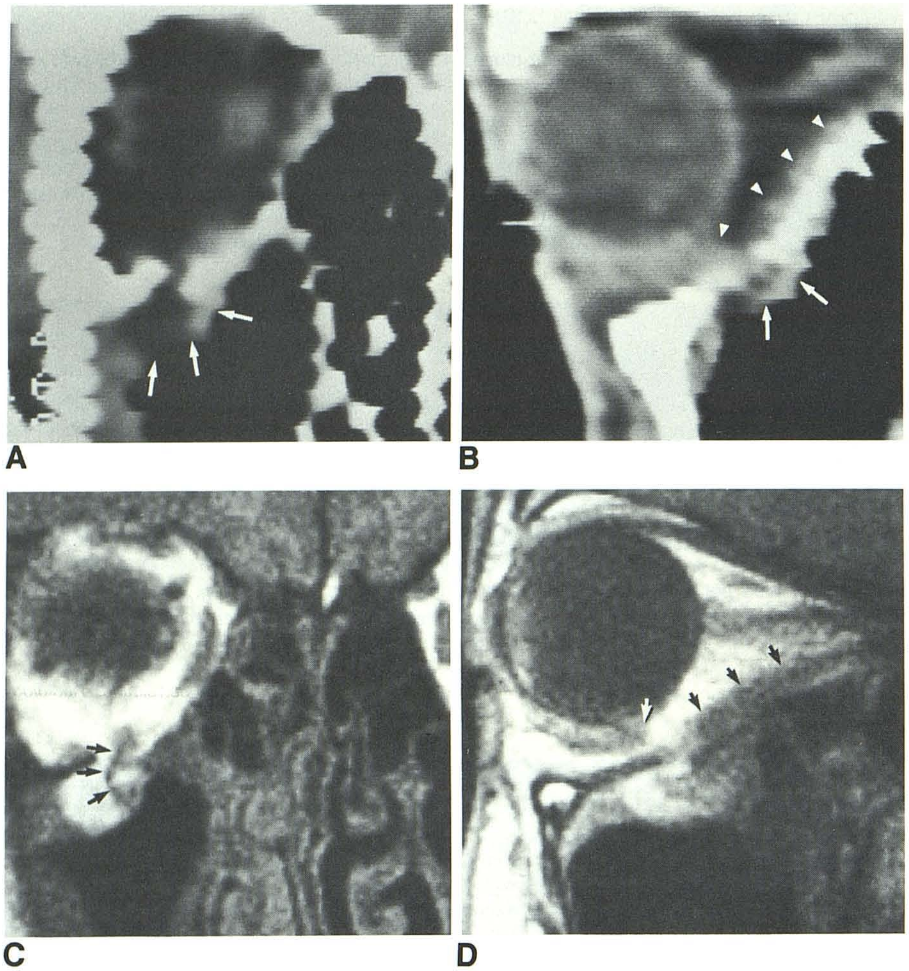

Fig. 4.—Case 4. Blowout fracture of inferior orbital wall with muscle entrapment. Coronal (*A*) and oblique sagittal (*B*) reformatted CT images show blowout fracture of inferior orbital wall on right (*arrows*). Inferior rectus muscle is kinked downward and obliterated at bone defect (*arrowheads*). Coronal SE 600/35 image (*C*) clearly shows herniation of muscle (*arrows*). Oblique sagittal SE 600/45 image (*D*) shows discontinuity of muscle much better (*arrows*).

Discussion

Radiology has long played an important role in the diagnosis of orbital blowout fractures. Plain radiography (including a 28° Caldwell and a Waters view), tomography, and CT have been used to evaluate this type of fracture. Among these, CT has proved to be the most accurate diagnostic method with the use of direct coronal scans and computer reformatted images in addition to routine axial scans [8, 9]. Direct coronal scans, however, sometimes fail to demonstrate the lesions because of dental filling artifacts, and there is an obvious loss of spatial resolution with computer reformatted images [9]. Furthermore, the risk of harmful ionizing radiation on the lens cannot be negligible [10].

Clinical application of MR imaging to the orbit has several advantages, including lack of harmful ionizing radiation, direct multiplanar imaging, and high soft-tissue contrast resolution. In addition, the use of surface coils enables the demonstration of anatomic and pathologic details better than those of CT.

In our study, surface coil MR also provided an overall improvement over CT in the evaluation of orbital blowout fractures. Although MR does not image the displaced bony fragments themselves, fracture can be diagnosed by the presence of the prolapsed orbital fat into the adjacent air-containing paranasal sinuses [11].

Although axial plane offers less diagnostic information in the evaluation of the inferior orbital wall, either coronal plane or oblique sagittal plane parallel to the axis of the inferior rectus muscle will eliminate this problem [9]. It is our impression that oblique sagittal plane provides realistic information about the relationship between the inferior rectus muscle and the inferior orbital wall defect. Kinking or entrapment of muscle and prolapse of the orbital fat will be well-defined in this plane. In addition, since this plane demonstrates the entire course of the optic nerve, the possibility of optic nerve injury can be excluded [11].

On the other hand, either axial plane or coronal plane will be useful to evaluate the medial orbital wall [12]. Between the two, axial plane along the course of the medial rectus muscle will be more useful, because this allows complete visualization of the muscle. Medial orbital wall fractures are less common than inferior orbital wall fractures. Medial wall fractures can occur alone but are frequently associated with inferior wall fractures [12]. Therefore, in evaluating orbital blowout fractures, the possibility of complex fractures should always be taken into consideration.

Diplopia and limitation of ocular motility, common symptoms in a blowout fracture, usually result from entrapment of orbital fat through the bone defect [13]. Orbital fat contains numerous fibrous bands that connect the muscle sheath to the periosteum. It has been suggested that increased tension on these fibrous bands following trauma produces these symptoms [9]. A true entrapment of the extraocular muscles will be rare. By direct multiplanar imaging, MR offers useful information both on the status of extraocular muscle and the degree of orbital-fat prolapse. Furthermore, the lack of harmful ionizing radiation by MR enables repeated follow-up studies to be performed safely.

Hemorrhage associated with the fracture was not assessed in our study, because the MR examination was performed with only T1-weighted pulse sequences. It would be necessary to obtain both T1- and T2-weighted images for the assessment of hemorrhage in the area of the fracture.

In conclusion, in appropriate clinical settings, surface coil MR may be performed soon after adequate plain radiography. As to the MR procedures, we propose that patients be studied initially in the coronal plane using a multisection technique. This allows visualization of tangential cross sections of all four orbital walls and of all extraocular muscles [8].

Thereafter, additional images of the other plane should be obtained, either the axial plane along the course of the medial rectus muscle in a medial wall fracture or the oblique sagittal plane parallel to the axis of the inferior rectus muscle in an inferior wall fracture. These additional images provide more precise information about the relationship between the muscle and the bone defect [9].

With these procedures, surface coil MR may replace CT in the evaluation of orbital blowout fractures.

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