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Demonstration of Diastematomyelia and Associated Abnormalities with MR Imaging

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Three patients were studied with a 0.3 T superconducting magnet to assess the role of magnetic resonance (MR) imaging in the recognition and evaluation of diastematomyelia and associated abnormalities. Comparison was made with other imaging techniques, including metrizamide computed tomographic (CT) myelography. With MR imaging, the divided spinal cord was well imaged in its entire craniocaudal extent, comparable to CT myelography. The bony septum, when it contained a marrow cavity, was also seen well. In two patients, dural ectasia and low position of the spinal cord with and without associated lipoma were clearly imaged. MR imaging demonstrated associated syringohydromyelia in one patient that was not detected by other radiologic studies. This preliminary experience with MR imaging of diastematomyelia suggests that once the bony details of the abnormality are defined, MR imaging can delineate the presence and extent of the divided spinal cord as well as its associated abnormalities adequately, obviating other studies.

The radiologic evaluation of spinal dysraphism, including diastematomyelia, has been heavily dependent on metrizamide computed tomographic (CT) myelography. The risks associated with contrast material (metrizamide), radiation exposure, and the invasiveness of the procedure have been considered to be far outweighed by its tremendous diagnostic value. Clinical experiences with magnetic resonance (MR) imaging have shown it to be truly promising in the evaluation of various abnormalities involving the spinal column [1-5]. Direct visualization of the spinal cord itself is probably the most rewarding feature of MR imaging compared with more conventional techniques. We report three patients with diastematomyelia and associated anomalies who were studied with MR imaging.

Subjects and Methods

Three patients with diastematomyelia identified on conventional radiographic studies were scanned on a cryogenic superconducting magnet (Teslacon, Technicare Corp., Solon, OH), operating at 0.3 T. MR images were obtained using a two-dimensional single-slice technique with about 12 mm section thicknesses. A spin-echo (SE) pulse sequence was chosen, with a repetition time (TR) of 500 msec and echo-delay time (TE) of 30 msec. Using the midline sagittal image as a guide, axial and coronal images were then obtained at appropriate levels. The results of the MR studies were compared and correlated with findings from plain radiographs, metrizamide myelograms, and metrizamide CT myelograms.

Results

Full descriptions of the MR findings from each patient are found in the legends of figures 1-3. A high level of contrast between the spinal cord and surrounding structures was achieved with the SE technique used. In general, axial images demonstrated the split cord as two separate, intermediate-signal-intensity structures in the spinal canal. The coronal images, obtained at several different levels

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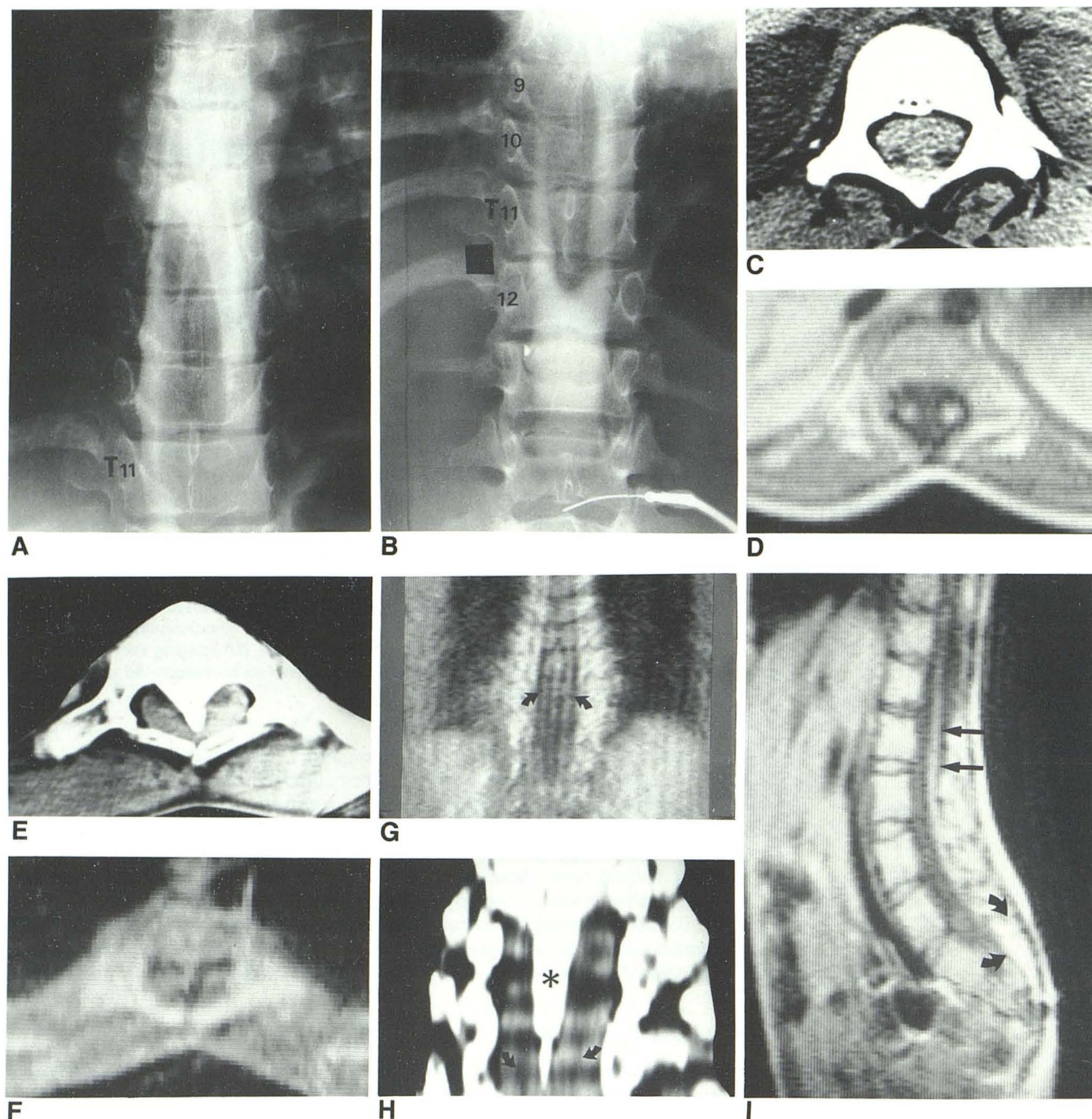
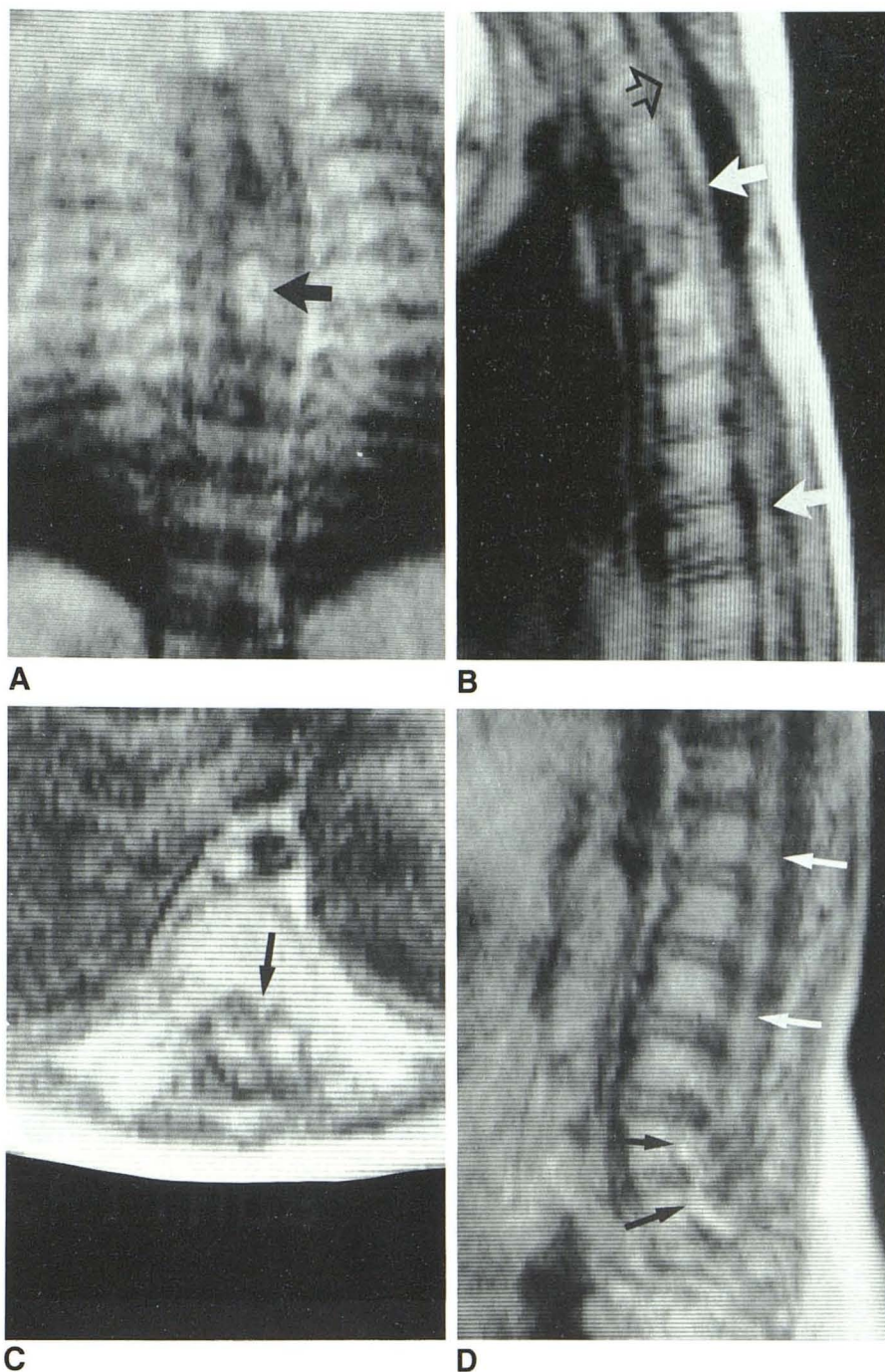


Fig. 1.—Case 1, 13-year-old boy with progressive foot deformities. He had been diagnosed soon after birth with spinal dysraphism; neurosurgical release of tethered cord was attempted at age 7. Anteroposterior metrizamide myelograms at midthoracic (A) and thoracolumbar (B) regions. Although there is suggestion of division of contrast column beginning at superior aspect of T12, detail is lost due to rapid dilution of contrast material in capacious thecal sac. Metrizamide CT myelogram (C) and MR image (D) at lower thoracic level, axial views. C, Two separate hemicords are seen indirectly as low-density filling defects in metrizamide-filled thecal sac. D, MR image provides direct cross-sectional imaging of hemicords. Metrizamide CT myelogram (E) and MR image

(F) at midthoracic level, axial views. Divided spinal cord and bony spicule arising from posterior aspect of vertebral body are seen as clearly on MR image as on CT myelogram. Spina bifida is well seen also. G, Coronal MR image. Longitudinal structure exhibits intermediate signal intensity between two spinal cords (arrows). H, Metrizamide CT myelogram, coronal reconstruction. Interposing structure clarified as rather long, bony bridge (asterisk) containing marrow cavity. Divided spinal cords (arrows). I, Midline sagittal MR image clearly delineates low-lying spinal cord (straight arrows) along posterior aspect of large thecal sac, with caudal lipoma (curved arrows).

Fig. 2.—Case 2, 1-year-old boy with multiple levels of spinal dysraphism. Coronal (A) and sagittal (B) MR images. Gross deformity of midthoracic spine: scoliosis (A) and irregular, anomalous appearance of vertebral bodies (B). Bony spicule containing fatty marrow is high-signal-intensity structure (black arrow). Divided spinal cord appears narrowed in anteroposterior dimension (white arrows), indicating upper and lower extents of split cord. Low-signal-intensity cystic cavity (open arrow) demonstrating syringohydromyelia is also clearly seen as incidental finding. C, Axial MR image, probably through inferior aspect of bony septum (arrow), shows separation of two cords anteriorly. D, Sagittal MR image in lumbar region. Low position of spinal cord (white arrows). Normal epidural fat at L5 and S1 levels (black arrows).



because of normal curvature of the spine, were able to delineate the entire extent of the divided cord. Although the associated bony spicules were not visible in their entirety, the larger part of each spicule containing fatty marrow was clearly seen as intermediate-to-high signal intensity according to the fat content. The smaller cortical part of the bony spicule was imaged as a low signal intensity similar to the normal extramedullary structures in the spinal canal. Differentiation between a small bony spicule, a fibrocartilaginous septum, and

normal extramedullary structures was not possible with the SE 500/30 technique alone.

MR imaging showed a particular advantage over other imaging techniques in demonstrating associated anomalies such as dural ectasia and tethered cord (cases 1 and 2) and caudal lipoma (case 1). Of particular interest was case 2, where only MR imaging showed associated syringohydromyelia. However, a tethered filum terminale in case 3 was seen on metrizamide CT myelography and subsequently

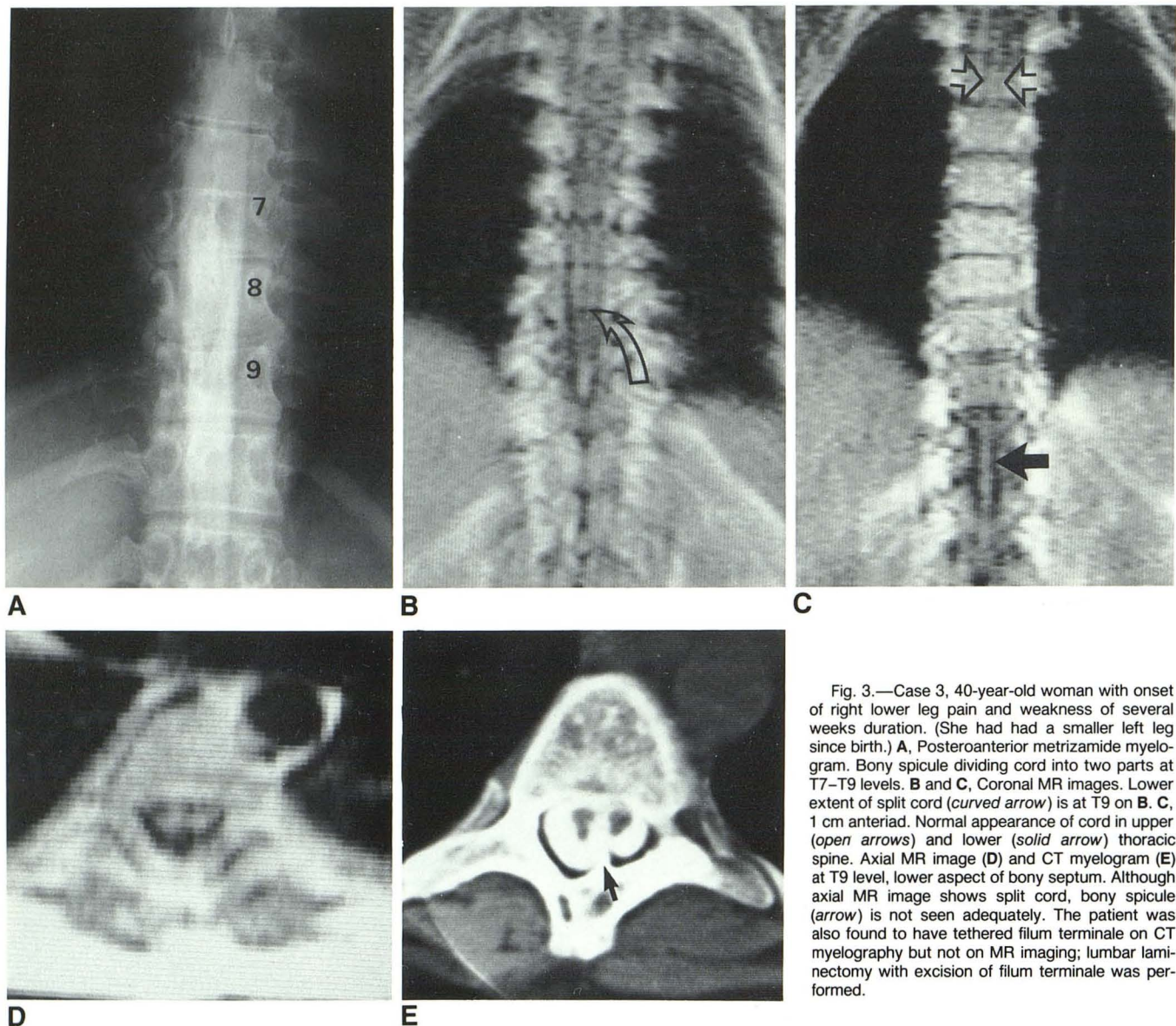


Fig. 3.—Case 3, 40-year-old woman with onset of right lower leg pain and weakness of several weeks duration. (She had had a smaller left leg since birth.) A, Posteroanterior metrizamide myelogram. Bony spur dividing cord into two parts at T7–T9 levels. B and C, Coronal MR images. Lower extent of split cord (*curved arrow*) is at T9 on B. C, 1 cm anterior. Normal appearance of cord in upper (*open arrows*) and lower (*solid arrow*) thoracic spine. Axial MR image (D) and CT myelogram (E) at T9 level, lower aspect of bony septum. Although axial MR image shows split cord, bony spur (*arrow*) is not seen adequately. The patient was also found to have tethered filum terminale on CT myelography but not on MR imaging; lumbar laminectomy with excision of filum terminale was performed.

proven at surgery, but was not demonstrated clearly on MR imaging. Likewise, osseous detail of vertebral anomalies was also not completely visible.

Discussion

Diastematomyelia is often part of a more complex dysraphic picture, and longitudinal assessment of the entire spinal column may be necessary for proper surgical management. Myelography carries the risks of invasiveness and contrast media and may not be able to show the abnormality satisfactorily due to contrast dilution in a capacious thecal sac, for example. CT myelography with intrathecal metrizamide has markedly improved the detection of diastematomyelia [6]. However, numerous axial CT cuts are often necessary to delineate the entire extent of the abnormality. Furthermore,

the detail in sagittal and coronal reconstruction that follows overlapped thin, axial CT sections may not be sufficient, and the resulting radiation dose, particularly for younger children, can be prohibitive.

MR imaging is an exciting new technique for the evaluation of spinal dysraphism; it is noninvasive, yet offers excellent tissue discrimination in several planes. In our study, MR reaffirmed its superior imaging capabilities relative to other methods. The entire extent of the divided spinal cord in cases of diastematomyelia can be demonstrated consistently on only a few selected coronal MR images, as compared with the numerous axial sections needed on metrizamide CT myelography. Visualization of associated abnormalities such as tethered cord and caudal lipoma is another advantage, and, in fact, these are better seen in exquisite detail on MR images.

One of our cases (case 2), in which syringohydromyelia

was demonstrated near the superior end of the split cord, deserves special comment. To our knowledge, syringohydromyelia without Chiari malformation has not been cited in previous studies as occurring with diastematomyelia. This may be because of difficulty in diagnosis unless the cavity is of large caliber and fills easily with contrast material. According to accepted embryologic theory, syringohydromyelia and diastematomyelia both represent dysraphic states, with syringohydromyelia being a "forme fruste" of a divided cord [7]. Our case points out that syringohydromyelia should join the list of abnormalities associated with diastematomyelia, and such a possibility should be carefully evaluated during the diagnostic workup.

While the inability of MR to image compact cortical bone is still one of its major disadvantages, the bony septa dividing the spinal cord into two hemicords are adequately seen when they are large enough to contain fatty marrow centrally. Due to time restraints imposed by the single-section technique in our study, we have used only one SE pulse sequence. Thus far, it has proven to be highly efficient in delineating the morphologic features of the spinal column [1, 5], but was probably the main reason for the inability to differentiate the various components of the septa: bone, fibrous cartilage, and other extramedullary structures. Using various SE pulse sequences with different TR and TE times might solve this problem.

The individual nerve roots and filum terminale are not consistently visualized, another drawback of MR imaging at its current state of development. However, we expect that

the rapid advances in MR technology will lead to improved images of smaller anatomic structures, and subtle abnormalities should become more readily detectable.

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