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The American Journal of Neuroradiology 1980–1999

Where We Have Been: Where We Are Going

The January 2000 issue of the *AJNR* presents the opportunity to reflect on the contributions of the *AJNR* to the field of neuroradiology since the publication of the first volume in January 1980 and to speculate what we may see in its pages over the next 20 years. This 20-year retrospective is not intended to be an extensive review of published works in neuroradiology; rather, it is intended to summarize briefly and put into focus what the editors believe have been the major contributions to the practice of neuroradiology, as published primarily in the *AJNR*. This selectivity undoubtedly will lead to the omission of some articles that readers might believe to be of equal importance. In this brief 20-year historical review, the editors of the *AJNR* intend to cover each of the major areas of neuroradiology, as seen through the eyes of the *AJNR*, and to give credit to those whose contributions we believe significantly furthered our specialty.

Also, with the start of the new millennium (and ignoring the curmudgeons who argue for January 2001 as the correct date of the millennium), we speculate about what the next 20 years might bring to our specialty. It will be difficult for the reader to view such speculations as outlandish, because one only needs to look at the dramatic changes that have occurred in neuroimaging and neurointervention since 1980 to be persuaded that, because significant advances are within our reach, they will eventually be in our grasp. Likewise, it will be difficult to judge the authors of this editorial too harshly if all the predictions do not materialize, because the worst we could be accused of in this “brainstorming” is wishful thinking.

The growth of the *AJNR*, both in terms of subscriptions (now at 6201, including individual and institutional subscriptions) and its impact on the practice of neuroradiology worldwide, has been substantial. The journal was nurtured and guided through its infancy and into its preteen years (1980–1989) by Juan Taveras, its founding editor. After a mere 6 years of existence, the shared ownership of the *AJNR* by the American Roentgen Ray Society and the American Society of Neuroradiology passed to exclusive ownership of the journal by the ASNR, certainly a sign of rapidly approaching maturity. During its teenage years (1990–1997), the *AJNR*, under the leadership of Michael Huckman, became increasingly influential in the practice of neuroradiology by exerting its independence as a self-publishing journal in 1991. The journal now enters adulthood and, as such, needs to take a broader and more worldly look at its mis-

sion and future. The masthead of the journal will reflect this vision; the Editorial Board will be expanded and become increasingly diverse, both geographically and according to areas of specialization and expertise. These neuroradiologists, basic scientists, and clinicians in other related specialties in the neurosciences will contribute substantially to the growth and influence of the journal in the future. We anticipate periodic changes in the composition of the Editorial Board because, as the direction of neuroradiology changes, the Board will change in concert.

It is not only the volume of manuscripts from countries outside North America that are submitted and published (now approximately 50% of the total), but also their originality and quality, which indicate loud and clear that the *AJNR* is truly international in scope. Our Editorial Board will reflect that reality by increasing representation of those who are at the forefront of neuroscience in imaging, regardless of their geographical location.

With the burgeoning of gene therapy, in vivo biochemical analysis of the central nervous system, detailed functional analysis of the brain, and novel endovascular therapy, it is clear that we cannot rely on neuroradiologists alone to advance the field of neuroimaging/therapeutics. We must incorporate into the Editorial Board individuals from various disciplines for their scientific and editorial contributions. The reliance we place on physicists for advances in neuroimaging is enormous, and this discipline too will be represented increasingly on the Editorial Board.

Although speculation abounds concerning where imaging and neurointervention will take us over the next 2 decades, it is certain that the way information is disseminated to the medical community will soon be far different than it is now. The journal is prudently working its way toward a full, on-line journal to supplement the printed journal. This will afford our subscribers not only instant access to multiple volumes of the *AJNR*, but will provide important links to other publications. On-line manuscript submission and peer review will be phased in over the next few years. With this will come more rapid evaluations and decisions regarding submissions, which will lead to more rapid publication. At a time when an 8-month-old idea or investigation borders on “old news,” it is incumbent on the journal to disseminate new and important information as quickly as possible and in a user-friendly manner.

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SPINE IMAGING

The ubiquity of spinal disorders, whether related to degenerative spondylosis and disk disease or to neural dysfunction of the spinal cord or peripheral nerves, has made spine imaging one of the most frequently ordered types of studies in radiology. The evolution of techniques, which has allowed the accurate display of the anatomy and pathology of the spine, has been mirrored in the pages of the *AJNR* for the past 20 years.

Techniques

Techniques involved in improving the radiologic evaluation of the spine have been emphasized in the journal over the years, and the changes in the emphasis from plain films, CT, and myelography to MR imaging is evident as one surveys the literature from the early-to-mid 1980s. Hirschy (1), in the first volume of the *AJNR*, emphasized the value of reformatted CT scanning of the lumbosacral spine and the need for axial sections parallel to the end plates of the vertebral bodies to ensure that a normal intervertebral disk would not be misdiagnosed as a herniation. As the value of CT with intrathecal contrast medium injection became accepted, articles then appeared concerning the use of CT myelography with metrizamide for the assessment of spinal cord size (2), the depiction of transneural migration of metrizamide into syringomyelic cavities in delayed imaging (3, 4), and the detection of abnormalities secondary to disk disease (5). It was clear that CT as a supplemental study after routine myelography would soon become widely used in spine evaluation. The fact that MR imaging for spine evaluation was lurking on the horizon was evident in Yeates' 1983 article (6) that showed a CSF equivalent signal in the center of the cord among five patients with syringomyelia. Later that year, Han (7) published an MR imaging study that depicted various abnormalities both in and outside the spinal canal. The term "nuclear magnetic resonance" was still being used at the time; however, in an important editorial following Han's article, Juan Taveras (8) made a strong and eventually successful plea for the elimination of the word "nuclear," and the use of the term "magnetic resonance." One need only look at the images in Han's (7) and Yeates' (6) articles to realize how far MR quality has progressed during the intervening 16 years. In consecutive articles, Norman (9) and Modic (10) published their early experience with MR imaging of the spine in patients with various intra- and extramedullary abnormalities, thus setting the stage for a shift in the way spine studies would be primarily ordered; ie, from myelography and CT to MR imaging. The improvement in quality of MR imaging of the spine became apparent

in the illustrations contained in Maravilla's (11) study of the lumbosacral spine. From this point forward, it became a matter of understanding and compensating for artifacts seen on MR images and evaluating new techniques and pulse sequences. Valk (12) demonstrated the value of gadolinium-DTPA in a range of nondegenerative spine abnormalities, including intramedullary and intraspinal tumors. Czervionke (13) beautifully explained truncation artifacts and the Gibbs phenomena seen with MR imaging of the cervical spine, discussed ways to avoid this annoying problem, and, in the same year, explained the reasons for magnetic susceptibility changes in gradient-echo studies (14). Later, Mirvis (15) reported the diminution in magnetic susceptibility artifacts in wire fusion of the cervical spine when titanium wires were used. How best to image degenerative spine disease then became a topic for a number of articles that spanned the 1990s, with the advantages and disadvantages of 3D Fourier Transform (FT) imaging of the cervical spine receiving particular attention. Youssef (16) advocated thin-section (1.5 mm), gradient-echo, low flip angle 3D imaging for evaluation of the neural foramina, whereas Ross (17) believed that for extradural disease in the cervical spine, contrast-enhanced T1-weighted gradient-echo imaging was an alternative sequence to be considered. Melhem (18) advocated the use of a preparation magnetization-transfer pulse prior to a 3D-FT, low flip angle, gradient-echo sequence for assessing cervical spondylosis because of contrast improvement between cord and CSF, diminished magnetic susceptibility effects, and decreased motion artifacts. Tsuruda (19) cautioned about the use of 3D imaging techniques for the spine when patient motion was anticipated, because of the long acquisition time needed when compared with 2D acquisition. Sze (20) later showed that fast spin-echo (FSE) imaging not only saved scanning time, but was as accurate as conventional spin-echo (CSE) imaging for revealing spinal abnormalities. He later refined these observations by analyzing the effect of echo train length (ETL) and echo spacing in FSE to compensate for CSF flow, and concluded that a long ETL and minimal echo spacing helped to optimize bright CSF with diminished flow artifacts (21). Sze (20) and Ross (22) concluded that FSE could replace CSE imaging of the cervical and lumbar spine. Although FSE has become a virtual standard in sagittal spine imaging, there are various opinions on the value and efficacy of additional sequences such as short-inversion-time inversion recovery (STIR) and fluid-attenuated inversion recovery (FLAIR) for evaluating spine and spinal cord disease. Hittmair (23) maintained that STIR-FSE depicted MS plaques in the cord best, whereas

FLAIR imaging, although excellent for the detection of MS in the brain, has a low sensitivity for MS in the spinal cord. In an extensive review of evolving MR techniques for spinal imaging, Ross (24) in 1999 included the explanation, uses, and advantages of all the commonly (and not so commonly) employed MR techniques for spine imaging, such as gradient-echo, diffusion, half Fourier reconstruction, FLAIR, STIR, and magnetization transfer. That article sets the stage for the development of future MR sequences for imaging the spine.

Physiologic Information

The recognition that MR imaging had the ability to portray physiologic information resulted in an important study in 1986 by Sherman and Citrin (25) in which MR imaging was used to assess CSF flow in the aqueduct and third and fourth ventricles. They recognized that incoherent CSF signal could obscure certain anatomic landmarks or lesions but, on the other hand, could potentially determine flow within cystic structures, such as syringohydromyelia (26). Importantly, they hypothesized that the pulsatile CSF flow within these cavities may play a role in their gradual expansion. The following year, the Dyke Award was given to Rubin (27), who studied imaging of spinal CSF pulsations that furthered our understanding of the effects of CSF flow, with its resulting signal loss and phase-shift images; gradient compensation and gating techniques were required to diminish these artifacts. This article and that of Enzmann (28) opened the door for greater understanding of how to use the display of CSF pulsations to give vital information, such as the potential of differentiating neoplastic from non-neoplastic cysts of the spinal cord. Brugières (29) demonstrated the value of imaging CSF flow patterns by showing how phase-contrast MR showed alterations in CSF flow pattern at the level of an anterior thoracic transdural spinal cord herniation. Although Watters (30) did not use CSF flow-sensitive studies in his description of cord herniation, he did draw our attention to this often subtle and easily misdiagnosed entity in which adhesions, cord atrophy, or a posteriorly located subarachnoid cyst may have been erroneously considered. Similarly, although Fischbein (31) did not use CSF flow-sensitive techniques, she did postulate that CSF flow alterations may be a reasonable explanation for a reversible intramedullary condition that could precede syrinx formation. With surgical restoration of normal CSF flow, reversibility of the MR findings was shown; the presence of a patient's central canal, in the face of these abnormal flow patterns, could foretell syringomyelia formation.

Back Pain

Back pain, with or without nerve root symptoms, has been one of the most, if not the most, common

indications for MR imaging of the spine, and over the years, articles have focused both on technique to show the changes of spondylosis and anatomic pathologic correlations in these abnormalities. Nomenclature appropriate for describing disk derangement persists. From myelography (32) to MR imaging (33), radiologists and clinicians alike still struggle with the appropriate terminology for what has been variously termed bulging, protrusion, extrusion, and herniation. The usage of these terms for lateral disks, as shown by Williams (34) on CT, extraforaminal disks (35) and disk sequestration, as described by Masaryk on MR images, has not, however, been in doubt. Imaging and anatomic correlations obtained by cryomicrotome sections of cadaver spine specimens enlightened us to the changes seen in vivo on MR images. Bergstrom (37) in 1983 published some of the early CT and post-mortem cryomicrotome comparisons and laid the groundwork for many future publications by the investigators working in Victor Haughton's laboratory (38–40). With cryomicrotomography, these investigators broadened our understanding of discogenic disease. They classified annular tears into concentric, radial, and transverse (38), demonstrated the anatomy and histologic characteristics involved in the intranuclear fibrous cleft (37), and later showed the effect of physiologic loading on the neural foramina in flexion, extension, and lateral bending (40). Jinkins proposed to sort out which particular nerve root in the lumbar spine might be responsible for symptoms, particularly in degenerative disk disease. He conducted postcontrast studies in the unoperated (41) and postoperative (42) back to determine active nerve root disease via nerve root enhancement. Crisi (43) also observed that selective intrathecal root enhancement was a direct consequence of disk herniation and was correlated with radicular symptoms. Lane, in an article appearing the following year, issued a cautionary note regarding the visualization of enhancing nerve roots. He not only found that lumbosacral nerve root enhancement correlated poorly with clinical radiculopathy, but he emphasized that enhancing structures in the cauda equina might represent normal but prominent great radicular veins.

Postoperative Lumbar Spine

Even with the advances in axial spine imaging, there have been difficulties with accurately diagnosing changes seen in the postoperative lumbar spine. Despite early optimism with CT and CT myelography (45, 46) in describing various patterns of enhancement and sac configuration, the distinction between a residual disk fragment and scar tissue remained difficult. Ross (47–49) published a number of important articles based on his clinical observations and experimental models in an attempt to make this task easier. First, he described how scar enhances by studying the time course and mechanism of contrast enhancement in the postoperative lumbar spine (47), and he followed that

clinical article with an experimental canine model for the evaluation of the posterior epidural scar (48). Then, in further differentiation between scar tissue and disk fragment (49), he concluded that, at 6 weeks or longer postoperatively, postcontrast T1-weighted imaging of the lumbar spine was effective for distinguishing scar tissue from a disk fragment. In his continuing work on the previously operated spine, Ross (50) described the patterns of intervertebral disk enhancement in asymptomatic postoperative patients; he stressed the importance of distinguishing the normal and expected disk end plate enhancement from infection.

Spinal Cord Disease

Intrinsic spinal cord disease was the focus of many articles published in the *AJNR* during the past 20 years. First, there was the rapid recognition that MR imaging had completely supplanted CT myelography, and, second, with improved contrast and spatial resolution, the ability to distinguish between various causes of myelopathy became apparent. Intramedullary tumors were readily identifiable by virtue of cord swelling, abnormal signal, cystic changes, and areas of enhancement. The more difficult problem involved distinguishing these predominately glial tumors from other intrinsic cord abnormalities, such as ischemia, demyelinating disease, and transverse myelitis of various causes. Mawad (51) and Friedman (52) showed the MR findings of cord ischemia and infarction, the former serving as a guideline for the major patterns of ischemia after resection of aortic aneurysms, and the latter revealing gray matter abnormalities in anterior spinal artery infarction. Yuh (53) showed associated spinal cord and vertebral body infarctions and concluded that a vertebral body signal abnormality may point to the cause of the underlying cord abnormality. Venous infarction of the cord owing to a spinal dural arteriovenous fistula (DAVF) was described by Larsson (54) and was one of the first articles that dealt with this subject and how such a condition might masquerade as other types of cord abnormalities. The article was followed closely by a study by Mirich (55) on subacute necrotizing myelopathy in which no spinal DAVFs were demonstrable. Biopsy of the cord in those cases revealed thickened, hyalinized vessel walls, demyelination, and myelomalacia. The clinical diagnosis of acute transverse myelopathy often went without a firm radiologic diagnosis. Provenzale (56) described four patients with lupus transverse myelitis, the underlying cause of which was either autoimmune or vascular in nature; these MR findings resolved over time. Campi (57), in the following year, described 30 patients with acute transverse myelopathy, and 18 patients had no definable cause for the cord dysfunction. Multiple sclerosis never developed among those who had greater than one segment involvement. She later described three patients with recurrent acute transverse myelopathy who had increased anticardiolipin antibodies, all of

whom had changing patterns on MR images. She asserted that these acquired blood protein defects led to venous thromboses or arterial thromboses (or both) that involved the spinal cord. Even the stated pathology of spinal cord tumors has changed over time and, in many series, has paralleled the greater sophistication in neural histologic staining techniques. Patel's work (59), in which 27 patients with proved spinal cord gangliogliomas, is one such example. Although the MR findings, including long tumor length, cystic changes, bone erosion, and patchy enhancement to the cord surface, wouldn't allow confident distinction from other glial tumors, the author suggests that these have a higher rate of occurrence than was previously believed and that in the past they may have been misdiagnosed as astrocytomas.

MR Angiography

The application of MR angiography (MRA) to the spine lagged behind its use in the brain and neck. The smaller vessel size, the tortuosity of the spinal vessels, and the lower prevalence of vascular lesions of the spinal cord in part explains this. A series of articles on spinal MRA, however, showed the value of MRA of the spine. Using a 3D post-contrast MR sequence, Bowen (61) beautifully demonstrated the abnormal venous anatomy in spinal DAVFs and correlated these findings with spinal DSA and operative results. In a follow-up article, Bowen (62) described the normal intradural veins of the thoracolumbar spine; this classic article stands as a guide for future spinal MRA interpretations. One year later, Mascalchi (63) employed phase-contrast MRA to show the arterial supply of spinal vascular lesions. These articles, along with those that employed routine MR pre- and postoperatively (64, 65) served to delineate spinal vascular malformations and their effects on the cord clearly and noninvasively.

Spine Trauma

CT and MR imaging have been pivotal in depicting spine trauma. Brant-Zawadzki (66) showed the greater accuracy of CT compared with plain films for detecting and assessing fractures of the thoracolumbar spine. Seibert (67) first described progressive post-traumatic cystic myelopathy and the technique for evaluating this syndrome with myelography (ie, air, Pantopaque, and metrizamide) and cyst puncture. Chakeres (68) showed that a movement toward imaging both acute and chronic spinal cord trauma was evident in the mid-1980s by showing some of the benefits of MR over CT in acute trauma. Quencer (69) showed the clinical utility of MR imaging of the chronically injured spine for detecting residual cord compression, myelomalacia, and post-traumatic cord cysts. Subsequently, Silberstein (70) used MR imaging as a predictor of neurologic outcome in acute spinal cord injury, describing the devastating neurologic effect

of a hemorrhagic contusion compared with the return of some useful motor function if the initial MR imaging showed only edema. He also evaluated delayed neurologic deterioration in previous spinal trauma with MR imaging (71), demonstrating cord atrophy, cord cavitation, residual cord compression, and identified treatable causes of neurologic deterioration in old spinal cord injuries. Becerra (72) revealed the ability of MR to show Wallerian degeneration both above (dorsal columns) and below (lateral columns) a cord injury, and he correlated those results with histologic findings at postmortem examination. Falcone (73) described the entity of progressive post-traumatic myelomalacic myelopathy, how it differs in appearance from post-traumatic cystic lesions on MR images, and what the surgical approach to the problem is. It became abundantly clear that MR imaging had assumed a major role in the depiction of acutely and chronically injured spinal cord.

Spinal Infections

For depicting infections of the spine, MR imaging became the technique of choice. Thrush (74) analyzed 17 cases of infectious spondylitis and recommended STIR imaging and warned against obtaining only a postcontrast study without a plain T1-weighted image, because gadolinium could raise the intensity of the affected vertebral body, making it appear normal. Smith (75), in an article on differentiating tuberculous spondylitis from pyogenic osteomyelitis in adults and children, related patterns of spread depicted on MR images to different types of microcirculation of the vertebrae and to the absence of certain proteolytic enzymes in tuberculosis. Schellinger (76) furthered our understanding of the MR appearance of soft-tissue masses in the anterior epidural space of the spinal canal. He beautifully demonstrated a generally unappreciated structure, the anterior epidural septum. He also attributed the shape of a retrovertebral soft-tissue mass to the posterior longitudinal ligament, the lateral attached membrane, and the attached anterior midline septum.

Congenital Abnormalities

Understanding the process by which congenital abnormalities of the spine develop is important for assessing MR images of younger patients. In 1983, Naidich (77) added significantly to our knowledge of spinal dysraphism in his classic article on dorsal dysraphism with lipoma (lipomyeloschisis). Bar-kovich published a number of important studies; of note was an article on spinal dermal tracts, their association with dermoids and epidermoids, and the fact that the intraspinal portion of a dermal sinus tract may be difficult to see on MR images (78). He carefully established the embryologic basis of a wedge-shaped conus as an important sign in the caudal regression syndrome (79).

Sonography

Spinal sonography has been employed both in the evaluation of the infant's spine and in the intraoperative assessment of patients undergoing a variety of surgical procedures. In 1984, two studies of spinal sonography performed in infants were published (80, 81). Naidich (80), who was awarded the John Caffey Award for this research, exquisitely correlated the sonographic features of congenital lumbosacral anomalies with CT myelography. The value of intraoperative spinal sonography (IOSS) is its ability to localize and characterize abnormalities and to assure that the proper immediate surgical outcome has been achieved prior to closure. In the 1980s, Quencer (82–85) and Knake (86) described the normal sonographic features of the spine and spinal cord, the appearance of soft-tissue masses in the spinal cord and in the spinal canal, the value of monitoring the surgical field with sonography to assure the proper placement of Harrington rods, and the use of sonography for the surgery of congenital lesions of the spine. Sklar (87) later compared CT and MR imaging for the evaluation of 14 patients with acquired subarachnoid cysts and showed the value of IOSS in their treatment. Mirvis (88) described the use of intraoperative sonography for the imaging of cervical cord injury, showing early cystic changes in the cord and areas of cord contusion.

Interventional Procedures

Nonvascular interventional procedures involving the spine have assumed increased importance in patient evaluation and treatment. In 1985, Onik (89) reported his results of percutaneous lumbar discectomy with the use of an aspiration probe and later described the same technique for the treatment of far lateral herniated disks (90). Quencer (91) described the percutaneous aspiration of intraspinal cystic lesions and the effect of these aspirations on the somatosensory evoked potentials; this information was found to be helpful for determining proper treatment and patient management. Abrahams (92), in the same year, demonstrated the utility of percutaneous aspiration of synovial cysts for securing a proper diagnosis. Renewed interest among radiologists in discography has been apparent over the past 5 to 10 years. Milette (93) studied patients with radiating pain to the lower extremities caused by disk rupture in the absence of direct spinal root involvement. With the clinical response after intradiscal anesthetic injection, he concluded that, in some patients, pain arises from within the disk itself, causing referred pain to the lower extremities. In what certainly must stand as one of the largest published series of cases, Johnson (94) reported his considerable experience of over 5000 cases of epidurography and therapeutic epidural steroid injection for back pain. Epidurography was strongly advocated to assure the installation of steroids in the proper location. Vertebroplasty, a procedure gaining in importance and popularity, was

shown to be effective in restoring the heights of vertebral bodies in compression fractures (95) and as part of a staging procedure for operative treatment of the vertebral body and epidural hemangioma (96). Jensen (95) published her transpedicular technique performed in 47 compression fractures. The percutaneous injection of polymethylmethacrylate resulted in 90% of patients experiencing immediate and significant relief of pain.

The Peripheral Nervous System

The peripheral nervous system has been a difficult area for imaging, whether by CT (97) or MR imaging. In their classic review article, Maravilla and Bowen (98) reviewed the radiographic anatomy of the brachial and lumbosacral plexus, described the MR appearance of nerve fascicles, detailed the techniques for MR imaging of the plexi and peripheral nerves, and demonstrated the changes on MR images of peripheral nerve abnormalities. This area of peripheral nervous system imaging is certainly one of the next frontiers in neuroimaging.

The Future

In the future, we can anticipate that MR techniques currently used to assess the brain will be applied to the spine. Early reports of diffusion imaging of the spinal cord point to its potential in the workup of a number of myelopathic conditions, but investigations of a large number of patients from many centers are needed to validate its widespread use. Diffusion tensor MR imaging of a variety of spinal cord lesions, particularly at high fields, may provide morphologic information that may approach the type of detail that now is only available with histopathologic analysis. The move toward physiologic and biochemical information is anticipated as schemes for MR spectroscopy are applied to the cord. Both diffusion-weighted imaging and MR spectroscopy could be used to follow drug therapy in inflammatory and neoplastic disorders and to follow the success of cellular implantation for neural tissue regeneration. It remains problematic whether functional MR imaging and neural tissue activation can be applied to the spinal cord because of a number of significant problems, such as normal physiologic motion of the spinal cord and susceptibility to artifacts. Time-resolved spinal MRA for the delineation of arterial, capillary, and venous phases of MRA is currently an active area of research. The hope is that diseases other than arteriovenous malformations, arteriovenous fistulas, and highly vascular tumors of the spine and spinal cord will be amenable to such investigations. By doing so, the diagnosis of ischemic cord disease may be possible by direct rather than indirect evidence of abnormal blood flow and perfusion. From a practical clinical standpoint, it is nearly certain that invasive spinal procedures will grow significantly in the upcoming years. Whether these pro-

cedures are performed by radiologists depends on the commitment of our residency and fellowship programs to mandate the teaching of these spinal interventions. Without such active advocacy, surgeons and anesthesiologists will dominate this field. The extent to which spinal surgery is done in an open magnet, particularly those operations dealing with cystic lesions in the canal and intramedullary abnormalities, will depend on the design of the entire magnet system and the ease with which operations can be completed. Imaging, which seriously prolongs time in the operating room or which makes surgery more cumbersome, will not be viewed as an advantage by the spine surgeon. Finally, the precise evaluation of peripheral neuropathies offers a great challenge to neuroradiology and opens up a whole new field previously void of meaningful radiologic interpretation. After such imaging separates medical from surgical disorders, MR imaging of the peripheral nervous system will allow an objective assessment of the effect of therapy.

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