

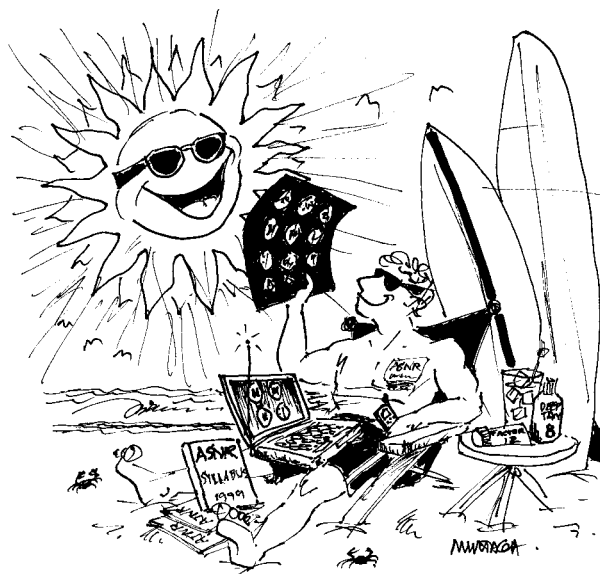
MEETING SUMMARY

Thirty-Seventh Annual Meeting of the American Society of Neuroradiology

The annual meeting of the ASNR was held in the San Diego Convention Center from Sunday, May 23 through Friday, May 27, 1999, under the direction of Jim Barkovich, President and the Presiding Officer. Prior to the meeting, the American Society of Head and Neck Radiology (ASHNR) sponsored a 1-day symposium on Saturday, May 22, entitled "Clinical Problem Focused Imaging in the Head and Neck." Combined attendance at the Symposium and the ASNR meeting was 1500.

Eric Russell, President-elect of the ASNR, served as Program Chairman for the meeting during which each of the constituent specialty societies held focus sessions and proffered papers in their special interest areas. As a result, the ASHNR and the ASPNR (the American Society of Pediatric Neuroradiology) were responsible for the topics on Sunday and Monday while the American Society of Interventional and Therapeutic Neuroradiology (ASITN) and the American Society of Spine Radiology (ASSR) had the same responsibility for Thursday and Friday. Eric worked closely with each chairman of the specialty societies, Rob Lufkin (ASHNR), Pat Barnes (ASPNR), Gary Duckwiler (ASITN), and Alan Williams (ASSR), to offer diverse and state-of-the-art topics in each area. The Electronic Learning Center, under the leadership of Vice President Bill Ball, was again highly successful, offering hands-on tutorials on digital applications for the radiologist and on the generation of neuroradiologic educational material. There were early morning lectures on the application of basic science to neuroradiology and tours of selected posters and "how-to" sessions in the late afternoon. Scientific, technical, and computer-assisted exhibits as well as posters were on display in the exhibit hall throughout the week. On Tuesday morning, Jim Barkovich's presidential address (see page 1760) was followed by the ASNR awards ceremony in which the society's highest honor, the Gold Medal, was given to Michael Huckman and to Grant Hieshima. Tributes to Drs. Huckman and Hieshima appear on pages 1762 and 1763. Aguilla Turk was the recipient of the Cornelius G. Dyke Memorial Award for his paper entitled *Definition of Aneurysm Ostium (Neck) and Morphology Using Intravascular Ultrasound: An Experimental Study in Canines* and the Berlex/ASNR Basic Science Fellowship Awards went to Kevin Moore for his proposal *MEG-Constrained High-Resolution Surface-Coil MR Imaging and MR Spectroscopy for Evaluating Medically Refractory Epilepsy* and to John Short for his proposal *Induction of Spinal In-*

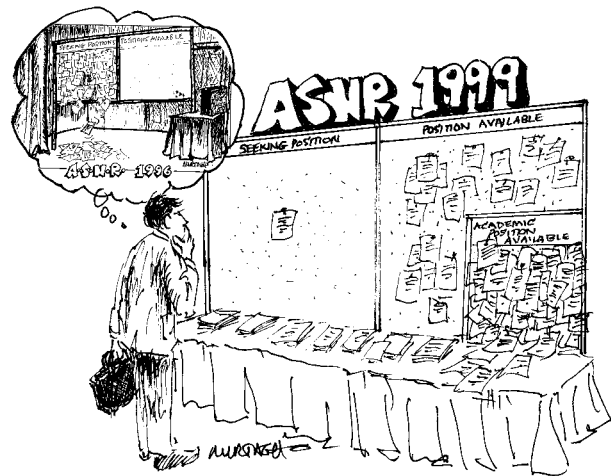
terbody Fusion Using Gene Therapy Tissue Engineering Techniques. Mary Gaskill-Shipley announced the winners of the outstanding papers from the 1998 ASNR meeting in Philadelphia given by each specialty society: 1) from the ASITN (the Michael Brothers Memorial Award), *Percutaneous Transluminal Angioplasty for Atherosclerotic Lesions of Intracranial Vessels: Report of Nine Years Experience* by Connors and Wojab; 2) from the ASSR, *MR Imaging Characterization of Axonometric versus Neurometric Peripheral Nerve Injury in a Rat Model* by Aagaard et al; 3) from the ASHNR, *MR Imaging for Predicting Neoplastic Invasion of the Cervical Esophagus* by Roychowdhury et al; 4) from the ASPNR (the Derek C. Harwood-Nash Award), *Functional MR Imaging of Language Distributions in Pediatric Epilepsy Patients* by Holland et al; and 5) from general neuroradiology, *Tissue Viability in Stroke by Sodium Magnetic Resonance Imaging: A Nonhuman Primate Model and Acute and Subacute Clinical Studies* by Thulborn et al. Each regional society, at their annual meetings held earlier in the year, selected a paper to be presented on Tuesday morning: 1) from the Southeastern Neuroradiological Society, *Diffusion-Weighted MR of the Normal Human Spinal Cord* by Chad Holder; 2) from the Eastern Neuroradiological Society, *Activities of the Thalamus with Implanted Electrodes: An fMRI Analysis of Externally Driven Brain Activity* by David Mikulis; and 3) from the Western Neuroradiological Society,



The Behavior of a New Liquid Embolic Agent, Neuracyl M, in Blood by Chuck Kerber. In Holder's paper, the technological ability to perform diffusion-weighted MR imaging of normal spinal cords was demonstrated. Interestingly, while the expected anisotropy of white matter tracts was seen, there was shown to be a small but greater than anticipated anisotropy of the gray matter in the cord. Applying diffusion-weighted imaging to the cord would clearly be an important step forward in spine imaging, perhaps even to a greater extent than its use for imaging the brain has been. In Mikulis' paper, the feasibility to perform functional MR imaging safely and accurately in conjunction with deep brain stimulation was shown. This technique may help in our understanding of how deep brain stimulation effects movement disorders. In Kerber's paper, a new liquid embolic agent, Neuroquil M, was proposed to have certain advantages because it could result in a significantly improved distribution of the embolic agent, particularly in terms of the control of its delivery and penetration into modeled arteriovenous malformations.

At Wednesday's Annual Business Meeting, Paul Capp, Claude Manelfe, and Lucy Rorke were introduced to the membership as the newly elected 1999 honorary members of the ASNR. A short biosketch of each of these people whom the society has honored in this manner appears in this issue of the journal (pages 1763–1764).

There were many excellent features of this year's meeting and what follows is a summary of just a few of its scientific highlights. In the pediatric neuroradiology segment of the meeting, the opening focus session dealt with the diagnosis and treatment of vascular anomalies of the head and neck. Stressed was the importance of a multidisciplinary approach to these lesions as well as the virtue of conservative treatment for self-limited lesions such as juvenile hemangiomas versus a more aggressive interventional/surgical approach to control vascular malformations with slow and fast flow. It was stressed that vascular anomalies in children are common but in many instances are incorrectly classified and often lead to ineffective or unnecessary treatment. Furthermore, this session emphasized the classification of these lesions into neoplasms (hemangiomas and variations) and vascular malformations. These two categories are often treated differently and have different clinical presentations and natural histories. Hemangiomas, which never appear initially in adults, have a characteristic proliferative phase presenting in early infancy followed by a slower phase of involution over the course of several years. If possible, it is best not to treat these lesions unless there is significant orbital or airway compromise. Vascular malformations, by contrast, never regress and often expand. New concepts regarding the genesis of these lesions and their growth factors may allow better control of larger lesions in the near future. On Monday, there were separate focus sessions of particular interest



to pediatric neuroradiology concerning craniocervical anomalies, neuroendocrine disorders, and pediatric epilepsy. In the session on epilepsy, emphasis was placed on the role of neuroimaging interpretation based on the current classification and known physiology of the epileptogenic focus. Papers in the ASPNR segment of the meeting brought to members' attention the role of advanced imaging methods such as metabolic, diffusion, and perfusion imaging as well as MR spectroscopy in the diagnosis and management of neurologic disorders in childhood. Glucose metabolism as seen with FDG positron emission tomography within suspected neoplasms in type 1 neurofibromatosis was correlated with tumor aggressiveness and clinical outcome. The results showed that glucose uptake did correlate with clinical outcome and the need for more aggressive management. This correlation was significant despite the fact that many of the tumors were to be determined benign by histologic analysis. Subsequent papers emphasized the use of MR spectroscopy with diffusion/perfusion imaging to predict and follow tumor response to therapy. Investigators found low levels of choline and decreased blood flow could accurately characterize necrotic tumors and in such cases the corresponding lipid levels and apparent diffusion coefficient values were elevated. MR spectroscopy was also found useful for following tumor response to therapy. These reports, along with other similar presentations, demonstrate that such techniques can and should play a role in the management of pediatric brain neoplasms.

Advanced imaging methods in pediatric head and neck disorders were shown to improve the understanding of pathologic processes and improve diagnoses. Four-dimensional virtual endoscopy was demonstrated as being a valuable tool in the assessment of the pediatric larynx because it assisted in preoperative evaluation and in planning surgical management. Other papers stressed conditions peculiar to children and the need to beware of normal variants in imaging the pediatric head and neck.

Cervical thymus as a cause of a neck mass in children and its relationship to the carotid sheath was presented. Likewise, the proper identification of accessory salivary tissue in the mylohyoid as a cause of potential misdiagnosis of tumor also served as a reminder that the key to imaging diseases in children is first to understand both normal and abnormal variations that might be encountered. Finally, the need to recognize variations in anatomy even in the face of disease was emphasized in a paper identifying the presence of prominent emissary veins in the skull base in children with Crouzon Syndrome. The identification of such variations has practical significance in avoiding hemorrhagic complications at the time of surgery.

The use of advanced imaging techniques in monitoring physiologic alterations in pediatric patients was also shown. Specifically, the use of cine phase-contrast MR imaging to assess flow of CSF in achondroplastic versus normal children provided important clues as to the potential origin of complicating syringomyelia by revealing abnormal motion of the brain stem and medulla. In a subsequent paper, diffusion-tensor and apparent-diffusion-coefficient imaging was used to evaluate three children with developmental delay. The results were striking in that all patients had what appeared to be normal myelination based on signal characteristics, but they demonstrated elevated diffusion values and decreased diffusion anisotropy in the internal capsule. This paper indicated that the use of such techniques may eventually fill a significant void in our current capabilities to assess subtle problems in myelin maturation accurately.

Cerebrovascular disease in children evaluated by diffusion imaging was shown to have value because, as in adults, the diffusion-weighted image may be abnormal before the T2-weighted images are abnormal; however, diffusion-weighted imaging may underestimate the size of the infarction secondary to hypoxic-ischemic disease. Investigators found evidence that silent infarctions may actually progress in children with sickle cell disease despite the use of hydroxyurea therapy. The presence of infarcts even in what are often considered the minor hemoglobinopathies was the topic of another paper in which evidence of infarct was identified on MR studies, even in children with thalassemia or sickle thalassemia. Based on this preliminary study, recommendations for MR screening of these groups was recommended.

Evolving imaging applications for head and neck disease included a presentation on the value of FDG positron emission tomography for the detection of recurrent disease and occult primary tumors as well as for the monitoring of patients to determine their response to therapy. The value of high-resolution CT for the detection of cochlear ossification, differentiating various cochlear anomalies, excluding agenesis of the cochlear nerve, and for identifying abnormalities in the mastoid or middle ear that could compromise a surgical approach to

temporal bone disease was presented. The use of high-resolution fast spin-echo MR imaging for congenital malformation of the inner ear showed not only that 70% of patients with the large endolymphatic duct and sac syndrome had a cochlear anomaly, but also that, in a number of these patients, subtle anomalies in the distal turns of the cochlear apex were seen on MR studies that were not identified on CT. Volume measurements of head and neck tumors with CT was shown to have predictive value in determining patient outcome, and such measurements could help predict which tumors would respond to radiotherapy. The importance of collaboration between imaging and clinical services was emphasized in a paper that assessed the value of reinterpreting cross-sectional imaging studies of head and neck cancer patients in the setting of a multidisciplinary conference. It was found that there was a change in interpretation in 35% of patients, the most common of which was upstaging from T3 to T4 disease. Nodal staging was changed in 22% of patients, increased in 16%, and decreased in 6%. The value of reinterpretation of images in the setting of such a conference has clear implications for patient care and also should impact the reimbursement issue of second readings by imaging experts in the field of head and neck oncology.

The emphasis on new and evolving imaging techniques was apparent throughout the week in all sections of the meeting. The principles of CT/MR perfusion imaging and xenon CT, with their applications for acute stroke patients, were presented in a focus session. An informative, albeit controversial, presentation of single photon emission CT (SPECT) and MR in acute ischemia and the importance of collateral and semiquantitative perfusion data ended this focus discussion. Important clinical points were raised; however, the advantages of SPECT over perfusion MR imaging remain in question. The significance of diffusion and perfusion abnormalities, both immediately prior to and after thrombolytic therapy, was examined in a group of six patients. In five of these patients, there was a reduction in abnormal apparent-diffusion-coefficient volume between the pre- and post-thrombolysis imaging *and* the mean infarct volume decreased by half compared with the initial apparent-diffusion-coefficient abnormality. Although this was a small sample size, the implications, if extended over a larger group of patients, is significant because it could indicate that salvageable brain tissue may include not only areas of diffusion/perfusion mismatch, but also areas of diffusion abnormalities. In addition to thrombolytic therapy, a possible role for mechanical balloon clot disruption for acute embolic stroke was presented. Using this technique, vessel recanalization was achieved in 11 of the 12 patients (seven complete, four partial) with some degree of distal embolization occurring in all patients. Balloon-assisted thrombolysis was felt to provide a means for rapid

vessel recanalization and may be appropriate for use in patients in whom thrombolysis is contraindicated or ineffective. This method is very frequently associated with downstream embolic events, the significance of which is not predictable. This risk, however, may be acceptable in certain clinical situations.

Volumetric measurements of brain tissue received significant attention. A novel means of determining cortical thickness in abnormalities such as cortical dysplasia, the use of phase-array imaging of the hippocampus and the limbic system, and cone-beam tomographic techniques using contemporary rotating digital fluoroscopic units were some of the examples shown.

The growing interest in image-guided therapy was evidenced by papers that dealt with the detection of intraoperative hemorrhage and for the placement of deep-brain stimulator electrodes. A different approach to electrode implantation used preoperative MR imaging of the substantia nigra for electrode placement, and such targeting was accurate in 85% of the patients, with the other 15% having a final target within 2 millimeters of the site indicated by MR imaging. Because MR imaging is usually effective in assessing the results of therapy, the finding that MR's inability to detect changes in patients receiving stereotactic radiotherapy for medically refractory trigeminal neuralgia was surprising. In spite of clinical improvement in the majority of these patients, no MR changes in the trigeminal nerve or adjacent brain stem were seen.

Each year, functional MR (fMR) imaging deservedly receives increased attention, and this year papers were presented that showed the advances in fMR. Integrating different types of functional brain images (magnetoencephalograph [MEG] and fMR) into surgical guidance systems was demonstrated; these could have significant impact on surgical decisions because such localization allows for defining differences in functional localization of simple motor tasks. Functional localization by FDG positron emission tomography and fMR was concordant in patients with brain tumors, and while it was acknowledged that fMR has practical advantages, FDG positron emission tomography does elucidate certain metabolic information that could be useful in surgical planning. Defining eloquent cerebral tissue at surgery was assisted by preoperative functional imaging using MEG and fMR. Neurophysiologic information derived from fMR included a study that showed very widespread cortical activation by the complex task of multiplication, as compared with a simple matching paradigm. These results present one of the challenges to understanding the significance of functional imaging results because it appears that a large area of the brain is involved in this task. There is, however, little evidence to show that if any one of the activated areas were to be removed, the subject would be unable to multiply. Many of these activated areas might therefore be associated with, but are not necessary

for, this particular task. Addressing various aspects of language localization, presentations showed that one could determine hemispheric language dominance by using either auditory or visual stimuli, that simple auditory paradigms activated Werckicke's area, that adults and children had similar fMR localization during verbal fluency tasks (although there was more trouble with artifacts and poor signal to noise in children), that there was cerebellar activation during reading tasks, and that there were differences in activation patterns induced by memory tasks in deaf versus hearing adults, particularly differences in right-left lateralization.

The desirability of obtaining more "lifelike" images was apparent in papers dealing with rotational angiography with 3D volume reconstruction and vascular visualization. In separate papers, this technique was applied to aneurysms and carotid atherosclerosis. The relationship between imaging speed and image quality, particularly with MR imaging, is always an important topic. Two fast imaging techniques (double-shot echo-planar and double-shot fast spin-echo imaging) for the evaluation of a variety of cerebral lesions revealed most lesions with only moderate image quality when compared with standard spin-echo techniques. Given the speed advantage of the echo-planar technique, it may be superior for examining patients unable to undergo more lengthy examinations, except for those patients who have lesions in the posterior fossa where artifacts are severe.

With increasing volumes of neurovascular surgery being performed via the endovascular route, it is not surprising that presentations dealing with the imaging and treatment of intracranial aneurysms and arteriovenous malformations (AVMs) were of great interest. Three-dimensional angiography was advocated as a superb method to analyze the morphologic features of these aneurysms and AVMs, because it more clearly assesses their suitability for endovascular treatment compared with 2D angiographic techniques. In addition, 3D angiography was well suited for post-treatment follow-up. The results of Guglielmi detachable coil (GDC) treatment of aneurysms, which were partially thrombosed, indicated that recanalization of aneurysms in this group of patients was four times more likely to recanalize than in patients who had non-thrombosed aneurysms treated with the same techniques. Great success in treating basilar-tip aneurysms with the GDC system was presented; specifically, out of 70 acute ruptured aneurysms, only four could not be treated, and of the 66 that were treated, complete occlusion was achieved in 61. Only four patients deteriorated as a result of the procedure. Importantly, the morbidity and mortality rate for aneurysms in this location are superior to those of most neurosurgical series. Basic research aimed at improving the healing response that occurs after endovascular treatment of aneurysms was the focus of experiments in a porcine

aneurysm model. Growth factor (GF) stimulation of intima formation by local GF delivery increased the thickness of the neointima at the surface of the embolic agent. Further work is required to determine whether this strategy could improve long-term results of endovascular treatment in human subjects. Flow characteristics within saccular aneurysms determine which aneurysm may rupture and which may not. Using cardiac-gated MR phase imaging, velocity components parallel and perpendicular to aneurysm necks were determined, and kinetic energy maps were calculated, allowing patterns of flow and energy to be distinguished in these aneurysms.

Applications of evolving imaging techniques and interventional procedures to the spine were presented in spine focus sessions and in subsequent papers. While diffusion-weighted imaging of the spinal cord has not reached a significant clinical level, preliminary work has shown strong anisotropy in white matter tracts in the cord and limited anisotropy in gray matter. The explanation for the latter remains unclear. It is theorized that spine diffusion imaging could be used in acute trauma, ischemic disease, spondylosis associated with myelopathy, and multiple sclerosis. The extension of diffusion-weighted imaging to the evaluation of vertebral-body bone marrow was presented. As diffusion weighting increased, there was gradual hypointensity in osteoporotic fractures, whereas in infiltrative disease such as metastasis, the signal from the bone marrow remains bright even with increased diffusion weighting. This bone marrow imaging technique was felt to be useful when the MR-revealed morphologic features of the abnormal bone was not definitely characteristic of either benign or malignant disease. Image-guided surgery of the spine was shown during an informative 8-minute video in a patient undergoing a spinal fusion with pedicle screws. A fascinating feature of this presentation was watching the surgeon never look at the operative field during the critical parts of the surgery but instead focusing on the real-time, projected images. The technique was helpful in surgical navigation, decreased operative time, and allowed accurate pedicle screw placement. Virtually all spine imaging in patients with low-back pain is done in a supine position, which often does not mimic the physiologic position that results in patient symptoms. A presentation in which upright MR imaging and MR imaging performed during flexion and extension showed the value of functional/positional MR imaging. Striking decreases in neural foramenal and central canal size were shown in the patient with low-back extension. Critical to achieving reasonable images with this technique are good surface coils.

In the paper presentations, the difference between a ganglion cyst and a synovial cyst was shown; ganglion cysts were described as arising from mucinous degeneration of disk material that are often misdiagnosed such as nerve sheath tumor

or a herniated disk. Synovial cysts, most often diagnosed as intraspinal abnormalities, were shown in another paper to be often retrosinal in location (behind a degenerative facet joint). These are more common than generally appreciated and are of clinical significance in that they should not be diagnosed as something more sinister; they simply point to underlying facet disease.

The use of cervical diskography to localize and identify different types of neck pain was evaluated in 40 patients. Of particular interest was the provoked response at C2–C3 when compared with the lower cervical diskography level. Diskography at C2–C3 was the level that reproduced the patients' symptoms of headaches. This response was independent of disk morphology (ie, it was independent of the disk signal on the prediskography MR image), indicating that one could not predict the patient's response to diskography. Vertebroplasty, which is being increasingly performed in this country, was the subject of a number of papers, one of which described a special syringe to be available this year in Europe, which allows far better control of the cement injection rate and was found to make vertebroplasty easier and safer. Spinal MR angiography (MRA) remains a poor cousin to MR angiography of the brain; however, with the use of an ultrafast 3D contrast-enhanced MR angiographic sequence, temporal resolution of 11 seconds allowed the evaluation of the arterial and venous phases of the spinal MRA. Without such high-speed MRA, one commonly identifies only spinal veins, so application of this technique could be a major advantage in detecting vascular disease of the spine.

The understanding of spinal biomechanics is increasingly important because there are now means of imaging patients (positional MR, diskography) with deranged biomechanics. A focus session on the practical aspects of biomechanics reviewed some of the basic concepts, defining a motion segment and coming to grips with terms such as hypermobility and instability. A point emphasized was the fact that a search for back pain should go beyond the search for disk herniation or stenoses. In this regard, evaluation for impending instability should be assessed by careful evaluation of the individual components of the motion segment because surgical stabilization of an abnormal motion segment in properly selected patients can give good clinical results.

Two spine focus sessions were devoted to the role of the neuroradiologist as a pain management consultant. Included in these sessions were descriptions of techniques and the result of spinal injections and blocks, vertebroplasty and spinal embolization, and diskography. The origin of nociceptive stimuli from many different locations in and around the spine, including bone, periosteum, muscle, ligaments, dura, facet joints, and intervertebral disks, was discussed. Percutaneous injection of local anesthesia and steroids into some of these regions,

including the facet joints, epidural space, and nerve roots for the purpose of pain relief and to determine the localization of pain origin, is beneficial diagnostically and therapeutically. It was emphasized that a neuroradiologist, with the proper anatomic knowledge and imaging/interventional skills, is well suited to performing these studies. Diskography was shown to be extremely useful in those patients who have back pain with no neurologic deficit. Emphasized was the fact that the most important information gleaned from a diskogram is not the morphologic characteristics of the disk, but the subjective pain response, and the determination of which segment is the "pain generator." This can be readily determined if there is careful attention to detail while performing the procedure and a digital pain scale is used. A scientific exhibit correlated MR with diskography and emphasized that it is those patients whose imaging findings are discordant with the clinical picture who are candidates for diskography. The exhibit went on to make some technical points including the need to inject the center of the disk, not the annulus, and pointed out the value of a standard diskography scoring sheet in which the pain, its location, and its severity are recorded.

Scientific papers in the spine sessions on the last day of the meeting dealt with a variety of topics including spinal neoplasms, the causes of non-tumoral myelopathy, bony spinal abnormalities, and vertebroplasty. One paper did describe that in 9% of proved intramedullary neoplasms, there was no enhancement after gadolinium injection. This seemingly high incidence appeared independent of steroid treatment. Enhancement along the lateral

columns of an enlarged thoracic cord in two patients presenting with a subacute myelopathy was ascribed to a paraneoplastic process, and one poster case was described as an idiopathic acute transverse myelitis. Both of these types of abnormalities were examples of spinal cord neoplasm mimickers. Changes in bone marrow of the spine inside and outside ports of radiation were evaluated with T1-weighted and post-contrast MR imaging. As expected, T1 signal increased for vertebrae inside the field but not for vertebrae outside the field. Vertebrae both inside and outside the radiation field demonstrated a decrease in contrast enhancement, with the vertebrae inside demonstrating an early increase in enhancement (2 weeks after radiation). The initial increased enhancement was felt to arise from changes within the sinusoids, with a later reduction in enhancement caused by decreased vascularity. Transient symptoms, including back pain, weakness, and difficulty with walking occurring after lumbar puncture, were present in 12 children and found to be due to spinal epidural collections, some of which were massive in size. The epidural fluid collections disappeared over time, and there were no symptomatic sequelae.

The annual meeting was adjourned at 3:30 pm on Friday, May 27. The Society awaits its 38th annual meeting to be held April 2–8 at the Hyatt Regency in Atlanta, Georgia.

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