MAGNETIC RESONANCE IMAGING OF THE SPINE: AN INITIAL EXPERIENCE

Fatma A. Al-Mulhim, MD; Ezzeldin M. Ibrahim, MD, FRCPI

Retrospective analysis was carried out for 477 magnetic resonance imaging (MRI) studies of the spine. The overall mean age ± SD of the entire series was 38.7 ± 12.9 years. Degenerative spinal lesions and prolapsed intervertebral disks were detected in 62% and 73% of all the studies and of those which showed spinal abnormalities respectively. Postoperative granulation tissue was the third most common abnormality detected (12%). MRI was superior to computed tomography (CT) and CT myelograms in the diagnosis of disk prolapse (97% versus 66%), degenerative disease of the spine (94% versus 48%), and postsurgical granulation tissue (100% versus 6%). Comparing the numbers of CT and CT myelograms requested in the year prior to the installation of the MRI to the numbers requested during the year where the MRI was functioning did not show any change in the frequency of ordering CT studies. We conclude that our hospital-based series has shown an interesting pattern for spinal disorders. The first year experience of the utilization of MRI in various spinal diseases has been satisfactory with prevailing diagnostic superiority for that modality. *Ann Saudi Med 1994;14(4):333-337.*

Disorders of the back and spine are among the leading causes of disability in the working years. In Britain, 25% of working men are affected in any given year and 2% of the population consult a physician each year because of low back pain;[1] moreover, at some time, 80% of all people will experience back pain.[2] Methods of assessment of spine disorders currently in use frequently involve ionizing radiation (plain radiographs and computed tomography [CT] scans), while in many cases the patient is subjected to a more invasive approach including injection of intrathecal or intradiskal contrast material (myelography, high resolution CT with contrast agents, or diskography).

Magnetic resonance imaging (MRI) is one of the most significant advances in medical imaging in this century. By the mid to late 1980s, spinal MRI had reached a fairly sophisticated level. The next few years brought further advances. Because of its superior soft tissue contrast resolution, multiplanar imaging capabilities, and lack of ionizing radiation, MRI has replaced CT as the study of choice for the majority of abnormalities of the central nervous system. Clinical studies have clearly shown not only that MRI can demonstrate normal spine anatomy and a variety of pathologic conditions but also that it can be performed safely in a noninvasive fashion in an outpatient setting.[3-9]

From the Departments of Radiology (Dr. Al-Mulhim) and Medicine (Dr. Ibrahim), King Faisal University, Dammam.

Address reprint requests and correspondence to Dr. Al-Mulhim: Assistant Professor, Department of Radiology, King Fahd Hospital of the University, Al-Khobar, P.O. Box 40044, Al-Khobar 31952, Saudi Arabia.

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In December 1991, a new MRI machine was installed at King Fahd Hospital of the University, Al-Khobar, Saudi Arabia, the first to operate in the region. Aiming principally at examining the experience gained after the first year of operation, this retrospective study was also intended to analyze the prevalence of spinal disorders in a hospital practice as diagnosed by MRI and to compare the diagnostic yields of MRI against other radiologic modalities. Also tested was the influence of having a new diagnostic modality on the frequency of requesting CT and CT myelograms.

Material and Methods

A total of 934 MRI examinations was obtained for different body sections during the period from January 1992 to December 1992. Of that total, 477 MRI studies (51%) were requested for patients with different complaints related to the spine. All radiologic studies were reviewed by one radiologist, who was blinded to the released report or to the final diagnosis. Lack of concordance with the original report was dissolved through open discussion with the radiologist concerned. Also reviewed were the medical records of patients and required data was obtained.

MRI studies were performed on 0.3-T permanent magnet (Fonar, USA). The MRI sequences reviewed consisted of sagittal and axial sequences 4 mm thick with 0.5 mm gap, TE 25/TR 450 (T1-weighted), with a 300x512 imaging matrix and four excitations, and a sagittal 4.5 mm thick with 0.5 mm gap TE 85/TR 2000 (T2-weighted) sequence with a 257x512 or 320x512 imaging matrix. An alternative method of obtaining the T2 effect was also used in fewer patients using a gradient echo imaging, which

significantly reduces imaging time, but signal-to-noise ratio and intrinsic T2 contrast were inferior to those obtained with true T2-weighted images. Post injection of gadolinium-DTPA T1-weighted spin echo at less than 10 minutes was also obtained in patients suffering from failed back surgery syndrome to differentiate recurrent residual disk herniation from epidural fibrosis (scarring) and for suspected tumors, infection, or vascular malformation.

CT scans were obtained using a Somatom ART continuous rotation, with 512 x 512 matrix (Siemans, West Germany). To test the effect of having a new MRI on the ordering practice of physicians of CT and CT myelograms, the numbers of the latter studies were compared during the year prior to the installation of the MRI to that requested during the first year of having a functioning MRI.

The final diagnosis was based on a correlation of the clinical history, disease course, laboratory and microbiological studies, pathology data and operative findings. In patients who were diagnosed to have degenerative disk disease, their final diagnosis was ascertained by clinical data and follow-up radiological studies.

A computerized data base was constructed to obtain all relevant coded data. Comparisons of proportions were performed using chi-square analysis.[10] Comparison of the mean age and mean duration of symptoms of patients from different diagnostic groups was carried out using analysis of variance.[11] For the comparisons of means of unequal variances as determined by Levene's test, the Brown-Forsythe statistic was calculated.[12] Correction for multiple comparisons was performed using Scheffe's method.[12] In all analyses, a two-sided P value of less than 0.05 was considered significant. The BMDP Statistical Software programs (P1D, P2D, P6D, P7D, and P4F) were used to analyze the data.[12]

Results

Of the 477 MRI studies, 288 were requested for males (60.4%) and the remaining 189 for female (39.6%) patients. The overall mean age ± SD of the entire series was 38.7 ± 12.9 years. A total of 66% of the requests were made by the Department of Neurosurgery, while 8% came from the Neurology Department, 8% from the Orthopedic Surgery Department, 2% from Internal Medicine Department, and 2% from the Department of Radiology. The remaining 14% of the studies were performed on requests made by physicians and surgeons from other hospitals.

Sixty percent of the studies were requested to evaluate the lumbar spine, while 37% and 5% of the studies were ordered to examine the cervical and dorsal spine respectively. Patients with cervical spine-related symptoms were significantly older (mean age in years ± SEM was 41.1 ± 0.9) than those with potential dorsal (30.5 ± 3.7, P=0.01) or lumbar lesions 37.2 ± 0.7, P=0.01). No significant difference was noted in the mean age of male and female patients in any of the three main spinal regions (data not shown). Also noted was the lack of a statistically significant difference between the mean duration of symptoms based on the site of the spinal lesions. Females had significantly longer duration of lumbar spine complaints as compared with males (26.9 ± 3.1 versus 18.8 ± 1.8 months; P=0.026). On the other hand, no other significant difference was noted between genders.

In 25 (5.2%) studies, diagnoses established on reviewing the films varied from those noted in the original reports. All these cases were discussed and a final diagnosis was made and supported by additional data such as clinical, radiological and surgical findings. Comparisons were made between the final, clinical and MRI diagnoses

TABLE 1. *Comparisons between final, clinical, and magnetic resonance imaging (MRI) diagnoses.*

Final Diagnosis	No. of Patients (477)	%	Age (Mean ± SD)	% Correct Clinical Diagnosis	% Correct MRI Diagnosis
Prolapsed intervertebral disk	166	34.8	39.3 ± 10.6	91	97
Degenerative disk disease	130	27.3	41.5 ± 11.4	0	97
Normal study	72	15	30.7 ± 12.3	0	100
Granulation tissue	31	6.5	42.1 ± 12.9	3	100
Vertebral collapse	16	3.3	30.9 ± 11.6	67	89
Recurrent disk	10	2.1	33.9 ± 12.7	80	100
Spinal tuberculosis	8	1.7	50.1 ± 12.6	63	100
Syrinx	8	1.7	33.8 ± 15.8	88	100
Spondylolisthesis	8	1.7	40.5 ± 6.2	25	88
Spinal neoplasm	7	1.5	43.3 ± 18.1	57	100
Spinal canal stenosis	6	1.3	49.7 ± 9.7	67	100
Congenital spinal lesions	4	0.8	9.3 ± 13.9	100	100
Nontuberculous spinal infection	3	0.6	16.3 ± 6.4	100	100
Post-traumatic scoliosis	3	0.6	33.0 ± 40.1	100	100
Spinal hemangioma and other vascular lesions	3	0.6	43.5 ± 23.2	0	67
Myelopathy	2	0.4	43.0 ± 2.8	50	100

(Table 1). The table depicts the young age of those patients with degenerative spinal lesions and prolapsed intervertebral disks. The latter two conditions constituted 62% of all performed MRI studies or 73% of all studies that showed spinal abnormalities. The table also shows that MRI demonstrated a high rate of diagnostic accuracy in patients with radiologically normal spine and among those with most of the spinal disorders. Conversely, relatively lower diagnostic yield was linked to the recognition of spinal vascular lesions, spondylolisthesis and vertebral collapse.

All patients who eventually showed evidence of degenerative disk disease had symptoms, mainly back pain, and the clinical diagnosis established by the clinicians was primarily to rule out prolapsed disk.

In 430 patients (90%), plain radiologic studies were performed prior to the MRI studies. The diagnostic outcome of these studies as compared with the findings revealed by MRI is shown in Table 2. The table demonstrates the expected low accuracy of plain films in the diagnosis of intervertebral disk prolapse or spinal tumors and tuberculosis.

In 134 patients (28%), CT and/or CT myelograms were also performed. The comparison between the diagnostic accuracy of the CT and that of the MRI is shown in Table 3. On the whole, MRI was superior to CT and CT myelograms in the diagnosis of disk prolapse, degenerative disease of the spine and postsurgical granulation tissue. MRI was also a preferred modality to rule out spinal pathology.

While only 28% of patients who had MRI studies also had CT and/or CT myelograms, analysis of the total number of CT and/or CT myelograms during the year prior to MRI installation (155 studies) was not significantly changed during the year when the MRI machine was functioning (134 studies).

Discussion

Disorders of the back and spine are among the leading causes of disability in the working years.[1,2] The current retrospective study was intended to examine the experience gained after the first year of using a newly installed MRI machine. Also examined was the prevalence of spinal disorders in a hospital practice in Saudi Arabia and the diagnostic yields of the MRI.

Patients with spinal complaints in the current series were strikingly young with an overall mean age (± SD) of 38.7 (± 12.9) years, while those with cervical symptoms were relatively older than those with either dorsal or lumbar complaints. Also shown was the young mean age (± SEM) of 39.3 (±0.8) and 41.5 (±1) years for patients with prolapsed intervertebral disk and those with degenerative disk disease respectively. While our patients were younger than those commonly reported in Western series, this pattern probably reflects the age distribution in Saudi Arabia.

On average, patients presented with a long duration of spinal symptoms with females having significantly longer duration of lumbar spine complaints as compared with males with lumbar disorders.

TABLE 2. *Comparisons between final, plain radiologic, and magnetic resonance imaging (MRI) diagnoses.*

Final Diagnosis	No. of Patients (430)	%	% Correct Plain Radiologic Diagnosis	% Correct MRI Diagnosis
Prolapsed intervertebral disk	149	35	34	97
Degenerative disk disease	118	27	97	97
Normal study	59	13.7	75	100
Granulation tissue	29	6.7	0	100
Vertebral collapse	16	3.7	94	87
Recurrent disk	9	2.1	11	100
Spinal tuberculosis	8	1.9	38	100
Spondylolisthesis	8	1.9	88	88
Syrinx	7	1.6	0	100
Spinal neoplasm	7	1.6	28	100
Spinal canal stenosis	6	1.4	17	100
Congenital spinal lesions	4	1	100	100
Nontuberculous spinal infection	3	0.7	33	100
Post-traumatic scoliosis	3	0.7	100	100
Spinal hemangioma and other vascular lesions	2	0.5	50	100
Myelopathy	2	0.5	0	100

TABLE 3. *Comparisons between final, computed tomography and magnetic resonance imaging (MRI) diagnoses.*

Final Diagnosis	No. of Patients (133)	%	% Correct CT Diagnosis	% Correct MRI Diagnosis
Prolapsed intervertebral disk	38	29	66	97
Degenerative disk disease	31	23	48	94
Granulation tissue	16	12	6	100
Normal study	14	10.5	43	100
Vertebral collapse	9	6.7	100	89
Spinal neoplasm	5	3.7	60	100
Syrinx	4	3	50	100
Congenital spinal lesions	4	3	100	100
Recurrent disk	3	2.3	0	100
Spinal canal stenosis	2	1.5	100	100
Spinal tuberculosis	2	1.5	0	100
Nontuberculous spinal infection	2	1.5	100	100
Post-traumatic scoliosis	1	0.75	100	100
Spinal hemangioma and other vascular lesions	1	0.75	100	100
Myelopathy	1	0.75	0	100

CT=computed tomography.

Patients with degenerative spinal lesions and prolapsed intervertebral disks constituted 62% of all performed MRI studies or 73% of all studies that showed spinal abnormalities. Postoperative granulation tissue and vertebral collapse were the next most common spinal disorders, occurring in 6.5% and 3.3% of patients respectively. In 15% of patients, spinal pathology was ruled out.

Patients who eventually showed evidence of degenerative disk disease had symptoms, mainly of back pain, and the clinical diagnosis established by the clinicians was primarily to rule out prolapsed disk. We were only able to review the written request forms, as the retrospective nature of our study did not allow exploring the reasons for such clinical omission (0%). However, it is possible that for those patients where the clinicians were more confident about that diagnosis, studies other than MRI were requested. Furthermore, it is also a possibility that clinicians may have overdiagnosed disk prolapse to justify ordering MRI studies. Data to support this hypothesis cannot be obtained.

The analysis has shown that MRI demonstrated a high rate of diagnostic accuracy in patients with normal spines and in those with various spinal disorders. The perfect diagnostic function of MRI in patients with pyogenic infections of the spine (tuberculous and nontuberculous) that was shown in our series is compatible with the previously reported sensitivity (96%), specificity (92%), and accuracy (94%) of that radiologic modality.[8,13] In another study, MRI was shown to be as accurate and as (and more) specific than radionuclide scanning in the detection of disk space infection and vertebral osteomyelitis.[8] It is known that MRI can help in differentiating tuberculous from pyogenic spondylitis where the cortical definition of affected vertebrae is lost in the first, in contradistinction to the latter.[14] Furthermore, pyogenic spondylitis is usually confined to the vertebral marrow with no significant extension into the paraspinal region with infrequent epidural spread.[9]

Conversely, MRI had a low diagnostic precision in patients with spinal vascular lesions or spondylolisthesis. However, the number of patients with these two conditions was not large enough to validate any precise judgment.

Comparing MRI with plain radiography (Table 2) revealed the low diagnostic correctness of plain films in identifying prolapsed intervertebral disk, recurrent disk, spinal neoplasm or spinal canal stenosis. Also shown was the detection of only three of eight patients with spinal tuberculosis and one of three with nontuberculous spinal infections. Plain film changes usually take days to weeks to become manifest in musculoskeletal infections.[13]

The comparison between the diagnostic accuracy of the CT and that of the MRI is shown in Table 3. Largely, MRI was superior to CT and CT myelograms in the diagnosis of prolapsed disk, degenerative disease of the spine and postsurgical granulation tissue. The equivalent efficacy of both MRI and CT in delineating the margins of most soft tissue tumors, as well as in differentiating the margins of bone tumors from fat and adjacent normal bone that was shown in our series, is consistent with that reported by Richardson et al.[15] and Hudson et al.[16] However, in the latter study, the authors believed that MRI was superior to CT in delineating bone tumors from adjacent muscle. MRI was also a preferred modality to rule out any spinal pathology and to delineate the normal spinal structure. This latter ability has been known since the earlier days of employment of MRI technology.[17]

Comparing the numbers of CT and CT myelograms requested during the year prior to the installation of the MRI to the numbers requested during the year where the MRI was functioning did not show any change in the frequency of ordering CT studies. However, that conclusion may be only valid for the first year since the introduction of the new modality and we predict that the requesting preference may be altered in the following years.

MRI was only introduced recently to our hospital; therefore, cost benefit comparison of that diagnostic modality with CT or CT myelography would be inappropriate and grossly misleading. Practicing physicians and surgeons may not yet have developed the full acquaintance of the diagnostic capability and limitations of MRI; therefore, their strategy for working up their patients with spinal complaints is yet to be influenced by that new modality.

In conclusion, our hospital-based series has shown an interesting pattern for spinal disorders. The first year experience of the utilization of MRI in various spinal diseases has been satisfactory with a prevailing diagnostic superiority for that modality.

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