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MR Imaging of Multiple Sclerosis: Comparison with Clinical and CT Examinations in 74 Patients

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Magnetic resonance (MR) imaging, the latest test for evaluation of patients with multiple sclerosis (MS), was assessed against clinical evidence in 74 patients with definite or probable MS. MR imaging was positive in 55 (85%) of 65 patients with definite MS but in only one (11%) of nine patients with probable MS. The examination is most likely to be positive when the patient is classified clinically as having definite MS; when the disease is active and not in remission; and if the constellation of symptoms indicates a multiplicity of regions with neurologic dysfunction. The examination was most sensitive for detecting lesions in the cerebral hemispheres, the posterior fossa, and the cervical spinal cord, in that order; it did not detect any lesions in the optic nerves. The paraclinical tests and MR imaging were of equal sensitivity in detecting MS lesions, but the latter method was more specific in localization. Cerebrospinal fluid evaluation was slightly less sensitive than the other two tests. There was no correlation between MR imaging and these examinations. The authors conclude that MR imaging is more sensitive than computed tomography (CT), which was positive in 25% of 59 patients with definite MS; it is always positive when CT is positive; and it probably can replace CT in the diagnosis and follow-up of patients with MS.

Multiple sclerosis (MS) is a chronic relapsing disease manifested clinically by a variety of symptoms and signs. There is no definitive laboratory test to confirm the diagnosis. Diagnostic criteria for MS are clinical signs and symptoms localized to at least two anatomic regions of the central nervous system (CNS) and a clinical course of relapses and remissions separated by at least 1 month [1, 2]. Early in the course of the disease, the typical clinical pattern of MS may not be apparent; there may be evidence of only one lesion, and the pattern of remissions and exacerbations may be in doubt [1, 3]. Moreover, some patients with MS may have a slowly progressive course in which clinical evidence of two separate lesions may not be apparent. Various tests and imaging procedures have been used to detect lesions in asymptomatic areas of the CNS and thus facilitate early diagnosis [1, 3, 4]. Magnetic resonance (MR) imaging is the latest test and the most sensitive imaging procedure capable of imaging MS plaques [5–7]. We compared the results of MR imaging with the clinical findings, paraclinical tests, cerebrospinal fluid (CSF) analysis, and computed tomographic (CT) studies, thus developing a perspective of the contribution of MR imaging to the diagnosis of MS.

Subjects and Methods

Sixty-five patients (48 women, 17 men) with clinically definite or laboratory-supported definite MS were referred to the Mary Ann and James L. Knight MR Diagnostic Imaging Center at the Mt. Sinai Medical Center during the 6-month period from March 29 through September 25, 1984. The patients were 20 to 83 years of age (mean, 43.3; bimodal distribution, 34 and 39 years). The number of years that their disease was considered to have been present ranged from 1 to 32 years (mean, 9.4; mode, 3 years). Nine additional patients (7 female, 2 male) with clinically probable or laboratory-supported MS were also

studied. These patients were 25–50 years of age (mean, 37.5; mode, 31 years). The duration of their disease ranged from 1 to 21 years (mean, 5.1; mode, 1 year). The criteria used in the clinical diagnosis and classification are outlined in table 1 [2].

The patients were examined on a Siemens Magnetom MR imager using a 0.5 T superconducting magnet operated at 0.35 T and a 25-cm-diameter head coil. Three multislice, 10-mm-thick, T1-weighted, sagittal scout images of the head and neck were obtained using a spin-echo (SE) sequence with a repetition time (TR) of 0.3 sec, an echo delay (TE) of 35 msec, and two-pulse averaging (total time, 2.56 min). The midsagittal image was chosen for planning and localizing the axial images of the brain and optic nerves. After localization, the axial images were acquired using a multislice, interlaced, T2-weighted, SE acquisition sequence with a TR of 1.5 sec and dual TE of 35 and 70 msec. Seven 10-mm-thick axial images were obtained with 10-mm spacing between images. The spacing was filled in by the interlacing so that 14 contiguous axial images were available at each echo delay. The images were acquired using a 256 × 256 matrix, reconstructed by a two-dimensional fast-Fourier transform, and visualized on a CRT terminal with a 256 × 256 display matrix. Two-pulse averaging was used so that one set of seven multislice images was available in 12.8 min or a complete interlaced examination in 25.6 min.

The MR examination was considered positive if there were one or more areas of increased signal intensity greater than 3 mm in diameter whose relative intensity became greater on the images obtained with the delayed echo (long T2 relaxation) [6, 8, 9].

The cervical spinal cord was evaluated on the T1-weighted scout projection of the head obtained with the 25-cm-diameter head coil. The spinal cord was visualized to the level of the seventh cervical segment in 46 patients. If the T1-weighted images were abnormal or if MR evaluation of the cervical cord was specifically requested, T2-weighted sagittal images were obtained with the same acquisition sequence as described for the axial images of the brain.

MR evaluation of the cervical spinal cord was considered positive if on the T1-weighted images there were one or more areas of decreased signal intensity whose size was 3 mm or more in diameter or if on the T2-weighted images there were similar areas of increased intensity [10]. The study was also considered to be positive if there was evidence of spinal cord atrophy (fig. 1). This was determined by measuring the midsagittal diameter at each segment level on the T1-weighted midsagittal images and comparing them with published normal values for the cervical cord [11]. If the measured values were less than normal, the patient was considered to have cord atrophy.

Using the above criteria the incidence of positive MR findings was determined in the group of patients with definite MS and in the smaller group of patients with probable MS. Those patients with positive MR studies were further subcategorized in each clinical group according to the location of the lesions; the duration of the disease; the number of lesions demonstrated; and whether the disease was active or in remission.

A patient's neurologic dysfunction was localized on the clinical examination [1] and grouped into four anatomic regions: the optic nerves (in patients with optic neuritis); the cerebrum (in patients with inappropriate affect, memory deficits, deficiencies in language skills, etc.); the posterior fossa, including the brainstem and/or cerebellum (in patients with intranuclear ophthalmoplegia, nystagmus, facial myokymia, ataxia, etc.); and the cervical spinal cord (in patients with disturbances of proprioception, the corticospinal tract, or the urinary bladder).

A positive MR study was correlated with the number of anatomic regions clinically symptomatic. The anatomic location of the lesions as demonstrated by MR imaging was correlated with the clinically

TABLE 1: Classification of MS*

Category: Diagnostic Criteria
Clinically definite MS:
Two attacks at least 1 month apart with clinical evidence of two separate lesions
Two attacks at least 1 month apart with clinical evidence of one lesion and paraclinical evidence of another lesion
Laboratory-supported definite MS:
Two attacks at least 1 month apart with clinical or paraclinical evidence of one lesion and a positive laboratory test on the CSF
One attack with clinical evidence of two separate lesions and a positive laboratory test on the CSF
One attack with clinical evidence of one lesion, paraclinical evidence of another lesion, and a positive laboratory test on the CSF
Clinically probable MS:
Two attacks with clinical evidence of one lesion
One attack with clinical evidence of two separate lesions
One attack with clinical evidence of one lesion and paraclinical evidence of another lesion
Laboratory-supported probable MS:
Two attacks and a positive laboratory test on the CSF

Note.—MS = multiple sclerosis; CSF = cerebrospinal fluid.
* Abstracted from [2].

localized lesions in 59 patients to determine whether there was MR-clinical concurrence. Similarly, the focal neurologic findings on the clinical examination were correlated with the location of the lesions on the MR study to determine whether there was clinical-MR concurrence.

The paraclinical tests included visual evoked responses, brainstem auditory evoked responses, somatosensory evoked responses, and a urodynamic assessment [3, 4]. If any one of these tests was abnormal, the patient was considered to have paraclinical evidence of MS.

The CSF was analyzed for oligoclonal bands, increased production of immunoglobulin G, and myelin basic protein. If any of these were abnormal, the patient was considered to have laboratory-supported evidence of MS [2, 3]. The results of the paraclinical tests and the CSF analysis were correlated with the results of the MR examination.

CT examinations were performed both plain and with contrast enhancement (100 ml Vascoray given by intravenous bolus) on a third-generation scanner (GE 8800). The CT scans were obtained between 2 weeks before and 1 week after the MR study. A CT examination was considered to be positive if there were hypodense lesions on the unenhanced scan and/or enhancing lesions on the contrast phase of the study [12–14]. The results of CT examinations in 59 patients with definite MS and eight patients with probable MS were available for comparison with the MR images. A positive or negative CT was correlated with the number of lesions present on MR imaging.

Results

Sensitivity of MR Imaging

MR imaging was positive in 55 (85%) of 65 patients with definite MS. In the positive group, two patients had one lesion, two had two lesions, and 51 had three or more lesions. One (11%) of 9 patients with probable MS had a positive MR study, which demonstrated two lesions.

Fig. 1.—36-year-old man with definite MS for 4 years, with neurologic dysfunction localized to cervical spinal cord. Disease was in remission at time of MR imaging. **A,** SE scan, TR 1.5 sec, TE 35 msec. Sagittal diameter of midcervical cord is smaller than adjacent superior and inferior portions of cord. Absolute dimensions are below normal; overlay (**B**) shows measurements obtained on monitor in comparison with normal values (in parentheses). **C,** SE scan, TR 1.5 sec, TE 35 msec. Axial image of brain at level of centrum semiovale demonstrates at least two other lesions (*arrows*), whose relative intensity becomes greater on more heavily T2-weighted, second-echo image (**D;** TR 1.5 sec, TE 70 msec).

A

B

C

D
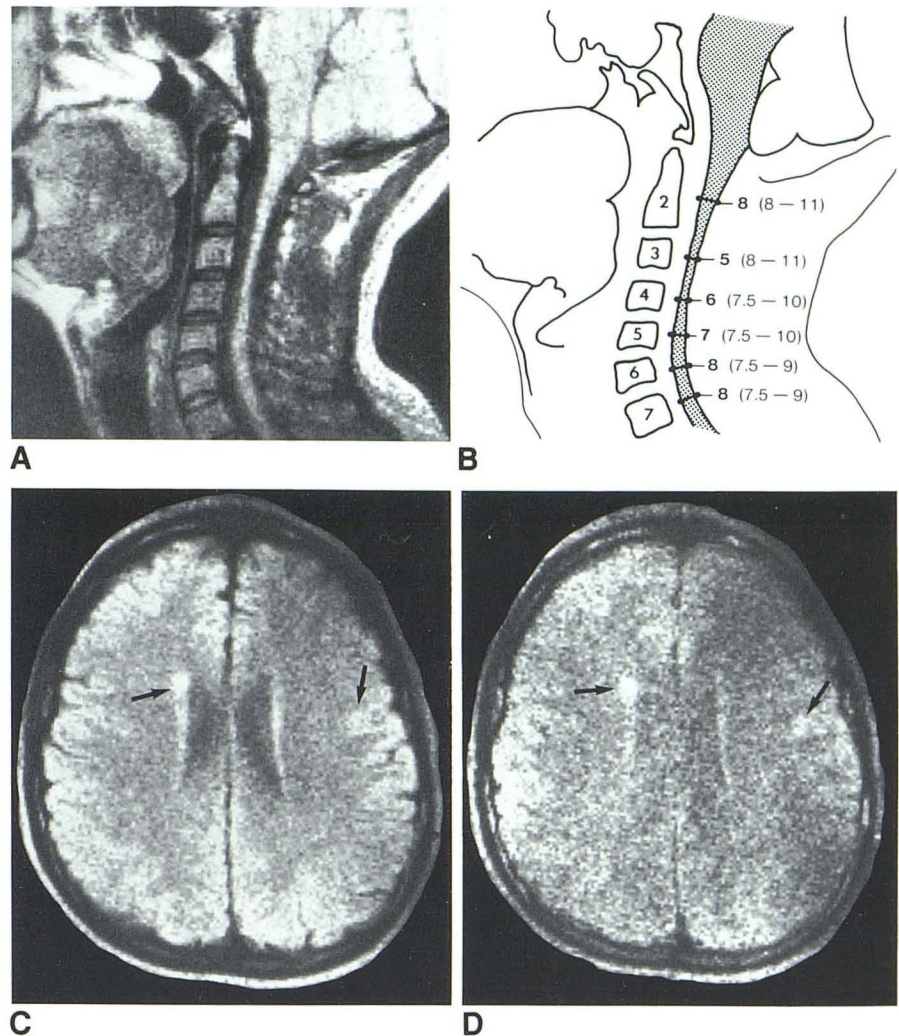
Location of Lesions

Lesions were located in the cerebral hemispheres in all 55 patients with definite MS and in the one MR-positive patient with probable MS. Twenty-four (44%) of the 55 patients with definite MS had concomitant lesions in the posterior fossa. The lesions in the cerebral hemispheres were most often contiguous with the ventricles but were also located in the anterior and posterior forceps, in the subcortical white matter, in the internal capsule, and in the temporal lobes. Their appearance was either discrete or confluent. The posterior fossa lesions were located predominantly in the brainstem (mainly the pons) and infrequently in the cerebellum.

In 46 patients, MR visualization of the cervical cord was obtained in the midsagittal plane to the level of the seventh cervical segment. The study was abnormal in nine (20%) of these patients. One patient with a normal T1-weighted study demonstrated a high-intensity lesion on the T2-weighted examination (fig. 2). Eight patients demonstrated cord atrophy. Five of these patients had concomitant lesions confined to the cerebral hemisphere and four had lesions in the cerebrum and the posterior fossa.

Lesions could not be demonstrated on MR imaging in the optic nerves of any of the patients with definite or probable MS, even in the 34 patients clinically considered to have optic neuritis.

Duration of Disease

Information as to the number of years a patient was considered to have definite MS was available in 62 of 65 patients (table 2). The MR examination was positive in 20 (71%) of 28 patients who had had the disease for 6 or fewer years and in all 34 patients who had had the disease for 7 or more years. The duration of the disease was also correlated with the number of patients having one, two, or three or more lesions (table 2).

MR imaging was positive in only one of four patients with probable MS who had had their disease for 1 year or less.
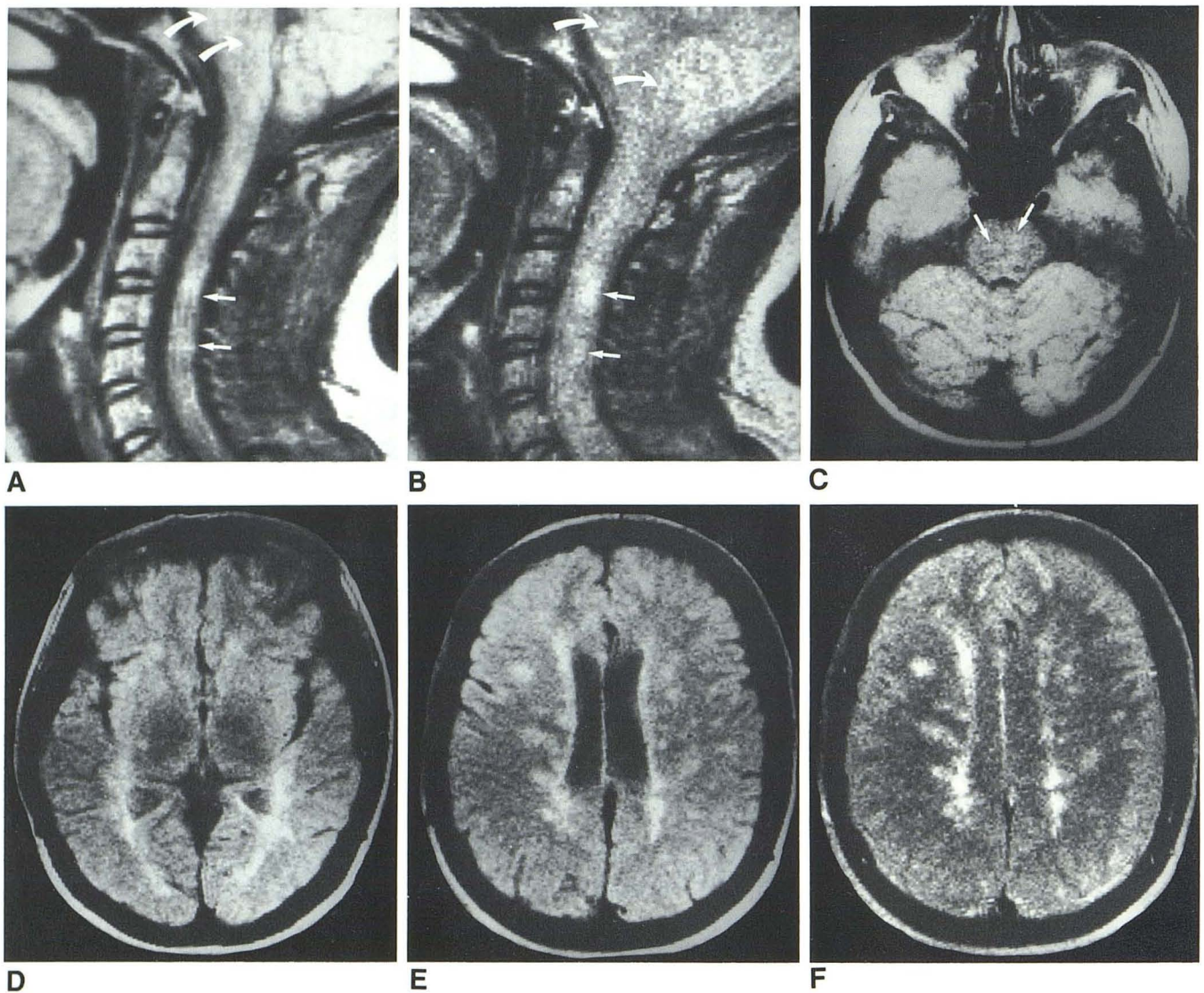
Fig. 2.—39-year-old woman with definite multiple sclerosis for 2 years. Patient was hospitalized with acute attack, with neurologic dysfunction localized to cervical cord at time of MR imaging. **A,** Moderately T2-weighted image (TR 1.5 sec, TE 35 msec) of cervical cord reveals high-intensity signals compatible with MS plaques (*straight arrows*). Lower pons and medulla demonstrated on this image also revealed plaques (*curved arrows*). There is relative increase in intensity of lesions on more heavily T2-weighted image (**B**; TR 1.5 sec, TE 70 msec). Lesions in lower pons are seen again on axial image (*arrows*, **C**; TR 1.5 sec, TE 35 msec). Other axial images (**D** and **E**: TR 1.5 sec, TE 35 msec; **F**: TR 1.5 sec, TE 70 msec) reveal other areas of white-matter involvement.

TABLE 2: **Duration of Disease Compared with MR Imaging Findings in 62 Patients with Definite MS**

| Duration of Disease (years)	No. of Patients	MR Imaging Findings: No. (%) of Patients			
		Positive for MS	1 Lesion	2 Lesions	3 or More Lesions
1–2	9	4 (44)	1	...	3
3–4	10	9 (90)	...	1	8
5–6	9	7 (78)	...	...	7
7–10	9	9 (100)	...	1	8
11–15	6	6 (100)	...	...	6
16–20	10	10 (100)	1	...	8
21–25	5	5 (100)	...	...	5
25–32	4	4 (100)	...	...	4

Note.—MR = magnetic resonance; MS = multiple sclerosis.

The MR study was normal in five other patients with probable MS, two whose disease had been present for 3 years and three whose disease had been present for 7, 8, and 21 years, respectively.

Activity of Disease

Fifty-one patients had definite MS that was in remission at the time of MR imaging; of these, 42 (82%) had a positive study. Fifteen other patients were having an acute exacerbation of their disease at the time of MR imaging; of these, eight required hospitalization and seven were treated as outpatients. Fourteen (93%) of the 15, including all of the

Fig. 3.—60-year-old woman with definite MS for 26 years, with history of optic neuritis and of neurologic dysfunction localized to cerebral hemispheres. **A** and **B**, T2-weighted (TR 1.5 sec, TE 35 msec) axial images obtained when disease was in remission. Focal areas of high signal intensity (*arrows*) in centrum semiovale and periventricular region are consistent with demyelination. **C** and **D**, T2-weighted images 3 months later, during acute exacerbation of disease, reveal enlargement of existing plaques (*arrows*) and presence of new plaques (*arrowheads*).
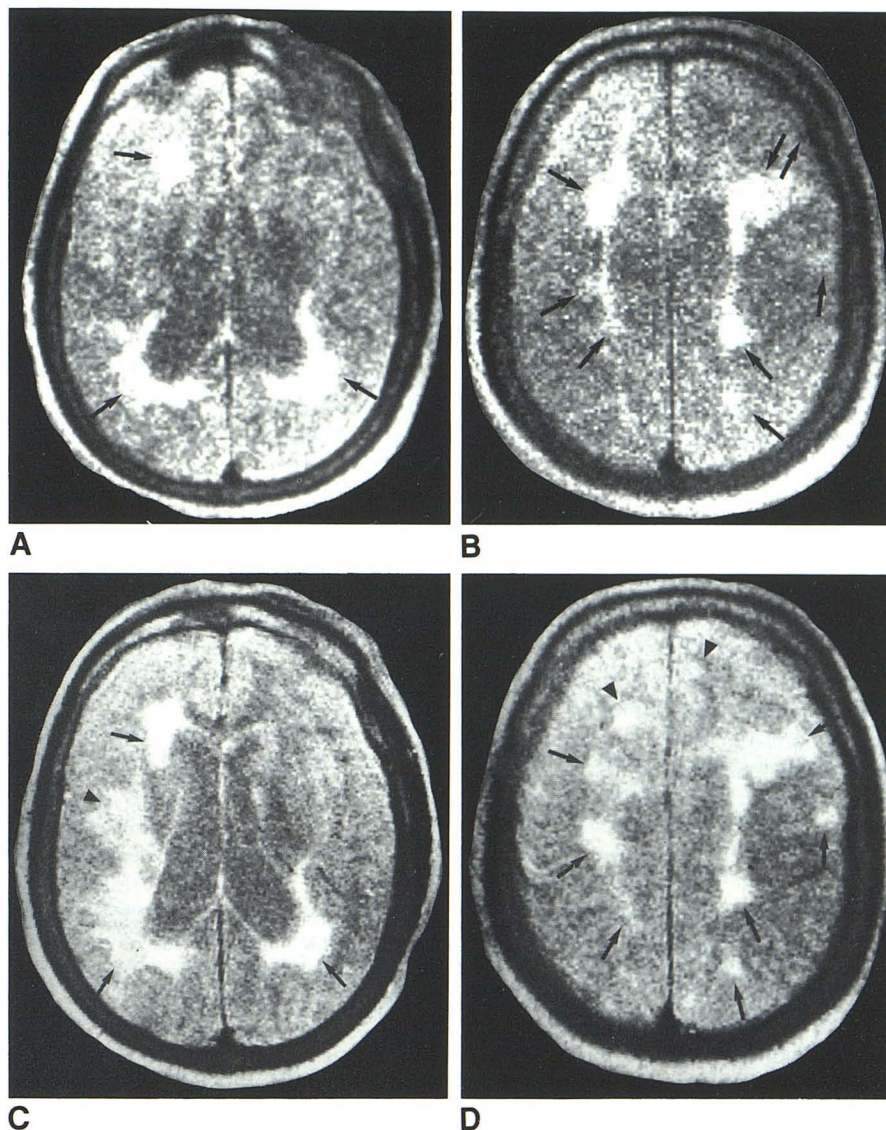
eight hospitalized patients, had a positive MR study. It was not possible to differentiate on the basis of a single MR examination whether a patient was in remission or having an acute attack. However, one patient studied during an acute exacerbation had had a previous study while in remission, which was available for comparison (fig. 3). In this patient, the number and size of the lesions were larger during the acute attack.

Five of the nine patients with probable MS were in remission, one of whom had a positive MR study. The other four patients in this group were having an acute attack, and all four had a normal MR examination.

Correlation with Clinical Lesions

The patients' neurologic dysfunctions were clinically localized to four anatomic regions; this information was available in 59 patients with definite MS. Thirty-four patients had optic neuritis, 31 had symptoms localized to the cerebral hemispheres, 47 had symptoms localized to the posterior fossa (brainstem or cerebellum), and 34 had symptoms localized to the cervical spinal cord. MR evaluation was positive in seven (78%) of nine patients with a single clinical lesion, 18 (82%) of 22 patients with two clinical lesions, 19 (87%) of 22 patients with three clinical lesions, and all six patients with four clinical lesions.

The MR location of the lesions was compared with the clinical localization to determine whether there was MR-clinical concurrence and to determine whether there were lesions in anatomic regions that had no referable clinical symptoms (clinical false negatives or subclinical lesions). The results are shown in table 3.

The clinical location of the lesion was compared with the MR findings to determine where there was clinical-MR con-

TABLE 3: **MR vs. Clinical Localization of Lesions in 59 Patients with Definite MS**

Anatomic Region	No. (%) of Patients		
	MR Locali- zation	MR-Clinical Concurrence	Clinical False Negative for MR Locali- zation
Optic nerves	0	...	...
Cerebrum	51	28 (55)	23 (45)
Posterior fossa*	24	20 (83)	4 (17)
Spinal cord	9	6 (67)	3 (33)

Note.—MR = magnetic resonance; MS = multiple sclerosis.
* Includes brainstem and cerebellum.

TABLE 4: **Clinical vs. MR Localization of Lesions in 59 Patients with Definite MS**

Anatomic Region	No. (%) of Patients			
	Clinical Locali- zation	Clinical-MR Concurrence	MR False Negative for Clinical Locali- zation	MR Positive in Other Anatomic Regions
Optic nerves	34	...	34 (100)	30 (89)
Cerebrum	31	28 (91)	3 (9)	18 (58)
Posterior fossa*	47	20 (43)	27 (57)	40 (86)
Spinal cord	34	6 (18)	28 (82)	31 (92)

Note.—MR = magnetic resonance; MS = multiple sclerosis.
* Includes brainstem and cerebellum.

currence, whether there were MR false negatives, and whether other anatomic regions showed evidence of disease. The results are shown in table 4.

Paraclinical Tests

The results of paraclinical tests were available in 38 patients with definite MS and eight patients with probable MS. Thirty (79%) of the 38 patients with definite MS had a positive paraclinical test; MR was positive in 26 (87%) of these and in six (75%) of the eight with a normal paraclinical test. Four of the eight patients with probable MS had a positive paraclinical test, but all four of these as well as the four with a normal paraclinical test had a normal MR study.

CSF

The laboratory results of CSF analysis were available in 35 patients with definite MS; of these, 26 (74%) had a positive CSF examination. MR imaging was positive in 21 (84%) of the 25 patients with a positive CSF evaluation and in eight (89%) of the nine patients with a normal CSF study. The CSF results were available in six patients with probable MS; of these, MR imaging was positive in one of four patients in whom the CSF was normal and normal in the two patients in whom the CSF was abnormal.

CT

The CT findings were compared with the MR findings in 59 patients with definite and eight patients with probable MS (table 5). CT was positive in 15 (25%) and MR imaging in 49 (83%) of the 59 patients in the definite MS group. MR demonstrated fewer than three lesions in five patients each and three or more lesions in 44 patients. The 15 patients with positive CT studies were in the latter group. When CT was positive, MR imaging showed three or more lesions and in all instances revealed more lesions than did CT. CT was normal in all eight patients with probable MS, one of whom had a positive MR study showing two lesions.

Discussion

The clinical factors determining whether MR imaging will be positive for MS appear to be several. The dominant factor

TABLE 5: **MR Imaging Compared with CT in 59 Patients with Definite and Eight Patients with Probable MS**

MS Classification	CT Positive*	CT Negative	Total
Definite MS:			
MR normal	0	10	10
MR positive:			
One lesion	0	3	3
Two lesions	0	2	2
Three or more lesions	15	29	44
Total	15	44	59
Probable MS:			
MR normal	0	7	7
MR positive:			
One lesion	0	0	0
Two lesions	0	1	1
Three or more lesions	0	0	0
Total	0	8	8

Note.—MR = magnetic resonance; MS = multiple sclerosis.
* CT was considered positive if there were one or more regions of hypodensity on the unenhanced scan, with or without enhancement of the same or other regions on the contrast-enhanced scan.

seems to be whether or not the patient fulfills the criteria for the diagnosis of definite MS. If the patient is in this category, the duration of the disease, the activity of the disease, and the clinical location of the lesions become factors.

MR imaging was more likely to be positive in patients with definite MS (55 of 65) than in those with probable MS (one of nine). In the former group, the examination was more likely to be positive in those patients whose disease was longstanding, who had active disease, and who had clinical signs of multifocal neurologic dysfunction. There was no correlation with any of these factors in the patients with probable MS.

In patients with active disease, it was not possible to determine on the basis of a single MR evaluation whether the patient was in remission or having an acute attack. However, if serial studies were available for comparison, an increase in the size and number of existing lesions would indicate active disease [15]. One of the patients in our series was examined first while in remission and again several months later at the time of an acute attack (fig. 3). In this case, the images obtained at the time of the relapse showed an increase in the number and size of existing lesions.

MR imaging with a T2-weighted image acquisition sequence was very sensitive for plaques located in the cerebral

hemisphere [6, 9]. All of our positive MR examinations demonstrated lesions in this location. In cases where clinical findings indicated a cerebral hemisphere lesion, MR demonstrated the cerebral plaques accounting for the symptoms in 91% (table 4). However, 44% of patients with cerebral plaques demonstrated on MR images did not have symptoms referable to the cerebral hemispheres (table 3). The probable explanation for this is that the plaques usually occur in cerebral association areas that tend to be clinically silent [1, 16]. Also, there probably is some recovery and resumption of conduction in axons that were blocked at the time of the acute attack so that at the time of MR imaging, the lesion is not causing clinical symptoms [1, 3, 14].

MR imaging with a T2-weighted image acquisition sequence is relatively insensitive for lesions in the brainstem and cerebellum. Only 43% of patients with clinical symptoms localized to the brainstem or cerebellum had posterior fossa lesions demonstrated on MR imaging (table 4). However, if a lesion was imaged in the posterior fossa (table 4), the patient usually had clinical symptoms (83%). The relative insensitivity of MR imaging to clinical signs of brainstem and cerebellar dysfunction is probably due to the presence of lesions that are small, perhaps even microscopic [16, 17], but which may cause severe neurologic deficits when strategically located. Small macroscopic lesions may be beyond the resolution of even current state-of-the-art MR imagers obtaining thinner sections than in this study.

No attempt was made to evaluate other pulsing sequences, and only T2-weighted images were obtained. A recent report confirms that this sequence is very sensitive for cerebral plaques, but that an inversion-recovery sequence emphasizing T1 relaxation may be more sensitive for posterior fossa lesions [9].

Thirty-four patients clinically had optic neuritis, but the optic nerves on MR imaging were normal in all of these patients. MS lesions in this location would be small and beyond the resolution of our imaging system, which used 10-mm-thick slices. Although plaques were not imaged within the optic nerves, 89% of the patients had lesions demonstrated in other locations on the MR study. Patients with MS often present with optic neuritis, so it is not surprising that MR imaging demonstrated subclinical lesions elsewhere in the CNS (fig. 2).

Only the cervical segment of the spinal cord could be evaluated by the 25-cm-diameter head radiofrequency coil. We attempted to evaluate the thoracic and lumbar segments of the cord with the larger (50-cm-diameter) radiofrequency coil used for body imaging. However, because of the lower signal-to-noise ratio inherent in the larger-diameter radiofrequency coil, the images of the thoracic and lumbar cord were not of sufficient quality to permit adequate evaluation.

The length of the cervical cord was evaluated in the sagittal projection. This was more difficult to accomplish in the coronal plane because of the normal cervical lordosis, and this projection was not used. Because of the long time required to obtain images of both the brain and the spine, a screening survey of the cervical cord was performed on the T1-weighted sagittal scout images obtained to plan the brain examination. Low-

intensity lesions described for MS plaques were not demonstrated, even in the eight patients with cord atrophy or in the one patient with a high-intensity lesion demonstrated on the T2-weighted image. The low-intensity T1 changes may have been masked by the not insignificant T2 effect associated with the 30-msec echo used in obtaining the T1-weighted scout images (TR 0.35 sec, TE 30 msec). Intraspinal plaques are better visualized on T2-weighted images [10] when the TR and TE are chosen to take advantage of the long T1 and T2 relaxation of the lesions (fig. 3).

Thirty-four patients had clinical symptoms indicating cord dysfunction, but MR imaging revealed lesions in only 18% of this group (table 4). Five demonstrated atrophy, a condition that has been described to involve the brain and less often the spinal cord in patients with MS [16]. There probably would have been a better MR-clinical correlation for cord dysfunction if thinner (5-mm) sections had been obtained to decrease partial-volume effect and if T2-weighted images had been used to evaluate the spine in all patients [10].

The sensitivity of MR imaging was correlated with that of other tests when the results of those examinations were available. MR imaging was positive in 85%, the paraclinical tests in 79%, CSF analysis in 74%, and CT in 25%. The results of the paraclinical tests were combined in this study [2]. If any one of these tests was positive, the patient was considered to have paraclinical evidence of MS. The tests are reported in the literature as the evoked-response tests [3] and the urodynamic assessment [4]. The evoked-response tests consist of three studies: The visual evoked response can reveal subclinical involvement of the optic nerve, the chiasm, and sometimes the retrochiasmal area; the brainstem auditory evoked response evaluates the brainstem; the somatosensory evoked response evaluates the sensory pathways of the spinal cord to the cerebral hemispheres. Reports in the literature indicate that at least one of the evoked potentials will be positive in 88% of patients with definite MS [3]. The urodynamic assessment is a cystometric evaluation of the urinary bladder. It evaluates the innervation of the urinary bladder from the sacral plexus through the pontine mesencephalic reticular formation to the cortical micturition centers. This examination has been reported to be positive in up to 96% of patients with definite MS, even in those without clinical evidence of urinary symptoms [4].

The paraclinical tests, although nonspecific and crude in terms of precise localization, can detect subclinical abnormality in the CNS. Other reports as to the sensitivity of these tests [3, 4] and our own results indicate that these tests areas sensitive as MR imaging in detection of subclinical evidence of disease. MR imaging, however, allows direct visualization of the plaques. It is noteworthy that MR imaging was positive in 87% of patients with an abnormal paraclinical test and 75% of patients with normal paraclinical tests. Thus, the results of the paraclinical tests do not closely predict the results of the MR examination. The paraclinical tests predominantly evaluate the optic nerves, the brainstem, and the spinal cord. Subtle changes in axon conduction potentials in these regions caused by microscopic disease as well as larger lesions can be readily detected by the evoked-response tests

when beyond the resolution of the MR examination. As previously indicated, MR imaging is not sensitive for evaluating the optic nerves nor very sensitive for the spinal cord and the brainstem. The paraclinical tests therefore appear to be complementary in that they evaluate the entire sensory pathway without focality [4, 18], whereas MR imaging gives direct visualization of the lesion when detectable.

Abnormalities in the CSF were detected in 74% of our patients with definite MS in whom laboratory results were available, in comparison with 81% reported in the literature [3]. There was no correlation between the results of the CSF evaluation and MR imaging, since the latter was positive in 84% of patients with an abnormal CSF and 89% with normal CSF analyses.

CT was the only method available for demonstrating MS plaques before the advent of MR imaging. Detection of plaques has been reported as 18%–47% in various series [12–14]. In our series, 25% of the patients with definite MS and none of the patients with probable MS had plaques demonstrated on CT. In the same two groups, MR imaging was positive in 83% of the patients with definite MS and one patient with probable MS. This indicates a markedly greater sensitivity of lesion detection than has been reported previously [5–7]. In all instances when CT was positive, MR imaging was also positive, revealed more lesions than did CT, and demonstrated three or more plaques. We conclude that MR imaging probably can replace CT in the diagnosis and follow-up of patients with MS.

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