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Magnetic resonance in multiple sclerosis

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Summary. Magnetic Resonance Imaging was performed in more than 200 patients with clinical suspicion or knowledge of Multiple Sclerosis. One hundred and forty-seven (60 males and 87 females) had MR evidence of multiple sclerosis lesions. The MR signal of demyelinating plaques characteristically has prolonged T 1 and T 2 relaxation times and the T 2-weighted spin-echo sequences are generally superior to the T 1-weighted images because the lesions are better visualized as areas of increased signal intensity. MR is also able to detect plaques in the brainstem, cerebellum and within the cervical spinal cord. MR appears to be an important, non-invasive method for the diagnosis of Multiple Sclerosis and has proven to be diagnostically superior to CT, evoked potentials (EP) and CSF examination. In a selected group of 30 patients, with the whole battery of the relevant MS studies, MR was positive in 100%, CT in 33,3%, EP in 56% and CSF examination in 60%. In patients clinically presenting only with signs of spinal cord involvement or optic neuritis or when the clinical presentation is uncertain MR has proven to be a very useful diagnostic tool for diagnosis of MS by demonstrating unsuspected lesions in the cerebral hemispheres.

Key words: Magnetic resonance - Multiple sclerosis

The sensitivity of Magnetic Resonance (MR) in detecting plaques in the Central Nervous System has been reported in the early clinical experience and subsequently confirmed by several authors [1-6].

The more convenient MR parameters for visualization of plaques in the supratentorial compartment, posterior fossa or spinal cord have been evaluated [6-8].

There is a general consensus that MR is the most sensitive modality in the diagnostic protocol of MS. We report our experience and our MR results based on the examination of more than 200 patients.

Our interest was not merely that of verifying the already known capabilities of MR in detecting plaques nor in describing their MR appearance, but more to compare the sensitivity of MR with respect to other examinations such as CSF examination, evoked potentials and computed tomography.

We have concentrated our analysis on a restricted homogeneous group of 30 patients (13 males and 17 females) with clinically suspected and MR proven MS, that had the whole range of diagnostic tests.

Materials and methods

Between October 1983 and June 1984 a total of 800 patients were examined for diagnosis of brain or cervical spinal cord lesions with a 0.15 T resistive system (Philips Gyroscan R). The system was replaced in October 1984 with a 0.5 T superconductive unit (Philips Gyroscan S 5).

Until January 1985 1400 patients were examined for diagnosis of CNS diseases. Among the total number of patients, more than 200 were referred with a clinical suspicion or knowledge of MS.

Both units were capable of performing inversion recovery (IR) and spin echo (SE) sequences. In the superconductive system multiple echoes (ME) were available and, more recently, a multislice program. Pulse sequences used in the multiple echoes (ME) usually had a repetition time (TR) varying from 500 to 800 ms with an echo time (TE) from 50 to 200 ms. Four images were usually obtained in the ME sequences. Inversion recovery images, with a time delay (TD) of 400 ms, TR of 1400 ms and TE of 50 ms

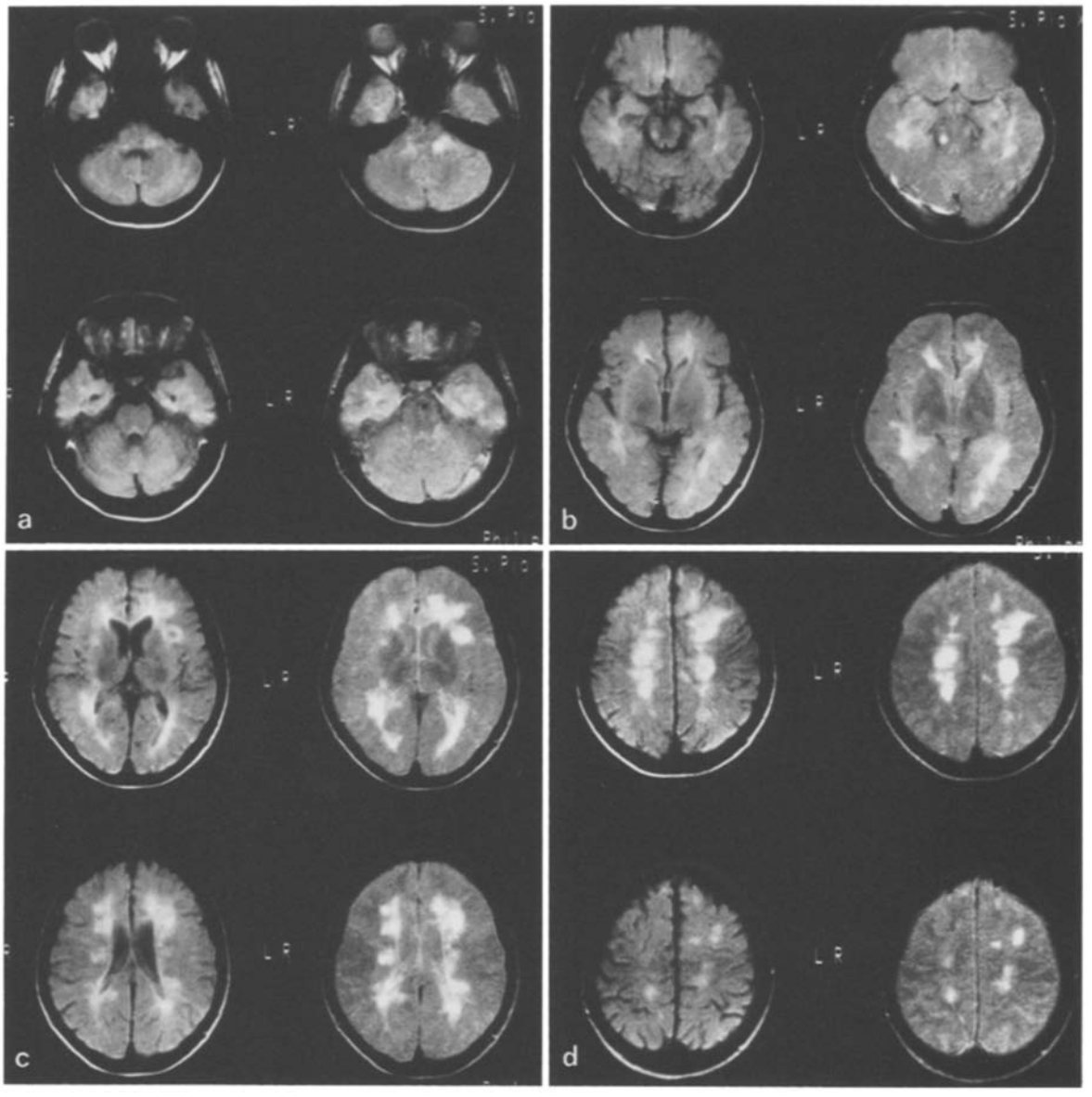

Fig. 1 a–d. Magnetic Resonance of the brain in a patient with Multiple Sclerosis. Axial contiguous slices, 10 mm thick, acquired with a SE multislice program, with a TR of 1050 ms, TE of 50 and 100 ms (two echoes). Long T 2 areas (demyelinating plaques) are demonstrated in the pons, midbrain and white matter of both cerebral hemispheres. The plaques are better seen in the more T 2 weighted images (second echo) as areas of higher signal intensity than the normal white matter

were obtained only in the patients studied with the resistive system.

Pictures were acquired on 256 × 256 matrix. Slice thickness varied from 6 to 8 mm.

The routine examination consists of axial slices from the foramen magnum up to the vertex and sagittal slice through the midline including the cervical spinal cord. Coronal slices were also frequently obtained in the pertinent position.

Results

MR examination was positive for the presence of demyelinating plaques in 147 patients. Eighty-three were diagnosed with the resistive system and sixty-four with the superconductive. There were 60 males and 87 females; mean age was 35.6 years (range 12–59).

The number of plaques varied from 1 to 2 in 13 patients, from 3 to 5 in 48 patients and more than 5 in 86 patients (Fig. 1). In 11 patients plaques were

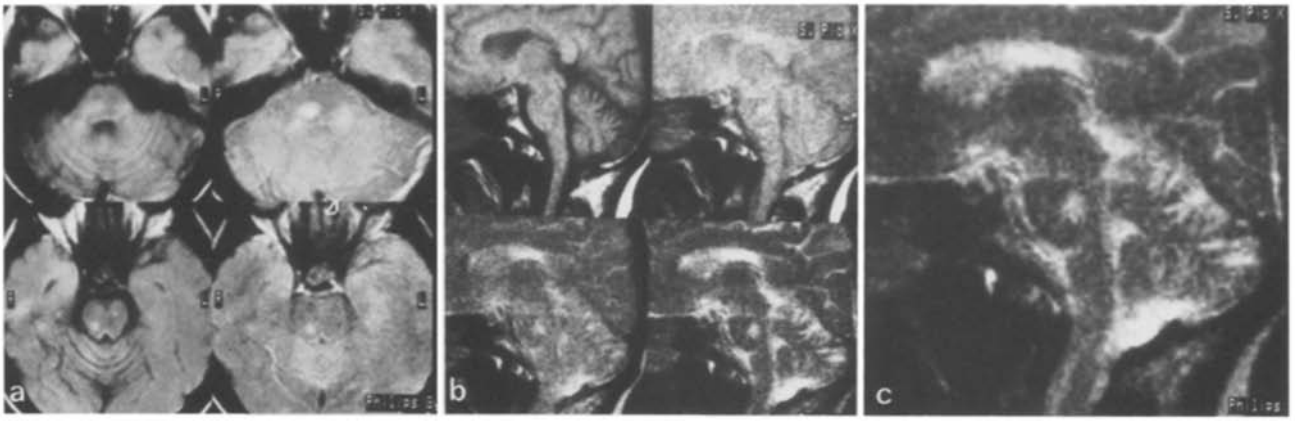

Fig. 2 a–c. Axial and sagittal demonstration of a brain stem plaque involving both the pons and the midbrain. The axial slices are acquired with a multislice program two echoes, TR 1050 ms, TE 50 and 100 ms. The sagittal slice is acquired with a multiecho program, TR 500 ms, TE 50, 100, 150 and 200 ms. Picture 2 C is an enlargement of the fourth echo (TR 500 ms, TE 200 ms)

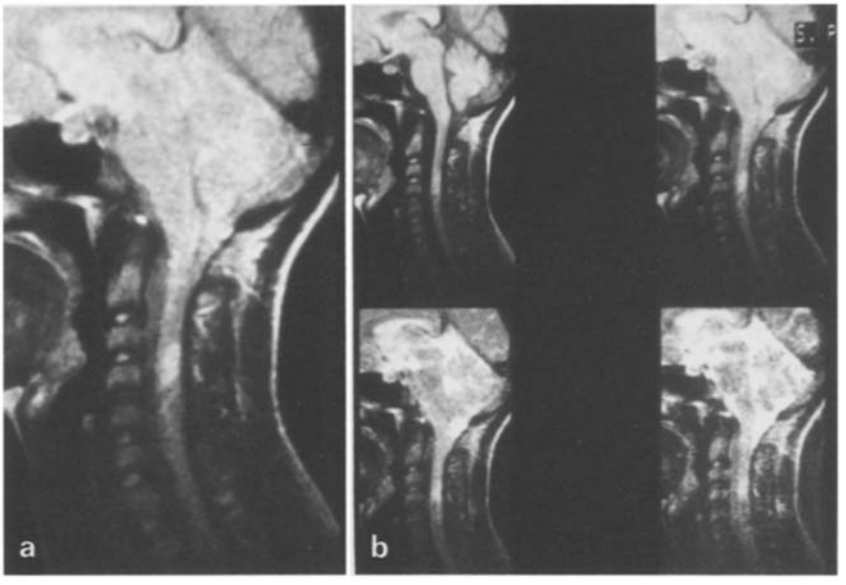

Fig. 3 a and b. Large demyelinating plaque in the cervical cord in a patient with proven MS. Sagittal view acquired with a multiecho program (TR 600 ms, TE 50, 100, 150 and 200 ms). Picture **a** is an enlargement of the first echo; **b** four echoes (live)

detected in the brainstem (Fig. 1 and Fig. 2) and in 3 patients in the cervical spinal cord (Fig. 3).

The MR signal of demyelinating plaques characteristically has prolonged T1 and T2 relaxation times. In the inversion recovery and in the T1-weighted spin echo sequences the lesions appear as areas of low signal intensity (black) contrasting with the surrouding higher intensity of the white matter; in the T2-weighted spin echo sequences they are better visualized as areas of increased signal intensity (white).

The T2-weighted images are generally superior to the T1-weighted sequences because the increased signal intensity of lesions facilitates their differentiation from surrounding normal areas and areas that appear normal in T1-weighted sequences show pathological findings on corresponding T2-weighted ones [5, 6, 8].

The distribution of lesions in MS show a predilection for the periventricular white matter. Advances in the resolution of MR and the use of surface coils, now becoming available, should allow visualization of dorsal spinal cord and optic nerve lesions, but our experience is still limited.

As other authors [3, 5, 6, 9] we have found no significant correlation between patient age, length of history and severity of symptoms and MR findings. The lesions seen at MR did not always correlate well with their localization by neurological examination and a great number of asymptomatic lesions were visualized.

In the group of 30 patients for whom the full range of diagnostic tests (CSF examination for oli-

Table 1.

Case	Sex	Age	Onset	Duration of symptoms	Clinical course	CSF	EP	CT	MR
1 BC	M	31	spinal cord	3 years	relapsing	+	VEP−	−	++
2 CF	M	24	post. fossa	4 years	relapsing	+	VEP+, BAEP+	−	++
3 LF	M	18	brain	11 months	relapsing	+	VEP+	+	+++
4 RA	F	42	spinal cord	2 months	relapsing	+	VEP+, BAEP+	−	++
5 DN	F	32	spinal cord	3 years	relapsing	+	VEP−, BAEP−, SSEP−	+	+++
6 DF	F	23	brain	7 months	progressive	−	VEP+	+	+
7 BN	F	23	brain	4 years	relapsing	−	VEP−	−	++
8 CF	F	30	post. fossa	-	progressive	+	VEP−	+	+++
9 GB	M	40	post. fossa	4 years	progressive	+	VEP−, BAEP−	−	+++
10 CG	F	54	spinal cord	2 years	progressive	−	VEP−	−	+++
11 CF	F	35	optic nerve	3 years	progressive	+	VEP+, BAEP−, SSEP−	−	+++
12 TA	F	25	brain	4 years	progressive	−	VEP−	+	++
13 SR	M	35	brain	11 years	progressive	+	VEP+, BAEP+	+	+++
14 TM	F	42	spinal cord	19 years	progressive	+	VEP+	−	+++
15 GG	M	44	spinal cord	4 years	relapsing	+	VEP−	−	++
16 TR	F	36	spinal cord	10 years	relapsing	+	VEP+	−	+++
17 TV	F	36	optic nerve	1 month	relapsing	−	VEP−	−	++
18 AM	F	38	brain	4 years	progressive	−	VEP+, BAEP+	+	+++
19 PM	F	21	brain	2 years	relapsing	−	VEP−, BAEP−, SSEP−	−	+
20 BA	M	53	spinal cord	12 years	progressive	+	VEP−, SSEP−	−	++
21 FW	M	24	spinal cord	1 year	progressive	−	VEP+	−	+
22 GR	M	45	brain	-	relapsing	+	VEP+, BAEP+	+	+++
23 MG	M	48	post. fossa	-	progressive	−	VEP+, BAEP+, SSEP+	+	+++
24 MR	F	45	spinal cord	13 years	progressive	−	VEP−	−	+++
25 MG	M	45	spinal cord	5 years	relapsing	−	VEP+	−	+++
26 RG	M	43	spinal cord	5 years	relapsing	+	VEP+	−	+
27 LM	F	24	optic nerve	9 years	relapsing	+	VEP+, BAEP+	+	+++
28 DE	M	45	spinal cord	8 years	progressive	−	VEP+	−	+++
29 MV	F	48	brain	-	-	+	VEP+	−	+++
30 CM	F	25	brain	1 year	progressive	+	VEP−, SSEP−	−	+++

MR: + from 1 to 2 plaques; + + from 3 to 5 plaques; + + + more than 5 plaques
EP: VEP = visual evoked potentials; BAEP = brain stem auditory evoked potentials; SSEP = somatosensory evoked potentials

goclonal bands, evoked potentials, CT) was available, the percentage of positive findings was as follow: CSF - 60%, EP - 56%, CT - 33.3% and MR - 100% (Table 1).

Comparison between MR and CT may be most appropriately based on the use of double dose delayed contrast enhancement CT [9-11]; in our series, since the patients came from different referring centers, this was rarely possible.

In this group of patients clinical symptoms were supratentorial in 10 patients, located to the posterior fossa in 4, to the optic nerve in 3 and the spinal cord in 13.

Discussion

Our experience confirms the high sensitivity of MR in detecting MS plaques and its superiority with respect to other forms of investigation (CSF examination, EP and CT). The low percentage of positive results with CSF examination and EP can be explained in our group by the fact that in many patients the symptoms were of recent onset and in almost 53% they were confined to the optic nerve or the spinal cord. Few CT scans were performed with double dose contrast.

Of particular interest is the use of MR in patients with initial episodes of optic neuritis or spinal cord involvement or with uncertain clinical findings. MR is able to properly classify these episodes as probably being manifestations of MS by showing frequently asymptomatic plaques concomitantly present in the cerebral hemispheres. Although MR has high sensitivity and in most cases the diagnosis of MS is not very difficult, its absolute specificity is uncertain. Differential diagnostic problems with other pathological processes involving the white matter that can have similar MR appearance (infarcts, metastases, infections and other white matter diseases) do still exsist.

Since MR is a highly sensitive and non-invasive technique, without discomfort or risk for the patient

and does not require a contrast agent, it should be the first examination to be performed in the diagnostic protocol of MS.

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