AJNR

Celebrating 35 Years of the AJNR: September 1984 edition

AJNR Am J Neuroradiol 2019, 40 (9) 1607
doi: https://doi.org/10.3174/ajnr.P0083
http://www.ajnr.org/content/40/9/1607

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September 1984 edition

Magnetic Resonance Imaging: Serial Observations in Multiple Sclerosis

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Three patients with four or more follow-up magnetic resonance imaging (MRI) examinations over a 15–22 month period are described to illustrate the differing patterns of follow-up seen with MRI in multiple sclerosis (MS). These cases illustrate patterns of remission, exacerbation and remission, and rapid progression. The value of MRI in the follow-up of MS is discussed.

Magnetic resonance imaging (MRI) has been shown to be a very sensitive method of detecting lesions in multiple sclerosis (MS) [1–3]. We illustrate the use of MRI in follow-up by presenting three patients with clinically definite MS examined on four or more occasions each over a 15–22 month period.

Subjects and Methods

Three patients with four or more follow-up studies are described; each had a different clinical pattern of MS. Their clinical histories are presented in detail to correlate with MRI findings. The MRI scanner and basic pulse sequences used in this study have been described [3, 4]. The principal pulse sequences used during the study are listed in table 1 and described according to American College of Radiology nomenclature [5]. Examination times were 60–150 min depending on the number of slices scanned. Up to 15 individual slices were obtained at each examination. Present slice thickness is 10 mm.

All examinations conformed to the guidelines for clinical MRI established by the National Radiological Protection Board [6]. The examinations were performed with the permission of the Ethics Committee of the Royal Postgraduate Medical School, and informed consent was obtained from each patient. No preparation or exogenous contrast agents were required, and no adverse effects were noted during or after the MRI examination.

Case Reports

Case 1

A 25-year-old man had acute left hemiplegia that progressed over 1 week and subsequently recovered completely. During the acute phase, he developed reflex and postural changes of an upper motor neuron lesion. Auditory- and visual-evoked potentials were normal. Lumbar puncture revealed slight increase in the number of lymphocytes (6/mm^3) as well as oligoclonal banding in the cerebrospinal fluid (CSF).

Initial computed tomography (CT) with and without contrast enhancement revealed a low-attenuation, nonenhancing lesion in the right supra- and periventricular region. An MRI inversion-recovery (IR) scan demonstrated a large lesion with long T1 in the corresponding location (fig. 1A). A smaller lesion with long T1 was also noted in the posterior limb of the right internal capsule.

Follow-up examinations 2 months later when the clinical symptoms had completely resolved revealed the right periventricular lesion to be smaller on CT and MRI scans (fig. 1B). The third follow-up MRI scan (17 months after the initial scan) included both IR and spin-echo (SE) pulse sequences and showed further diminution of the right periventricular lesion, with long

Received January 4, 1984; accepted after revision March 29, 1984.

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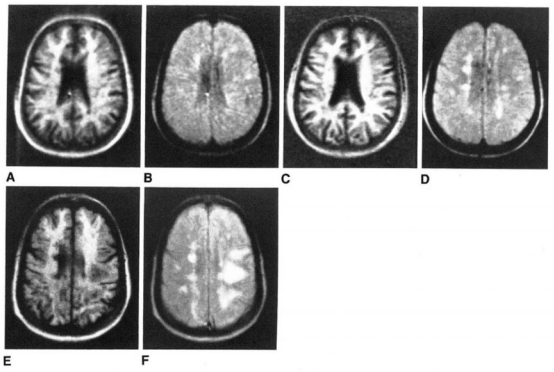
AJNR 5:495–499, September/October 1984
0195–6108/84/0505–0495



Experimental in vivo Imaging of the Cranial Perineural Lymphatic Pathway

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After intraventricular injection of ^{99m}Tc antimony sulfide in rabbits (n = 12) and cats (n = 14), radiolabeled colloid was imaged passing into the nasal mucosa and subsequently into the cervical lymph nodes. The cervical lymph nodes accounted for about 12% of the injected dose in rabbits sacrificed at 22–24 hr after injection and about 5% of the injected dose in cats sacrificed at 5–6 hr after injection. In both animals this represented at least one-third of the cerebrospinal fluid colloid clearance. This technique is applicable to in vivo imaging studies of the perineural lymphatic pathway for cerebrospinal fluid absorption in primates and, with modifications, in human subjects.

The perineural lymphatic pathway (PLP) has been demonstrated in a variety of animals using a broad array of imaging agents [1–29]. Materials injected into the cerebrospinal fluid (CSF) can be seen passing along the olfactory nerve into the nasal mucosa and cervical lymphatics. Although the PLP or accessory pathway may be present around all nerves to some extent, the olfactory nerve is the predominant site of CSF efflux by the PLP [1–4].

The PLP carries a significant proportion (at least 15%–30%) of CSF efflux under physiologic conditions (17, 21–24]. The PLP behaves as a bulk-flow drainage pathway. Materials of different molecular weights (60,000–150,000) are cleared at nearly identical rates [21–24). The PLP appears to be pressure-dependent. McComb et al. [30] showed that at higher intracranial pressures, intracisternal dyes and tracers were cleared into the periorbital and nasal tissue at higher rates. The pathophysiology of the PLP is largely unknown, except for its relation to communicating hydrocephalus and central nervous system infections in some animals [31–38].

Evidence for a PLP in primates and humans is conflicting [7, 11, 31, 32, 39–42]. Since researchers have stressed the similarity between primates and cats in CSF absorption dynamics, it is noteworthy that a PLP has been demonstrated in the latter [32, 42]. We report an experimental technique for visualization of the PLP in the intact animal, which has been applied in cats and rabbits. With modifications, this imaging method may be applicable to clinical studies.

Materials and Methods

About 0.20 ml of $^{99m}TcSb_2S_3$ (antimony sulfide) colloid (370 MBq/ml) was instilled into the lateral ventricles of rabbits (n = 12) and cats (n = 14) and viewed with a Nuclear Services, Inc., upgraded HP Pho Gamma III camera with a 3-mm-aperture pinhole collimator, interfaced to a Mod Comp III computer.

Regions of interest for the cranial CSF, olfactory bulb, nasal mucosal region, and cervical lymph nodes were assigned and analyzed. The animals were then sacrificed, and relevant tissues were analyzed for radionuclide activity.