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Craniovertebral Junction Pathology: Assessment by NMR

R. C. Hawkes,[1] G. N. Holland,[1,2] W. S. Moore,[1] R. Corston,[3] D. M. Kean,[4] and B. S. Worthington[4]

In nuclear magnetic resonance (NMR) studies choice of imaging plane is achieved by a variety of methods that restrict data collection to the desired region. This means that the additional perspectives of direct sagittal and coronal views are possible. In sections traversing the brainstem and cervical cord the neural tissue is clearly seen contrasted against the surrounding cerebrospinal fluid (CSF). NMR studies of a wide variety of lesions in the vicinity of the craniovertebral junction, including congenital and acquired bony deformities, intrinsic tumors, and syringomyelia, are evaluated. It is concluded that the assessment of clinical problems involving this region is simplified by NMR imaging and that its use will probably allow more invasive procedures to be avoided.

The skull base and craniovertebral junction are important anatomical areas where significant abnormalities may be overlooked when reporting plain radiographs. McRae [1] reported in 1960 that in a study of 68 patients with bony abnormalities of the craniovertebral angle no less than 27 had been diagnosed as suffering from multiple sclerosis. One of the features of a lesion at this level is that clinical localization is imprecise, and signs and symptoms overlap those of certain intrinsic degenerative disorders such as amyotrophic lateral sclerosis and multiple sclerosis. The problem is compounded by the fact that many bony abnormalities occurring at the craniovertebral junction are completely asymptomatic [2]. While the topographical relations of the bony elements at this level can be assessed from plain radiographs supplemented by tomography, invasive procedures have in the past been necessary to determine the configuration of the brainstem and cervical cord and their relation to the bony elements; to assess the position of the cerebellar tonsils and fourth ventricle in hindbrain anomalies; and to establish the presence of an extrinsic tumor.

Materials and Methods

In NMR imaging there are no specifically directed photons or specially aligned detectors. Choice of imaging plane is achieved by methods restricting data collection to the desired region, which means that coronal and sagittal views as well as transverse sections are possible [3]. The sagittal perspective is best for studying the craniovertebral junction because it shows the brainstem, spinal cord, and midline ventricular system in continuity, as illustrated in the following examples. Because cortical bone gives a zero signal, however, the precise margins of the bones cannot be determined with certainty. The scans were obtained in 2 min on a Picker resistive system at the Queen's Medical Centre, Nottingham, using steady-state free precession spin sequences. Each slice is about 1 cm thick.

Results

The patient whose scan is shown in figure 1 presented with a spastic quadriparesis. For many years she had been regarded as

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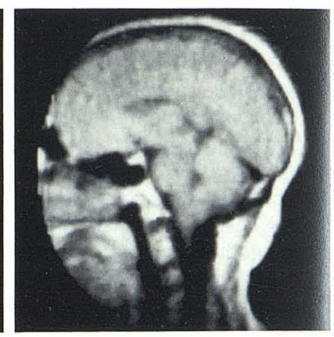

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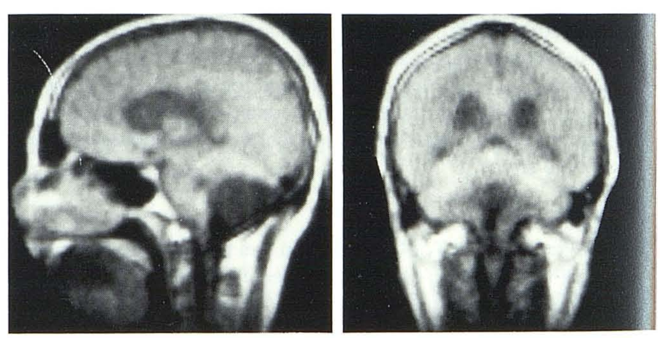
Fig. 1.—Sagittal NMR scan in patient with basilar invagination shows associated brainstem deformity.

Fig. 2.—Sagittal NMR scan in patient with long-standing syringomyelia shows atrophy of upper cervical cord.



A B

Fig. 3.—Sagittal (**A**) and coronal (**B**) NMR scans in patient with midline cerebellar lesion extending into upper cervical cord.

[1]Department of Physics, University of Nottingham, Nottingham, England.
[2]Present address: Picker International, Highland Heights, OH 44143.
[3]Department of Neurology, University of Nottingham, Nottingham, England.
[4]Department of Academic Radiology, Queen's Medical Centre, University of Nottingham, Nottingham NG7 2UH, England. Address reprint requests to B. S. Worthington.

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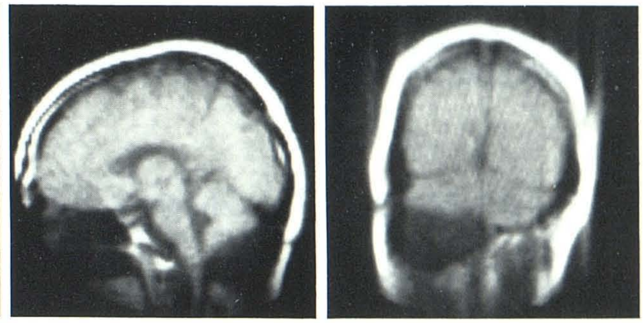
Fig. 4.—Sagittal NMR scan in patient with brainstem glioma shows expanded brainstem and backward displacement of fourth ventricle.



5A 5B

Fig. 5.—Sagittal (**A**) and coronal (**B**) NMR scans in patient with loculus of infected CSF after posterior fossa craniotomy. Sagittal scan (**A**) shows sinus track entering upper part of loculus.

suffering from multiple sclerosis. The diagnosis of basilar invagination was made on a study of the lateral skull film. On the midline sagittal NMR scan the abnormal clivus-odontoid angle is seen together with the associated brainstem deformity centered on the apex of the odontoid peg. We have also used NMR scans to establish normality of the neural axis in patients with congenital skeletal abnormalities in this region. After fracture of the cervical spine in two patients we were able to demonstrate that despite bony encroachment on the spinal canal the residual space was sufficient to prevent flattening or deformity of the cord in concordance with the absence of physical signs.

Extracranially situated cerebellar tonsils that are not secondary to increased intracranial pressure usually denote a congenital anomaly of the hindbrain and often appear in conjunction with syringomyelia. Figure 2 shows the midline sagittal scan of a patient with a long history of syringomyelia. Narrowing of the upper cervical cord is seen; the associated tonsillar ectopia is difficult to recognize, since the posterior margin of the foramen magnum cannot be precisely defined. In the Chiari type II malformation the depressed fourth ventricle and brainstem can be clearly shown. Figure 3 shows the NMR scans of a patient who presented with unsteadiness of gait and was found to have minimal cerebellar signs. A midline lesion giving a low NMR signal in the posterior half of the cerebellum causes displacement of the fourth ventricle. The coronal view shows the lesion extending downward into the upper cervical cord, which was found to be expanded at myelography. The patient declined further investigation or treatment.

Intrinsic tumors of the brainstem produce a change in the configuration of its anterior aspect and a flattening and backward displacement of the fourth ventricle with deformity of its floor (fig. 4). The scans shown in figure 5 are of a patient who developed a discharging sinus some months after a posterior fossa craniotomy for removal of an intrinsic cerebellar tumor. The loculus of infected cerebrospinal fluid (CSF) is clearly seen and the sinus track can also be identified in the midline sagittal section.

In conclusion, although our present experience is limited we believe the multiplanar facility of NMR imaging will be of great value in the investigation and assessment of patients whose clinical presentation indicates the possibility of a lesion at or adjacent to the craniovertebral junction. The use of NMR will probably lead to a decline in the number of invasive studies that are performed in these cases.

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