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# NMR Imaging in the Diagnosis and Management of Intracranial Angiomas

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**Fourteen intracranial angiomas were clearly visualized and diagnosed with certainty on fast saturation-recovery images, which highlight blood vessels without the use of contrast media, and on steady-state free-precession images, in which the moving blood leads to removal of signal. Performed as the initial investigation, nuclear magnetic resonance obviates angiography when the site and extent of the angioma would preclude operation, and in other cases provides useful anatomic information complementing the angiogram. When clinical presentation follows hemorrhage the size and position of the associated hematoma can be reliably assessed.**

Most intracranial angiomas detected by neuroradiologic techniques are arteriovenous malformations involving the brain parenchyma and sometimes the overlying dura. In those cases with a spontaneous subarchnoid hemorrhage the purpose of preliminary investigation by computed tomography (CT) is to identify the site of bleeding so that detailed selective angiography can be applied to define the precise morphology of the underlying lesion and its connection to cerebral vessels. Where clinical presentation relates to the space occupation and "steal" effects of the unruptured lesion the first objective of neuroradiologic investigation is to separate angioma from other possible causes [1, 2].

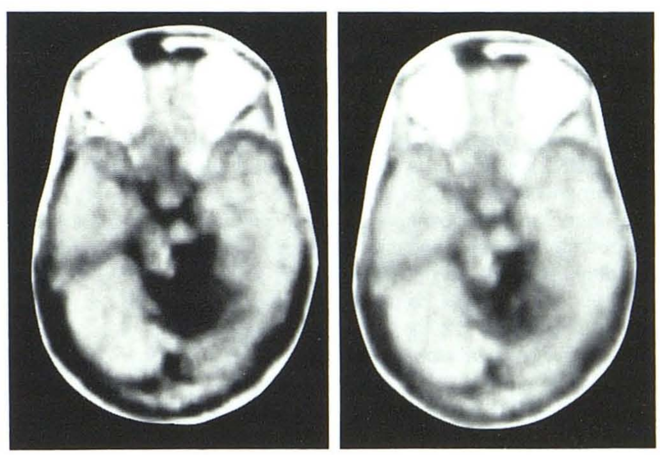
## Materials and Methods

We examined 14 patients with intracranial angioma using a variety of scan sequences. The nuclear magnetic resonance (NMR) scanner in Nottingham uses two steady-state free-precession (SSFP) techniques where the overall contrast is determined by $\rho$ $(T_1/T_2)$. In one sequence all structures with a $T_1$ greater than 0.8 sec give a zero signal, which means that cerebrospinal fluid (CSF) with a very long $T_1$ appears black despite its high proton density. With the other sequences that embrace all the $T_1$ values CSF appears white. Because of the sensitivity to motion with both of these multiple-pulse techniques there is selective removal of signal from areas of high flow such as blood vessels, which appear black in images using either sequence.

## Results and Discussion

We correctly predicted that angiomas would be seen as a spongework of contiguous dark spaces contrasted against the brain parenchyma [3]. The configuration of the malformation and the shape of the constituent elements depend on the plane of section. The multiplanar facility of NMR is particularly valuable for assessing the size of the malformation and its topographic relations, particularly to the ventricular system. By suitable windowing the component vessels of the malformation frequently can be seen (fig. 1), and by using the two spin sequences in succession the presence of moving blood in the angioma can be proven.

Since hematoma gives a very high signal it is easily recognized on NMR scans. As with CT, the position of the hematoma may suggest angioma as the underlying cause when the presentation is by subarachnoid hemorrhage, as is the case when the clot abuts on or bulges into a ventricular cavity. The use of contrast enhancement is not uniformly successful in suggesting the diagnosis before



A B

Fig. 1.—Axial transverse NMR scans (SSFP) show effect of different window settings on appearance of angioma. Vessels can hardly be discerned on narrow setting (**A**), but are better seen with wider setting (**B**).

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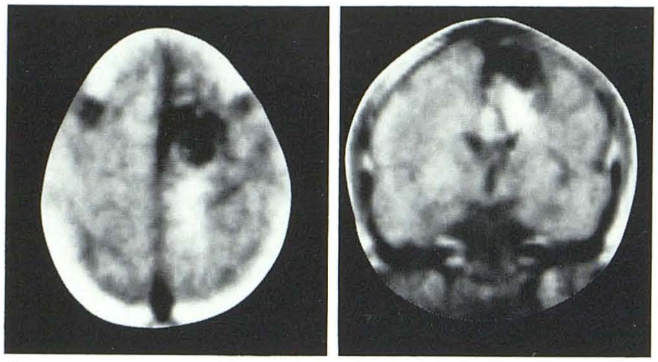
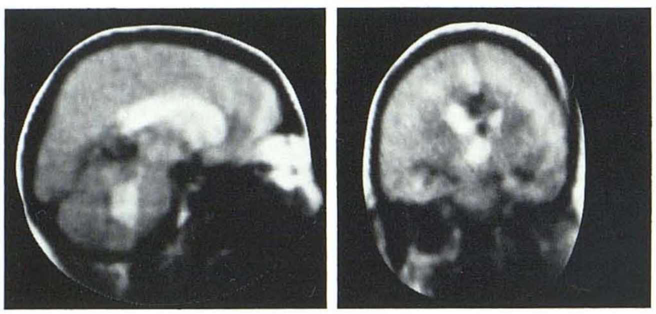


A B

Fig. 2.—Axial transverse (**A**) and coronal (**B**) NMR scans (SSFP) in patient with frontal parasagittal angioma who had subarachnoid hemorrhage. Angioma contrasts sharply with adjacent hematoma, which extends backward and downward into hemisphere.

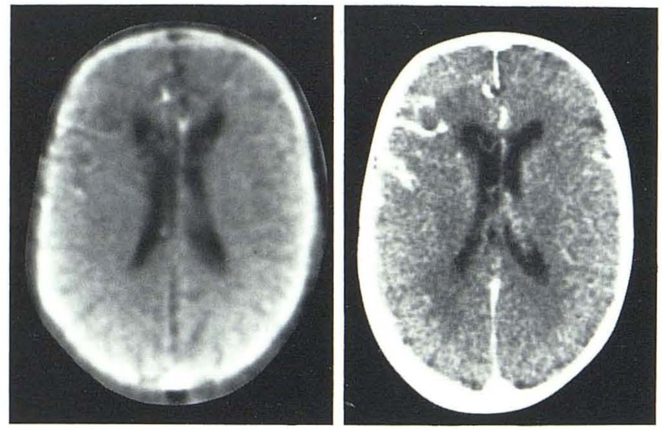


A B

Fig. 3.—Sagittal (**A**) and coronal (**B**) NMR scans (SSFP) of patient with angioma of corpus callosum who had subarachnoid hemorrhage. Ventricular system is full of blood, and several large vessels are seen in midline on **B**. Dilated vein of Galen is shown on **A**.

angiography, since enhanced vessels and clot are of similar density. With NMR, however, the vessels are dark and contrast with the background of clot so there is a greater chance of discerning them. The patient whose scans are shown in figure 2 presented with a spontaneous subarachnoid hemorrhage. The angioma in the parasagittal region of the right frontal lobe is seen as a group of black tubular densities. The hematoma situated posterior to the malformation, extending downward into the brain parenchyma and into the anterior interhemispheric fissure, is clearly shown, reflecting its high signal.

The patient in figure 3 presented with a coma-producing subarachnoid hemorrhage. The ventricular system is filled with blood. In the coronal section several areas of flow signal are seen in the region of the corpus callosum, and in the sagittal scan a grossly dilated vein of Galen is visualized. The angiogram showed a malformation involving the corpus callosum.



A B

Fig. 4.—Axial transverse NMR scan (**A**) using flow-dependent saturation-recovery sequence that highlights vessels in frontal angioma. **B**, Contrast-enhanced CT scan for comparison.

An alternative NMR technique for visualizing angioma employed at the Hammersmith Hospital is the use of flow-dependent saturation-recovery images, which allow blood vessels to be highlighted [4]. This is shown by the patient in figure 4A, who has a left frontal angioma. The contrast-enhanced CT scan (fig. 4B) is shown for comparison.

Like CT, NMR does not obviate angiography except when the extent or position of an angioma or the condition of the patient precludes treatment by surgery or embolization. NMR provides complementary information in angiomas that have bled, showing more accurately the extent of associated hematoma and the relation of the angioma to the ventricular system. By the use of flow-dependent sequences the detection of angiomas and their distinction from other intracranial pathologies by NMR could potentially be as accurate as by CT.

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