Use of Nuclear-Magnetic Resonance (NMR) in Newborn Diagnosis

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Although still relatively early in its development nuclear magnetic resonance (NMR) scanning has added a powerful new technique to body imaging. NMR brain scans clearly distinguish grey and white matter and in addition infarction, demyelinating disease, tumour, aneurysm, oedema and haematoma can all be distinguished in adults (1,2). Few children have been scanned with NMR and results up to date are only preliminary (3). In particular the role of NMR in neonatal imaging, particularly in the recognition of haemorrhagic, ischaemic and asphyxic pathology has not been explored and in this presentation I will report our preliminary findings in infants scanned during the neonatal period as well as in older children who had previously suffered IVH or related conditions. A comparison is made between NMR and ultrasound imaging and the potential role of NMR in neonatal neurology assessed.

The hydrogen atom is a proton and when placed in a magnetic field behaves like a small magnet. If the proton is then perterbed its magnetic behaviour can be detected and used to produce images. In order to do this the patient is placed inside a large magnet which generates an homogenous and stable field. Radiofrequency (RF) pulses are used to change the orientation of the magnetisation and by adjusting the duration of the RF pulse rotation to any angle can be obtained. After cessation of the RF pulse "relaxation" of the proton to its neutral position occurs which induces an electrical signal in a coil around the patient's head.

The relaxation is described by two time contrasts T1 and T2. T1 (also called the longitudinal relaxation time) is a measure of the time taken for the magnetisation in the long axis of the patient to return to equilibrium. T2 (transverse relaxation time) reflects the time taken for relaxation in the plane transverse to the direction of the main magnetic field. In liquids, T1 and T2 are approximately equal (a few seconds). T2 is always less than or equal to T1 and contrast in the images is largely related to differences in T1 and T2 between tissues; pathology usually causes both T1 and T2 to be prolonged. In the brain, white matter has a shorter T1 than grey matter and this is related to the presence of protons in phospholipids such as myelin, thus T1 dependent images may show marked grey white matter contrast.

NMR imaging has been performed on over 50 children and 20 of these had problems related to the newborn period. The scans

provided information on anatomy, presence of large haemorrhage, porencephaly, cystic periventricular leukomalacia, extent of apparent myelination and extraventricular fluid. NMR does not appear to detect small haemorrhages seen on ultrasound examination. Although NMR clearly displays anatomy, ultrasound has a greater ability to resolve structure but does not detect periventricular water nor the degree of myelination. NMR displays diffuse intracerebral water (oedema) following birth asphyxia and this is an interesting area for further research. In infants with acute hydrocephalus transependymal periventricular fluid was noted on the NMR scans. Those who had the most marked evidence for this were the ones with acute blockage of a shunt. Those in whom there had been persistent ventriculomegaly for a prolonged time appeared to have compensated as there was relatively little fluid extravasation. This information may be particularly useful when assessing infants with ventriculomegaly for shunt surgery.

The detection of developing myelination by NMR is a particularly exciting facility which no other imaging technique offers. The correlation however between an apparent delay in myelination and adverse neurological or developmental outcome has not been shown to be particularly good but much work needs to be done on the range of normal myelination as well as prospective longitudinal studies on preterm infants particularly those with neonatal neurological problems before the role of NMR in assessing progressive myelination is clear.

In conclusion real-time ultrasound will probably remain the method of choice for routinely scanning the newborn infant for haemorrhage, ventricular dilatation or anatomical abnormalities. The diagnosis of cerebral oedema and transependymal fluid extravasation associated with acute hydrocephalus may be the most important indication for NMR in infancy and deserves further evaluation. Assessment of the degree of apparent myelination may prove to be of some importance for future prognosis.

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