CLINICAL IMAGES

Fetal magnetic resonance imaging – the new horizon in fetal anomaly screening

Mala Modi

Magnetic resonance imaging (MRI) has been used extensively in neonatal imaging to further characterise abnormalities identified on ultrasound (US) or computed tomography (CT) scan. This technological success was followed by use of MRI in fetal imaging. The first fetal MRI (FMRI) was performed in 1983 in the USA.[1] FMRI has since gained momentum, as MRI gives better soft-tissue resolution and anatomical delineation than US. A further development of FMRI has been a balance between obtaining images with sufficient contrast and spatial resolution, and achieving a short imaging time to obviate the need for maternal sedation. With the advent of newer technologies and better machines, use of FMRI has greatly increased in the Western world. While FMRI is used routinely in some institutions, US remains the primary fetal imaging modality.[2] FMRI is a useful complementary tool.

No biological side-effects have been reported with the use of FMRI so far, but it should be avoided in the first trimester of pregnancy, and its use should be restricted to cases with particular indications.[3] Intravenous paramagnetic contrast should also be avoided, especially in the first trimester, as it crosses the placenta and is ingested by the fetus, and the risk to the fetus is as yet unknown.[2] When performing a FMRI, it is necessary to use a dedicated pelvic coil (phased array), not to administer maternal sedation, to use short MR sequences, and to image in three orthogonal planes for maximum information. T2-weighted images provide anatomical information, while T1-weighted and gradient-echo images are complementary and help to characterise tissue properties (fat, myelin, blood).

The advantages of FMRI over antenatal US include better contrast resolution, a larger field of view, and images that are better understood by parents.[1-3] FMRI is especially useful in the third trimester as fetal calvarial ossification deteriorates the US image quality significantly. The other major advantage is that pitfalls associated with US are minimised, viz. operator dependency, fetal position (e.g. cephalic pole in the maternal pelvis), maternal body habitus, and poly- or oligohydramnios.[1]

The advantages of US over FMRI include better spatial resolution, fetal lateralisation, cost, availability and portability.[1]

FMRI is indicated when US is not sufficient for diagnostic or prognostic purposes.[3] Central nervous system (CNS) anomalies, where one can image the brain and cord in detail, are one of the greatest advantages of FMRI; however, cervical masses, diaphragmatic hernias, renal cystic lesions, and complex abdominal masses are also recognised indications.[2] Lung assessment on FMRI is well documented (the fetal lung is well seen on MRI as it is filled with fluid).[1] FMRI is also used for placental anomalies and maternal indications, and fetal cardiac MR use is evolving.[3]

As intra-uterine and neonatal surgeries evolve, so will the use of FMRI as it is extremely useful for planning therapeutic interventions.

Case discussion

The following patients were all late referrals to the Chris Hani Baragwanath Hospital antenatal clinic.

Patient A

A 17-year-old patient presented to the clinic at 28 weeks' gestation. US scan of the fetus revealed bilateral intracranial frontal cysts measuring 29.8 and 33.9 mm. The relationship to the ventricular system was not well visualised (Fig. 1a).

The MRI scan confirmed the large bifrontal unilocular cysts. The cysts were noted to be extraventricular. The frontal horns of the lateral ventricles were attenuated, and the cortical mantle of tissue was markedly thinned (Fig. 1b).

The FMRI assisted the clinician in making the difficult decision of termination of pregnancy, as the severity of the findings pointed to a very poor prognosis.

Patient B

A 30-year-old patient presented to the clinic at 39 weeks' gestation. US scan revealed a huge occipital encephalocele containing CSF and cortical tissue. However, a comment of 'suboptimal scan' was made in view of the advanced gestational age of the fetus (Fig. 2a).

The fetal MRI demonstrated a 3.6 cm occipital bony defect with an associated encephalocele measuring more than 16

Dr Modi is a senior radiologist and senior lecturer in the Department of Radiology, Chris Hani Baragwanath Hospital, Johannesburg. She is author of numerous papers in national and international peer-reviewed journals and is assistant editor of the South African Journal of Radiology.

Corresponding author: *M Modi (Mala.Modi@wits.ac.za)*

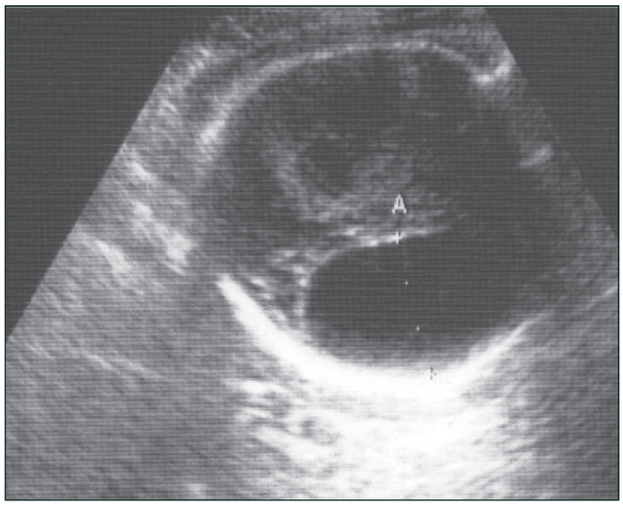

Fig. 1a. US scan of the fetal brain demonstrating frontal lobe cysts.

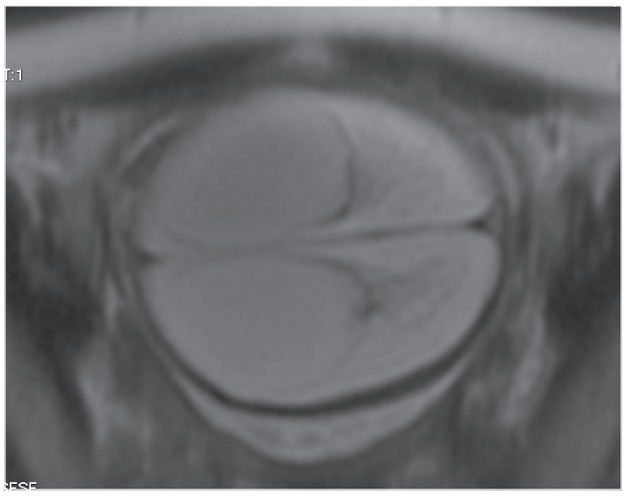

Fig. 1b. T2-weighted axial MR image demonstrating bifrontal cysts with better clarity. Note associated oligohydramnios and larger field of view.

cm and containing cerebellar tissue. There was no associated hydrocephalus, brain atrophy, spinal abnormality or other anomaly. Posterior fossa anomalies, especially in advanced gestational situations, are better visualised on MRI, as was noted in this patient (Fig. 2b).

The child was delivered by caesarean section a week later.

A CT scan of the brain was done as recommended by the neurosurgeons. This confirmed the anomalies seen on MRI. The child was blind and spastic, and the prognosis was poor.

Patient C

A 30-year-old patient presented to the clinic at 34+ weeks' gestation. US scan revealed probable thoraco-omphalopagus conjoined twins and polyhydramnios. The MRI demonstrated 2 heads, 2 sets of upper limbs, and 2 complete spines.

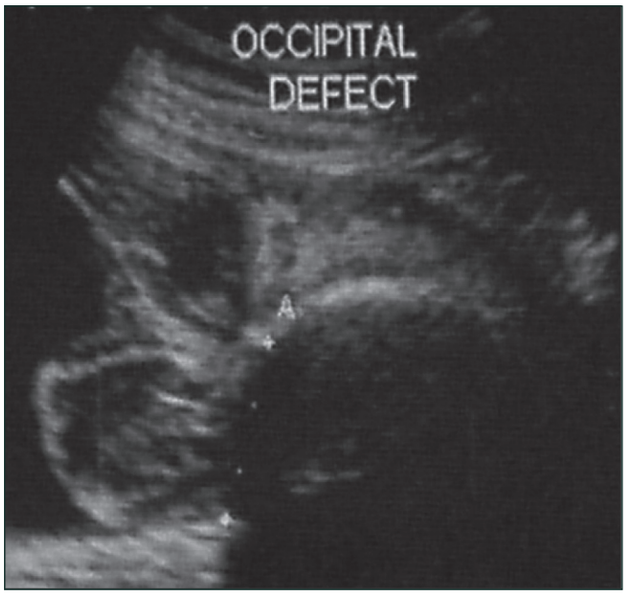

Fig. 2a. US scan demonstrating a bony occipital defect with an associated encephalocele. Note increased acoustic shadowing due to fetal calvarial ossification resulting in poor visualisation of the intracranial contents.

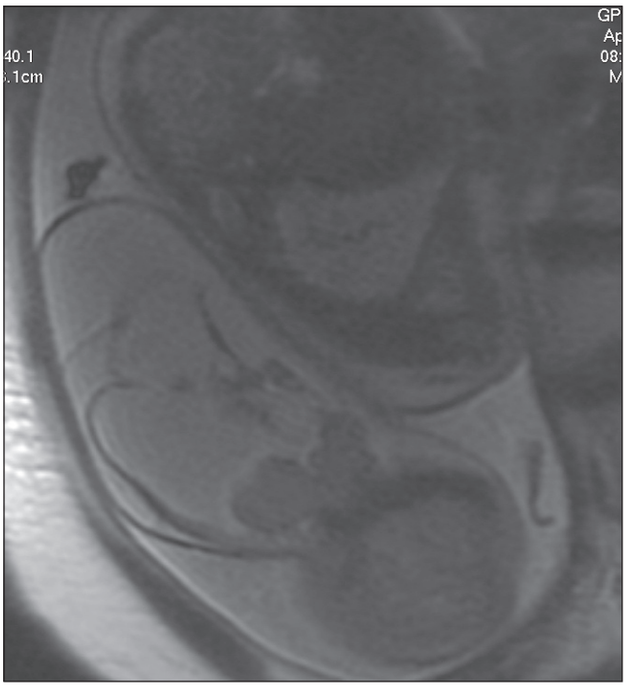

Fig. 2b. T2-weighted MR image demonstrating a large occipital encephalocele, as well as parenchymal information (grey-white matter differentiation).

Twin A was the bigger, dominant twin. There was a single multichambered heart, conjoined liver, 2 stomachs, a complex renal system with a single bladder, single pelvis, and single set of lower limbs. Twin B also had a hyploplastic right lung, and aplastic left lung (Fig. 3a).

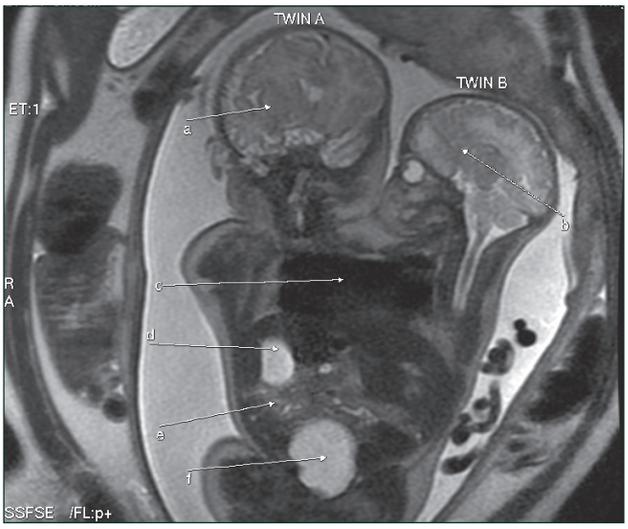

Fig. 3a. Coronal T2-weighted MRI scan. (a= brain of twin A demonstrating mature grey-white matter differentiation; b = twin B on the right in a sagittal position looking at twin A; c = the complex conjoined (multichambered) heart; d = high signal from stomach of twin A; e = horseshoe kidney of twin A; f = high signal in the pelvis from single full bladder).

The twins were delivered by caesarean section a few days later.

A CT scan of the twins was done post delivery to assess viability and separability. This further characterised the complexity of the twin's anatomy. There was a horseshoe kidney in twin A, and twin B had a single malpositioned kidney (Fig. 3b). The complexity of the twins' anatomy was better evaluated on FMRI than US.

The twins died on day 3.

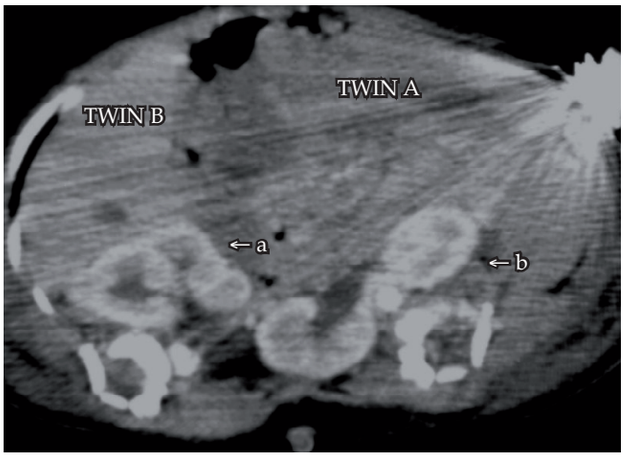

Fig. 3b. Axial post-contrast CT scan of the abdomen (a = single kidney with a ventral collecting system in twin B; b = central horseshoe kidney with a ventral collecting system in twin A).

Conclusion

FMRI is in its infancy in South Africa. However, the vast spectrum of pathology that we encounter suggests an increased use for it in the future. FMRI must be used judiciously in conjunction with clinical, ultrasound and gestational information.

I thank Professor E Nicholau and Dr J Jeebodh for their assistance.

1. Werner H, Daltro P, Bulas D. MRI, Part 1: 2005-10-12-11. www.TheFetus.net (last accessed September 2007).
2. Cassart M. Fetal magnetic resonance imaging. *Radiology Update* 2006; 5(2): 55-65.
3. Rypens F, Dubois J. Fetal MRI technique. The International Pediatric Radiology Fifth Conjoint Meeting, May 2006.