Contents lists available at ScienceDirect

European Journal of Obstetrics & Gynecology and Reproductive Biology

journal homepage: www.elsevier.com/locate/ejogrb

Review article

The use of antenatal fetal magnetic resonance imaging in the assessment of patients at high risk of preterm birth

L. Story[a,b,*], J. Hutter[b], T. Zhang[c], A.H. Shennan[a], M. Rutherford[b]

[a] Division of Women's Health, King's College London, St Thomas's Hospital, United Kingdom
[b] Centre for the Developing Brain, King's College London, St Thomas's Hospital, United Kingdom
[c] Department of Biomedical Engineering, King's College London, United Kingdom

ABSTRACT

Preterm birth, defined as birth occurring prior to 37 weeks gestation is a common obstetric complication affecting 8% of pregnancies and is associated with significant morbidity and mortality. Infection/inflammation has been implicated in both the aetiology of preterm birth itself and associated neonatal pulmonary and neurological morbidity. Treatment options are currently limited to prolongation of the pregnancy using cervical cerclage, pessaries or progesterone or administration of drugs including steroids to promote lung maturity and neuroprotective agents such as magnesium sulphate, the timing of which are highly critical. Although delivery is expedited in cases of overt infection, decisions regarding timing and mode of delivery in subclinical infection are not clear-cut. This review aims to explore the use of magnetic resonance imaging (MRI) in the antenatal assessment of pregnancies at high risk of preterm birth and its potential to guide management decisions in the future.

© 2018 Published by Elsevier B.V.

Contents

Background

Preterm birth (PTB), defined as birth less than 37^{+0} weeks gestation, is a significant health issue, projected to cost health services in England and Wales £939 million per year [1]. Morbidity is inversely correlated to gestational age, with the most severe adverse outcomes associated with very PTB, defined as occurring less than 32^{+0} weeks gestation. These births account for 1.4% of all deliveries in the United Kingdom [2], affecting 13,500 individuals every year. Of children that are born very preterm, neurodevelopmental sequelae are responsible for a significant proportion of the associated morbidity. Up to 10% of surviving infants will develop motor impairments in the form of cerebral palsy (CP) [3] and 25–50% will suffer cognitive, behavioural, attention and socialisation deficits. In addition PTB is associated with significant

pulmonary morbidity including respiratory distress syndrome and bronchopulmonary dysplasia.

Treatments are currently limited to mechanisms aimed at prolongation of the pregnancy, encompassing cervical cerclage, pessaries and supplemental progesterone, promoting lung maturity by the appropriate timing of administration of antenatal steroids and administration of the neuroprotective agent magnesium sulphate in labour. However, despite these treatments and although survival rates have improved over the last decade for extremely preterm infants born between 22 and 26 weeks, rates of disability are unchanged [4].

The intrauterine environment may contribute to and compound the associated neonatal morbidity. Infection has been implicated in both the aetiology of spontaneous PTB and subsequent cerebral and pulmonary pathology. When overt chorioamnionitis is present, prolongation of the pregnancy is detrimental and associated with an increased risk of cerebral palsy [5] and iatrogenic delivery is in the best interest of both the mother and the child. However, subclinical infection is known to be common, particularly at lower gestations but methods of assessing this are limited. Decisions regarding the timing of delivery are therefore not clear cut, the risks of prematurity being weighed against the likelihood and significance of infection in the fetal compartment.

The ability to accurately assess fetal development and pathology and the consequences of in utero infection as well as to accurately time when spontaneous PTB is likely to occur may significantly improve subsequent neonatal morbidity. This review will explore how antenatal magnetic resonance imaging (MRI) may add to the clinical picture in pregnancies at high risk of PTB and help guide management decisions.

MRI

MRI is a non-invasive imaging technique which has been increasingly utilised for assessing the fetus over the last 20 years, partly due to its excellent safety profile [6–8], good soft tissue contrast and anatomical delineation, and its ability to provide additional information to obstetric ultrasound [9]. MRI is particularly useful in assessing the fetal brain, providing more accurate cerebral biometry, superior visualisation of the posterior

fossa and assessment of sulcal formation [10,11]. More recently it has also been used in the assessment of non-cerebral fetal structures including the thorax [12] and renal tract [13]. In addition, the development of advanced MRI techniques in the fetus including diffusion [14] imaging and spectroscopy [15] have facilitated the analysis of tissue microstructure and function of not just fetal tissues but also the maternal reproductive tract.

MRI uses a static magnetic field, which aligns the nuclear magnetisation of ions within tissue. Radiofrequency pulses are applied which alter their alignment. As they return to their original state a radiofrequency signal is produced which is detected by a receiver coil placed over the maternal abdomen. Fourier transformation results in the generation of an image. Image contrast can be weighted in order to optimally assess specific structures. Tissues return to their resting states via a combination of T1 and T2 relaxation: T1 is the time required to regain longitudinal magnetization and T2 the transverse relaxation time. Tissue with a high water content such as unmyelinated white matter is seen as low signal intensity (SI) on T1 weighted images and high SI on T2 weighted images (see Fig. 1).
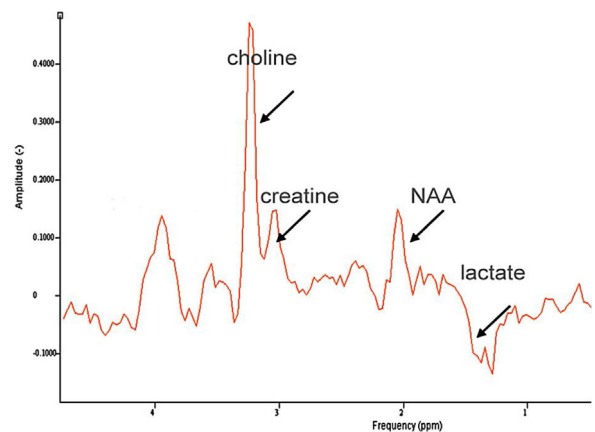

Fig. 2. Example of a fetal spectrum, at an echo time of 136 ms, illustrating the presence of Choline (3.2 ppm), Creatine (3.0 ppm), *N*-acetylaspartate (NAA 2.0 ppm) and Lactate (inverted bifid peak at 1.3 ppm) acquired at 1.5 T.
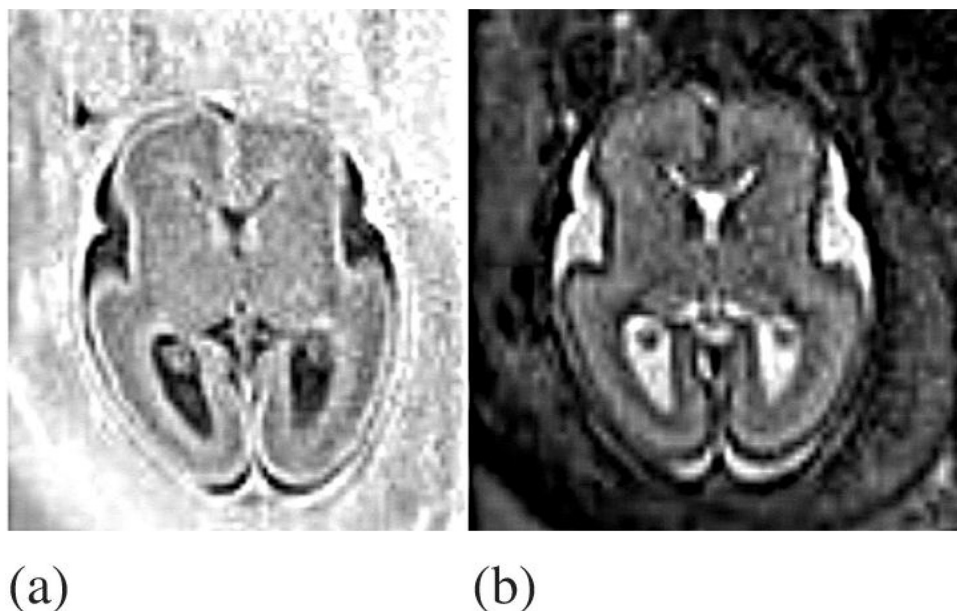

Fig. 1. Snapshot inversion recover T-1 weighted (a) and T2 (b) weighted MRI images of the fetal brain in the transverse plane in a patient at high risk of preterm birth with premature rupture of the membranes at 24^{+4} weeks gestation on a 1.5Tesla MRI scanner.