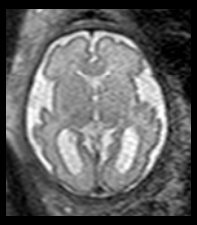
Fetal CNS: what to refer and when



Tim Jaspan - Nottingham University Hospital
RCR meeting 3rd February 2012

Why MRI?

- Excellent anatomical display
- Germinal matrix zones, cortical plate, basal ganglia, brainstem , cerebellar anatomy well demonstrated
- High sensitivity for blood, calcifications, fat
- Less affected by maternal obesity, reduced fetal liquor, low lie or poor fetal position

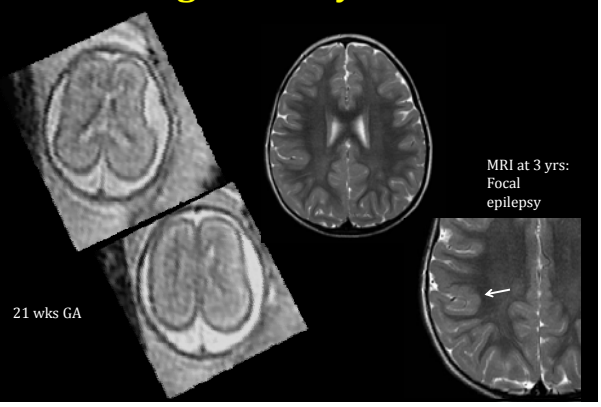
Indications for fMRI

- Maternal/fetal conditions (oligohydramnios, fetal lie)
- Brain anomaly seen on USS, diagnosis uncertain
- Suspected familial genetic syndromes
- When detection of additional abnormality on MRI may carry profound prognostic/counselling implications (e.g. sulcation disorder associated with mild VM)
- Maternal trauma/insult
- Intervention planning

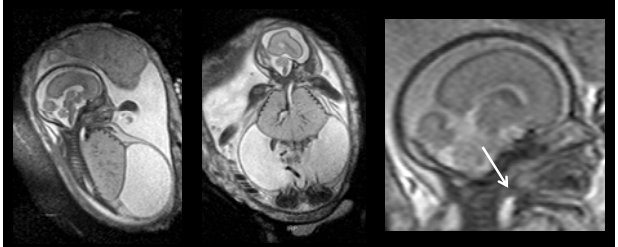
Timing of MRI

- Anomaly US at 19-20 wks
- If abnormal, MRI undertaken subsequently
- Benefits of early MRI include early confirmation of suspected pathology
- But MRI too early risks failure to detect neuronal migrational abnormalities before cortical development is complete
- Preparing for EXIT procedure needs late scan

Scanning too early - focal PMG



Late stage planning - CHAOS



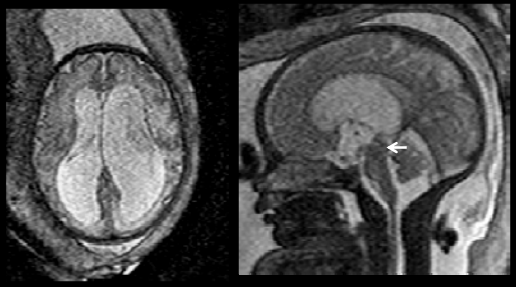
Primary indications for fetal MRI

- Ventriculomegaly
- Congenital abnormalities
- Acquired lesions

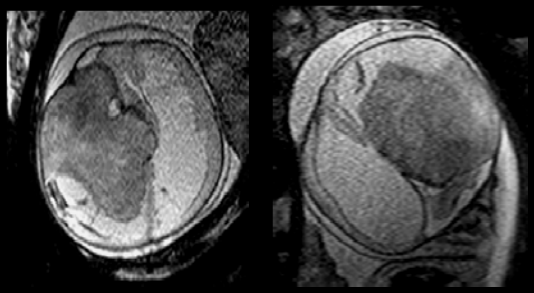
Ventriculomegaly

- Occurs in 1-2/1000 pregnancies
- Mild VM associated with good prognosis
- When >12-14mm, increased risk
- Clinically relevant abnormalities in up to 17%
- Up to 6% have congenital abnormality
- MRI used to detect associated anomalies that carry a poorer prognosis

Hydrocephalus – congenital aqueduct stenosis



Hydrocephalus - CPP



Congenital abnormalities

- Disorders of brain formation occur at the varying stages of maturation
- Risk of MRI too early is that errors of cortical formation, organisation , development may be missed before 21-22 weeks
- If equivocal findings, repeat MRI in 2-3 weeks

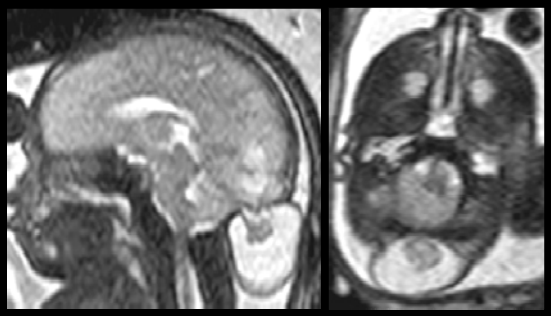
Congenital anomalies

- Failure of dorsal induction
- Failure of ventral induction
- Failure of neuronal proliferation, differentiation and histiogenesis
- Failure of neuronal migration

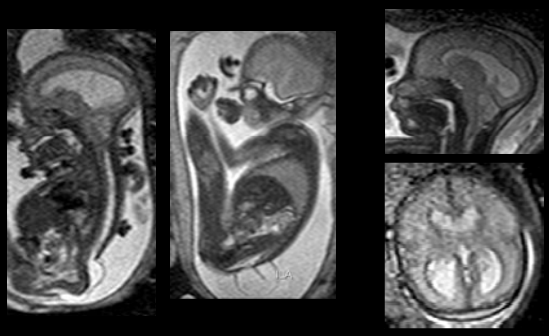
Failure of dorsal induction

- Failure of neural tube closure: 4-6 wks GA
- Neural tube defects readily identified by US
- MRI is of variable quality in spine
- Identifying level of lesion is of prime importance for prognostication – US and MRI equivalent
- MRI can identify neural elements entering sac

Occipital cephalocoele



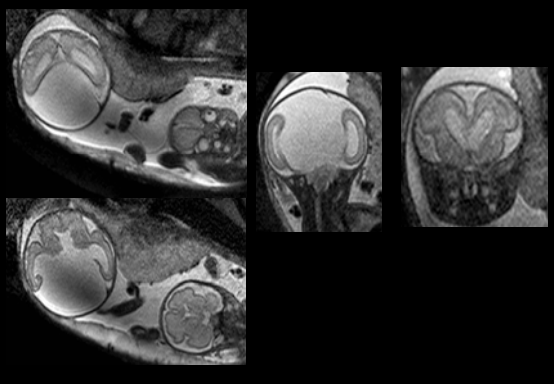
Myelomeningocoele + Chiari 2



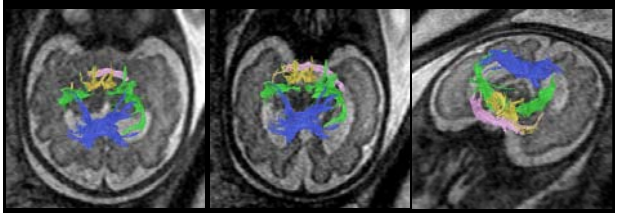
Failure of ventral induction

- Occurs between 6-12 wks GA
- Errors of prosencephalic, mesencephalic and rhombencephalic development are generally better assessed by MRI
- Callosal status >20 weeks (when myelination commences) and complex posterior fossa lesions best assessed by MRI

Semilobar holoprosencephaly

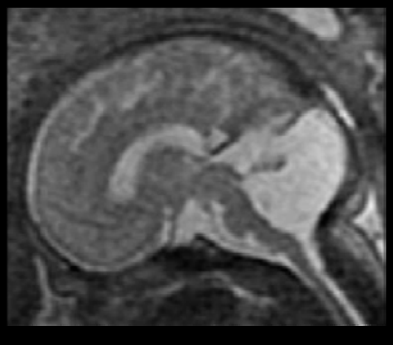


DTI in lobar holoprosencephaly

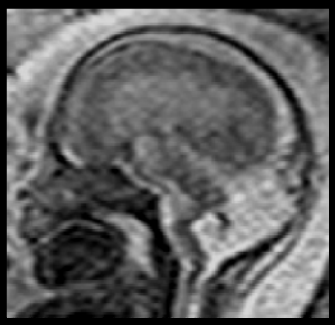


Blue = partially formed hippocampal commissure Pink = anterior commissure,
Green = corticospinal tracts, Yellow = frontopontine projections

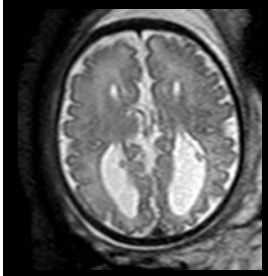
Dandy Walker malformation

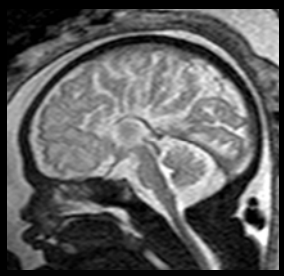


Brainstem kinking – SHH signalling failure



Callosal dysgenesis

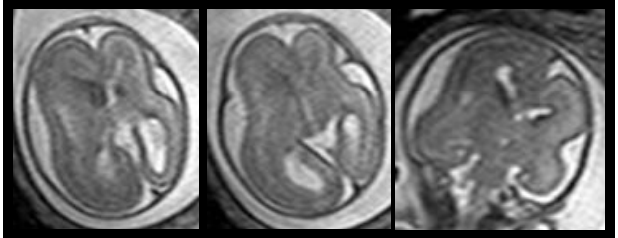




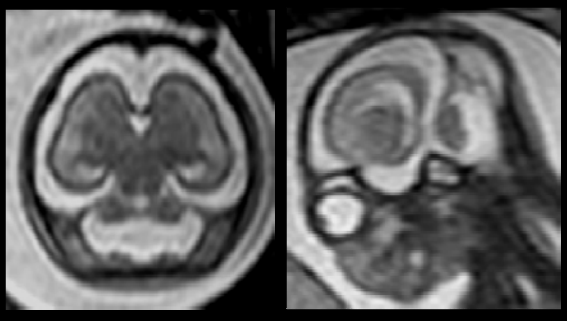
Failure of neuronal proliferation, differentiation and histiogenesis

- Begins between 7-24 wks, continues into post natal life
- Wide range of abnormalities (micrencephaly, megalencephaly, congenital tumours, vascular malformations) better assessed by MRI
- MRI more accurately characterises intra-tumoural blood, fat, calcification, subependymal nodules

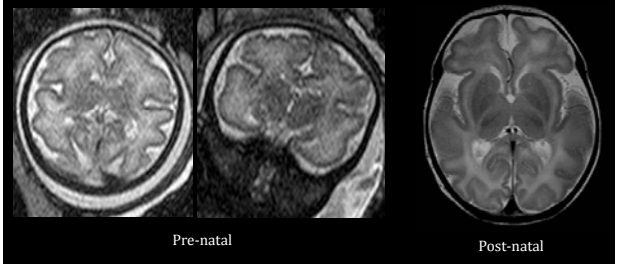
Hemimegalencephaly



Severe microcephaly – 28 wks GA



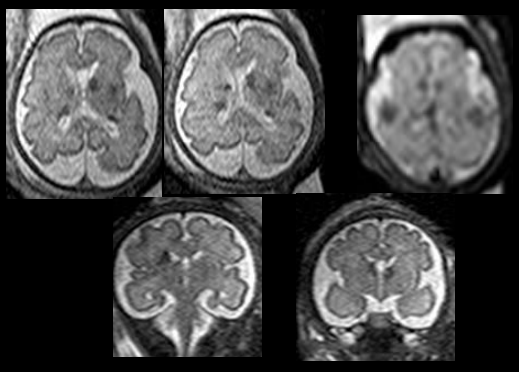
Micrencephaly



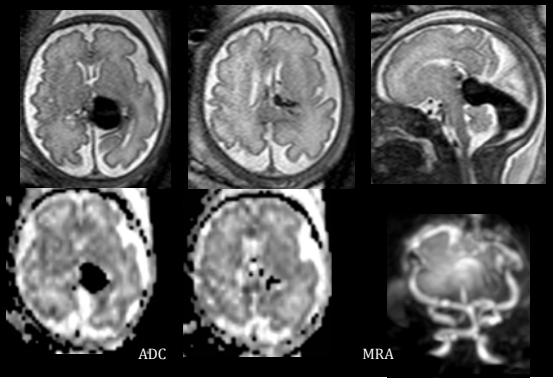
Pre-natal

Post-natal

28 wks. US = cardiac lesions, normal cranial exam



VOG – parenchymal status



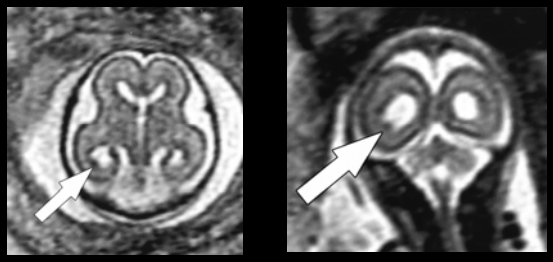
ADC

MRA

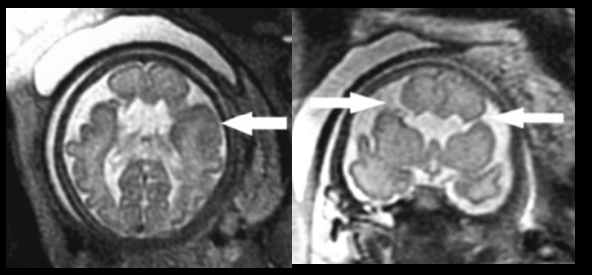
Failure of neuronal migration

- Occurs between 12 -24wks GA
- Defects give rise to lissencephaly, schizencephaly, polymicrogyria, pachygyria, GM heterotopia
- US detects these with reasonable sensitivity
- MRI demonstrates waves of migrating neurones, tracks cortical development

Subependymal GM heterotopia – 23wks GA



Schizencephaly



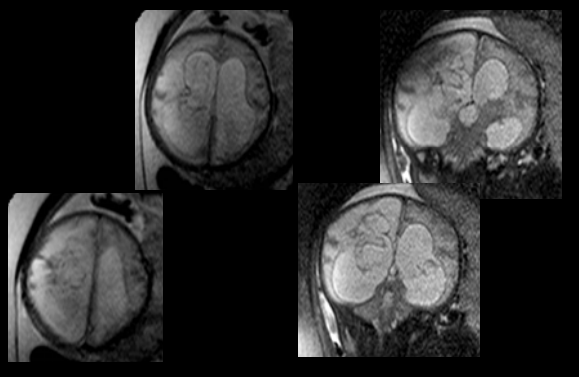
Acquired lesions

- Ischaemic injury
- Infection
- Trauma
- Haemorrhage
- Venous thrombosis

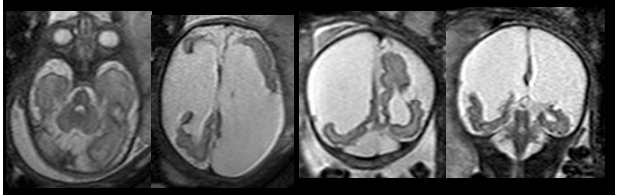
Ischaemic injury

- Established insults equally well detected by US and MRI
- DWI allows sensitive, early detection of ischaemic injury
- Location of injury determined in part by GA

MCA infarct



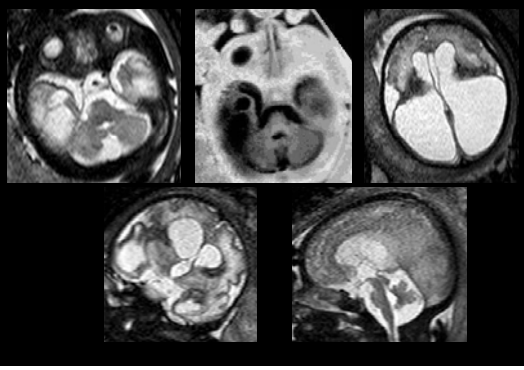
Anterior circulation infarction - hydranencephaly



Infection

- US well suited to detecting associated pathology such as VM, parenchymal calcifications, striatal vasculopathy
- MRI can demonstrate subtle cystic lesions, cortical developmental and post fossa defects

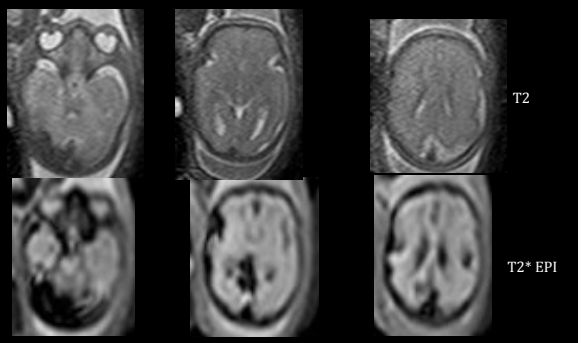
CMV



Trauma

- Maternal abdominal trauma may rarely cause intracranial haemorrhage (SDH, EDH, parenchymal haematoma) or ischaemic pathology (infarct, schizencephaly, hydranencephaly)

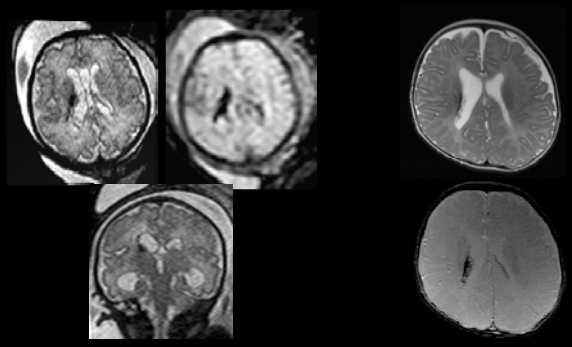
Maternal trauma – fetal SDH



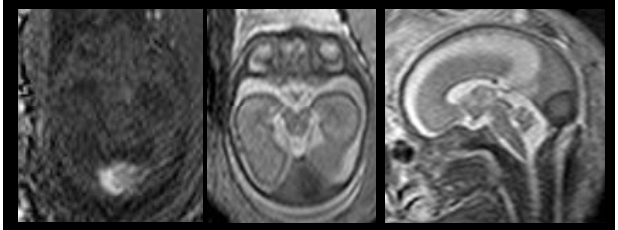
Haemorrhage

- Properties of blood products allow ready detection of recent haematomas by MRI (T1 hyperintense, T2 hypo/iso-intense)
- Haemosiderin allows ready detection of older haematomas on GE images

GMH/IVH



Venous sinus thrombosis: US = ?cyst



Summary

- MRI is complimentary to US
- Use MRI to clarify anatomy, characterize tissue elements and assess ischaemic injury
- Multidisciplinary approach
- Discuss findings with professional who will be doing the counselling (neurosurgeon/FM)
- Potential for rapid evolution of techniques and applications in the near future

Thank you