MRI scan in the newborn

Magnetic Resonance Imaging (MRI)

MRI is a non-invasive imaging procedure that uses a powerful magnetic field, radio-frequencies and a computer to visualise and record neuro-anatomical structures in the area being studied. MRI demonstrates, in macroscopic detail, normal and abnormal tissues and is a valuable diagnostic and prognostic tool.

Brain MRI has the advantages of not exposing infants to ionising radiation, and provides detailed information about brain parenchyma and changes induced by hypoxia / ischaemia. MRI is a relatively safe procedure provided specific guidelines are strictly maintained.

Safety Issues

The use of a powerful magnet means that all ferrous (iron) containing materials, both within the patient and in equipment must not be taken into the MRI room. The relatively long image acquisition times and the long image tunnel create safety concerns for the infant, resulting in increased needs for the infant i.e. sedation, monitoring and support.

The Magnet

An object can react to a magnetic field either by translational force (when an object is strongly pulled to the centre of a magnetic field such as when equipment becomes airborne) or by rotational force (torque) which can rotate objects even within the body in the case of implants. Therefore in-situ ferromagnetic devices, objects or equipment must not be taken into the MRI room as these items can become lethal projectiles causing injury and death.

- Hospital personnel or family members entering the MRI room must be screened by MRI staff for removal of any ferromagnetic materials eg. name badges, pagers, belts, prostheses etc.

- Ensure the infant has no internal ferromagnetic devices such as a pacemaker or surgical clips in situ before entering the MRI room. Parents and/or medical officer must complete and return the checklist to MRI before the procedure.

- Ensure infants are wearing clothing free of any ferrous material such as metallic press studs, pins, buttons etc.

- All monitoring and supportive equipment must be MRI safe/MRI compatible. Check with MRI staff if unsure.

- The magnet is noisy so for comfort, safety and to maintain a settled state apply ear muffs or ear plugs prior to transfer to MRI. Clinicians who need to remain in the MRI room to monitor the infant should also wear ear plugs for protection/comfort.

- The infant must be accompanied by appropriately trained senior neonatal nursing staff +/- neonatal fellow or consultant as deemed necessary by consultant on call.

- The infant must remain monitored with saturation and pulse rate at all times whilst in the scanner.
In which babies should MRI be considered?

MR related modalities are especially useful in imaging brain and spinal cord parenchyma, as well as other soft tissues. They are excellent at detecting early, acute changes of hypoxia / ischemia, may delineate haemorrhages, but are poor in detecting bony fractures and ectopic calcification.

Relatively long acquisition times, the presence of a powerful magnet, and these limitations mean that CT scans should be considered where infants are unstable, ferrous objects cannot be excluded and trauma to the skull with fractures and/or haemorrhage are suspected. Infants are not able to be imaged by MRI when on nitric oxide or HFOV.

The following infants are likely to benefit from MR imaging techniques:

- Infants with suspected moderate or severe hypoxic ischaemic encephalopathy (HIE)
- Infants with other causes of neonatal encephalopathy, either with
  - global CNS dysfunction for detection of structural brain abnormalities and exclusion of hypoxic – ischaemic changes, or
  - infants with focal neurological signs (including seizures) for detection of cerebral infarction, intracranial haemorrhage or other focal lesions.

Available tests

Test/s ordered will be dependent on the underlying reason for MRI and the age of infant at time of scan and must be discussed with the relevant consultant neonatologist.

Magnetic resonance techniques include magnetic resonance imaging (MRI), diffusion weighted imaging (DWI) and magnetic resonance spectroscopy (MRS). These techniques are complimentary and it is routine at RPA to combine these in the newborn period when imaging infants with neonatal encephalopathy between day 2 and 8 after birth. Both DWI and MRS are more sensitive than MRI at detecting ischaemic changes associated with HIE. A repeat MRI is performed at 3-4 months on infants with initial abnormal images to correlate findings with the early imaging and assist with prognosis.

- **Magnetic resonance imaging (MRI)** – Abnormalities on T1 and T2 weighted images may be subtle in the early period in infants with HIE, taking several days to become obvious. MRI can detect characteristic patterns of cerebral injury in infants with suspected HIE, and is useful in providing predictive neurological outcome data for these infants. MRI is also useful in delineating patterns of injury consistent with neonatal cerebral infarction, and visualising the posterior fossa structures including cerebellar malformations. MRI is probably best performed late in the 1st week after birth to detect changes on T1 and T2 images. At present there is insufficient evidence to support routine MRI of all very preterm infants who have an abnormal cranial ultrasound. Imaging at 3-4 months may detect cerebral atrophy or encephalomalacia in infants with preceding abnormalities on DWI and/or MRS.

- **Diffusion weighted imaging (DWI)** – DWI measures the diffusion of water through tissues, with restricted diffusion indicative of cellular injury. Abnormalities on DWI are apparent before MRI changes can be detected. DWI may underestimate the size of the lesion if performed <24 hours after injury, with maximum sensitivity achieved when imaging is performed between day 1 and 3.

- **Magnetic resonance spectroscopy (MRS)** – Proton MRS gives quantitative information about specific tissue chemicals. A lactate peak develops within 24 hours of neuronal injury, with
subsequent reductions in neuronal N-acetyl aspartate (NAA). Lactate/creatine ratios >1 in the first 18 hours are predictive of abnormal long term neurological findings consistent with HIE. Other finding consistent with neuronal injury include elevated lactate/NAA, lactate/creatine, and lactate/choline ratios in the first 2 postnatal weeks.

**Initial MRI Scan - infants having scan during their first admission to the unit**

**Booking the scan –**

- *Every Thursday at 13:00 hours* there is an allocated slot for RPA Newborn Care (except the first Thursday in Jan, March, May, July, Sept, Nov where there are no MRI services available) If an appointment is not made by Wednesday morning, this time will be allocated to another urgent inpatient within RPA.

- At other times MRI appointments can be difficult to obtain, especially at short notice and infants are often placed on the standby list. Newborn Care staff may need to move promptly when a spot becomes available.

- Ring MRI department on **58093** and ask for next available MRI appointment for a neonate. Let them know the condition of the baby (stable, unstable, ventilated etc), urgency of the MRI and which MRI needed (MRI, MRS, DWI etc)

- Complete electronic order or fax the completed request form to **58592**.

**Care issues**

- Brain MRI takes a minimum of 30 minutes from commencement of scan or 60 minutes if spectroscopy is ordered.

- Newborn infants in the 1st month will generally not require sedation for MRI if appropriate feeding, preparation and comfort measures are initiated.
  - Assess the infant’s temperament before planning the MRI. If the infant is difficult to settle, then contact the Neonatologist on duty for advice.
  - On occasion a baby may require IV sedation (e.g. phenobarbitone or midazolam) for MRI and need a cannula sited prior to MRI. Dose and type of sedation will depend on the baby’s condition and age at time of MRI. Discuss with Neonatologist on duty.

- Ensure that IV/IA lines are capped according to protocol (hep locked etc.) and removed from pumps before entering MRI room. If baby is on enteral feeding ensure last feed is given within 1-2 hours of the MRI so baby is not hungry or unsettled.

- Ventilated/unstable infants are transported to MRI by an experienced neonatal nurse and fellow/consultant.
  - Place baby on open care cot system with ventilator, UPS and monitoring. To minimise handling it is best to connect the MRI compatible monitoring probe to the baby prior to transport.
  - The Smiths Baby Pac ventilator is the dedicated MRI compatible ventilator for Newborn Care infants who require ventilatory support at time of MRI.
  - Ventilator is to be set up and checked by senior nurse or medical officer with appropriate settings for infant prior to transporting baby for MRI.
  - At MRI connect the infant to the ventilator. Fellow/neonatologist and senior nurse to remain with ventilated infant throughout procedure to monitor the infant’s condition.
**Follow-Up Scan**

**Booking procedure – babies usually admitted from home**

- Babies must be less than 4 months old and well at time of scan.

- Follow up MRI appointments are to be made by the Developmental Follow Up Co-ordinator (pager 80655) and conducted **ONLY** on Tuesday, Wednesday or Thursday.

- MRI appointments are to be preferentially booked for 1000hrs following admission to Special Care Nursery at 0800hrs.

- Once appointment has been made the relevant neonatologist needs to complete 2 forms;
  
  - the “MRI Request Form” (faxed by the MRI Dept) and fax back to MRI on 58292
  - Recommendation for Admission Form’ (available from Developmental Follow Up Co-ordinator) which is handed in to the RPA Women and Babies Front Desk.

- The Developmental Follow Up Co-ordinator will speak with parents and provide an information letter with appointment details and a RPAH ‘Registration Form’ to be completed at home.

- NUMs and Physio to be informed in advance about the appointment and patient details given i.e. appointment time & date, baby’s name, MRN & DOB.

- Medical records are ordered by F/Up Co-ordinator to be available the morning of admission.

**Care issues for babies having follow-up scan**

- Parents to present completed RPAH Registration Form to admin person at front desk of RPA Women and Babies on arrival at 0800hrs

- Parents are advised to feed baby just prior to admission time (or just after).

- Baby then to be admitted into Special Care Nursery. Record baseline observations.

- Baby to have a physiotherapy assessment (unless conducted recently) and examination by a senior medical officer on admission **PRIOR** to sedation. The medical officer will also obtain parental consent for MRI. It is best to inform the relevant physiotherapist and medical officer the day before that the baby will need early admission and examination.

- For preparation of baby see section ‘MRI General’ on page 6.

- **Sedation - Chloral Hydrate 75mgs/kg** to be given orally approximately 30 mins before MRI as per protocol. Due to volume and taste this is usually best given via an IG tube (give sucrose and pacifier prior to IGT insertion). Dilute 1:3 with water according to Chloral Hydrate for MRI protocol.

- If the baby does not settle for the procedure (ie sedation is inadequate) an additional ½ dose of chloral hydrate may be given **after consultation with the neonatologist or fellow**.

- Monitoring - Whilst sedated, the baby is to be continuously monitored with pulse oximetry. Monitoring may cease when baby is no longer sedated.

- Equipment - The F/Up Co-ordinator/nurse will prepare equipment:- bean-bag, ear plugs, resus, monitoring and transport equipment.
• Transport - The Follow Up Co-ordinator/ nurse will transport baby to MRI in cot or pram and stay throughout the procedure. If baby has any airway or other compromise or at the neonatologist’s request a senior medical officer will also accompany the baby and stay throughout procedure.

• Parents - Parents may accompany baby to the MRI and remain in the waiting room during the procedure or use this time to take a break. Ensure parents’ immediate contact number (mobile) is recorded in notes in event they are needed to settle/feed baby or to advise them that the scan is completed. Scan is charged at Medicare only rate and parents need to present baby’s Medicare card to MRI personnel for charging.

• Discharge and Follow Up - The baby may be discharged from unit when he/she is no longer sedated, has completed a good sucking feed and is discharged by the medical officer. Document the baby’s discharge number (Bed Returns on 58083) in medical record. A follow up appointment with the relevant neonatologist is usually made by the f/up co-ordinator for approximately one week after the MRI and appointment card is given to parents. Consider Social Worker involvement in follow up meeting if adverse outcome is reported or at parental or neonatologist request.

MRI – General Monitoring

• All Babies undergoing MRI are to be continuously monitored for heart rate and oxygen saturation before, during and after the procedure. Babies requiring only numerical readout for HR and SpO2 during the MRI use a Nellcor saturation probe (also used for transport to MRI). NICU and HDU babies requiring SpO2 monitoring during the MRI, use the neonatal probe from MRI (collect and secure prior to transport if possible). Both these probes can be secured to the baby’s feet using Coban. Check that baby has 2 correct identification bands on hands or feet.

Preparing the bean bag

• All Babies are to be placed on the bean bag immobiliser mattress prior to transport to MRI. Ensure that the suction port is on the underside and at the foot of the mattress. If baby is in a cot the mattress must be removed (for safety reasons) before placing bean bag into cot.

Newborn Care has two immobilisers - one in blue plastic cube in the nursery equipment room and the other in the Newborn Family Support Team office. Clean and return mattress when finished.

• Ensure that the baby’s clothing is free of any ferrous metals such as metal press studs, buttons etc. It is best to dress baby in cotton singlet, cotton nightie with ties and a disposable nappy. Remove ECG leads and ensure that appropriate MRI safe saturation probe (Nellcor) is in place and transport baby using the newborn care transport monitor. If using Massimo monitor for transport make sure probe is replaced with MRI compatible probe before entering MRI room.
• Cover the bean bag with a sheet. Secure ear muffs to baby’s ears and swaddle baby in a cuddly. Place baby on bean bag leaving free space around head. Whilst a second person (perhaps a parent or staff member) gently moulds the beanbag around the baby’s head and shoulders (ensuring as best you can that baby’s head is in midline position) apply enough wall suction to the port to create a comfortable shape around baby for immobilisation. Secure clip to keep beanbag shape. This procedure may need to be repeated until the desired outcome is achieved. Shaping the beanbag can be redone in MRI if necessary. Take care not to puncture or use pins on the beanbag.

• Additional equipment required includes – Appropriate re-breathing bag (Laerdal or anaesthetic) and mask, oxygen tubing, ear muffs/plugs, stethoscope, 33% sucrose in syringe, spare nappies and pads, 10FG suction catheters, medical record (including observation charts), oxygen cylinder (if necessary for transport ONLY) and any other equipment specifically required. Newborn Care has a portable suction unit if needed for transport.

References


6. Royal Australian and New Zealand College of Radiologists MRI safety guidelines