Paediatric body MRI

1 April 2014

Venue: Stewart House, London

6 CPD credits

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BIR Annual Congress 2014: 22-23 October, London

Welcome and thank you for coming to the '*Paediatric body MRI*' event organised by the British Institute of Radiology.

This booklet contains the abstracts and biographies for each speaker (where supplied).

This meeting has been awarded 6 RCR category I CPD credits.

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We hope you find the day interesting and enjoyable.

Dr Owen Arthurs
Meeting Organiser
Magnetic Resonance SIG, BIR

We are most grateful to

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Bayer HealthCare has provided sponsorship for the cost of the exhibition stand only at this meeting.

Programme

- 08:45** **Registration and refreshments**
- 09:20** **Welcome and introduction**
Chair Dr Owen Arthurs, Consultant Paediatric Radiologist,
Great Ormond Street Hospital, London
- 09:30** **Physics for paediatric MR**
Dr Oystein Olsen, Consultant Paediatric Radiologist,
Great Ormond Street Hospital, London
- 10:15** **Guidance about sequences and protocols**
Dr Oystein Olsen, Consultant Paediatric Radiologist,
Great Ormond Street Hospital, London
- 11:00** **Refreshments**
- 11:30** **MSK MRI - inflammation/infection**
Dr Paul Humphries, Consultant Paediatric Radiologist,
Great Ormond Street Hospital and University College London
- 12:15** **MSK MRI 2 - bone marrow**
Dr Karl Johnson, Consultant Paediatric Radiologist,
Birmingham Children's Hospital
- 13:00** **Lunch**
- 14:00** **Abdominal MRI - techniques, common applications and findings in paediatric MR enterography and hepatobiliary MR imaging**
Dr Helen Woodley, Consultant Paediatric Radiologist,
Leeds Teaching Hospitals NHS Trust
- 14:45** **Abdominal MRI - oncology, pelvis**
Dr Oystein Olsen, Consultant Paediatric Radiologist,
Great Ormond Street Hospital, London
- 15:30** **Refreshments**

- 16:00** **Use of whole body MRI and PET-MRI in paediatrics**
Dr Paul Humphries, Consultant Paediatric Radiologist,
Great Ormond Street Hospital and University College London
- 16:45** **New/emerging techniques**
Dr Owen Arthurs, Consultant Paediatric Radiologist,
Great Ormond Street Hospital, London
- 17:30** **Close of meeting**
-

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Speaker profiles (where supplied)

Dr Owen Arthurs

Consultant Paediatric Radiologist, Great Ormond Street Hospital, London

Dr Owen Arthurs is a newly appointed Academic Consultant Paediatric Radiologist at Great Ormond Street Hospital and University College London. He trained in Paediatrics and Radiology in Cambridge and London, and was awarded a PhD in brain imaging in 2002 from the University of Cambridge. He has co-authored over 35 peer reviewed papers and won several awards at national and international level for his work in paediatric MRI. His current interest is in developing post mortem imaging in children, funded by NIHR.

Dr Paul Humphries

Consultant Paediatric Radiologist, Great Ormond Street Hospital and University College London

Dr Humphries is a Consultant Paediatric Radiologist, working at both University College London Hospital NHS Trust and Great Ormond Street Hospital for Children. His research interests include whole body MRI imaging, with a particular focus on oncology and inflammatory disorders.

Dr Karl Johnson

Consultant Paediatric radiologist, Birmingham Children's Hospital

I am a Consultant Radiologist at Birmingham Children's Hospital. I have a special interest in musculoskeletal imaging.

Dr Oystein Olsen

Consultant Paediatric Radiologist, Great Ormond Street Hospital, London

Dr Oystein E Olsen is a Consultant Paediatric Radiologist at Great Ormond Street Hospital for Children. He has a special interest in body MRI, and oncological and musculo-skeletal imaging.

Dr Helen Woodley, Consultant Paediatric Radiologist, Leeds Teaching Hospitals NHS Trust

Dr Woodley undertook undergraduate training at Cambridge University and The Royal London Hospital. Following house jobs in London she headed north to Leeds for a medical SHO rotation followed by a place on the Yorkshire Radiology Registrar Rotation. Following a fellowship year in paediatric radiology at the Women and Children's Hospital, Adelaide, Australia, she took up her current post as Consultant Paediatric Radiologist in Leeds Teaching Hospitals Trusts (LTHT) in 2000. LTHT became the 3rd centre in the UK for paediatric liver transplantation at the time of her appointment and as well as performing the full range of paediatric imaging in her consultant post she has developed a specialist interest in paediatric hepatobiliary imaging.

Abstracts (where supplied)

Physics for paediatric MR

Dr Oystein Olsen

Main challenges with MRI in children:

- 1) Motion artefacts
- 2) Poor signal-to-noise ratio (SNR)
- 3) Sometimes surprising tissue contrast compared to adults

SNR is proportional to voxel volume, which must therefore not be too small, however, usually needs to be reduced compared to adult imaging to account for the finer anatomy of the child. Multi-channel coils with element sizes appropriate for the anatomy of interest ensures optimal baseline SNR.

Longer acquisition time increases SNR (with a square-root factor), but this allows more motion artefacts! Attention to patient preparation and to techniques for motion artefact reduction is therefore crucial. Most important are fat attenuation, peristaltic attenuation and physiological triggering.

Low SNR may in part be compensated by optimising the image contrast by weighting (tissue and lesions T1 and T2 may differ from adults) and by using contrast agents. It is also powerful to combine different image contrasts during post-processing.

Educational aims: Be able to identify the main elements of diagnostic quality and how these interact. Be able to suggest ways of manipulating these during the MRI acquisition.

Guidance about sequences and protocols

Dr Oystein Olsen

My mantra: Delivering an imaging service is mostly about achieving good-quality imaging - reporting is secondary.

My best advice: One properly acquired sequence is better than a dozen half-decent ones.

Some general ideas:

1. Anatomical planes (ax, sag, cor) are really arbitrary. Therefore, volumetric acquisitions are valuable.
2. Spin-echo is almost always better than gradient-echo (but lengthy, so use triggering or k-space techniques to minimise motion artefact).
3. Coronal views are nice for non-radiologists but, really, most anatomical planes are perpendicular to the axial plane, so do mostly axial acquisitions (exceptions: spine, anterior mediastinum, pelvic midline structures).
4. Fat (high signal on the move) gives motion artefact, so suppress it. BUT always obtain one good axial/volumetric spin-echo sequence without fat suppression to define the anatomical planes.
5. One never regrets having done DWI.

Educational aims: Be able to devise a core MRI protocol based on the principles of sensitivity, anatomical specificity, pathological specificity

MSK MRI - infection and inflammation

Dr Paul Humphries

In this talk the MRI features of paediatric musculoskeletal/multisystem inflammatory and infectious disorders will be discussed. Clinical and imaging features will be described and areas of diagnostic uncertainty highlighted.

MSK MRI 2 - bone marrow

Dr Karl Johnson

Imaging the bone marrow in children, as with any other aspect of paediatric imaging requires an understanding of the normal variations which can occur with growth and maturation. This is particularly relevant to the bone marrow as there is significant variation in appearance during childhood because of the haemopoietic requirements of the growing child.

This talk will emphasise the best approach to imaging the marrow, highlight the changes with age and illustrate a variety of pathological conditions. The pathologies covered will include sickle cell disease, avascular necrosis, leukaemias, metastatic disease, traumatic changes and storage disorders.

An overview of the more advanced imaging techniques, such as dynamic contrast enhancement and diffusion imaging will be discussed. The limitations of imaging and the correlation with clinical findings will be highlighted.

Abdominal MRI - techniques, common applications and findings in paediatric MR enterography and hepatobiliary MR imaging
Dr Helen Woodley

Aims:

1. Knowledge of MR technique and protocols in paediatric MR enterography (MRE) and hepatobiliary MR.
2. Understanding of the common indications for paediatric MRE and hepatobiliary MRI.
3. Recognition of signs of inflammatory bowel disease on MRE.
4. Knowledge of the characteristic MR findings of common paediatric liver masses and understanding of the use of liver specific contrast agents in hepatobiliary MR.
5. Recognition of the common biliary pathologies in paediatric MR.

Learning points:

MRE

The commonest indication for MRE in children is the investigation of Crohn's disease although MRE also has an emerging role in the assessment of small bowel tumours and sub acute obstruction. MRE has largely replaced conventional barium studies of the small bowel due to the lack of ionising radiation and comparable diagnostic capabilities for Crohn's disease aside from more subtle aphthous ulceration. MRE assesses extent of disease, disease activity, treatment response and extraintestinal complications. MR findings can be classified as active inflammatory disease, penetrating and fistulating disease, fibrostenotic and reparative and regenerative. There is emerging use of DWI to assess activity of disease with potential to replace the use of contrast.

Hepatobiliary MRI

Indications for hepatobiliary MRI in paediatrics include characterisation of focal liver masses, staging of malignant disease, vascular assessment, evaluation of the biliary tree and assessment of diffuse parenchymal disease. MR is often able to characterise focal liver lesions with the use of appropriate sequences avoiding the need for biopsy or further investigation.

The use of hepatocyte specific agents further increases diagnostic accuracy distinguishing hepatocellular lesions from non-hepatocellular lesions and also improves delineation of tumour margins and the relationship to the biliary tree. MR of the biliary tract accurately detects the level and cause of obstruction; including stones, tumours, inflammatory lesions and choledochal abnormalities. Hepatocyte specific agents are excreted via the biliary system and have an emerging role in functional imaging with potential application for congenital abnormalities, post-operative complications and differentiation of biliary from extra-biliary lesions.

References

1. Einstein et al., MR Imaging of the Small Bowel, Radiographics 2009; 29:1811-1825
2. Taylor et al., MR Enterographic Manifestations of Small Bowel Crohn Disease, Radiographics 2010; 30: 367-384
3. Harisinghani et al., Prospective Evaluation of MR Enterography as the Primary Imaging Modality for Pediatric Crohn Disease Assessment, AJR 2011; 197: 224-231
4. Vasanawala et al., An Approach to Pediatric Liver MRI, AJR 2011; 196: 519-526
5. Sahani et al., Hepatobiliary-specific Contrast Agents: Role in Imaging the Liver and Biliary Tree, Radiographics 2009; 29: 1725-1748
6. Vidarsson et al., Pediatric MR Cholangiopancreatography: Principles, Techniques, and Clinical Applications, Radiographics 2008; 28:1951-1962

Abdominal MRI - oncology, pelvis Dr Oystein Olsen

1. Primary diagnosis

A. Regional extent of disease (sensitivity): STIR is sensitive but non-specific. In particular, enlarged lymph nodes and bone-marrow "oedema" are difficult to categorise

B. Local extent of disease (anatomy): high-resolution T2-w TSE or, even better, isotropic T2-w TSE. This is excellent for describing relations within the organ of origin and relations to adjacent organs. It is probably the best sequence for tumour thrombus, capsular breach. MinIP gives vascular information. Fusion with DWI and contrast-enhanced sequences increases the amount of useful information.

C. Biopsy planning (specificity): DWI with ADC mapping. NB! must always be cross-referenced with contrast-enhanced T1 since necrosis/pus can mimic tumour.

2. Response assessment

A. For any preoperative imaging, repeat the full investigation with emphasis on the anatomical sequences. Retroperitoneal tumours mostly retain their anatomical relations despite often undergoing substantial reduction in volume. Neuroblastic tumour can be difficult to define following chemotherapy; the most reliable sequence is 3-D FLASH in arterial/portal-venous phase following IV pump-injection of gadolinium chelate.

B. For oncological response assessment, the combination volume-change and ADC-change are useful. Lack of volume-reduction (or even increase in volume) is not evidence for poor response in Wilms tumour. A right-shift of the ADC distribution is usually seen. One caveat: tumours that have sclerosed or calcified are usually not suitable for ADC re-assessment.

3. Surveillance

A. Abbreviated protocols are usually OK, e.g. 2-D T2 TSE replacing 3-D T2 TSE saves time.

B. For multifocal renal lesions, or following partial nephrectomy, a full tumour protocol (including isotropic T2 TSE) is suggested.

Educational aims: Understand how to acquire diagnostically relevant information at primary diagnosis, response assessment and surveillance of tumours in the abdomen and pelvis.

Use of whole body MRI and PET-MRI in paediatrics **Dr Paul Humphries**

In the past 10 years paediatric MRI applications have developed rapidly. Advances in hardware technology, sequence development and testing against established reference standards have taken anatomical whole body imaging from a pilot “proof of concept” to a technique that is now available for routine clinical use.

More recently the reliable acquisition of “functional” imaging techniques, such as diffusion weighted imaging (DWI), outside of the nervous system and at a whole body level has been established, opening up a whole new avenue of research. Modern hybrid imaging systems incorporating MR and positron emission tomography (PET) further push the boundaries away from anatomical imaging and towards the realm of molecular imaging.

In this lecture I will describe the evolution of whole body MRI (WB-MRI) technique in paediatrics; evaluate the evidence base for WB-MRI for various paediatric disorders; describe the principles of DWI, its acquisition on a whole body level and the potential utility of DWI in paediatrics. I will discuss the new hybrid imaging platform PET-MRI and illustrate its potential in the paediatric setting with case examples.

The recent and historic literature will be referenced during the talk, to illustrate where there is evidence for and against WB-MRI in paediatrics.

By the end of this session, the audience will be aware of the technical developments facilitating WB-MRI in children, the strengths and weaknesses of the technique; the evidence base for its clinical use and potential areas that are ripe for on-going research.

New/emerging techniques

Dr Owen Arthurs

This presentation will cover some of the new developments that have been made in paediatric and other areas of MRI imaging, in order to understand which of these are most applicable to day-to-day practice, and which should be adopted as routine in the near future. Promising techniques will include MR elastography, as well as functional techniques including quantitative MR imaging and hyperpolarisation. New areas of imaging including post mortem and non-accidental imaging will be covered.

The aims of this talk are:

1. To highlight recent hardware and software developments which may help improve paediatric body MRI
2. To understand how novel quantitative MR techniques may be applied to children
3. To emphasise new areas of paediatric body MRI

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