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BAMRR news

THE NEWSLETTER OF
THE BRITISH ASSOCIATION OF MR RADIOGRAPHERS

SHARE YOUR POSTERS AND PROFESSIONAL KNOWLEDGE AT THE

**BAMRR CONFERENCE
1ST OCTOBER 2016
CARDIFF**

IN THIS ISSUE:

USING TECHNOLOGY TO ENHANCE MRI CPD

FULL REPORT - PAGE 11

welcome

from your BAMRR PRESIDENT

Welcome to the Spring 2018 BAMRR Newsletter. The BAMRR Policy Board have had a very busy 2017 with two successful and well attended Intro courses, our UKRC session and the annual conference in Glasgow.

2018 promises to be just as busy, we have our 'Further MRI' course on the 10th March in London, our UKRC session on the 4th July in Liverpool and the 'Intro MRI' course on the 2nd and 3rd of November in Loughborough. The Annual conference is on Saturday 6th October and is in Nottingham this year. Thanks to our sponsors and particularly Guerbet, we are again keeping the costs of our courses and particularly the conference as low as possible to allow as many people as possible to attend. Please check the website for the full details and to see what other information is available for you at BAMRR.org.

The volunteers on the Policy Board have welcomed a new member this year, Niamh Cleary who you will read more about in the Newsletter.

Finally, I want to thank the policy board for all of their hard work in 2017, all the work that we do is in our own time and on a volunteer basis. I would also like to thank all of you for your continuing support of BAMRR.

Helen Estall
BAMRR President

from your EDITOR

The lead-up to compiling an edition of BAMRR News usually gives me a few weeks of stress for whilst I twist peoples arms to provide me with content. This time however the Policy Board got stuck in and in no time at all I had a good selection of relevant and interesting subject matter which I hope you will enjoy. Thank you to all my PB colleagues for their engagement. Please remember though that I would encourage any member to submit interesting articles – it's your magazine after all.

So can I now go and put my feet up? Not quite! I will be presenting on the further course in March and then my team at the Royal Bournemouth will be preparing to host this year's SMUG meeting on June 16th (advert within!). You are all very welcome and would love to see you in Bournemouth.

Matthew Benbow
BAMRR Editor

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WELCOME from our sponsor GUERBET

Guerbet wishes you a warm welcome to the Spring edition of BAMRR News.

Guerbet wishes you a warm welcome to the Spring edition of BAMRR News.

In Novemebr 2015 we completed the acquisition of the "contrast media and delivery systems" (CMDS) business of Mallinckrodt. The new entity brings together 2,500 employees creating a global leader specializing in contrast media and imaging solutions and services (ISS).

We continue our committment to supporting continuous professional development for MR Radiographers. Throughout the year, in partnership with Radiologists/Radiographers who are passionate about sharing their knowledge, we organise and support teaching courses which are informative and relevant. Please visit our website www.guerbet.co.uk to find out more about the events we hold or sponsor.

Do not hesitate to get in touch on 0121 733 8542 or uk.info@guerbet-group.com if there is something you would like to tell us. As always, we welcome your comments and suggestions as we are here because of you.

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BAMRR Conference

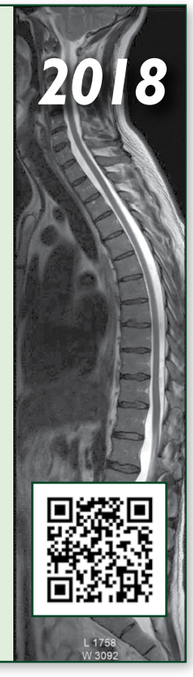
Saturday 6th October at Nottingham Conference Centre

Topics Include:

- Fetal MRI
- 7T and Beyond
- Forensic MRI
- MR Guided Radiotherapy Planning
- New Sequences and Techniques
- eGFR and Gadolinium Retention
- Clinical Cardiac MRI

Programme to be confirmed, registration opens June 2018

www.bamrr.org.uk/home



BAMRR Policy Board Members, Spring 2018

The co-ordination of the Associations activities is overseen and undertaken by an elected Policy Board. BAMRR consists of up to 15 individuals who are full members of BAMRR and are working in different regions of the UK.

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2017 BAMRR Conference

Friday Evening Report

Delegates of this year's 34th annual BAMRR conference were treated to an educational evening lecture on Friday 6th October at the Beardmore Hotel & Conference Centre, Glasgow

Bayer not only sponsored the speaker but also provided a light supper beforehand to ensure the audience were well catered for and ready to concentrate.

Dr Lukas D. Weberling overcame flight delays from Germany enabling him to give us an 'Update on gadolinium presence in the brain after repetitive administration of gadolinium based contrast agents'.

Dr Weberling is one of the key researchers in the neuro-oncological imaging group at the Heidelberg University Hospital and the German Cancer Research Centre, whose research most recently has been looking at gadolinium-retention in the dentate nucleus and globus pallidus after different MRI contrast agents.

The group has published over five major publications on this topic in the last two years

Dr Weberling discussed the current literature regarding gadolinium presence in the brain and the requirements for critically evaluating a paper and what components are essential for good quality research.

His unbiased approach was refreshing and his expertise was much appreciated by all those who attended

BAMRR would like to thank Bayer once again for providing an excellent educational evening

Rachel Watt
BAMRR Policy Board Member

BAMRR Conference Report

Glasgow October 2017

Yet another successful BAMRR conference was held on Saturday 7th October 2017 in the Beardmore Hotel & Conference Centre, Glasgow, Scotland. This was an excellent venue for the 34th annual conference and AGM.

A full day of informative lectures kept the 75 delegates well engrossed and the sponsors' stands offered a wide variety of opportunities to gain more information. This was made possible by our most generous sponsors, whose support added to the success of this event.

Platinum	Gold	Silver	Bronze	Sponsor Stand
GE Healthcare and Guerbet	*Phillips*	*Bracco, Devon Medical, Toshiba, Metrasens and Wardray Premise*	*Bayer*	*The College and Society of Radiographers*

After welcoming delegates, speakers and sponsors, Paola Griffiths (BAMRR President) introduced the three speakers who were talking before the morning coffee break;

Dr Gordon Cowell (Consultant Radiologist, Queen Elizabeth Hospital, Glasgow), Ms Jelena Jovanovik, (Research MRI Radiographer, Imperial College, London) and Mr Steve Shorrock (Chartered Ergonomist, Psychologist and Human Factors Specialist)

Dr Gordon Cowell in his talk entitled 'Whole body MRI- A Whole Load of Hassle? explained the clinical indications for whole body MRI, sharing his tips for optimising protocols and highlighted some common image quality and imaging interpretation pitfalls.

Ms Jelena Jovanovik, former Veterinary MRI Radiographer with the 'Supervet' at Fitzpatrick Referrals Ltd shared her experience encountered in the challenges of scanning animals of all different shapes and sizes along with the rapid developments in veterinary medicine and imaging in her talk 'Veterinary MRI: New fashion or New essential'?

Mr Steve Shorrock from Eurocontrol gave a unique insight into the different perspectives on human work that have significant implications for the safety and effectiveness of MRI and all clinical work.

His talk, 'The Varieties of MRI Work' provided a framework for thinking about work, along with practical examples and some implications.

During the coffee break, the delegates enjoyed a chance to network, speak to the stand holders from a wide range of companies associated with MRI and view the posters.

This year there were four excelled posters for judging submitted and a few others for display only:

1) Improving the safety of MRI in Scotland: development and testing of a multi-interventional approach to reducing risks

   Barbara Nugent, Scottish NHS NES AH Career Learning Fellow, MRI & CT Superintendent Radiographer, Royal Hospital for Sick Children, Edinburgh.

2) Magnetic Resonance Imaging of Metastatic Spinal Disease

   Claire Currie, MRI Radiographer, NHS Greater Glasgow and Clyde

3) Normal Left Ventricular volume and mass using Cardiovascular Magnetic Resonance in healthy

   West-Africans and the significance of these findings in the context of Hypertrophic Cardiomyopathy..

   Ann Briody ,Superintendent Radiographer, MRI Unit, King's College Hospital, London

4) Balanced Steady-State Free Precession in MRI Foetal Imaging of the Abnormal Placenta

   Lindsay Walker, Wrightington, Wigan and Leigh NHS Foundation Trust and PGc student at University of Cumbria,

Feeling refreshed after coffee, the audience settled down to listen to two further lectures and a proffered paper before the BAMRR AGM.

Mr Roddy O' Kane, Consultant Neurosurgeon, Queen Elizabeth Hospital, Glasgow entertained the delegates with his 'colourful and effervescent' running commentary, describing how he performed complex neurosurgery as featured in his extraordinary intra-operative video footage.

'What you see is what you get- MRI in Neurosurgery' left the delegates in stitches (no pun intended....)

Mrs Barbara Nugent, CT/MRI Superintendent, Royal Children's Hospital, Edinburgh updated all on her work in the development of an elearning 'MRI Safety Program' and the importance of reporting near misses. Ensuring lessons are learned and concerns are being addressed, along with the need for education are key for MRI safety in departments.

Karyn Chappell, PhD student at Imperial College London, closed the morning session with her proffered paper entitled 'Making the invisible visible: Magic Angle a source of artefact or a new technique for imaging? highlighting a technique which has the potential to change musculskeletelal MRI by early diagnosis of degenerative joint disease.

This was followed by the BAMRR AGM, where Aileen Wilson, BAMRR membership secretary and Helen Estall, BAMRR treasurer gave an update on the membership and financial status of the organisation, before everyone enjoyed a beautiful lunch in the Waterhouse restaurant.

The afternoon session commenced with the new BAMRR President Helen Estall introducing the first speaker, Dr Tanja Gagliardi, Consultant Radiologist, NHS Grampian, Aberdeen whose presentation was entitled 'Breast MRI and MRI Guided Biopsy' - More harm than charm ?

Tanja explained why we do breast MRI, it's role in breast imaging and how to perform breast MRI guided biopsy, giving some common indications, which were reinforced by sharing relevant case studies.

This was followed by Dr Dympna Mcateer, Consultant Radiologist, NHS Grampian, Aberdeen, who gave an excellent synopsis of anatomy and pathology during her talk 'Head and Neck MRI, with an overview of clinical examples.

Tanja returned to enlighten the delegates with 'Gynaecology MRI- what the Radiographer needs to know or how to make the Radiologist happy'.

An introduction to the most common gynaecological cancers staged with MRI using the FIGO criteria and prognostic factors was given.

Following a coffee and cake break, the afternoon's proceedings were brought to a close by Dr Dr Jonathan Ashmore, Principal MRI Physicist, NHS Highland, Raigmore, Inverness who gave two excellent presentations.

His first session 'The virtual reality MRI experience: A free app to prepare paediatric patients for their MRI scan' was interactive and involved audience participation by means of an app on their mobile phones. This app allows patients to benefit from preparation resources prior to their scan and has the potential to save money for the NHS.

In the final talk of the day 'Blanket implant scanning policies for MRI: Is there a risk? Jonathan presented data outlining the potential dangers in the lack of consistency not only between different sites but between radiographers working within the same site in their approach to screening and dealing with patients presenting with implants. The making of a risk profile was also explained.

BAMMR President, Helen Estall brought the day to a close and presented the prizes - £150 to Lindsay Walker who submitted the winning poster and £300 to Karen Chappell, for her successful proffered paper.

Work is already underway for our 2018 projects, the BAMRR session at UKRC (2nd-4th July in Liverpool) and the 35th annual BAMRR conference (Sat 6th October in Nottingham)

Hope to see you there....

Rachel Watt

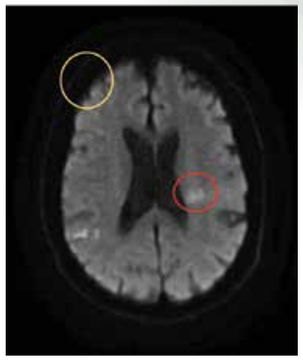
BAMRR Conference Organiser 2017
and UKRC Organiser 2018

Restricted Diffusion in the Brain

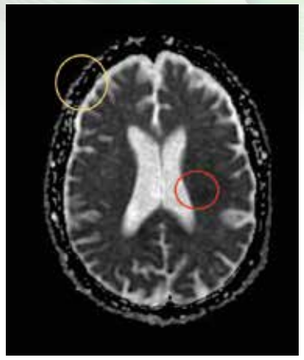
Helen Estall, Lead Superintendent Radiographer CT/MRI, University Hospitals Leicester

When we think of restricted diffusion in the brain we normally think of an acute ischaemic infarct, however there are other conditions that also demonstrate restricted diffusion, tumours such as lymphomas, some demyelinating plaques in Acute disseminated encephalitis (ADEM) for example and infections such as abscesses. To confirm that the high signal on the DWI image is due to restricted diffusion, there must be an associated low signal area on the ADC map. If there is no low signal on the ADC image then this is likely to be due to T2 shine through.

Acute Ischaemic Infarct:



◆**Figure 1: DWI axial**



◆**Figure 2: ADC axial**

The above images demonstrate a small area of high DWI and low ADC signal adjacent to the left lateral ventricle indicating a small acute infarct (red circle). There is also a further small acute infarct posteriorly on the right (yellow circle). This patient has had more than one vascular territory affected.

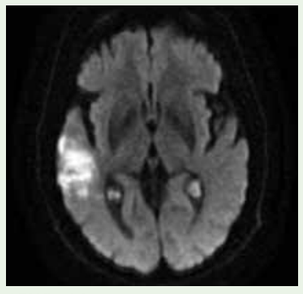
Ischaemic stroke occurs due to a sudden loss of sufficient blood supply to an area of the brain, it usually presents with the rapid onset of a neurological deficit, this is determined by which area of the brain is involved. Symptoms can change over hours and may improve or worsen depending on any re perfusion.

MRI has significantly higher sensitivity and specificity for the diagnosis of acute ischaemic stroke in the first few hours after the event. The ADC signal will start to normalise around 10-15 days after the event.

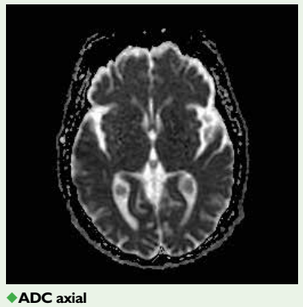
Thrombolysis and mechanical thrombectomy can be extremely successful treatments if carried out early enough.

Sub-Acute Ischaemic Infarct:

The images below show high DWI signal but no associated low ADC signal, denoting a sub-acute infarct.



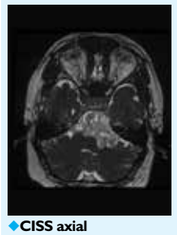
◆**DWI axial**



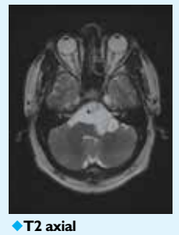
◆**ADC axial**

Epidermoid Cyst:

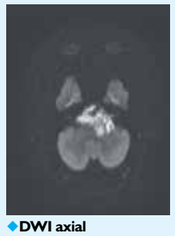
These are predominantly congenital tumours and account for approximately 1% of all brain tumours. They are very slow growing, are mostly isointense to CSF on T1 and T2 but have high DWI signal due to a mix of restricted diffusion and T2 shine through, 40- 50% of them present in the cerebellar pontine angle as below. They are often indistinguishable to arachnoid cysts except on the DWI sequence, treatment is by surgical excision, but only if symptomatic.



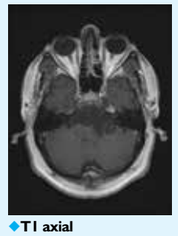
◆**CISS axial**



◆**T2 axial**



◆**DWI axial**

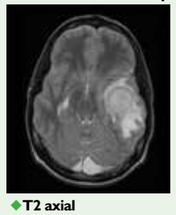


◆**T1 axial**

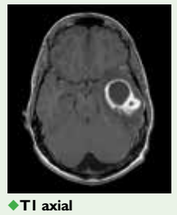
Abscess:

A brain abscess is a potentially life-threatening condition, MRI can distinguish an abscess from other ring enhancing lesions on CT as there will be restricted diffusion and therefore high DWI/ low ADC signal centrally. Treatment is usually by surgical resection and drainage and then antibiotics. Complications can occur such as herniation, intraventricular rupture, choroid plexitis and leptomeningitis. The T2 weighted image below shows a decreased signal rim, fluid signal internally and oedema, post contrast imaging will demonstrate rim enhancement.

◆**DWI axial post contrast**



◆**T2 axial**



◆**T1 axial**

New BAMRR Board member

◆**Niamh**

Niamh trained as a diagnostic radiographer in Kingston and St George's Hospital and completes a Masters in MRI in the University of Dublin in 2015. Niamh has working in London and Ireland as a MRI radiographer over the last 10years. Niamh currently works in Co. Sligo, Ireland as a MRI radiographer.

Niamh wanted to be involved in the BAMRR group as she has an avid interest in professional development and feels a good way of this is sharing knowledge and developments in MRI to the other members in BAMRR. Niamh enjoys organising events and feels the group can have a vital role in MRI education and professional development."

Date for Your Diaries

2018 BAMRR Conference

Saturday 6th October 2018

Nottingham Conference Centre, Nottingham City Centre

Provisional Agenda:

Scanning during Pregnancy
Dementia Friendly Departments
Foetal MRI
Disease evaluation on 7T
Setting up a MRI Radiotherapy Service
Forensic MRI
Multiparametric Prostate MRI
Compressed Sense imaging
Gadolinium Retention

Costs:

BAMRR Member: £55
Non-member plus membership: £85
Non-member: £100

Register via the BAMRR website:
http://www.bamrr.org/conferences/conference-home

Closing date -28th September 2018
www.nottinghamconferencecentre.co.uk

INTRODUCTORY MRI COURSE

An excellent value MRI course for those new to MRI or learning the modality. Includes:

BAMRR Members: £135 Non Members: £185
Non Member including one year membership only £165!

sponsored by Guerbet Contrast for Life

- **Hands on MRI sessions**
- **MRI safety and artefacts**
- **General MRI techniques**
- **Anatomy and pathology workshops**
- **Lunch and refreshments**

Saturday 6th October 2018
Nottingham Conference Centre

Call for Posters and Oral Papers

Send your proposals/abstracts for MRI related Scientific Posters

Proferred paper £300
Best Poster £150

First Drafts to be received by:
31st August 2018

Send your proposals/abstracts to:

Rachel Watt
Lead MRI Superintendent
MRI Department - West Aberdeen
Royal Infirmary
NHS Grampian
Foresterhill Road
Aberdeen
Scotland AB25 2NZ
or email: rachelwatt@nhs.net

British Association of MR Radiographers

BAMRR Education Grant

•An £1000 award is available per year for MRI research or improved service development

All applicants should meet the following criteria:

- Be a full member of BAMRR
- Be enrolled on MSc course at present and currently progressing the research in the field of MRI.
- Outline use of the grant and provide an audit trail on completion
- Give a presentation at next BAMRR annual conference
- Provide an article for publication in the BAMRR Newsletter

How to apply:

- Complete the application form available on the website under “About Us” -Education Grant
- Applications must submit a brief outline of the intended project (maximum 750 words)
- Applications must to send to BAMRR via the website ***www.bamrr.org***

Balanced Steady-State Free Precession in MRI Foetal Imaging of the Abnormal Placenta

Wrightington, Wigan and Leigh NHS
NHS Foundation Trust
Lindsay Walker BSc (Hons)
University of Cumbria

Introduction

MRI Imaging of a maternal patient poses many barriers in clinical practice; scan time needs to be quick to help avoid the potential adverse effects of RF energy, prolonged exposure to gradient fields, increased acoustic noise, and possible bio-effects associated with the static field. Although risks are low, they remain a concern in foetal imaging. (MHRA, 2015)

In abdominal imaging, such as the imaging of Placenta Accreta and Placenta Praevia, maternal breathing and foetal movement create an additional barrier. Balanced Steady-State Free Precession imaging (bSSFP) gradient echo pulse sequences such as Balanced FFE, TrueFISP, FIESTA provides a T2/T1 weighted sequence with quick acquisition time, suitable for short breath holds, resulting in high SNR increased, contrast to noise ratio and reduced motion sensitivity.

What is Balanced SSFP?

Balanced SSFP is a coherent GRE sequence where a dynamic equilibrium is achieved through three planes of magnetization (Fig 1) by keeping the TR shorter than the T2 relaxation values of tissues, using the same flip angle (50-80◦) through out the application of RF pulses. (Chavan et al, 2008)

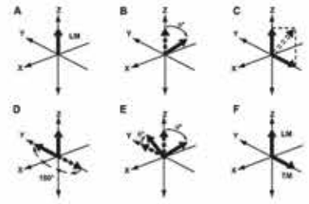


Fig 1. Diagramatic representation of steady-state magnetization throughout the period of a TR. (Chavan et al, 2008)

During the pulse sequence (Fig 3) the effective TE (Time between echo and the excitation pulse which created it's FID) is longer than TR. Within one effective TE, an excitation and a subsequent re-phasing RF pulse of equal flip angle is applied at alternating TRs. Each RF pulse provides a number of signals (Fig 2); The Post-excitation signal (S+), or Free Induction Decay (FID), is formed from the most recent RF pulse. The Echo Reformation signal (S-) is from the refocusing of residual echo in the subsequent (paired) RF pulses - this mimics a Spin echo (SE) sequence. Stimulated Echo signal (STE) is formed from a triad of RF pulses.

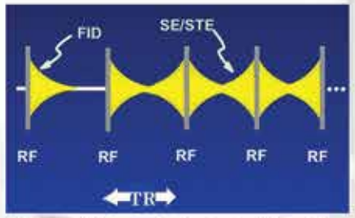


Fig.2 FID created from every RF pulse, spin echo (SE) created from each pair of RF pulses and stimulated echo (STE) from each triad of RF pulses resulting in a continuous signal of varying amplitude. (Elster, 2016)

To avoid reading and transmitting simultaneously, a rewinding gradient (Fig 3) is applied 9msec prior to the end of the effective TE. (Hashemi et al, 2010)

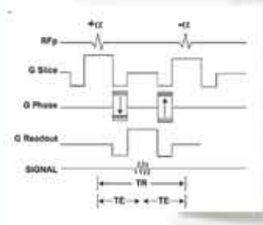


Fig3. Pulse sequence diagram of Balanced SSFP showing true TE with gradients along all 3 axis balanced. (Chavan et al, 2008)

Below: Effective TE equation. (Westbrook et al, 2005)

$$effective\ TE = (2xTR) - TE$$

Clinical Application

The Royal College of Obstetricians and Gynaecologists recognises high maternal and foetal mortality where Placenta Accreta and Placenta Praevia are present, particularly in patients with existing Caesarean section delivery. Although NICE guidelines recommend Ultrasound placental localisation at 20wks with follow up abdominal and transvaginal ultrasound imaging, MRI is more accurate in evaluating the depth of infiltration in Placenta Accreta cases. (RCOG, 2011)

MRI has common indicators of Placenta Accreta:
- Uterine bulging (85% predicitive)
- Dark intra-placental bands on T2 weighted images (95%)
- Heterogonous signal within the Placenta

(Riteau, 2014)

The reviewed literature (Bour, 2014; Maher, 2013; Riteau, 2014; Wang 2017) showed that MRI had a high specificity for the evaluation of abnormal placentation, but the sensitivity remained with Ultrasound; suggesting the role of MRI in these cases is complimentary and more useful in complex cases where ultrasound diagnosis is equivocal.

MHRA, 2015 recommend patients be scanned on a Risk Vs Benefit principle with sequences of optimal solution in minimising the risk of RF and acoustic noise exposure.

Each study used balanced SSFP and Ultrafast T2SE weighted sequences within their protocols. With the actual image time being 33% of the total study time. (Brugger, 2012)

Maternal comfort should be paramount to reduce risk of motion artefact. Breathing coaching should be applied with imaging performed supine or left lateral decubitus to avoid pressure on the IVC. (Saleem, 2014)

TrueFISP Vs T2HASTE

The combination of short TR, Spin Echo effect and application of rewinding gradients in balanced SSFP create a heavily T2 weighted sequence, with elements of T1 due to the T2/T1 ratio (Fig 4) unlike most other GRE sequences which are T2*. As highlighted; bSSFP and Ultrafast T2 are employed in reviewed protocols – so what makes the two T2 sequences different in the analysis of Placenta Accreta and the abnormal placenta?

Fig 4. Signal intensities of tissues related to the T2/T1 ratio. Fat/Fluid show as bright on bSSFP. (Elster, 2016)

Tissue	T2/T1
Muscle	0.05
Liver	0.08
Brain	0.11
Fat	0.30
CSF/Fluids	0.70

T2HASTE

A form of Half Fourier Single Shot Turbo Spin Echo acquisition; T2HASTE (Fig 5) is a single shot technique using a single RF excitation pulse with a long Echo Train Length using phase conjugate symmetry to sample data in k-space which has been used as a standard sequence for many years. Degradation of spatial resolution could potentially occur in this sequence due to T2 decay. (Bernstein, 2004) Although analysis of the placenta is the primary indication, the foetal organs will be reviewed, T2HASTE and TrueFISP have comparable image quality of the brain in the 2nd trimester. (Saleem, 2014)

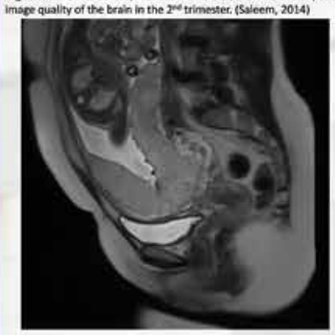


Fig.5 Sagittal T2HASTE image of patient 29/40 weeks pregnant with placenta praevia (Image courtesy of Base Hospital)

TrueFISP

bSSFP sequences (TrueFISP) (Fig 6) has developed over time along with the increased gradient strength and is a fast sequence capable of a scan time of 1sec per slice. It has a high SNR which is suitable for use with acceleration factors of 2 or greater resulting in shorter breath hold times and increased spatial or temporal resolution. The use of greater flip angles also increases SNR generating bright fluid signal. (Bernstein, 2004) TrueFISP has a lower RF heat deposition (3x) than T2HASTE. Thus, is considered to be safer. In the 3rd trimester, this sequence is superior in the review of the axonal myelination and is the sequence of choice for heart and vessel visualisation. (Saleem, 2014)

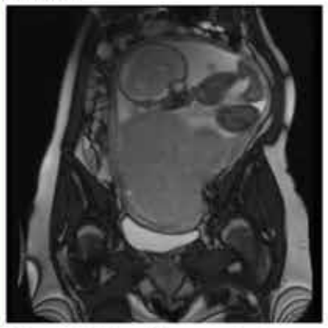


Fig6. Coronal TrueFISP Image of placenta praevia patient. (Image courtesy of Base Hospital)

Disadvantages

The main drawback of the use of bSSFP in foetal imaging are banding artefacts (Fig 7) forming in regions of susceptibility change. E.g. air/tissue interfaces caused by field inhomogeneities.

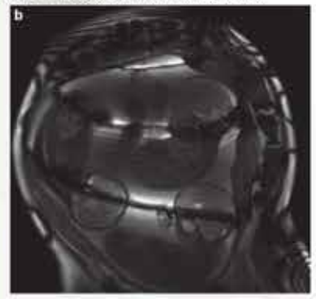


Fig 7. Banding artefact in a coronal bSSFP image of a patient expecting triplets. (Prayer, 2011)

Conclusion

Balanced Steady-State Free Precession Imaging is a complex coherent gradient echo sequence which has developed over time with gradient strengths. Its Spin Echo effect creates a T2/T1 weighted sequence superior in the analysis of major foetal organs and that of the abnormal placenta; where dark intra-placental bands on T2 imaging gives a 95% prediction of Placenta Accreta.

bSSFP is a quick sequence (1sec per slice) with high SNR which can be used in conjunction with k-space speed up tricks e.g. GRAPPA with an acceleration factor of 2 or greater resulting in shorter breath holds and increased spatial or temporal resolution. In most cases, a full sequence can be performed in one breath hold – reducing time in the scanner.

bSSFP is considered to be a more desirable imaging option to its Half-Fourier Single Shot Turbo Spin Echo counterpart as it's RF heat deposition is lower.

Maternal breathing coaching and optimum comfort throughout the scan can help reduce the risk of movement artefact. However, banding artefact may occur due to field inhomogeneities in areas of air/tissue interfaces.

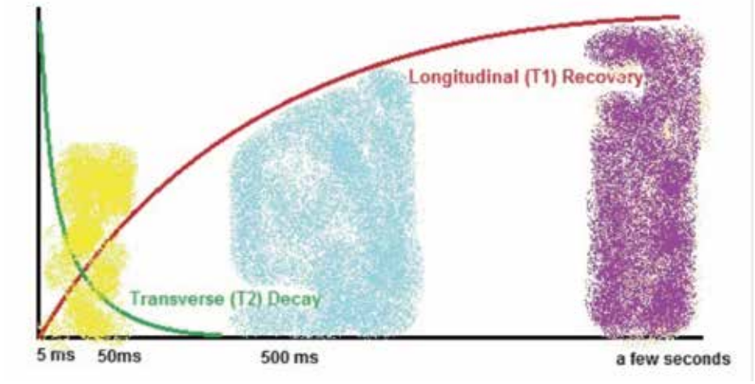
Fast Imaging with Short TRs

(Spoiling and Steady State)

Matthew Benbow *Superinterintendant Radiographer, Royal Bournemouth Hospital / BAMRR News Editor*

In spin echo MRI T1, T2 and PD image weighting can be obtained by manipulation of the TR and TE times plus flip angle.

Employing a long TR time will allow all tissues to fully achieve T1 recovery (purple area), and so minimise T1 weighting. A long TR is therefore used in T2 and PD imaging to discourage T1 contrast effects.



Magnetisation Relaxation

However to achieve T1 weighting in spin echo, differences in tissue T1 recovery need to be exploited. To do this, shorter TR times are employed (blue area) to ensure that tissues do not achieve full longitudinal recovery before being exposed to the next RF pulse. When gradient echo imaging is used (which will be discussed later) much lower flip angles are used, and so the T1 recovery time for tissues is significantly reduced.

In contrast to longitudinal recovery, transverse decay is very much faster. For this reason even the long TE times used in T2 weighted imaging are shorter than the TR times used, even for T1 weighted imaging, i.e. transverse decay will have already completed (or at least be well under way) before the next TR.

So what if an extremely short TR time is used? Shorter than even the T2 time of tissues (yellow area)? What effect does this have? Well, by doing this both the longitudinal recovery and transverse relaxation are unable to complete before the next TR. When such a sequence is initiated, the rapid reintroduction of RF at each of the next TR will achieve a persistence of the tilted magnetisation vector, i.e. coexistence of transverse and longitudinal magnetisaton. This is known as the Steady State and can allow very fast image acquisition times. It's a bit like Rocky being knocked partly over, getting partially up, being hit again, recovering, hit, up, hit, up, etc. The more often he is hit, the more he leans. The harder he is hit, the more he leans. A bit unrealistic, but the best amusing analogy I can come up with.

As the sequence starts it will initially take a number of reputations to reach steady state. As we have seen, the short TR time used (maybe 20-50ms) will prevent full longitudinal recovery. Therefore after each subsequent RF input the residual longitudinal magnetisation will be reduced. But as it gets smaller, it will recover faster until equilibrium is reached. The flip angle chosen is important to ensure optimum image signal. Flip too small and all virtually longitudinal magnetisation will recover each time and the signal will be tiny. Flip too much and recovery would barely have a chance to get started before the next RF, and so again, poor contrast. There is therefore an ideal angle for each given tissue that will achieve a maximum signal.

This is called the Ernst angle, which for geeks = $\arccos(e^{-TR/T1})$.

Unfortunately it is different for each tissue so any one particular flip angle chosen may not be optimum to achieve maximum SNR for differing tissues being examined (never simple in MRI is it!?).

Think of Rocky again, but this time also some more boxers of varying get-back-up-ability. If every few seconds you gave them all a small jab and just watch them teeter a bit you would only see a tiny difference between them – poor contrast. On the other hand you could land them all with massive right hooks and see them hit the canvas and barley move before you wallop them again. Who would get up first? You don't know as you never gave them a chance – again, poor contrast. The best way to show the difference in their ability to recover would be to give them reasonably decent left

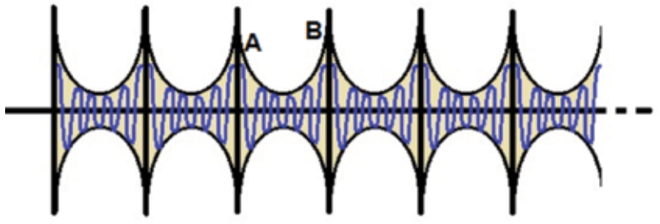
◆ **Rocky Balboa in 'steady state', experiencing a 35o flip angle from an Ernst left hook**

hooks to sort out the men from the boys – good contrast! Plus, it would also be quite good fun to smack Rocky around a bit.

Steady as She Goes

To achieve a signal that can be imaged, proton rephasing is of course needed. Using a 180o pulse, i.e. spin-echo is not possible as this would ruin steady state, and so therefore gradient rephrasing is used, i.e. Steady State imaging is a gradient echo sequence. Remember, this repahsing is done quickly, so there is residual transverse magnetisation, i.e. the FID does not get a chance to fade away before the echo is again forced to grow.

Both Free Induction Decay (FID) and Spin Echo signals are produced and each if these can cleverly be encouraged or suppressed to achieve several different image weightings.



Steady State FIDs

Signal from the FID can be sampled just after each FR pulse (position A above) and offers a mix of T1 and T2* weighting. Signal from the Echo can be sampled immediately before each RF pulse (position B above) and offers T2 weighting.

Option 1:

Sample the FID signal only (A)
Weighting: Usually T2* (Longer TE = more T2*)
Names: FISP, GRASS

Option 2:

Sample the Echo signal only (B)
Weighting: T2 (suffer from motion artefact, so not commonly used)
Names: PSIF, SSFP,T2-FFE

Option 3:

Sample both the FID and Echo signal together (A&B)
Weighting: T1 and T2
Names: TruFISP, FIESTA, Balanced FFE (CISS, FIESTA-C, COSMIC)

Option 4

Sample each signal separately (Option 1 and Option 2 above), then combine them
Weighting: mixed!
Names: DESS, MENSA

Now You've Gone and Spoiled it all…

The above are all referred to as 'coherent' sequences as the phase coherence of the transverse magnetisation is preserved between RF pulses. An alternative possibility is to disrupt, or spoil these before the next RF input (incoherent). If there was enough time, a long TR would allow this to happen naturally (long TR spoiling) and this is successfully used in standard gradient echo imaging (MEDIC MPRG, MERGE, M-FFE) but the TR times used for this technique are usually way shorter than the tissue T1 time, so this is not an option. Instead, a combination of gradient and RF spoiling is used whereby the phase of the RF and the amplitude of the gradients are varied in a pseudo-random way to prevent coherence becoming established. So what does spoiling achieve? Generally it is done to remove T2* weighting, i.e. to obtain strong T1 weighting with short acquisition times. As such, this sequence is the standard used for gradient echo imaging, and has been the mainstay of dynamic contrast enhanced MRI / angiography for many years.

Option 5:

FID – spoiled, echo signal only

Weighting: T1 or T2* possible (Large flip angle & short TR = T1, Long TE = T2*)

Names: FLASH, T1-FFE, SPGR
(also 3D versions of these - VIBE, LAVA, THRIVE)

Short TR gradient echo imaging can incorporate some clever techniques such as RF spoiling and steady state acquisitions to achieve a plethora of image contrasts. This has enabled us to image challenging subjects such as contrast media that will only be within fast flowing vessels for a short time, or large data sets during a breath-hold or even a heart beat.

Next edition I will try to expand on these sequences by giving examples and images of where each might clinically be useful.

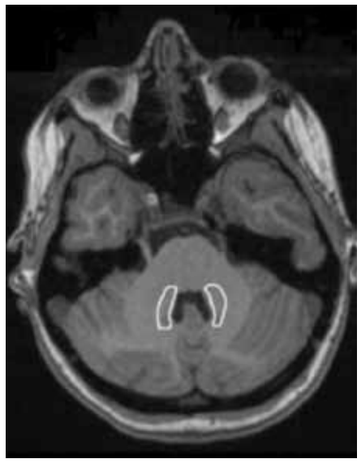
Gadolinium-containing Contrast Agents Update

Cath Mills, BAMRR Policy Board Safety Coordinator

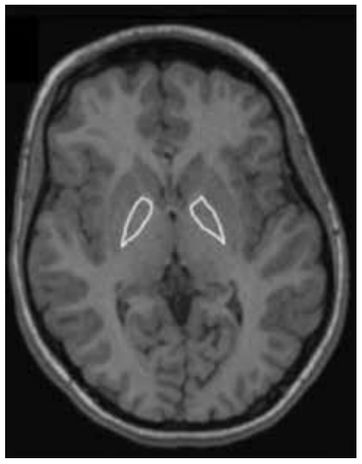
The topic of gadolinium retention in the brain and other tissues has been prominent over the past two years, with regular alerts, communications and updates issued to Health Care Professionals. Here is a current update.

Over the past two years studies have been done to determine whether gadolinium is retained in the brain and other tissues, and whether it has a harmful effect.

A European-level scientific review to investigate gadolinium retention in brain and other tissues has now completed.



◆ **Dentate nucleus**



◆ **Globus pallidus**

Low levels of gadolinium deposition in the brain, particularly in the dentate nucleus of the cerebellum and in the sub-cortical structure the globus pallidus, were confirmed by mass spectrometry and studies of MRI data

There are two types of gadolinium containing agents: linear and macrocyclic.

Data on stability, as well as in-vitro and non-clinical studies, shows that macrocyclic agents have a significantly lower potential to cause retention of gadolinium in the body

The European Medicines Agency (EMA) concluded its investigation in July 2017. The final stage of the review procedure was the adoption by the European Commission of a legally binding decision applicable in all EU Member States. The commission decision date was 23/11/2017. Whilst there is no evidence that gadolinium deposition in the brain has caused adverse neurological effects in patients licenses for some agents have been removed, and restrictions have been placed on some of the remaining ones.

From 1st February 2018

The intravenous use of Omniscan and Magnevist was suspended and remaining stock should now have been recalled

Authorised use of Multihance and Primovist has been limited to delayed phase liver imaging only

Updates to product information have been issued for some of the gadolinium agents that remain in use.

The EMA have published information on their website (link below and on BAMRR website). There are sections on 'information for patients' and 'information for health care professionals' that you may find useful.

http://www.ema.europa.eu/ema/index.jsp?curl=pages/medicines/human/referrals/Gadolinium-containing_contrast_agents/human_referral_prac_000056.jsp&mid=WC0b01ac05805c516f

Information has been posted on the Society of Radiographers website (link below and on BAMRR website)

https://www.sor.org/news/ema-confirms-restrictions-use-linear-gadolinium-agents

Gadolinium Agent	Type	Injection method	EMA Recommendation effective 1 Feb 2018
 Artirem /Dotarem (gadoteric acid)	macrocyclic	Intravenous	maintain
	macrocyclic	Intra-articular	maintain
Gadovist® 1.0 (gadobutrol)	macrocyclic	Intravenous	maintain
Magnevist® Gadopentetate Dimeglumine (gadopentetic acid)	linear	Intra-articular	maintain
	linear	Intravenous	suspend
multihance (gadobenic acid)	linear	Intravenous	restrict use to liver scans
OMNISCAN® (GADODIAMIDA) INJECTION (gadodiamide)	linear	Intravenous	suspend
Optimark® (gadoversetamide)	linear	Intravenous	suspend
Primovist® Gadoxetic Acid (gadoxetic acid)	linear	Intravenous	maintain (in its intended use for liver scans)
ProHance (gadoteridol)	macrocyclic	Intravenous	maintain

References:

Gov.uk. Drug Safety Update: Gadolinium-containing contrast agents: removal of Omniscan and iv Magnevist, restrictions to the use of other linear agents

www.ema.europa.eu. Gadolinium containing contrast agents

www.sor.org EMA confirms restrictions on use of linear gadolinium contrast agents

www.cas.dh.org. Central Alerting System NHS Alert (issued 13/12/2017)

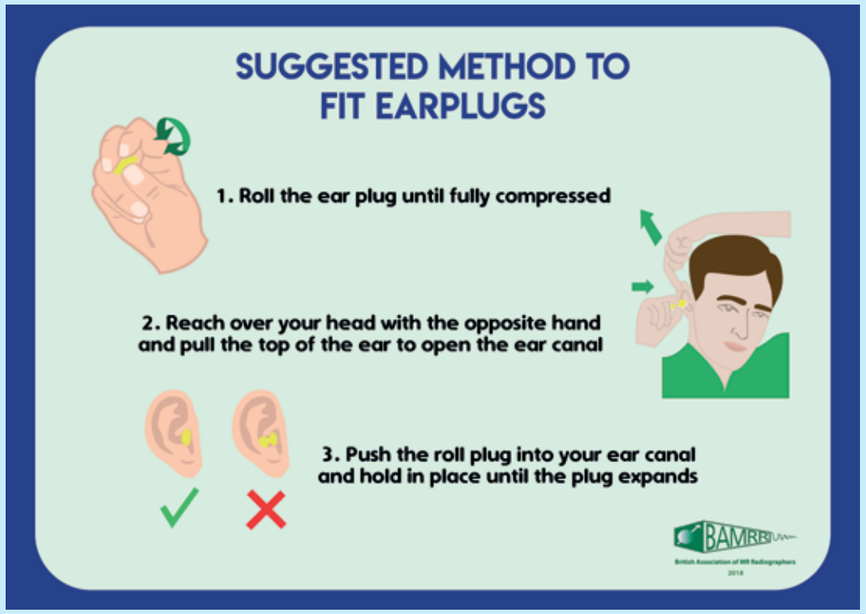
MRI Images: Auntminnie.com

BAMRR Patient Posters

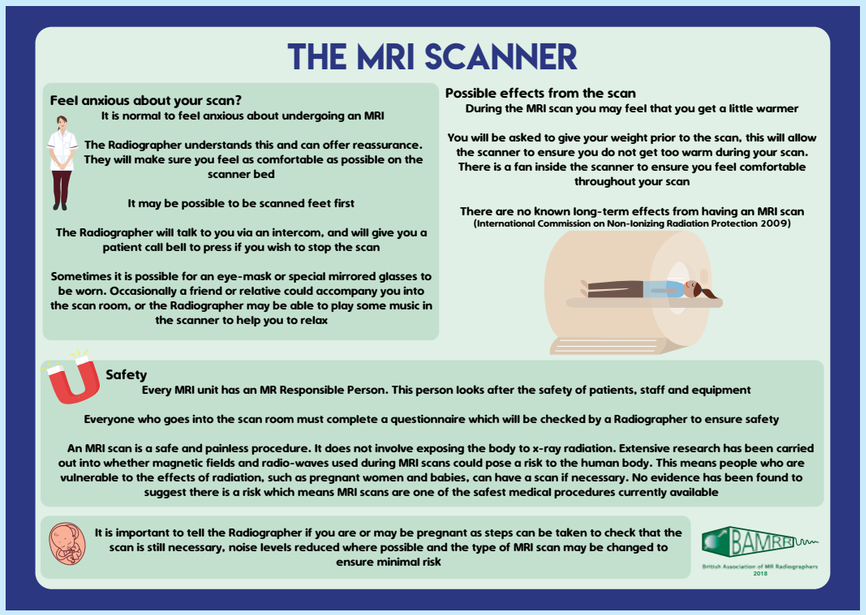
The BAMRR panel identified that although there is plenty of information and resources available to patients there is currently little in the way of information that can be displayed in patient areas. Therefore, we decided to create a poster that could be displayed in MRI patient waiting and changing areas to inform patients and raise awareness about MRI.

The final poster content aims to educate about the MR Environment, raise awareness about MR safety, help patients to prepare for their scan, and offer reassurance to anxious patients. Technical considerations included: bioeffects from the static magnetic field, thermophysical response to RF, acoustic noise, and the risks of MRI. Brief text explanations using patient friendly language, and diagrams, have been used to aid effectiveness.

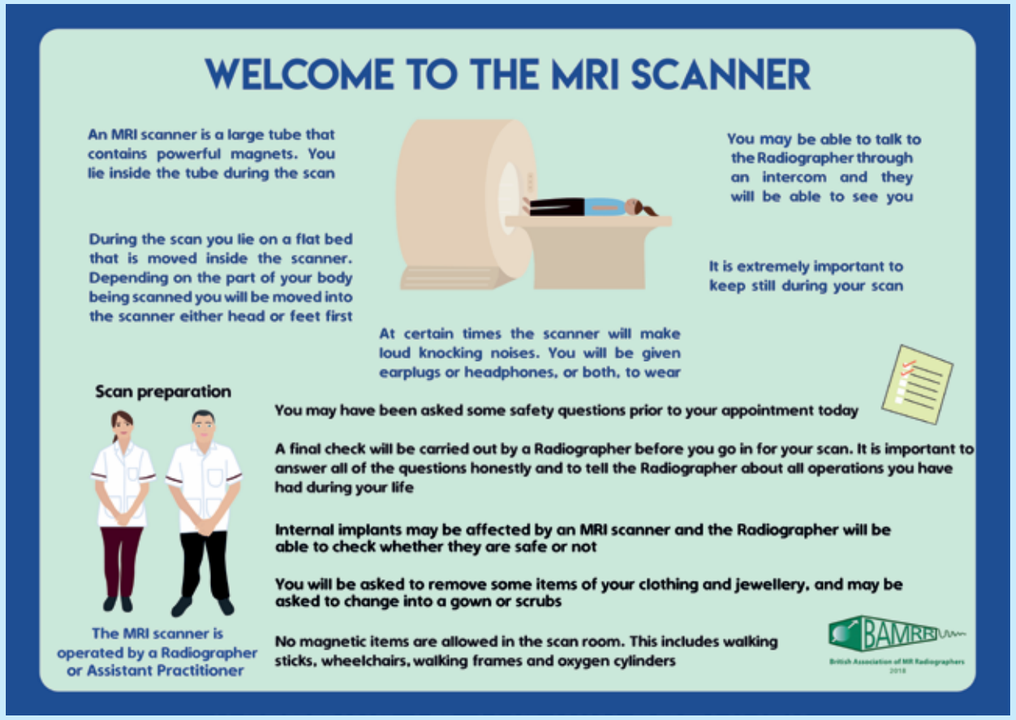
Three posters were created as every MRI department is different, and the content may not be applicable to all (for example, some departments do not routinely give earplugs).



Recommended print size A4



Recommended print size A3



Recommended print size A3

You can download the posters on the BAMRR website member area in the 'MR Safety news' section

BAMRR session at UKRC

Arena and Convention Centre Liverpool
Wednesday 8th June 2016
2.20pm onwards

Ms Eli Jovanovik, Head of Imaging Fitzpatrick Referrals
(As seen on national television's 'The Super Vet')
'Paws for thought: MRI epilepsy in small animals'

Dr T Blakeborough, Consultant Radiologist
Royal Hallamshire Hospital
'Hepatobiliary MRI'

Mr David Grainger, Senior Device Specialist
Medicines & Healthcare Products Regulatory Agency
'MHRA MRI safety guidance update'

Please see UKRC website for more information
Hope to see you there.....

Patient Safety News

Patient preparation

Do not allow clothing such as sportwear, underwear or yogawear that contain metal-based fibres to be worn for MRI procedures.

To prevent excessive heating and possible burns associated with MRI procedures it is advisable to change all patients into a gown or scrubs.

Reference **http://www.mrisafety.com/SafetyInfov.asp?SafetyInfoID=166**

Associated article ***'Invisible Metallic Microfiber in Clothing Presents Unrecognized MRI Risk for Cutaneous Burn'* (http://www.ajnr.org 2013)**

The recent news of an MR safety incident in Mumbai that resulted in a fatality serves a reminder to all in the MRI community to ensure that safe practice is followed.

Think.....

Do you know your departments emergency procedure for cardiac arrest in MRI?

How would you deal with a patient who became unwell and required oxygen?

Have you heard about therapeutic male underwear that contains magnets? Or sports clothing that contains metallic fibres?

Equipment identified as MR Conditional should be permitted in the MR Environment and all equipment in the Controlled access area should be clearly labelled (MHRA Safety Guidelines for Magnetic Resonance Imaging Equipment in Clinical Use March 2015, section 4.9)

On BAMRR website member area: in MR Safety section

THE BRITISH ASSOCIATION OF
MR RADIOGRAPHERS

Renew or begin your membership now!

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WE FORGE LINKS WITH OTHER ORGANISATIONS, eg SOR, MHRA, BIR

FREE NEWSLETTER TO KEEP YOUR DEPARTMENT UP TO DATE WITH CURRENT ISSUES

WE PROMOTE EDUCATION TRAINING FOR MR RADIOGRAPHERS THROUGH VALIDATED COURSES AND CONFERENCES. (reduced rates for members!)

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