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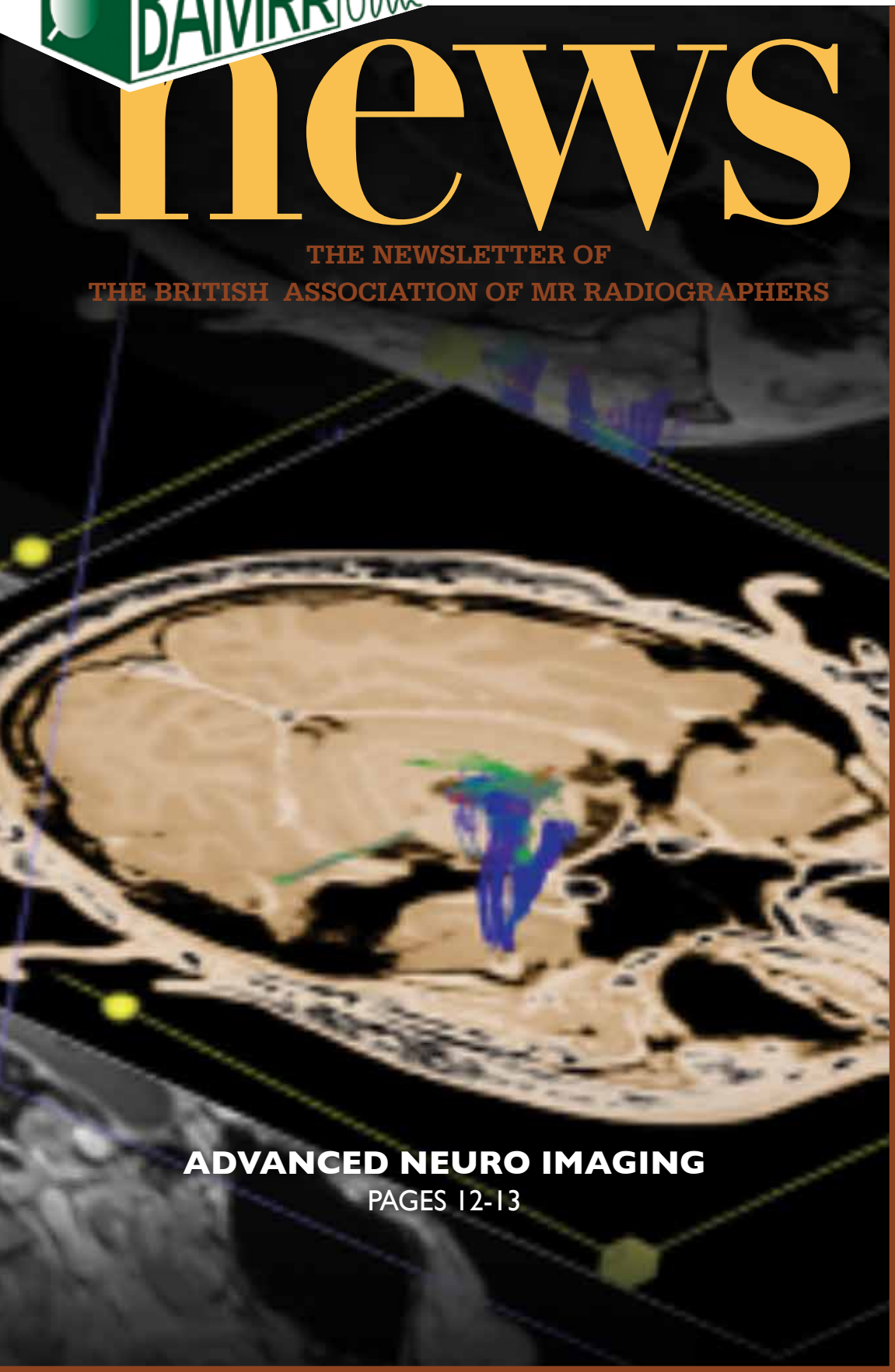
AUTUMN 2023

BAMRR news

THE NEWSLETTER OF
THE BRITISH ASSOCIATION OF MR RADIOGRAPHERS



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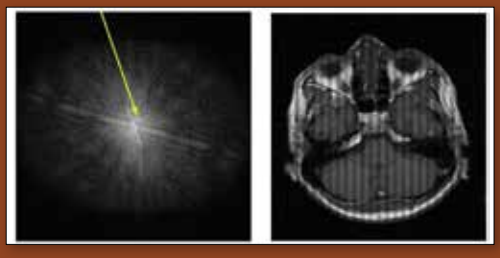

welcome from your BAMRR PRESIDENT

Welcome to the Autumn 2023 edition of the BAMRR Newsletter. I can't believe that my tenure of President is nearly complete (and probably will be by the time you are reading this) and I will have to retire my 'President patch' badge. I always knew BAMRR's work covered many areas, but being involved as President and therefore aware of everything this group does has made me feel very humbled to be a part of it. BAMRR is a not-for-profit organisation, and the policy board members volunteer their time for free and it is down to their tireless work and effort that enables BAMRR to deliver its educational support for all our radiology colleagues out there. For that, I just want to say a huge thank you to my fellow board colleagues from me and I have no doubt, from our members and the wider MRI community.

But back to this year then. It has already been packed with events. We ran the first of this year's Introduction to MRI course, which went well despite some chiller issues for our hands on sessions - well, we've all been there, I'm sure. The Intro course in November is open to registration right now and places are filling up. The Further MRI course will be upcoming next year.

In June BAMRR hosted the educational session at UKIO in Liverpool. It never fails to be a good session and we were delighted to welcome back speakers Dr Jane Belfield and Leonardos Papadopoullos along with new speaker Louise Jones for some fantastic lectures.

July brought us MRI Safety Week 2023. There are some great 'How Safe is Your Department?' checklists on our website to download and get you thinking, along with an MR themed crossword for a bit of light-hearted relief. There are so many resources published this week from around the world and still available afterwards - MR safety is not just for July.

To round off, don't forget the Annual BAMRR Conference in Chepstow on 7th October. It is shaping up to be another outstanding day, so we really hope as many of you as possible can make it. We'd love to see you.

Details of all our conference, courses and events and contact details can be found at our website www.bamrr.org

So that's me signing off then and hope to see you in October!

Trudi Whitehead
BAMRR President
trudi.whitehead@nhs.net

from your EDITOR

Welcome to the Autumn 2023 BAMRR News.

Welcome to the Autumn 23 edition of BAMRR News. All being well, I have managed to get my act together to ensure it has been printed in time for the annual BAMRR conference, this year in Chepstow. I look forward to seeing you there and am sure it will be a great meeting.

Talking of conference, recently, as I am sure you are aware, there was a very successful UKIO meeting in Liverpool. In the lead up to this I found myself 'volunteered' (thanks Alex Tait!) to present the William Stripp Memorial Lecture. Of course this was a great honour and I was pleased to take it on…really!

Whilst my presentation subject was to discuss whether the purchase of an extremity MRI was a sensible option, I also took the opportunity to step briefly on my soapbox about my opinions on the need to modernise how we train MRI radiographers in the UK. I can (nay, I like to be) a bit controversial at times. So, being that I had a captive audience, I thought there was nothing to lose by saying my piece.

I have summarised this all in an article for this edition of BAMRR News. Please have a read and see what you think. I would be very interested to hear anyone's thoughts.

Matthew Benbow
BAMRR Editor

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On Facebook, search for **"BAMRR"** - be our fan and 'like' us and we will keep you update.

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For tweeting visit
twitter.com/#!/BAMRR

WELCOME from our sponsor GUERBET

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

Guerbet are proud to continue our sponsorship of the BAMRR community and supporting your dedication to such a pivotal profession. 2023 is a significant year for Guerbet, with exciting developments around our MRI contrast portfolio planned, so we look forward to meeting you all at the BAMRR courses, and annual conference, through the year.

As MRI enthusiasts, we'd like to share with you our new website; Innovation4MRI.com, where you can find summaries of recent research findings, infographics and video interviews with leading academics as well as industry experts. For further support with educational programmes or to learn more about our CPD accredited educational webinars please contact your local Guerbet representative or email uk.events@guerbet.com

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Guerbet
Contrast for Life

REGISTRATION FOR THE INTRODUCTION TO MRI COURSE NOW OPEN

Friday 17th and Saturday 18th November 2023

Course to be held at the
National Centre for Sports and Exercise Medicine (NCSEM) at Loughborough University

Topics include:

Hands on scanning ◆ Contrast Agents ◆ Physics – how it works and pulse sequences
Artefacts ◆ Safety ◆ Fat sat imaging ◆ MSK
Neuro ◆ Knee ◆ Lumbar spine

Teaching by experienced MR radiographers and MR physicists

Registration is via www.bamrr.org

Cost:
£135 BAMRR member, £165 course and BAMRR membership, £185 non member

BAMRR Policy Board Members, Autumn 2023

The co-ordination of the Associations activities is overseen and undertaken by an elected Policy Board. The board currently consists of the following who are members of BAMRR and working in different regions of the UK.
The Policy Board is composed of:

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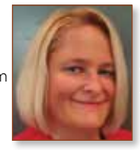

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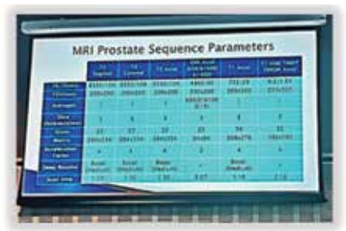
BAMRR Session UK10 Report 2023

It was another successful BAMRR session at UKIO at Liverpool ACC on Wednesday 7th June 2023.

Trudi Whitehead (president BAMRR) and Cath Mills (President Elect, BAMRR chaired the session titled "MR in Contemporary Practice"



Left to right Trudi Whitehead, Cath Mills, Louise Jones, Dr Jane Belfield, Leonnardos Papadopoullos.

We saw the welcome return of the successful double act of Dr Jane Belfield (Radiologist, Liverpool) and Leo (Deputy Lead Radiographer) in their presentation on 3T imaging of the prostate. Leo's talk gave us helpful tips and trick to overcome challenges in prostate imaging specifically on a 3T scanner. Dr Jane gave us the radiologists perspective what they are looking for in relation to reporting. It was evident to see the collaborative working within the department. MR Radiographers and Radiologist work together to achieve optimal imaging detrimental to patient diagnosis.

We are very grateful to Louise Jones, Deputy Lead Radiographer from Liverpool who stepped in last minute for a colleague and gave an excellent presentation on Cardiac MRI and Myomaps. She gave us the Radiographers overview of scanning and then presented the cardiologists audit data and background from the cardiologist perspective. It was a well received informative talk.

The session was very well attended, covering great topic. A sincere thanks to all speakers and to those of you in the audience.

Work is already underway to secure speakers for next years BAMRR session to be held at the Exhibition Centre in Liverpool June 10th-12th so save the date …….

EDUCATION GRANT 2023/2024

STILL AVAILABLE

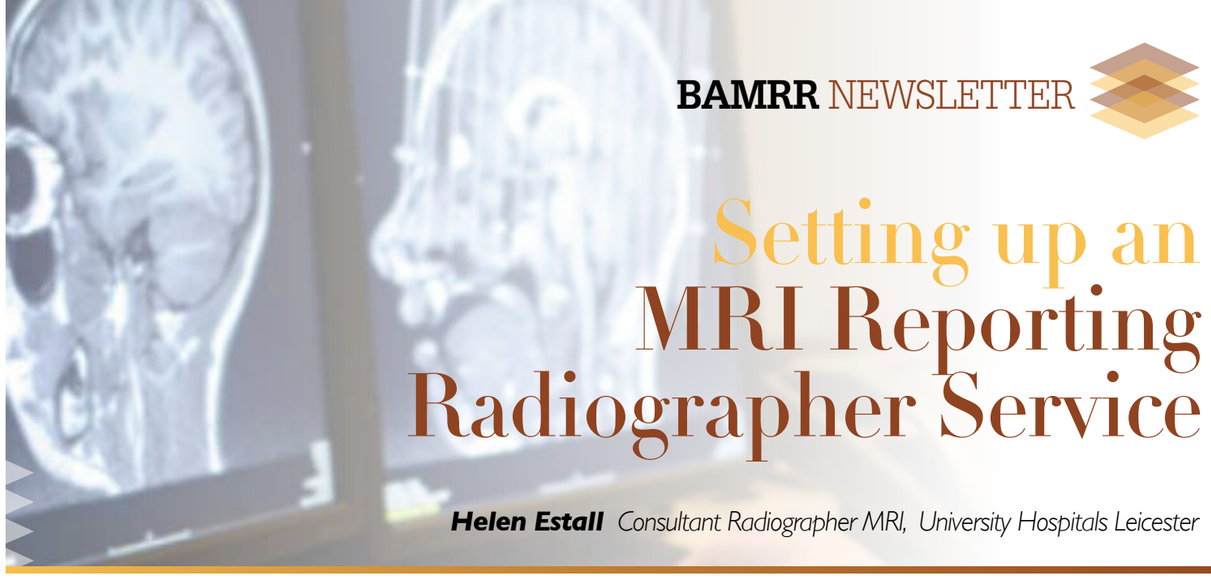
BAMRR members are invited to apply for an education grant to enable them to complete their MSc

Max award of £1000 per academic year

All applicants should meet the following criteria:

- Be a member of BAMRR
- Be enrolled on a MSc course, the grant is for the research aspect of the MSc only
- Outline the use of the grant and provide an audit trail on completion
- Agree to present at the next BAMRR annual conference
- Provide an article for publication in the BAMRR Newsletter

Applications will be assessed by the BAMRR Policy Board. The applicant will be informed as soon as possible whether they have been successful or not. There is one grant available per academic year.



Setting up an MRI Reporting Radiographer Service

Helen Estall *Consultant Radiographer MRI, University Hospitals Leicester*

The first accredited programme of post graduate study for the reporting of MRI examinations by radiographers was available in 2003, starting with thoracolumbar spines, knees and IAMs, MRI brain and cervical spine were available in 2007 and MRI breast in 2014[1]. The literature on reporting radiographers in MRI is limited and the role of radiographers providing a clinical report for MRI examinations has been a slower development than for some other modalities. However, several studies have demonstrated that reports provided by radiographers are clinically relevant and equivalent to those provided by medical colleagues[2,3].

Setting up a radiographer reporting service has its challenges and there are barriers to changing working practices including radiographer and radiologist shortages, funding issues and support for a change in practice. The use of a skill mix approach to reporting has a large cost saving potential, reduces report turnaround times and improves radiographer self-confidence, self-esteem and job satisfaction.

Any service improvement process should be led by service requirement. Support from both the management team and the appropriate sub-speciality radiologist group is essential for setting up the service, and for during and after training. Any concerns that may be raised such as training opportunities for radiology registrars, backfill for the trainee radiographers, appropriate study time and time allocated to radiologist mentors need to be discussed and agreed before the process starts. Other factors to consider are whether the trainees will be new posts in addition to the current workforce and what banding they will be as trainees and as qualified reporters. Consideration needs to be given to the job title as well, will they be reporting radiographers or enhanced practice or advanced practice radiographers as all these roles will have different elements prioritised.

Funding is required for training which is usually via a university, funding is also required for backfill to enable the trainees to attend university, allow them to meet with the radiologist mentor and to have an appropriate amount of study time. A decision is also required on the number of trainees, this will depend on funding and radiologist mentor support, but peer support during training is very important to the trainee[4], ideally, more than one should be trained if possible.

A specific job description is required which describes the role content in terms of the level and complexity of the role and the AfC banding. It plays a vital role in staff selection and attracting appropriate candidates and can be used as a basis for performance appraisal and training needs.

There needs to be a strong governance framework for any reporting radiographer role to assure patient safety. A local policy should be written to document the requirements for selection of the candidates, education and training, mentorship, backfill and funding, preceptorship, post qualification competency assessment, attendance at MDTs and REaLMs and peer review audit expectations.

Each reporting radiographer during and after training should have a job plan which includes study/CPD time, reporting sessions, MDT/REaLM attendance, any clinical shifts and the other elements of the role as defined within the job description. Time within the consultant radiologist job plans is also required to enable support of the trainee. All reporting radiographers also require a clear documented scope of practice which as a minimum includes, the examination type and modality that they are authorised to report, any restrictions on referrer or patient type and any other restrictions such as the inclusion or not of research or medicolegal scans.

The role of the radiographer in reporting MRI scans is still a relatively new concept and numbers are still low nationally[5]. It is essential that radiographers and radiologists work together to create a culture that enables radiographers to extend their roles into MRI reporting if there is a service requirement. Setting up a service can be challenging but communication and appropriate governance processes can ensure the process succeeds.

References:

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2. Brealey, S., Piper, K., King, D., Bland, M., Caddick, J., Campbell, P., et al.. Observer agreement in the reporting of knee and lumbar spine magnetic resonance (MR) imaging examinations: Selectively trained MR radiographers and consultant radiologists compared with an index radiologist. European Journal of Radiology 2013; 82(10), p.e597-e605. https://doi.org/10.1016/j.ejrad.2013.05.024
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5. Estall, H. and Mitchell, M., 2021. MRI reporting radiographers - A survey assessment of number and areas of practice within the United Kingdom. Radiography, 27(2), pp. 568-573. https://doi.org/10.1016/j.radi.2020.11.017

MRI is not alone in being considered a 'special' modality. I am an MRI radiographer, and the fact you are reading this, the chances are that you are too. Indeed we do (quite rightly) believe it to be special. But the fact remains that because of this, little training in our modality is given to radiography students during their 3 years of learning. The vast majority of their time is spent in projectional radiography, based, dare I bring myself to say it through gritted teeth, in what is often termed the 'Main' Department. Then, once qualified, they get themselves HCPC registered and are free to apply for radiographer positions across the UK, both within and out of the NHS. And this includes some of them choosing to go into MRI, perhaps after a few

MRI Student Training in the UK Is it Fit for Purpose?

Matthew Benbow *Superintendent Radiographer CT & MRI Royal Bournemouth Hospital, Policy Board Member for BAMRR (BAMRR News Editor)*

Even if they have an interest in MRI, they are still likely only to have spent minimal time during their undergraduate time, observing in MRI. So how to they then become proficient? How can they possibly get a career operating an MRI scanner? Well, as we all know, we take them into our departments and then we train them up on site. But is this ok? Is this a reasonable way to produce MRI radiographers? An MRI scanner is, I would argue, the most dangerous machine in radiology by some margin, so is this fair on them? Is it safe? And additionally is it fair on those responsible for them during this period – i.e. the likes of me!?

The success of training people in this way of course will vary. Differing hospitals will have variable standard of training 'programmes' or perhaps none at all. There is no common measure of the standard of training received at institutions. There is no official or mandatory qualification for MRI. Skills learned may often be dependent on who leads the service at the site and how engaged they are in training. It may even come down to who the learner happens to be sitting next to at the console each day. Imagine this in industries such as the airline pilot training! Sit next to another pilot and have a go!! Would that be ok?

So what can be done about it? In my view, a pretty radical shake-up is needed. I am extremely pleased to see that the HCPC have recognised this too. In September 2023 they will issue revised Standards of Radiographer Proficiencies. In these, it is great to see they have beefed up the student's MRI requirements from 'be able to assist with standard MRI procedures', to, 'perform standard MRI procedures'. This is a positive stride forward, and will require degree courses to be adjusted to provide enough MRI time and magnet time to facilitate this. I would urge all of you to embrace this, welcome students, timetable them as required and do all you can to make this work with, as these will be the badly needed radiographers who will make up your numbers going forward.

For me though, it needs to go further. In order for us to able to produce radiographers of a certain MRI calibre, surely areas such as MR safety and safety checking, basic MRI physics, MRI sequences, use of gadolinium, MRI pathology appearances, protocol variations, image quality control and parameter optimisation could go alongside this. But how would they find time to do this within their 3 years, I hear you ask? They have so much else to learn. Well, maybe some work I have also been involved with in CT could elude to the answer:

Earlier this year I was part of a group set up as a collaboration between the SOR and HEE called the Radiographer Workforce Reform Programme (WRAP). The aim was to look at undergraduate CT training and experience to see if more advanced training and skills could be offered. This was in response to the need to prepare them for employment which increasingly includes operating CT scanners in their early career. It is in the feedback stage at the moment, but I very much hope it might offer students the option to choose in their final year to effectively 'major' in CT, and thereby work towards their 'CT Passport' which will provide them with additional skills, making them more prepared to become part of the CT workforce. This could include knowledge of contrast delivery, contrast safety, contrast phases, bolus triggering/ timing techniques, IV cannulation, exposure modulation, reconstruction processes, QA, image quality, etc. Once qualified as a radiographer, they would of course not be limited to working in CT, but would have this as an extra string to their bow.

So what about other modalities? Whilst similar work hasn't been proposed here as yet, surely this could be considered. Students could tailor their course final year to focus on an area that most interests them. This could maybe include angio and fluoroscopy, or projectional and reporting, maybe research, industry, ultrasound, mammography, or of course, MRI? Controversially, could some of these options not require the student to perform a research project?

So, in essence, just as now students could qualify with a radiography degree, but one where they 'majored' in an area they were more drawn to. Crucially, they would all still be qualified and free to apply for any job they choose. In fact, their demonstration to achieve, say, the CT passport would still be a good thing on their CV that would hopefully impress any employer in other modalities of their ability to focus on and succeed in a dedicated area. Perhaps after qualifying, if they so wish, they could return part time to universities to complete other passports. This could be self-funded, or, maybe departments would like to fund and use these add-ons as training for staff moving into new modalities.

Selfishly, as someone who regularly advertises for CT and MRI staff, I would love access to more fruitful pickings of the workforce. I would like to interview more radiographers who have a basic knowledge of my modalities which will help them begin their careers with a better grounding. I am convinced this would reduce the stress of local departmental training requirements, and ultimately promote the safety and quality of the service they provide in their early months and years. I believe this would be good for their own well-being, as well as for their new colleagues who are watching over and guiding them through this difficult stage of their career.

WRAP group for CT:

https://www.sor.org/news/scor/welcome-to-our-macmillan-radiographer-clinical-fel

HCPC Radiographer Standards:

https://www.hcpc-uk.org/standards/standards-of-proficiency/radiographers/

Implant News

British Cochlear Implant Group

British Cochlear Implant group resource for MRI Safety

The Manchester Auditory Implant team have developed a fantastic online training resource for MRI healthcare professionals about cochlear implants.

In the Professionals section of the website there is section called 'Safety and MRI' that contains information about the different types of cochlear implants, and how to safely carry out an MRI scan. There are training videos and links on how to prepare the patient, setup scanner protocols, and carry out post scan checks. There is information for Radiographers and Radiologists, MRSE's, and patients, including British Sign Language patient information videos.

The overall message that the BCIG want to communicate is that **MRI scanning with magnets in situ is safe and tolerated.**

Don't know much about cochlear implants and want to find out more?

We recommend watching the *MRI Scanning with hearing implants: patient experience and complications presentation.* It can be found under the Magnetic Resonance Imaging and Auditory Implantation Radiographer training heading.

www.bcig.org.uk

Implant News

Cath Mills *BAMRR Safety Co-ordinator*

Implanted Hearing Devices

We have received two reports from BAMRR members about these new types of hearing device.

The first is an implanted hearing aid containing parts that include a battery, receiver, microphone and mini circuit board. It is fitted by a professional and designed to be worn 24 hours a day for months at a time. Its design makes it invisible in the ear canal.

https://www.phonak.com

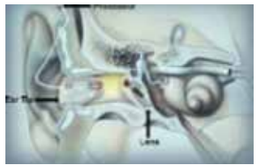
This hearing device is MR Unsafe and should be removed prior to MRI.

Further information can be found at mri.safety.com

The second type of implanted hearing device is called an Earlens. It has an external processor that looks similar to a conventional hearing aid, and a second component called a lens that is implanted by a professional in the ear canal next to the tympanic membrane. The lens contains several components.

For more information visit the Earlens manufacturer website

https://earlens.com



Picture: earlens.com

For all MRI examinations standard screening procedures should require the patient to identify whether they have hearing aids. MHRA guidance includes advice on assistive technology that covers the external part of hearing aids (Safety Guidelines for Magnetic Resonance Imaging Equipment in Clinical Use February 2021, section 4.11.10) and guidance on implanted medical devices (section 4.11).

Safety News

MRI risk assessment updated

Following the recent update from the IEC to relax the limit from 0.5 mT to 0.9 mT the British Institute of Radiology has updated Risk Assessment 13: Occupational Exposure to Electromagnetic fields template to include this change.

BIR template Risk Assessment 13 :EMF

https://www.bir.org.uk/get-involved/special-interest-groups/bir-magnetic-resonance/risk-assessments.aspx

Further resources:

BIR MR Safety week sheet: Update on Safety Standards

https://bir.org.uk/media/525509/mr_advice_sheet_4__update_on_mr_standards.pdf

MR Safety Advice 2023

BIR The British Institute of Radiology

Update on MR safety standards

In the past year the following international MR safety standards have been updated.

IEC 60601-2-33

In Aug 2022, version 4 of IEC 60601-2-33, the international standard for basic safety and essential performance requirements of MR equipment to provide protection for the patient and the magnetic resonance worker, was published. Some of the changes introduced here were covered in an advice sheet produced for MR safety week 2022. Note the original version of this BIR article contained an incorrect suggestion that there will have to be a change in the ICNIRP guidelines or a change in the CEMFAW legislation for the UK to adopt 0.9 mT rather than 0.5 mT for the extent of the MR Environment. An erratum has been issued to clarify that while there remains an action level of 0.5 mT under CEMFAW legislation in the UK that requires employers to perform an occupational risk assessment and put control measures in place, this is separate from the definition of the MR Environment. Note, the recently updated example BIR MRI risk assessment for EMF is designed to help with this CEMFAW requirement.

ASTM F2503

In May this year an update was published for ASTM F2503, the international standard that defines MR safety labelling, i.e. MR Safe, MR Conditional and MR Unsafe and defining the term 'MR Environment'. For clinical MRI staff there are perhaps two changes to note. Firstly, there is a small change to the definition of the MR Environment, replacing the inclusion of a specific value (previously 0.5 mT) for the static magnetic field threshold with simply the mention of the B0 Hazard Area, a new term introduced in the recent update of IEC 60601-2-33 that defines the space around the MR equipment where the static magnetic field can cause harm. Essentially, ASTM F2503 now points to the IEC standard for defining what static magnetic field should be associated with the B0 Hazard Area, currently 0.9 mT (as discussed in the 2022 advice sheet).

The updated definition of the MR Environment is now "the three dimensional volume surrounding the MR magnet that contains both the Special Environment (Faraday shielded volume) and the B0 Hazard Area (space around the MR equipment where the static magnetic field can cause harm). This volume is the region in which an item might pose a hazard from exposure to the electromagnetic fields produced by the MR equipment and accessories, and for which access control is part of the risk mitigation. **Adapted from IEC 60601-2-33"**

MR Conditional

Additionally, the updated ASTM F2503 standard introduces a lengthy table of potential MR conditions and suggested wording. The aim of this is to help improve the wording used on MR Conditional labelling. As a reminder, this standard is not just for medical devices, but for any items that are to be brought into the MR Environment. Consequently, this section may be helpful for people involved in local decisions to label equipment as MR Conditional. For now, this table is part of the non-mandatory section of the standard, so nobody is obligated to use it when following this standard. However, this is a long-term effort. It will take some time for this to filter through to MR Conditional labelling that we see for devices implanted in patients referred for MRI scans.

In the meantime, people are encouraged to highlight examples of poor MR Conditional labelling to the MHRA that people feel may negatively impact on MR safety. The MHRA have powers to force manufacturers to update labelling if they deem appropriate.

Change to the pacemaker limit-what does it mean?
By Donald Mcrobbie

https://drdonaldmcrobbie.com

MR Safety Week 24 July 2023

July this year marked the 22nd anniversary of the tragic accident where a 6-year-old was killed whilst having an MRI. Michael Columbini was struck by a magnetic oxygen cylinder when it was taken into the MRI scan room by accident.

MR Safety week is an annual event that takes place on this anniversary with the aim of promoting the importance of MR safety and best practice within MRI services.

This year BAMRR released the 'how safe is your department' checklist © for Radiographers to complete in their workplace.

If you missed it visit bamrr.org to download the checklist and get links to other international organisations that honoured this special week in the MR community.

MRI Artefacts
A Window into Physics

Paul Morgan *Professor of Medical Physics, University of Nottingham*

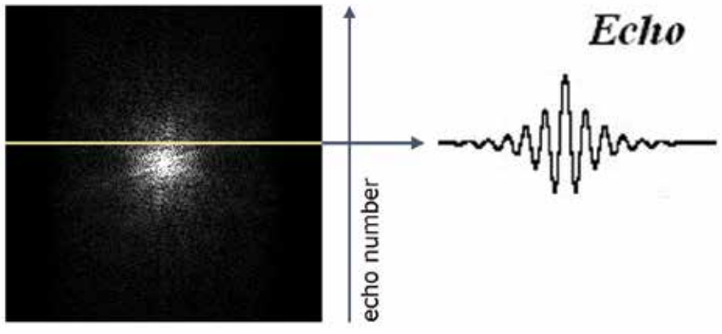
Introduction

Artefacts in MR images are unwanted, can result in mis-diagnosis or undiagnostic images, and can be a sign of scanner or equipment malfunction. As such they are problematic for radiographers. While this is true, artefacts can also be unexpected reminders of the physics underpinning MRI, and as such can form part of reflective learning from everyday experience from working in a MRI facility. This article focuses on some specific MRI artefacts which highlight the underlying MR physics.

MRI Physics Recap

Let's first undertake a high level recap of basic MR image acquisition and formation. Radiowaves are transmitted in the scanner at the resonant, or Larmor, frequency which is around 64 MHz at 1.5T and 127 MHz at 3T. This is usually done in short bursts of a few milliseconds each, called RF pulses. This transfers energy to protons in Hydrogen atoms and flips their average alignment away from the main magnetic field. After the RF pulse is switched off, these protons emit radiowaves back, also at the Larmor frequency. The strength of these emitted radiowaves drop off quickly with T2* decay; in MRI we usually create an echo at this stage which is picked up by the RF coil. The average alignment of the protons returns to that of the main magnetic field by the slower T1 recovery. The scanner then repeats this process over and over, acquiring all the data for an image.

To create the required digital image, we need to define a slice and split this into a matrix of voxels. Usually, the scanner detects one radiowave echo for each line, and these echoes are stacked up in a matrix called k-space, see Figure 1. Once full, a Fourier transform turns k-space into a more familiar MR image.



◆ Figure 1. k-space is formed by stacking up the detected radiowave echoes. The figure shows an example of one of the echoes used.

K-space usually has low frequencies at its centre, the bright region in the centre of Figure 1. The frequencies get larger – both positive and negative, the further away from the centre. Low frequencies near the centre contribute to the main contrast in the images, i.e., which areas are bright or dark, T1 or T2 weighted. Whereas the higher frequencies instead mainly contain information about edges in the images. This is demonstrated in Figure 2.

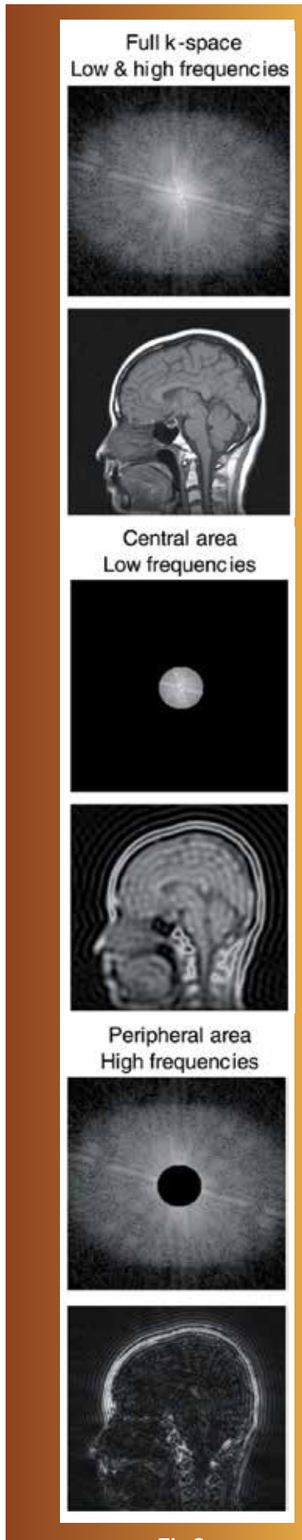


Fig 2

Figure 2. The left column shows complete k-space at the top and the resultant MR image at the bottom. The central column shows just the central low-frequency portion of k-space and the image just this would produce at the bottom – note that it shows bright and dark regions but the image has low resolution. The right column shows just the high frequencies of k-space and the image those would produce – note that in this case there is a lot of edge definition but no contrast difference between the brain and background.

Truncation / Gibbs Ringing Artefact

Now on to the artefacts! A well-known MRI artefact is Gibbs ringing. An example is shown in Figure 3. This is identified as the shape of the ringing artefact mirrors the shape of a sharp change in intensity of a nearby structure, in this case the edge of the brain, and does not extend throughout the image. While a movement artefact might also appear as ringing, this would extend throughout the image and not just near to edges. Gibbs ringing is due to a lack of sufficiently high frequencies in k-space – the image artefact looks more like that in the centre column of Figure 2. The solution is to acquire regions of k-space further away from the centre to fill-in these missing high frequencies, which in turn requires increasing the matrix size – the usual method to reduce Gibbs ringing. The effect of increasing matrix size is shown in Figure 4.

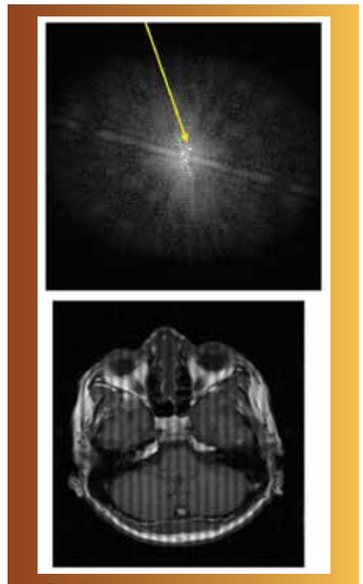
◆ Figure 3. Truncation, or Gibbs ringing artefact, indicated by the white arrows.

Spikes

The name "spike" artefact refers to its cause, a single spike in k-space that should not be there. RF coils pick up all radiowaves present, not just those from the patient, and if the erroneous radiowaves are in a frequency range close to the Larmor frequency, they can contribute to the image as an artefact. RF spikes can occur from a range of sources, but often tiny cracks in wires that create intermittent sparks (and hence a radiowave spike) only in certain operating conditions. This could be from wires connecting gradient coils, or power supplies but only when running one particular pulse sequence, or one particular slice orientation. Whether a small crack generates sparks also depends on humidity in the scanner room. Because the spike in k-space is usually very intense, it swamps the frequency information that should be at that point in k-space. After the Fourier transform, this results in a distinct ripple across the image. If the spike is detected near the centre of k-space, the ripple across the image is slowly varying; if the spike is detected near the edge of k-space then the image ripple varies more rapidly.

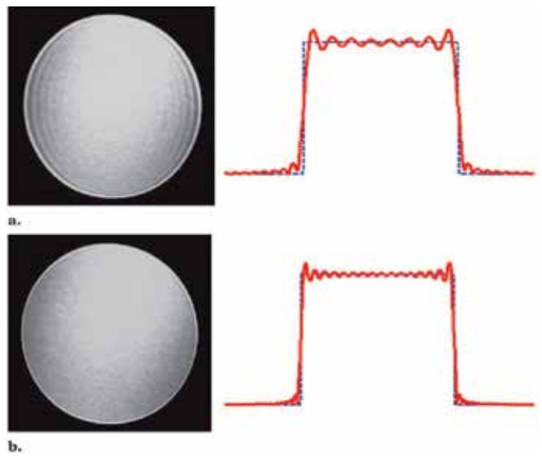
Unlike Gibbs ringing, or motion artefacts, the ripple caused by spikes is in straight lines and is uniform across the image – it does not follow the shape of anatomy nor is it only near to edges.

As spike artefacts are usually intermittent, it is important to note the main scan parameters, such as pulse sequence, slice orientation, FOV, and body region, as well as scanner room humidity. This helps look for a pattern to reproduce the artefact for the investigating MR engineer.



◆ Figure 5a. A spike in k-space is shown on the left, indicated by the yellow arrow. The resultant image artefact is shown on the right. As the spike is close to the centre of k-space it affects low spatial frequencies in the image, resulting in a slowly varying ripple.

◆ Figure 5b. A spike artefact caused by a spike in k-space further from the centre of k-space, resulting in a ripple artefact varying more rapidly



◆ Figure 4. The Gibbs ringing seen in (a) is reduced by re-acquiring the scan using a larger matrix size in (b). Ringing still remains but is considerably reduced.

Summary

Two types of MRI artefacts have been reviewed, both presenting as ripples in the image. By reflecting on k-space as the source of MR images, the different causes and distinction between the artefacts can be appreciated. This not only results in better classification of artefacts in clinical practice, but also presents a different and more practical window on understanding k-space.

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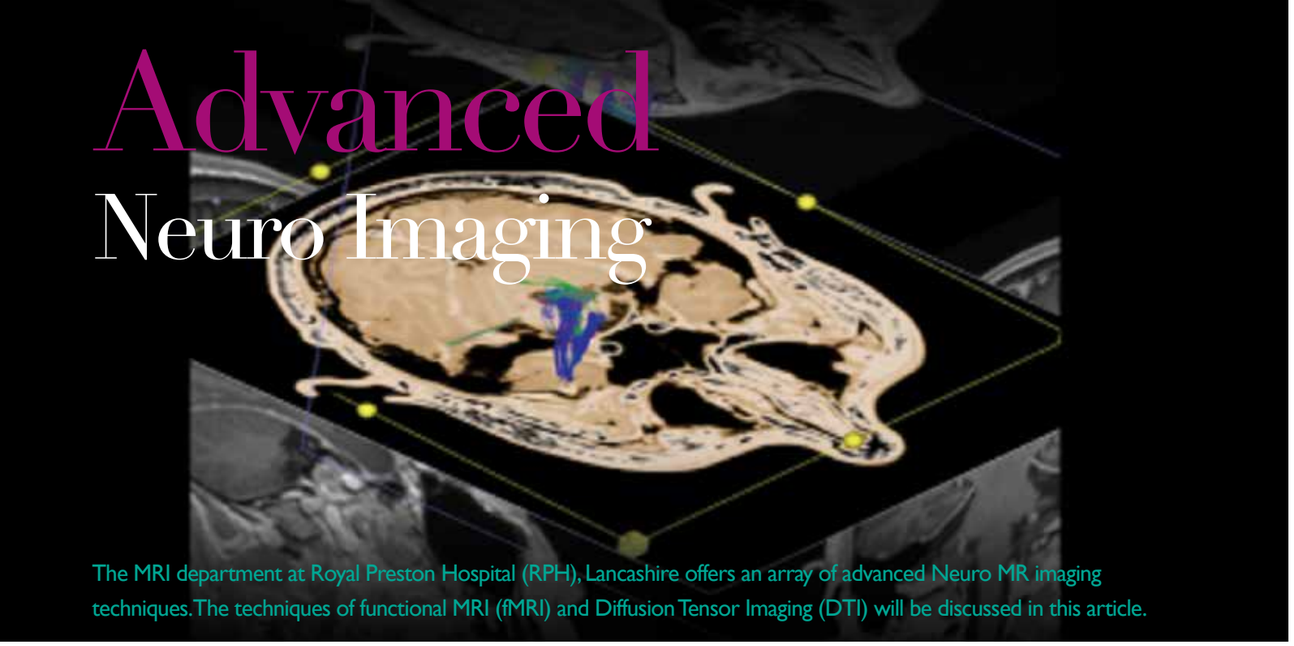

The MRI department at Royal Preston Hospital (RPH), Lancashire offers an array of advanced Neuro MR imaging techniques. The techniques of functional MRI (fMRI) and Diffusion Tensor Imaging (DTI) will be discussed in this article.

Functional MRI (fMRI)

The Specialist Radiographers and the Clinical Scientist are guided by the Neuroradiologist to produce a series of fMRI images that in turn aim to assist the Neurosurgeon in making decisions for patient treatment regimes. During fMRI, the patient is instructed to carry out a series of tasks (paradigms) during the examination. Blood oxygen level dependant (BOLD) imaging is used to map the neural activity of the brain during these tasks as these specialised sequences are sensitive to the subtle changes in blood flow to different regions of the brain over time. Brain functionality can be studied non-invasively in comprehensive detail, thereby allowing a greater understanding of how the brain works when performing certain tasks and processing information.

Surgical planning for brain tumour patients is complex and fMRI has an important role to play in helping the Neurosurgeon provide safe and effective care. It helps shape decisions on treatment plans and minimises the risk of post-operative neurological deficit. This can help the patient to continue / maintain normal everyday functionality.

One of the main criteria used in deciding whether an fMRI examination would be useful in individual patient management is the location of the lesion. For example, if the tumour is in close proximity to critical regions of the brain that control specific functions such as movement (motor strip) and language (Broca's & Wernikes area) then fMRI is indicated. These sensitive regions carry a high surgical risk as they are critical areas for normal functioning. Every patient is unique and the impact of a brain tumour can vary widely. This is why a case-by-case analysis is extremely useful.

How does BOLD imaging work?

During BOLD imaging, structural images of the brain are obtained. Blood flow in the brain is highly locally controlled in response to oxygen and carbon dioxide tension of cortical tissue. When a specific region of the cortex increases its activity in response to a task, the extraction fraction of oxygen from the local capillaries leads to an initial drop in oxygenated haemoglobin and an increase in local carbon dioxide and deoxygenated haemoglobin. Following a lag of 2-6 seconds, cerebral blood flow increases. This delivers a surplus of oxygenated haemoglobin, washing away deoxyhaemoglobin. It is this large rebound in local tissue oxygenation which is imaged. The reason fMRI is able to detect this change is due to a difference in the paramagnetic properties of oxygenated haemoglobin and deoxyhaemoglobin. Deoxygenated haemoglobin is paramagnetic whereas oxygenated haemoglobin is not, and therefore the former will cause local dephasing of protons. In turn, this reduces the returned signal from the tissues in the immediate vicinity. Heavily T2* weighted sequences are used to detect this change. Sophisticated software is then used to transcribe this data into images of brain activity over time in response to the different stimuli or tasks. The BOLD signal has to be measured very quickly and as a result the resolution of these images is lower than a regular MRI image.

Pre-Appointment patient preparation

Since the onset of our fMRI service at RPH we have continued to refine our pathway. The Neuroradiologist specifies which paradigms are required. We then discuss with the patient via telephone consultation the specific tasks that will be undertaken. We document if the patient is right or left handed as this is important information for the Neuroradiologist when it comes to analysing the fMRI data. (About 99% of right-handed people have a 'left side dominant' speech centre. Left-handed people can either have a 'right side dominant' or a 'left side dominant' speech centre, however it is more likely to be situated on the left side). We ask if the patient is long or short sighted. If the patient is short sighted and has contact lenses they are asked to wear them during the scan so that their ability to see the presented data on the projector screen is not compromised. If the patient is bilingual / multilingual there is evidence to suggest the results could be affected. We explain that our speech & language paradigms are in English and so we would like them to use English alone rather than alternating between different languages during a specific task.

- **fMRI in practice**
  Careful patient preparation is key to the success of the examination overall. On the day of the scan, the Clinical Scientist briefs the patient by showing them examples of the tasks on a laptop screen and informing the patient of what is required during each paradigm. At RPH we undertake all of our fMRI examinations on a 3T Siemens Skyra.
- **3D T1 mp-Rage**
  We run this sequence prior to obtaining fMRI data. The anatomy information from this sequence can be used in the analysis stage where the Neuroradiologist can fuse 3D data over the top of the fMRI data.
- **fMRI paradigm design**
  The order in which we run the paradigms is important to help avoid patient fatigue and improve overall patient compliance. The ideal running order that we use at RPH is as follows: motor - finger tapping, motor - toe scrunching, object naming, motor - tongue movement, sentence completion, word generation. We would rarely run all paradigms for one patient. We are guided by the Neuroradiologist on the specific paradigms to be undertaken based on the nature of the individual patients tumour characteristics.

We use a 'block design' of paradigm delivery. This is where stimuli are presented to the patient in 'blocks' with alternating periods of rest or baseline. There are multiple cortical regions of the brain related to motor control, speech, vision, olfactory and somatosensory sensations (touch and proprioception.) We aim to image how certain tasks can highlight brain activity. The Neuroradiologist analyses the fMRI data on the Siemens Syngo Via post processing workstation.

Typical examples of individual fMRI paradigms may include:

Motor paradigms

This task analyses the activation in specific regions of the primary motor cortex responsible for the control of voluntary movement. Various motor paradigms may be undertaken. Well-defined movements of the hands, fingers, toes or tongue are undertaken to allow a measurement of changes in blood flow (and therefore brain activity.) The data acquired can be used to help establish whether the tumour has affected the normal functioning of the motor cortex and how surgery may affect the patient's voluntary movements.

- **Finger tapping:**
  During the 'stimulus' segment the patient uses both hands together (to allow mapping of activity in both cerebral hemispheres) and taps each finger in turn against their thumb repetitively. During the 'baseline' segment the patient should pause this activity.
- **Toe scrunching**
  During the 'stimulus' segment the patient repeatedly scrunches their toes on both feet (to allow mapping of activity in both cerebral hemispheres). During the 'baseline' segment the patient should pause this activity.
- **Tongue movement**
  During the 'stimulus' segment the patient repeatedly moves their tongue from side to side in a closed mouth. During the 'baseline' segment the patient should pause this activity.

Speech and Language paradigms

fMRI helps to delineate the specific location of the language and speech centres which can be used in surgical planning. The information can help predict the impact of surgery on the brain tumour with respect to the patient's overall quality of life, including their ability to communicate effectively, helping to minimise the degree of potential impairment.

Two areas in particular we would expect to see activity during speech and language tasks are Broca's and Wernicke's areas. Broca's area of the brain is located in the frontal / temporal area, specifically in the left hemisphere in most people. fMRI studies have shown that this region is consistently activated during tasks related to language production and comprehension. This includes writing, speaking and the understanding of spoken and written language. The Broca's area has also been found to have an involvement in speech planning, working memory and attention.

A region in the brain that is critical for language comprehension and production is Wernicke's area, located in the temporal lobe on the left side of the brain. The effects on the patient's language function can be significant if the brain tumour is located in or near Wernicke's area. If the tumour is pressing on Wernicke's area it can lead to Wernicke's aphasia. This is a type of language impairment characterised by difficulty producing fluent speech and understanding spoken language.

- **Object naming**
  During the 'stimulus' segment the patient is shown a number of objects on the screen. They are instructed to name the presented object silently in their head rather than saying the word out loud in order to avoid movement of the head. Activity is normally seen in Broca's area. During the 'baseline' segment a random nonsense symbol is shown on the screen and the patient should relax and keep still.
- **Sentence completion**
  During the 'stimulus' segment the patient is asked to silently fill in the missing word in a sentence. Activity is normally seen in Wernicke's area. During the 'baseline' segment, sentences made up of random nonsense letters will appear on the screen and the patient should relax and keep still.
- **Word generation**
  During the 'stimulus' segment a letter of the alphabet is projected onto the screen. The patient should silently begin to think of words that begin with that particular letter. Following this a different letter will then appear on the screen and the patient should then begin to think of words beginning with that letter. During the 'baseline' segment a random symbol will appear on the screen and the patient should begin at the number 1 and continue counting upwards. Another random symbol will appear on the screen thereafter and the patient should begin at the number 1 again and continue to count upwards.

DTI sequence

DTI (Diffusion Tensor Imaging) is a further advanced Neuro MR imaging technique that is undertaken at RPH. This technique incorporates a complex diffusion sequence. The brain is wired with fibres. The aim of DTI is to show the 'wiring' or 'fibre pattern' of the white matter. (DTI is the actual diffusion sequence or technique. Tractography refers to the post processing or quantification of the DTI sequence.) DTI is important when planning surgery to help prevent damage to these white matter tracts.

Conclusion

Advanced neuro imaging techniques are an important addition to be considered in treatment regimens for brain tumour patients. BOLD fMRI is a widely accessible technique that allows physicians and researchers to safely, painlessly, and non-invasively observe the brain's activity during different tasks. Although fMRI has some limitations, such as limited spatial resolution and high sensitivity to patient movement, it is one of the most fundamental techniques in cognitive neuroscience.

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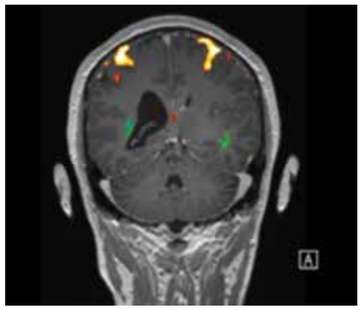

Figure 1: Large left fronto-temporal tumour with areas of early high grade transformation. This image depicts the expected areas of activity during the motor paradigm of finger tapping. They are seen to be well away from the tumour.

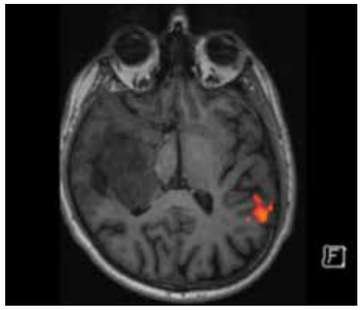

Figure 2: Right-sided Oligodroglioma. The highlighted activity represents a sentence completion paradigm showing good activation in the Wernicke's area in the left posterior superior temporal lobe. The patient's speech and language dominance is shown to be in the left cerebral hemisphere.

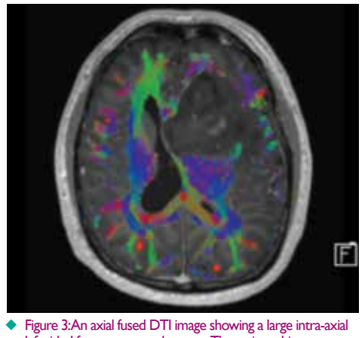

Figure 3: An axial fused DTI image showing a large intra-axial left sided fronto-temporal tumour. The major white matter tracks appear to be displaced and deviated by this tumour without any obvious evidence of infiltration or destruction.

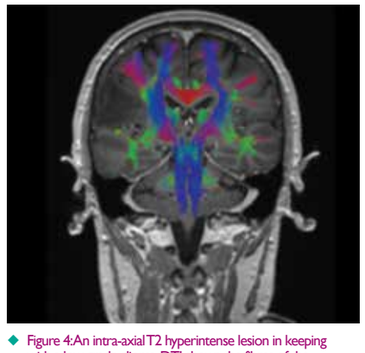

Figure 4: An intra-axial T2 hyperintense lesion in keeping with a low grade glioma. DTI shows the fibres of the cortico-spinal tract related to the face area displaced mildly by the tumour.

AXREM

Chris Kasap *MRI Clinical Expert Applications Specialist, Siemens Healthcare Limited*

What is AXREM?

I represent AXREM on the BIR MR Safety committee where BAMRR are represented by Cath Mills who along with Newsletter editor Matthew Benbow asked me to give an introduction to AXREM.

AXREM is the UK trade association representing the interests of suppliers of diagnostic medical imaging, radiotherapy, healthcare IT and care equipment including patient monitoring in the UK. The group is comprised of most of the industry supply companies, complemented by the services of a secretariat.

AXREM members supply the majority of diagnostic medical imaging and radiotherapy equipment installed in UK hospitals. In doing so, AXREM member companies and their employees work side by side with Radiologists, Radiographers and Practitioners, Oncologists and a wide range of healthcare professionals in delivering healthcare to patients using our technologies. AXREM members therefore have unique knowledge, experience and insight into the workflow and challenges faced by healthcare professionals on a day-to-day basis, which enables us to develop and offer innovative solutions to improve the speed and quality of diagnostic procedures and treatments with our ultimate aim of improving patient care.

Although AXREM members operate in a highly competitive commercial environment and in strict conformity with UK laws and regulations, certain issues require focus and resolution on an industry-wide basis.

Accordingly, the Association's primary role is to help promote and develop the industry by providing a collective interface to address the regulatory and technical needs of the UK Healthcare market – public and private.

Examples of the services undertaken by AXREM on behalf of its membership as a whole are:

(i) Consultation with the Department of Health & Social Care and government bodies regarding regulatory and other issues.

(ii) Consultation with NHS organisations regarding trading terms and conditions.

(iii) Appointment of representatives to technical standards committees.

(iv) Appointment of representatives to professional bodies of the diagnostic, radiotherapy and care sector, e.g., British Institute of Radiology, Royal College of Radiographers, Society and College of Radiographers, etc. A relevant example is in my representation on the BIR MR Safety committee. The driving force for AXREM membership to the BIIR MR Safety committee was the build up to The European Union physical agents (electromagnetic fields) directive.

(v) Appointment of representatives to the Radiology & Oncology Conference Board who manage and organise leading Scientific and Technical Meetings and Exhibitions.

AXREM was formed originally as the Association of X-ray Equipment Manufacturers. However, as technology advances have increased the scope of diagnostic imaging and treatment modalities the Association is now represented by the strapline: Association of Healthcare Technology Providers for Imaging, Radiotherapy and Care.

AXREM is also particularly keen to encourage innovation and evaluation of new technologies to improve healthcare provision in the UK.

A Recent relevant development is the AXREM Member Accreditation (AMA) Scheme launched in April 2022. AMA is a true low cost "not for profit" accreditation scheme which reduces the cost burden within the supply chain; (costs that would otherwise inevitably find themselves reflected in the cost of products and services borne by NHS Trusts). Fundamentally this is an employer scheme, such that the AXREM employer organisation underwrites the credentials of employees against agreed criteria. AXREM will carry out "audits" to ensure that the correct procedures are being adhered to by the relevant companies. Scheme member employers commit to reflect NHS policies relating to DBS checking, Vaccination policy, Health & Safety, etc.

The AMA scheme is specifically aligned with NHS requirements and policies. AXREM wanted to ensure that the scheme is open and transparent, maintaining alignment with NHS and Professional Body stakeholders. The AXREM Member Accreditation Scheme Council includes representations from The Society and College of Radiographers, Institute of Physics & Engineering in Medicine, The Royal College of Radiologists and The British Institute of Radiology.

Registrants carry an AMA membership card which will display their name, their employers company name, their photo, and a unique ID number and associated QR code. The employment status of the individual can be simply checked at any time by scanning the badge on the QR code without requiring specialist equipment and enabling validation of the registrant.

The AMA scheme now has over 2000 registrants and is the most comprehensively adopted accreditation scheme in the diagnostic imaging sector. Ask your MR engineer or applications specialist for their AMA card when you see them

For further resources see website: **https://www.axrem.org.uk/resource/**

Mafalda Sousa

My name is Mafalda Sousa, and I work as a Senior Cross-Sectional Radiographer at the University Hospitals of Leicester, and as a Lecturer in Diagnostic Radiography at the University of Leicester. I was always very keen on MSK MRI Imaging, with a special interest in soft-tissue sarcoma.

I was successful in my application for the BAMRR education grant, which partly funded my tuition fees for my MSc dissertation on 'Assessing the Impact of Gadolinium-Based Contrast Agents on Patient Diagnostic Pathway in Magnetic Resonance Imaging of Soft-Tissue Sarcoma: A Retrospective Study', which was a great financial aid.

Soft-tissue sarcomas are a rare group of tumours affecting connective tissues in the body, with varying levels of malignancy. The diagnosis of malignant soft-tissue sarcomas is typically obtained through MRI followed by biopsy and histology. Different imaging departments use varying MRI protocols for the diagnosis of this pathology, with gadolinium-based contrast agents being commonly employed. The study aimed to assess whether the administration of gadolinium-based contrast agents during soft-tissue sarcoma MRI affects the subsequent patient pathway.

From literature, it is uncontroversial that gadolinium-based contrast agents provide image enhancement and have potential side effects, but it is unclear whether these enhanced images result in a reduction of the number of lesions deemed to be suspicious, and thus in the number of biopsies performed, or if a biopsy will still have to be performed regardless, and therefore exposure to gadolinium-based contrast agents has no real effect in the patient pathway. It is also unclear whether, or in which cases, gadolinium-based contrast agent enhancement could be replaced without loss of diagnostic effectiveness, by present and emerging advanced non-contrast sequences, which would be another variation in which contrast administation would not influence the patient pathway.

There is no doubt about the importance of adding DWI to the routine MRI protocol for these lesions. The DWI sequence gives both quantitative and qualitative characteristics such as tumour cell density and membrane integrity, and improves specificity for assessing tumour margin infiltration.

A sample of 200 patients was selected using a stratified convenience sampling method. Cases were analysed, and findings where no contrast was administered were compared to those where gadolinium-based contrast agents were used. Results revealed similar numbers of biopsy referrals in both groups, despite some differences regarding the number of benign lesions and of those found not to be a soft-tissue sarcoma. When performed, biopsy results confirmed the MRI report in more cases in the contrast group than in the no contrast group, and particular situations were found where gadolinium-based contrast agents are particularly important.

I cannot wait to share all my findings on next year's BAMRR Conference!

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