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BAMRR news

THE NEWSLETTER OF
THE BRITISH ASSOCIATION OF MR RADIOGRAPHERS

ANNUAL CONFERENCE BOURNEMOUTH

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Cover photo: Cat Preen, RDA at Bournemouth CT & MRI Department

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welcome

from your BAMRR PRESIDENT

It is hard to believe I am almost a third of the way through my tenure now.

I must thank Helen Estall, BAMRR past president for all her hard work last year in steering the group forward. I have a hard act to follow....I would also like take this opportunity to thank everyone on the BAMRR Policy Board, who work tirelessly to promote education and safety in MRI on a voluntarily basis, receiving no remuneration except expenses.

Last year was another busy year for BAMRR, during which we organised many successful events- our Introductory MRI course, a special focus educational session at UKRCO in Liverpool and our 35th annual conference in Nottingham. A big thank you once again to all of the policy board members involved in arranging these events and our loyal sponsors for their financial support- without them we would not be able to keep our Introductory course fee and conference registration price so low, which has been unchanged for the last few years.

BAMRR have also recently been involved in several national MRI projects such as a pacemaker survey, Skills for Health documentation and updating the joint MR Safety Guidance and Advice manuscript in collaboration with the Magnetic Resonance Advisory Group (MRAG) as part of the Society and College of Radiographers (SCOR).

It is vital to established and maintain relationships with these leading UK institutes. BAMRR has representation on both MRAG and the British Institute of Radiology (BIR) MR safety group- these partnerships ensure BAMRR members are kept abreast of all the latest in MRI safety and education.

Our membership continues to grow, with almost 600 members now, which is great news. Please encourage any student radiographers to take advantage of the free membership option. We are hoping to make some improvements to our website this year to make membership renewal and event registration more automated - so watch this space...

Preparations are underway for our special focus BAMRR educational session at UKIO (formally UKRC) conference on Tues 11th June. Jill has organised fantastic speakers and I look forward to seeing you there. Cath is making plans for MR Safety week 22nd-28th July, so be sure to check out the BAMRR website for all things safety related.

It is with regret I have to inform you that we are no longer able to run the BAMRR Introductory MRI course in May due to unforeseen circumstances but we will be running the November course as planned, so please register early as these excellent courses sell out fast.

Dave and Matthew are already busy working on our 36th annual conference later this year in Bournemouth. I hope you will be able to join us on Sat 5th Oct for what promises to be a great educational day out.

Prizes of £300 and £150 are on offer for the best oral proffered paper and poster for all the budding MRI radiographers who wish to present on the day. All conference details will be on the BAMRR website in due course.

The BAMRR educational grant is still available - please see the website for the proforma and if anyone has any articles for our e-newsletter, please let Matthew know.

Finally I am sure you will join me in bidding Janine Sparkes a fond farewell following her decision to step down from her commitments with the BAMRR policy board. Janine has been a BAMRR stalwart, joining the board way back in Oct 2008 and deserves a medal for her long standing support of BAMRR and MRI education. Working tirelessly, Janine has held many varied roles on the board over the years from secretary to safety/education and was president two years running.

We wish Janine all the best and I am sure we will all catch up again soon.

Roll on Bournemouth....

Wishing you all a lovely spring

Rachel Watt
BAMRR President

from your EDITOR

Times are a-changing.

As you will have most certainly realised by now, BAMRR News has gone electronic. At time of writing this letter though I don't know how well it has gone or how you the members will have received the new format. I really hope it is positive and I would certainly be interested to hear your thoughts.

Now this edition is complete I will be focusing time on working with Dave Reed to organise this year's BAMRR Conference which will be held on our patch, down here in the Queens Hotel, Bournemouth. Please see the flyer included in this edition Registration will open around June at www.bamrr.org so please make a note in your diary to book a place. We have negotiated a good rate at the venue for those wanting to stay over either on the Friday night, Saturday night or even both. We are planning live music on the Saturday evening, so try to make that if you can and book your room early. You could even enter the Bournemouth sea front marathon on the Sunday morning if this is your thing!

Happy page clicking……

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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UK RADIOLOGICAL AND RADIATION ONCOLOGY CONGRESS

UKRC UKRO

UKIO
UK IMAGING & ONCOLOGY
CONGRESS 2019

UKRC and UKRO are amalgamating in 2019 to become United Kingdom Imaging and Oncology (UKIO), designed to appeal to medical and healthcare professionals working across the entire spectrum of radiology and clinical oncology.

Join us for the
BAMRR Session at UKIO,

Tuesday 11th June at 14.00-15.20.

ACC & Exhibition Centre, Liverpool

Details on the BAMRR website
http://www.bamrr.org

Hope you can make it

BAMRR Policy Board Members, Spring 2019

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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Excellent BAMRR Conference 2018

October 2018 BAMRR hosted another excellent conference in Nottingham with a fabulous attendance of delegates in a superb venue in The Nottingham Conference Centre. The feedback was excellent and delegates were delighted to hear some fantastic presentations.

These included Professor Gerry McCann giving a very informative overview of abnormalities seen in Cardiac Imaging, Carolyn Costigan talking about indications and safety considerations when scanning pregnant ladies, Dr Kevin Mulcahy gave an interesting overview of current thinking in scanning of prostates and Dr Martin Graves gave a very easy to understand explanation of that phenomenon Compressed sensing.

A huge thank you to everyone who attended and presented and those involved in the organising. Keep the date for the next conference on Saturday 5th October 2019 in Bournemouth.

Lisa McBain
BAMRR Policy Board Member

BAMRR

Bamrr Education Grant

from the British Association of MRI Radiographers

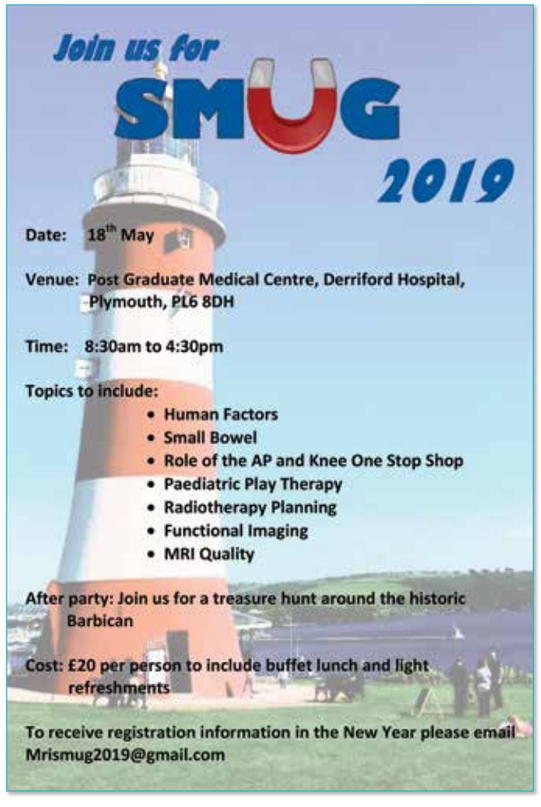
- An £1000 award is available per year for MRI research or improved service development

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:

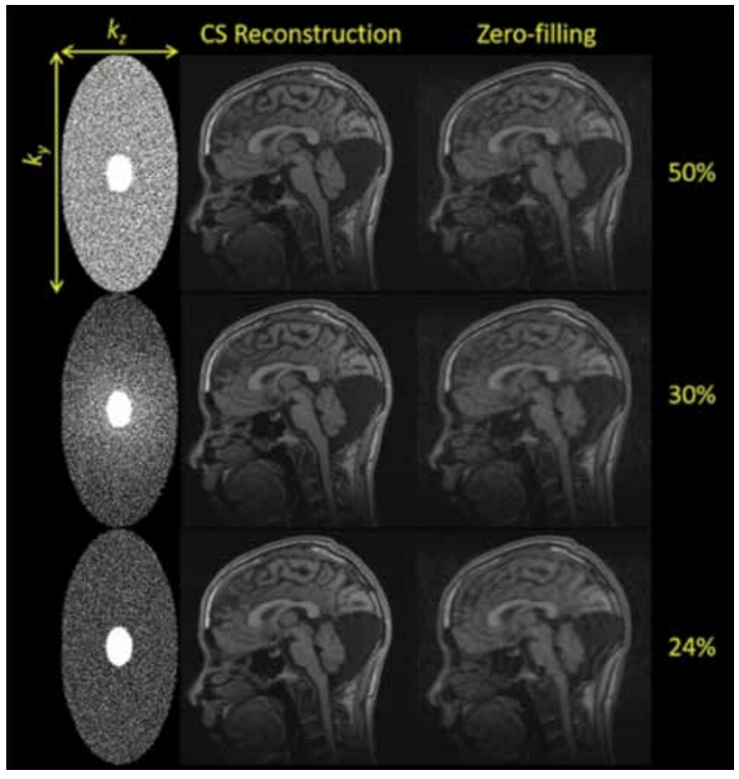
- Complete the application form available on the website under "About Us" -Education Grant .
- Applications must submit a brief outline of the intended project (*maximum 750 words*)
- Applications must to send to Bammr via the website



Compressed Sensing in MRI

Martin Graves *Cambridge University Hospitals*

Compressed sensing (CS) is a new method of accelerating image acquisition that is based upon the concepts used in image compression. We are all familiar with the concept of compressing images or movies to reduce the space required for storage. The Joint Photographic Experts Group (JPEG) standard is a typical example of a compressed image format that is extensively used to reduce the size of image files, whilst the Motion Picture Encoding Group (MPEG) standard is used to compress video. Both can be performed with little or no reduction in image information.



◆ **Figure 1 Under-sampled MRI k-space (left) where the missing data is reconstructed using a compressed sensing algorithm (middle) compared to simple zero-filling (right)**

CS essentially involves this process in reverse. We sample a reduced number of raw MRI data points (k-space) and then iteratively reconstruct the image by estimating the missing data points. There are however several requirements for CS to work in the context of MRI. Firstly, the data must be sparse, or be transformed into a sparse representation. Sparsity in this context means that the data contains very little information. An MR angiogram is a good example of sparse data in the image domain. Alternatively, other images may require some form of transformation to make them sparse, for example, the voxels in a standard brain image are relatively smoothly changing with position, i.e., two adjacent voxels are likely to be very similar, so a suitable sparsifying transform could be to simply take the difference between adjacent voxels. More sophisticated algorithms may use a wavelet transformation. Secondly, the aliasing artefacts caused by the sub-sampling of k-space must be incoherent (noise-like). We know that regular sub-sampling of k-space results in regular aliasing artefacts, whereas if we randomly sample k-space then the resulting incoherent artefacts appear much more like background "noise". Finally, an iterative reconstruction algorithm is used that effectively "denoises" that image by retaining the sparsity of the image and the consistency of the reconstruction with the acquired samples. CS can be combined with parallel imaging; however careful choices need to be made in terms of the random sampling distribution. There are several algorithms in the literature that fulfil this requirement as well as commercial implementations being developed by the MRI system vendors

Figure 1 shows a sagittal image from a 3D acquisition where k-space has been under-sampled by 50%, 30% and 24%. The column on the left shows the under-sampled k-space in the slice-encoding (kz) and phase encoding (ky) directions. Note that the centre of k-space is fully sampled. The middle column shows the reconstructed images obtained using a CS reconstruction algorithm. The column on the left shows what happens when the missing data is filled with zeros, note the incoherent noise-like artefacts and the blurring of the images.

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3. Feng L, Benkert T, Block KT, Sodickson DK, Otazo R, Chandarana H. Compressed sensing or body MRI. J Magn Reson Imaging. 2017; 45(4): 966-87.

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.

Register for your free ticket here.

The convention features 200 industry leading exhibitors and 100 expert-led seminars along with a new dedicated focus area for AI & Machine Learning. The event provides a unique platform for 2,500 medical imaging professionals and senior management teams to discover the latest innovations currently revolutionising the industry with a dedicated focus area for MR imaging.

Some of the expert speakers dedicated to research and clinical practice in the field of MR imaging include:

- Dr Simeon Nill, The Institute of Cancer Research and the Royal Marsden NHS Foundation Trust: 'MR image-guided radiotherapy treatment on the MR-Linac'
- Prof Dorothee Auer, University of Nottingham: 'Novel MRI biomarkers in Parkinson's'
- Prof James O'Connor, University of Manchester / Cancer Research UK / The Christie Hospital: 'Developing a new MRI method of tracking hypoxia in cancer'

Your complimentary ticket will enable you to move freely between all of the co-located shows, including the European Neuro Convention and the European Oncology Convention. To book your free tickets go to: www.imagingconvention.com or call 0117 990 2097.

Please use the following link when linking to our website:
http://www.imagingconvention.com/tracker.asp?code=BAMRRnewsletter

Hwyl Fawr Janine

Janine Sparks

In October 2018 the BAMRR Policy Board said a reluctant goodbye to Janine Sparkes who had decided to step down from the board after many years of faithful service. Janine who is a past President, has been an integral, enthusiastic and highly valued member of the board and is greatly missed by her BAMRR colleagues.

Her level-headed, knowledgeable and professional contribution has helped shape BAMRR into the successful and growing organisation it is today. During her eleven years as a board member she completed two spells as BAMRR President. We all wish Janine the very best for the future at her home and place of work in South Wales.

David Reed
Treasurer

INTRODUCTION TO MRI COURSE

Friday 22nd and Saturday 23rd November 2019

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 and Lumbar spine**

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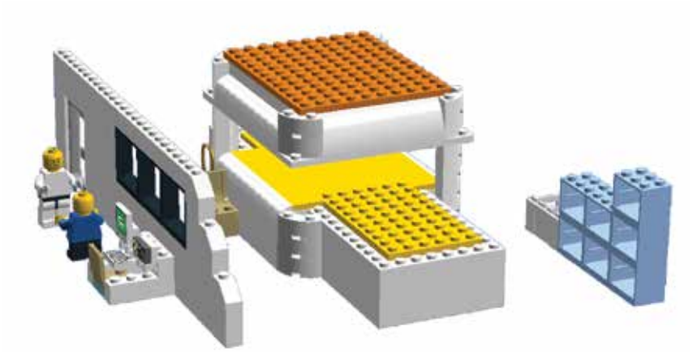
Registration is via www.bamrr.org

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

The Lego Open MRI Scanner

Apollo Exconde, Senior MRI Radiographer, Croyden University Hospital



One of the radiological machineries available today is a Magnetic Resonance Imaging (MRI). The most common type of MRI is the closed cylindrical type called as the conventional MRI which for some people find it claustrophobic and can trigger panic attacks or anxiety.

InHealth Croydon MRI unit at Croydon University Hospital houses three MRI machines one of which is the open MRI that provides diagnostic images in a comfortable way to those who have failed to do their scans in the conventional MRI.

I, Apollo Exconde, a MRI senior radiographer has a special interest in anxiety and claustrophobia. I have been trying to improve my approach by attending seminars and through self-research which some of them are either expensive or not applicable for a clinical set up.

Kids, plus size, first time, anxious and claustrophobic patients each with given medical histories and not having get through their scans makes me sad and subdued. A few of my patient's whilst going inside or just outside staring at the machine will scream "Apollo, bring me out!" "take me out" "I cannot go in there" and most of them was because they were not informed. The echoes left me disturbed, feeling guilty for every cancellation and kept me thinking how can I help them?

I was challenged, if a patient has failed to do the open MRI after being referred from a conventional MRI it means that the clinical treatment will be delayed further. I learnt that it was not only anxiety or claustrophobia that stops them from having the scan but also the lack of support system.

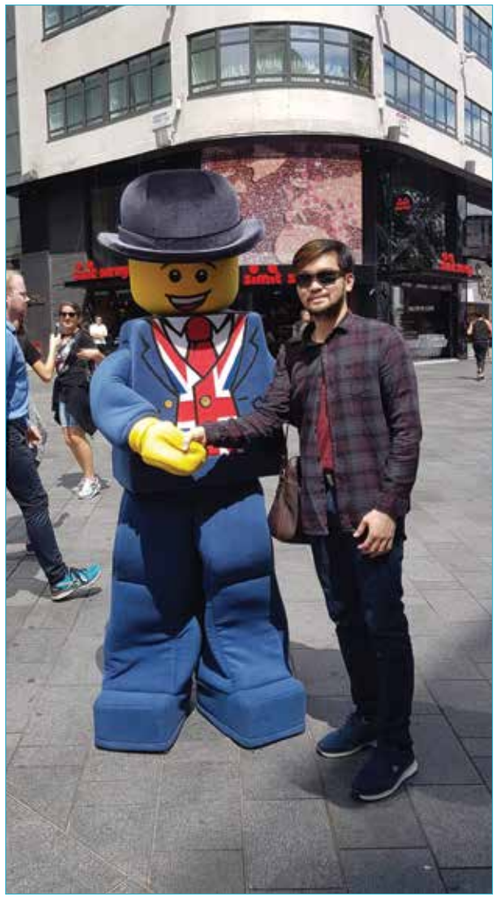
This inspired me to devise a solution that will help them conquer it alongside the holistic approach, I came up of why not explain to them in an interactive way? Something tangible and fun. Something every generation loves and can relate to. Thus, the Lego open MRI was born under Lego ideas still gathering support.

The original aim was to have it in MRI unit as a tool to show how the MRI process works and patient positioning will be, if head first, feet first, supine, prone, sideways, how far the head inside or is it outside. I have realised that if this be available in the earliest possible like wards, clinics and doctor's offices, the referrer will then be able to discuss these issues and may reduce or eliminate any misconceptions or fear that they may have whilst waiting for the agreed appointment.

Today, Lego has given me a year to gather support to reach 1k, after which a further boost of 6 months to get 5k supporters and additional 6 months to hit 10k. To cast your support for free, just type in any search engine Lego open MRI ideas, register, key in activation code, agree to terms, click support until it says supporting and a number will be given as a confirmation.

For every cast that you do get us closer to the 10k goal, helping patients build confidence one Lego brick at a time. For every share that you do raises awareness about claustrophobia and anxiety that I hope one day will be dealt clinically and properly.

I hope the world will help me help those who cannot.



BAMRR

British Association of MR Radiographers

Annual Conference

Saturday 5 October 2019

Queens Hotel, Bournemouth

Provisional topics:

- Non-conditional pacemakers
- Experiences from an extremity scanner
- MR artefacts and solutions
- Radiotherapy MR planning
- Cardiac T1 mapping
- Lego open MRI
- Getting ready for ISAS accreditation

Members £55

Non-members inc. one year membership £85

Non-members £100

Registration opens in June at www.bamrr.org

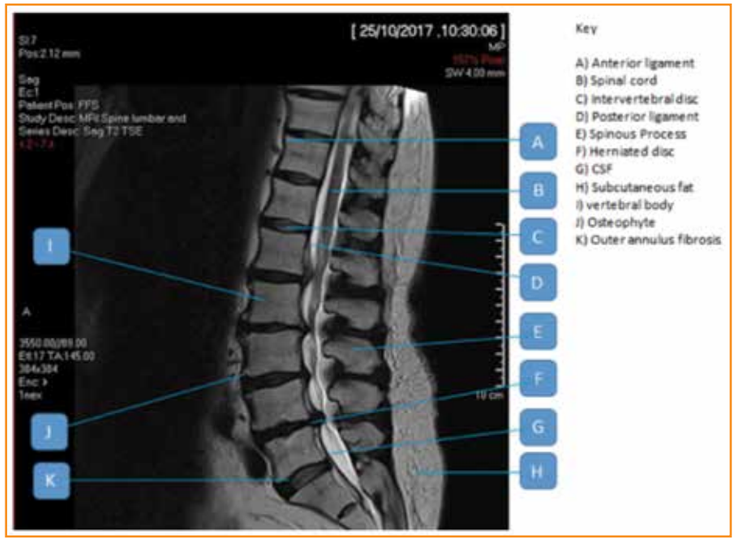
We have negotiated a very competitive accommodation rate of £64 pppn B&B, and £74 pppn Dinner, B&B. Limited number of rooms available and you must book direct by emailing: dale@queenshotelbournemouth.com

There will be a live band at the hotel on Saturday evening!

Image Critique of Sagittal MRI Thoraco-Lumbar Spine

Melany Palmer *Senior Radiographer, Royal Bournemouth Hospital*

Anatomy and FSE T2-w sequences



◆ **Figure 1: Sagittal TSE T2-w midline slice through the lumbar spine.**

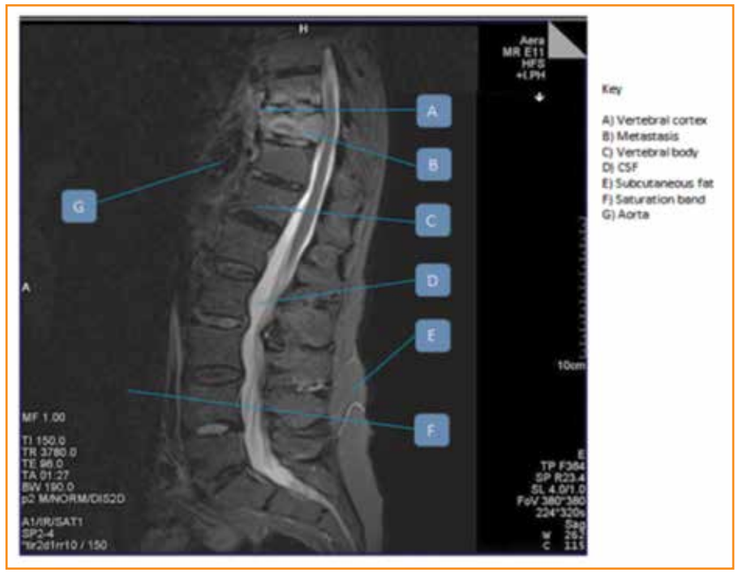
Figure 1 shows a turbo spin-echo (TSE) T2-weighted image of the lumbar spine through the spinal cord in the sagittal plane. TSE is a fast spin echo sequence in which multiple single spin echoes are collected following each excitation pulse. The shorter scan time is achieved by using several 180o rephasing pulses to produce a train of echoes which acquire multiple lines of data and fill several lines of K space at a time (Westbrook, Kaut Roth and Talbot, 2011). TSE has become the standard sequence for T2-w images as conventional spin-echo (CSE) has relatively long scan times due to the long TR required to produce T2-weighting. The T2-weighting in the TSE image demonstrated was achieved by using a long TR of 3550ms to minimise T1 effects and an effective TE of 89. The TE controls the amount of T2 decay allowed in the pulse sequence before acquiring the signal and thus controls the amount of T2-weighting in an image. Normal T2-weighting results in a high signal intensity from water molecules due to their relatively long T2 decay times, seen at Label G which demonstrates the cerebrospinal fluid (CSF) as relatively hyperintense to the vertebral body (Label I). The opposite is true for fat; their spin-spin interactions occur more rapidly, resulting in a low signal intensity due to their relatively short T2 decay times (Westbrook, Kaut Roth and Talbot, 2011). In TSE images, the resultant contrast is however, slightly compromised, resulting in fat (Label H) displaying with a higher signal intensity and is therefore relatively hyperintense to the vertebral body. This is due to the J-coupling effect which is a result of the repeated, closely spaced 180o pulses of the echo train in TSE sequences.

The sagittal plane allows for imaging of a larger section of the spinal cord (Label B) and compliments its longitudinal position in the body, as is true for the anterior (Label A) and posterior (Label D) longitudinal ligaments. The sagittal plane is useful in evaluating the vertebral bodies, the intervertebral discs (Label C) and the spinous processes (Label E). The intervertebral discs have the same appearance throughout the whole spine (Helms, et al., 2008). They consist of an inner gelatinous nucleus pulposus, composed of water and proteoglycans (proteins); and an outer annulus fibrosis. The inner portion of the annulus is composed of fibrocartilage and the outer is composed of collagen fibres.

It is impossible to see a distinction between the nucleus pulposus and inner annulus fibrosis on MR images; however the outer annulus fibres (Label K) are relatively hypointense to the rest of the disc which has a higher water content (Runge, 2012). In the middle of the disc at Label C is a relatively hypointense horizontal line which represents an intranuclear cleft. This shows that the nucleus is dehydrated, having lost water and proteoglycans due to ageing and degeneration. It displays as hypointense on both T2 and T1-w images because the nucleus becomes more fibrous as it loses water and gains collagen, resulting in more signal loss. Continuing degeneration causes the disc to progressively lose height and signal intensity (Helms, et al., 2008), as seen at Label F. Normal discs usually stay within the margins of the vertebral bodies (Label C) and abnormal herniated discs extend beyond these margins (Label F) in a variety of directions, causing varying degrees of symptoms in patients. As the discs degenerate and bulge, the fibres attaching them to the vertebral bodies experience traction stress, resulting in bony projections called osteophytes (Label J).

The vertebral body consists of spongy cancellous bone which appears relatively hyperintense on this TSE T2-w image, due to its fatty marrow contents (Runge, 2012). This spongy bone is surrounded by dense cortical bone, thus displaying as relatively hypointense at the edges of the vertebral bodies. At the discovertebral interface, it is indistinguishable from the cartilage that covers the vertebral endplates (Label K). The relatively hyperintense line seen parallel to the endplates is a flow phenomenon resulting from venous drainage. This flow-related enhancement from the slow venous flow decreases time-of-flight effects in SE pulse sequences (Westbrook, Kaut Roth and Talbot, 2011). This appearance is different from chemical shift artefact as it persists despite a change of phase encoding direction. Chemical shift artefact only occurs in the frequency encoding direction, which is anterior to posterior in figure 1, and can therefore not be responsible for this enhancement effect. Frequency encoding is usually located along the long axis of the anatomy being imaged; for imaging of the spine however; phase and frequency encoding gradients should be reversed so that pathology in the endplates or discs is not obscured by chemical shift artefact (Helms, et al., 2008).

Pathology (Metastases), STIR and Saturation bands



◆ **Figure 2: Sagittal STIR image of thoracolumbar spine showing vertebral body metastases**

Figure 2 demonstrates vertebral metastases using a short tau inversion recovery (STIR) sequence. There is a large vertebral lesion at the level of the tenth thoracic vertebra resulting in destruction of the cortex (Label A). This protocol was indicated for spinal cord compression from metastasis in a patient with known lung carcinoma. Bulging of the posterior border of the vertebra is noted, however, no cord compression is demonstrated. Any malignant tumour can involve the spinal vertebra; however, lung and breast carcinomas are the most common and tend to metastasis to the thoracic spine (Grey and Ailinani, 2012).

A STIR sequence was added to the protocol as it offers an additional type of image contrast in which signal from fat-containing tissue has been nulled (McRobbie, et al., 2017); resulting in an image with low signal from fat (Label E), seen as relatively hypointense to the high signal from fluids, such as CSF (Label D). Normal bone contains fatty marrow and is thus suppressed on STIR images, making lesions such as bone bruising and tumours, more clearly visible (Westbrook, Kaut Roth and Talbot, 2011). The relatively hyperintense tumour at label B is highly contrasted with the hypointense lipid marrow of a normal vertebral body (Label C). STIR sequences should always be used when imaging the vertebral bodies for metastatic disease as detection of marrow abnormalities is difficult on TSE T2-w images (Westbrook, 2014). This is because the fatty marrow in TSE has a higher signal intensity than normal, thus obscuring any abnormalities within it.

STIR is a type of inversion recovery (IR) sequence which starts with a 180o pulse to invert the protons magnetisation prior to the excitation pulse; the time between these two pulses is called the inversion time (TI) and is an important extrinsic contrast parameter that can be adjusted to achieve the best fat suppression (McRobbie, et al., 2017). The TI depends on the T1 relaxation time of the tissue; by setting it to a value of 70% of the T1 value, it is therefore, possible to null the signal from that tissue. A TI of 150ms has been used in the STIR sequence above as fat has a T1 of 220ms at 1.5T

The use of gadolinium enhancement is helpful to delineate metastatic lesions of the vertebral bodies (Westbrook, Kaut Roth and Talbot, 2011). These sequences should be combined with fat suppression techniques as enhancement can raise the signal intensity of bone lesions to that of normal marrow making the lesion isointense with normal bone, thus difficult to visualise. STIR sequences should not, however, be used as a fat suppression technique post contrast enhancement as its inverting pulse may nullify the signal from the tumour being imaged. This is because gadolinium shortens the T1 time of enhancing tissues so that they approach the T1 time of fat; making them relatively hyperintense on the image. STIR sequences may, therefore, result in the enhanced tissue of the lesion being nulled with the fat (Westbrook, 2014).

Another signal suppression technique used in the demonstrated image, is via the use of a spatial pre-saturation band, seen anterior to the spine as a thick relatively hypointense area (Label F). In figure 2, the aorta (Label G) is seen adjacent to the lower thoracic spine, this can create motion artefact from the flowing blood within it, across the vertebrae and spinal cord (McRobbie, et al., 2017). To reduce this flow artefact, a saturation band is placed in the field-of-view in the slice select gradient direction. A 90o pulse is applied to all tissues within the band, immediately prior to the start of the imaging pulse sequence. A large gradient pulse is then applied to dephase the protons resulting in a signal void. In the demonstrated image, however, the saturation band is unable to cover the aorta effectively due to the curvature of the spine.

Contrary to the suggestions of Helms, et al. (2008) the phase and frequency encoding directions have not been swapped in this sequence. Frequency encoding is parallel to the long axis of the anatomy, in the head to foot direction, with phase encoding anterior to posterior. As discussed in figure 1, swapping of phase and frequency encoding is utilized in the spine to reduce chemical shift artefact which may obscure endplate or disc pathologies. This is not of concern in whole-spine imaging however, which is usually employed to demonstrate cord compression. For this reason, the spatial resolution is not as important as a quick diagnosis (Westbrook, 2014).

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MR Safety Week 22-28th July 2019

MR safety week commences on the 18th anniversary of the tragic accident at Westchester County Medical Centre, New York, where 6 year old Michael Columbini was struck and killed by a magnetic oxygen cylinder when it was mistakenly taken into the MRI scan room. Today nearly everyone that works in an MRI unit; managers, Radiographers, Assistants, Administrators, and Radiologists will have heard of this infamous accident, and they will all know that this was preventable. There have been many changes in working practice as a result of the accident, with particular focus on MR Safety training, procedures, department layout and incident recording. Worldwide regulatory and professional bodies have published guidelines. In the UK MRI departments operate under guidance from the MHRA called Magnetic Resonance Imaging Equipment in Clinical Use: Safety Guidelines (May 2016). The Society of Radiographers has just released the updated publication Safety In Magnetic Resonance Imaging (February, 2019).

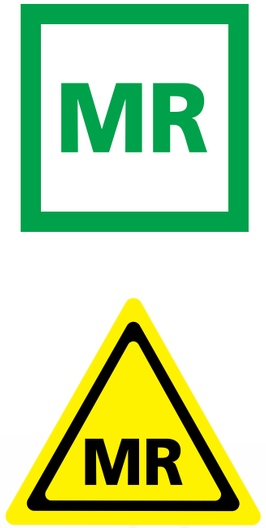
Society of Radiographers Safety In Magnetic Resonance Imaging new publication
https://www.sor.org/learning/document-library/safety-magnetic-resonance-imaging-2

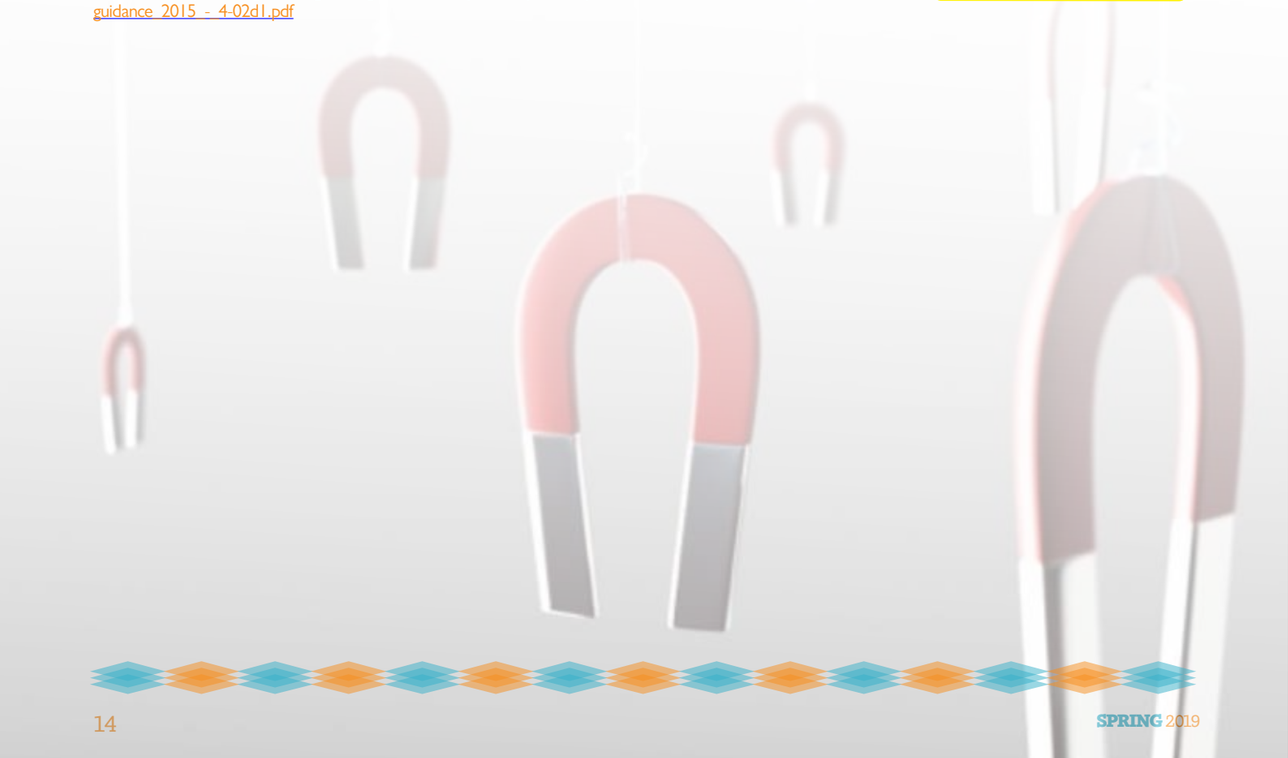
During MR safety week lots of organisations including BAMRR and the British Institute of Radiology (BIR) will be publishing features on their websites to support the professional development of Radiographers in MRI and promote best practice and excellence in MRI safety.

BAMRR website
http://www.bamrr.org/home

BIR website
https://www.bir.org.uk/

MHRA Safety Guidelines for Magnetic Resonance Imaging Equipment in Clinical Use
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/476931/MRI_guidance_2015_-_4-02d1.pdf





Value of Image-Guided MRI for Target Definition Before and During Cervical Cancer Brachytherapy

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Introduction

A standard of care in advanced cervical cancer is external beam radiotherapy (EBRT) with concurrent chemotherapy, followed by brachytherapy (BT)[1-3]. Recently, the use of MRI scans for BT treatment planning has been introduced due to its superior soft tissues visualization, allowing for better assessment of gross tumour volume and delineation of target volume, while reducing dose to the adjacent normal tissues/organs[1-3]. A significant variation in position of the BT applicator and adjacent anatomical structures between treatment fractions has been reported[4].

The aim of this study was to assess the use of repeated MRI between treatment fractions, during the brachytherapy course, in patients diagnosed with cervical cancer.

Methods

- MRI for target definition in cervical cancer brachytherapy was acquired at 2 time points: within 1h of applicator insertion (MRI1) and 24h post-insertion (MRI2).
- Patients were scanned on 1.5T (Siemens, Aera) using a flat table and a body array coil with the BT applicator in situ (Elekta, Interstitial Ring CT/MR Applicator Set).
- T_2-weighted axial high-resolution MRI scans performed for BT treatment planning, in a group of 7 patients with cervical cancer were used in the study (Axial 2D TSE: TR=8070 ms, TE=113 ms, voxel size=0.8x0.8x2.0 mm^3, no slice gap, FOV=200 mm, BW=250 Hz/Px).

Figure 1. Interstitial Ring CT/MR Applicator Set (left), T2-weighted image with the applicator in-situ (centre / right: sagittal / axial plane)

- MRI images (MRI1 & MRI2) were compared using Prosoma (Medcom) Radiotherapy Planning Station (RTPS), which allowed for co-registration of MR images acquired at different time points (point based registration method[5], 3-ring reference points and tip of the applicator in MRI 1 & 2).
- **The change of the applicator position in relation to the tumour was calculated as a difference in the tumour's centre mass position, by co-registering applicator position in both studies.**
- The total displacement of the applicator/target was calculated using the distance formula:

$$d = \sqrt{(x_2-x_1)^2+(y_2-y_1)^2+(z_2-z_1)^2}$$, where x = RL, y = AP, z = FH.

- The correlation between displacement and uterus volume was tested using the Kendall correlation coefficient.

Results

- The point-based method allowed for a successful image co-registration for all 7 patients enabling the displacement calculations.
- The image co-registration revealed gross differences in the uterus and applicator positions in relation to patients' bony anatomy (***Figure 2***).

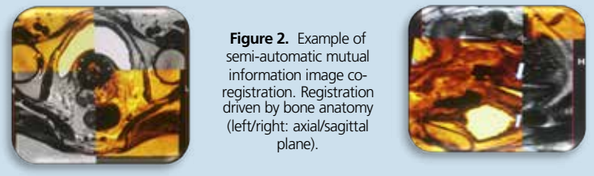

Figure 2. Example of semi-automatic mutual information image co-registration. Registration driven by bone anatomy (left/right: axial/sagittal plane).

- The image co-registration based on the BT applicator demonstrated differences in position of the patient's bone anatomy and structures around the applicator (***Figure 3)***. It also indicated a variation in the tumour position that can be more significant in particular patient axis (***Figure 4 and Table 1)***.

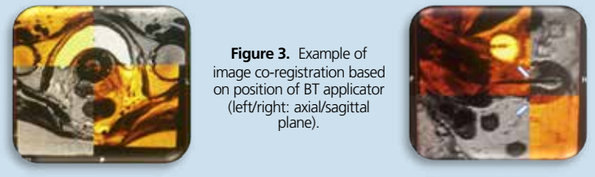

Figure 3. Example of image co-registration based on position of BT applicator (left/right: axial/sagittal plane).

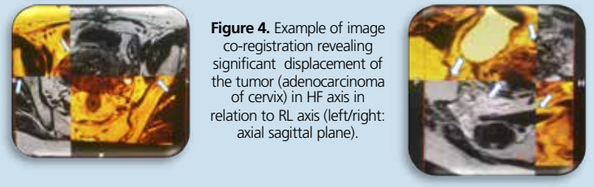

Figure 4. Example of image co-registration revealing significant displacement of the tumor (adenocarcinoma of cervix) in HF axis in relation to RL axis (left/right: axial sagittal plane).

Patient number	ΔRL [mm]	ΔAP [mm]	ΔHF [mm]	Total displacement [mm]	Volume [cm^3]
1	2.2	5.8	1.4	8.0	174.9
2	0.4	1.8	0.2	1.9	15.1
3	0.9	0.6	1	1.5	129.6
4	0	0.2	1.3	1.3	70.6
5	5.2	0.2	2	5.6	10.6
6	1.6	1.4	1.6	2.6	58.3
7	1	2.8	1.6	3.4	64.2
Median	1.6	1.8	1.3	2.6	70.5

Table 1. The median values of the displacement and uterus volume

- There was no correlation between the displacement and volume of the uterus (***p***=0.293).

Conclusions

The outcomes demonstrate a potential for BT applicator displacement in relation to the treatment target volume between day 1 and 2 of the brachytherapy. The displacement doesn't correlate with uterus size and is affected by factors like tumour position, bladder, rectum and sigmoid volumes**.**
The results highlight the value of the second MR scan to adapt/verify treatment planning during the brachytherapy course.

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ACTIVE INGREDIENT: Gadoteric acid, 279.32 mg/ml (equivalent to 0.5 mmol/ml). Osmolality: 1350 mOsm.kg-1. Viscosity at 20°C: 3.2 mPa.s (2.0 mPa.s at 37°C). pH: 6.5 to 8.0. **THERAPEUTIC INDICATIONS:** Dotarem should be used only when diagnostic information is essential and not available with unenhanced magnetic resonance imaging (MRI). *Adults and paediatric population (0-18years).* Contrast enhancement in Magnetic Resonance Imaging: ***Encephalic and spinal MRI:*** Detection of brain tumours, tumours of the spine and surrounding tissue, invertebral disc prolapse, infectious diseases; ***Whole Body MRI:*** Including renal, cardiac, uterine, ovarian, breast, abdominal and osteo-articular pathology; ***Angiography:*** Dotarem is not recommended for angiography in children under 18 years of age due to insufficient data on its efficacy and safety in this indication. **POSOLOGY AND METHOD OF ADMINISTRATION:** The lowest dose that provides sufficient enhancement for diagnostic purposes should be used. The dose should be calculated based on the patient's body weight, and should not exceed the recommended dose per kilogram of body weight detailed in this section. The product is intended for IV administration only. Intravascular administration of contrast media should, if possible, be done with the patient lying down. After the administration, the patient should be kept under observation for at least half an hour, since experience shows that the majority of undesirable effects occur within this time. **Adults including the elderly:** *Encephalic and spinal MRI:* The recommended dose is 0.1mmol.kg-1, i.e. 0.2ml.kg-1 to provide diagnostically adequate contrast. A further injection of 0.2mmol.kg-1, i.e. 0.4ml.kg-1 within 30 minutes, may improve tumour characterisation and facilitate therapeutic decision making. *Whole body MRI and angiography:* The administration of 0.1mmol. kg-1, i.e. 0.2ml.kg-1 is recommended to provide diagnostically adequate contrast. *Angiography:* In exceptional circumstances administration of a second consecutive injection of 0.1mmol.kg-1, i.e 0.2ml.kg–1 may be justified. However, if the use of 2 consecutive doses of DOTAREM® is anticipated prior to commencing angiography, the use of 0.05 mmol.kg-1 (i.e. 0.1ml. kg-1) for each dose may be of benefit, depending on the imaging equipment available. **Paediatric population (0-18 years):** *Brain and spinal MRI, whole body MRI:* the recommended and maximum dose of Dotarem is 0.1 mmol/kg body weight. More than one dose should not be used during a scan. Due to immature renal function in neonates up to 4 weeks of age and infants up to 1 year of age, Dotarem should only be used in these patients after careful consideration, at a dose not exceeding 0.1 mmol/kg body weight. *Angiography:* The efficacy and safety of DOTAREM® in children under 18 years has not been established. **Patients with renal impairment:** The adult dose applies to patients with mild to moderate renal impairment (GFR > 30ml/min/1.73m2). Nephrogenic systemic fibrosis (NSF) has been reported with gadolinium-containing contrast agents in patients with acute or chronic severe renal impairment (GFR < 30ml/min/1.73m2). As there is a possibility that NSF may occur with DOTAREM®, it should therefore only be used in this group after careful risk/benefit assessment and if the diagnostic information is essential and not available with non-contrast enhanced MRI. If it is necessary to use DOTAREM®, the dose should not exceed 0.1 mmol.kg-1. Because of the lack of information on repeated administration, DOTAREM® injections should not be repeated unless the interval between injections is at least 7 days. **Patients with hepatic impairment:** The adult dose applies to these patients. Caution is recommended especially in the perioperative liver transplantation period. **CONTRA-INDICATIONS:** Hypersensitivity to gadoteric acid, to meglumine or to any medicinal product containing gadolinium. **SPECIAL WARNINGS AND PRECAUTIONS OF USE:** Do not use by intrathecal route. Take care to maintain strictly intravenous injection: extravasation may result in local intolerance reactions, requiring the usual local care. The usual precaution measures for MRI examination should be taken, such as exclusion of patients with pacemakers, ferromagnetic vascular clips, infusion pumps, nerve stimulators, cochlear implants, or suspected intracorporal metallic foreign bodies, particularly in the eye. **Hypersensitivity:** Hypersensitivity reactions can be either immediate (< 60 minutes) or delayed (up to 7 days), allergic or non-allergic. Anaphylactic reactions occur immediately, can be fatal and are independent of dose. There is always a risk of hypersensitivity regardless of the dose injected. Patients with hypersensitivity or previous reaction to contrast media are at increased risk of severe reaction. In these patients DOTAREM® should only be administered after careful consideration of the risk/benefit ratio. Hypersensitivity reactions may be aggravated in asthmatic patients or those taking beta-blockers. During the examination, supervision by a physician is necessary. If hypersensitivity occurs, administration of the contrast medium must be discontinued immediately and appropriate specific therapy instituted. **Impaired renal function:** Prior to administration of DOTAREM®, it is recommended that all patients especially those above 65 years are screened for renal dysfunction by obtaining laboratory tests. Due to the risk of NSF in patients with acute or chronic severe renal impairment, administration in this group should be considered and performed as above. Haemodialysis shortly after administration may be useful in removing DOTAREM® from the body. However, there is no evidence to support the initiation of haemodialysis for prevention or treatment of NSF in patients not already undergoing haemodialysis. **CNS disorders:** Special precaution is necessary in patients with a low threshold for seizures. All equipment and drugs necessary to counter any convulsions must be readily available. **INTERACTIONS:** No interactions with other medicinal products have been observed. Formal drug interactions studies have not been carried out. **PREGNANCY AND LACTATION: Pregnancy:** There is a lack of human data on the use of gadoteric acid in pregnancy. Animal studies do not indicate direct or indirect harmful effects. Administration during pregnancy should be avoided unless absolutely necessary. **Lactation:** Gadolinium containing contrast agents are excreted into breast milk in very small amounts (see section 5.3 of the SmPC). At clinical doses, no effects on the infant are anticipated due to the small amount excreted in milk and poor absorption from the gut. Continuing or discontinuing breast feeding for a period of 24 hours after administration of DOTAREM®, should be at the discretion of the doctor and lactating mother. **UNDESIRABLE EFFECTS:** Side effects associated with use of gadoteric acid are usually mild to moderate in intensity and transient in nature. Injection site reactions, nausea and headache are the most frequently observed reactions, as well as feeling cold, hypotension, somnolence, dizziness, feeling hot, burning sensation, rash, asthenia, dysgeusia and hypertension are also common. These reactions can be immediate (within 60 minutes after injection) or delayed (within 7 days after injection). Immediate reactions include one or more effects, appearing simultaneously or sequentially, and often cutaneous, respiratory, gastrointestinal, articular and/or cardiovascular reactions. Each sign may be warning of starting shock and go very rarely to death. Isolated cases of nephrogenic systemic fibrosis (NSF) have been reported with gadoteric acid most of which were in patients co-administered with other gadolinium-containing contrast agents. Children: Safety of paediatric patients was considered in clinical trials and post-marketing studies. As compared to adult, the safety profile of gadoteric acid did not show any specificity in children. Most of reactions are gastrointestinal symptoms or signs of hypersensitivity. Please consult the SmPC in relation to other side effects. **MARKETING AUTHORISATION HOLDER:** Guerbet B.P. 57400 F-95943 Roissy CdG Cedex France. **LEGAL CATEGORY:** POM. **MARKETING AUTHORISATION NUMBERS:** PL 12308/0016 (vials); PL 12308/0017 (PFS). **LIST PRICE:** 10 x 5ml vials £272.50, 10 x 10ml vials £440.20, 10x 15ml PFS £569.10, 10 x 20ml PFS £666.50. **DATE OF REVISION OF TEXT:** March 2018.

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