MAGNETIC resonance imaging is a non-invasive technique that provides structural and functional information. Its origins date back to the 1930s when magnetic characteristics of atomic nuclei were first described. However, it was not until 1971 that nuclear magnetic resonance (NMR) was applied in biomedical applications, when Dr Raymond Damadian measured T1 and T2 relaxation times (see ‘Basic concepts’ section) in rat neoplasms and observed that neoplastic tissue possessed longer T2 relaxation times than those of normal tissue. At that same time Dr Damadian correctly predicted that the NMR technique might prove useful in the detection of malignant neoplasms.

In 1977 the first magnetic resonance images of humans were produced (the ‘N’ was dropped to avoid negative connotations associated with ‘nuclear’). Fundamental work in diffusion imaging in 1984 laid the groundwork for functional MRI techniques, and in 1986, the first reports of the calculation of diffusion coefficients occurred. In the following years, diffusion tensor imaging and functional MRI using blood oxygenation level-dependent techniques were also developed. Today, an ever-growing array of novel techniques for MRI is currently under investigation to increase the number of structural and functional (eg, tissue angiogenesis, tissue ultrastructure) correlations that can be assessed using magnetic resonance-based techniques. MRI may be a safer choice. This is particularly relevant to children and young adults who are at greater risks of harm from ionising radiation than older adults.

In this article we aim to provide an overview of the physics behind MRI scanning, an understanding of the techniques used to enhance the effectiveness of MRI, how and when MRI may be used to assist in a patient’s management and the potential adverse events and safety issues that should be addressed.
How To Treat – MRI in general practice

**Basic concepts**

**Physical basis**

MRI produces cross-sectional images that bear some similarity to those of CT scans, but the physical foundation underlying both techniques is entirely different. MRI is based on signals derived from the protons associated with body water and, to a lesser extent, fat. The images are essentially maps of the spatial distribution of water and fat within the body.

**Emerging and aligning protocols**

The physical principle underlying MRI is the weak magnetic property of the hydrogen proton. When protons experience a strong magnetic field, there is a tendency for them to spin (‘precession’) and align with an external magnetic field. When a brief radiofrequency pulse is applied with a frequency matching that of the hydrogen protons (‘nuclear resonance’), the net magnetisation direction of the protons is altered, and the protons are transiently in phase (‘phase coherent’). A weak electronic pulse is associated with these perturbed, or ‘energised’, protons.

During an MRI scan the patient is placed in a large static magnetic field causing some of the patient’s own protons to align with the static magnetic field (about one in 1012 protons). These protons are then energised with the application of a radiofrequency pulse of short duration. Once this pulse is switched off, the energised protons emit a characteristic signal specific to their chemical composition that is detected as the MRI signal. Smaller magnetic fields are used to localise the origin of the detected signal (Figure 1).

**T1 and T2 parameters**

As soon as the matched external electronic pulse (the applied radiofrequency pulse) stops, the inherent signal from the perturbed protons begins to decay. The signal loss is a result of two independent factors:

- T1 relaxation time (or spin–spin relaxation), where interactions between nearby molecules disrupt phase coherence.
- T2 relaxation time (or spin–spin relaxation), where interactions between nearby molecules disrupt phase coherence.

Both processes take place independently of each other and under exponential kinetics. Table 1 lists the common imaging techniques used in MRI and a brief explanation of their respective uses.

**Imaging techniques**

- **T1 weighting**: A T1-weighted image is obtained at short repetition time (TR) and short echo time (TE), resulting in structures having short T1 relaxation times appearing with the highest signal intensity. Therefore tissues with a high lipid content (e.g., normal adult bone marrow, normal subcutaneous fat) will appear brighter on a T1-weighted image.
- **T2 weighting**: A T2-weighted image is obtained at long TR and long TE, resulting in structures that have a long T2 relaxation time, i.e., having higher signal intensity than structures with short T2 relaxation times. Therefore tissues with a high water content (e.g., CSF, pathological tissue oedema) will appear brighter on a T2-weighted image.
- **Diffusion-weighted imaging (DWI)**: DWI is an MRI technique that maps molecular movement of water molecules. Using DWI in stroke, ischaemic regions can be detected as early as 15 minutes after arterial occlusion. More recently, DWI has been shown to improve tumour detection and can serve as a non-invasive marker of tumour aggressiveness.
- **Perfusion-weighted imaging (PWI)**: PWI is an MRI technique that allows for non-invasive, high-resolution measurements of tissue perfusion at the microvascular or capillary level.
- **MRA**: MRA is a technique that provides a non-invasive method for imaging the vascular and cardiac systems. The most common form, time-of-flight (TOF) MRA selectively images blood flow while suppressing signal from stationary tissue to provide three-dimensional images of blood vessels.
- **BOLD–fMRI**: BOLD–fMRI is a technique used to obtain maps of human brain activity on the basis of signal changes during rest and stimulated sensory states. This is accomplished by exploiting the magnetic differences between oxygenated and de-oxygenated blood and neural tissue utilisation of oxygen during task activation.

**Table 1: MRI techniques and explanations**

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**Safety and contraindications**

**Safety**

LIMITATIONS OF MRI include time constraints and safety concerns related to the strong external magnetic fields, applied radiofrequency pulses and rapidly switching gradient magnetic fields. A safety check will always be performed on-site at the radiology practice before a patient proceeds to MRI. However, it is recommended that GP’s complete a simple pre-MRI safety checklist in the GP rooms to limit patients encountering problems on the day of scanning (see ‘Pre-MRI safety checklist’ box).

**Potential adverse events**

Strong external magnetic fields may cause a ‘muzzle effect’, where loose metallic objects are rapidly attracted by the strong external field and pulled toward the scanner bore, even from within the patient’s body. Human body tissue may heat up from the applied radiofrequency pulses. Strict guidelines govern the amount of energy deposition, but care should be taken when non-ferrous metallic implants (e.g., joint replacements) or patients with injured thermal regulation are scanned. Rapidly switching gradient magnetic fields may cause unexpected and uncomfortable sensations in the body, i.e., magnetic resonance imaging (MRI) is a paramagnetic ion that markedly shortens T1 and T2 times of hydrogen protons, even in low concentrations.

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**Practical considerations**

Keeping patient still

In comparison with CT, patient co-operation or immobility is much more important. Most MRI tests need a series of separate ‘acquisitions’ or ‘sequences’ (at least three, commonly 4-6, sometimes as many as 8-10). Each sequence typically lasts 3-4 minutes, sometimes longer. Additional dynamic contrast-enhanced acquisition demonstrates contrast flow or perfusion can significantly add to the examination time. It is essential that the patient remains still during these periods of image acquisition, as the slightest motion degrades the image acquisition process, and can necessitate the rescanning of all, or part, of the study. Sedation, and general anaesthesia with young children, may be required when clinically indicated.

**Patient monitoring**

Patient monitoring is also more challenging in magnetic resonance scanning compared with other imaging modalities, but is not impossible. The monitoring devices and instrumentation taken into an MRI scanner room must be MRI-compatible, where no ferrous metal-containing component is present.
MRI provides excellent contrast resolution and is able to produce detailed images of soft tissue (e.g., brain, nerves, cartilage, tendons, ligaments) making it a superior modality in some clinical situations. However, it should be cautioned that the more sensitive the imaging modality, the more likely it is to find an incidental “abnormality” that is not clinically relevant and will not progress to malignancy that is not clinically rel-

### Pre-MRI safety checklist

- Does the patient have any metallic implants? If so, are these surgical or traumatic?
- Are there any implanted devices, such as pacemakers or neurotransmitters?
- Have any wires been left in the patient?
- Has the patient had a previous eye injury which may result in a metallic foreign body being present in the orbit or globe?
- Does the patient have significantly impaired renal function or risk factors for administration of MRI contrast agents?
- Is the patient claustrophobic?

### MRI and clinical findings

When requesting MRIs, GPs should consider the presenting symptoms and the relevant clinical examination. The purpose of the MRI should be clear, such as to confirm a clinical impression and address the imaging expectations of patients before referral. Patients need to be advised that structural changes detected on MRI do not necessarily correlate well with symptoms.

### ALARA principle

Choosing medical imaging tests that do not use ionising radiation as the basis of the technology is the ideal, and applying the “as low as reasonably achievable” (ALARA) principle when using imaging as an investigation tool should be a primary goal for everyone. There is always a preference to minimise any ionising radiation (e.g., with an X-ray, CT or nuclear medicine) in the younger age group, especially children, as all forms of ionising radiation are cumulatively additive during a lifetime, with associated increased risk of radiation-induced side effects (see Online resources for recommendations and protocols).

### Renal risk

There is a low risk of aggravating renal impairment associated with using IV contrast in MRI. It is important that GPs inform the radiology practice if the patient has significant renal impairment (i.e., eGFR <30mL/minute/1.73m²). As mentioned above, patients whose eGFR is between 30-90mL/minute/1.73m² may need additional management before their MRI with contrast. This prior management may include additional fluid intake and renal function monitoring, with repeat serum creatinine testing 24-48 hours after the contrast injection.

### NSF presentation

There are no known adverse effects of MRI during pregnancy. However, if the MRI is not clinically necessary, it is sensible to wait until after pregnancy, or at least until the first trimester. Contrast-enhanced studies are generally avoided during pregnancy unless absolutely necessary.

### Paediatric patients

MRI is generally safe for the paediatric population who are more sensitive to ionising radiation-induced side effects (including cancer development). The only significant consideration is that sedation or general anaesthesia may be required to minimise any motion artefact. There are no other known or relevant qualified medical practitioners is needed to administer this.
UNEXPLAINED headache or seizures

IN children and adolescents under the age of 16 with an unexplained headache, the diagnosis of exclusion is commonly a space-occupying lesion, typically a neoplasm. Many neoplasms can be detected with CT if they are large or causing major mass effect. However, some lesions may be difficult to discriminate from normal adjacent brain tissue on non-contrast CT, which may commonly be improved with the use of an iodinated contrast agent.

If imaging findings are still negative following contrast-enhanced CT (as can be the case with poorly perfused or very small lesions) the subtle morphological tissue alterations associated with these types of lesions are often better depicted with MRI.

Detection is the first objective in suspected cases of intracranial neoplasm. The second objective is the analysis and characterisation of the neoplasm if present. However, not every neoplasm has a specific signature. Most importantly, despite the high prevalence of headache, neoplasm as a cause is extremely uncommon.

Generalised seizures are also not commonly associated with abnormal imaging findings. With both these potential diagnoses, a CT scan when indicated is often the first test performed and a good screening test. But in patients with chronic intractable symptoms, a negative MRI result may give an extra level of assuredness that there is no actively treatable lesion.

Sinuses

A Medicare rebate is also available for GPs requesting an MRI of the sinuses where conservative management has failed. It is typically necessary to first perform a CT scan, as bony sinus margins are poorly seen with MRI. The diagnoses of exclusion are occult neoplasms, and atypical (eg, fungal) infections.

Suspected pathology of the brain, skull base, soft tissue of the neck

MRI affords excellent soft tissue detail; it is able to differentiate between grey and white matter, midbrain, cerebellum and brainstem, and the structures in the spinal cord in detail that cannot be matched with CT (figure 3). Lesions at the skull base, pharynx, paranasal regions and oral cavity, their presence and extent of infiltration, are best defined with MRI due to the demonstration of detailed anatomy and subtle changes with much of the pathology.

Stroke

MRI can assess very early ischaemic changes in a stroke. At the same time, arterial vasculature can also be assessed. Compared with a special (and expensive) high-end ‘perfusion CT’, MRI (including perfusion MRI) can better evaluate the ischaemic core for irreversible damage and the ischaemic penumbra for hypoperfused tissue at risk of irreversible damage and can help in aiding with prognosis. In any event, perfusion CT with analysis may not be available in hospitals without an acute stroke unit.

However, motion can significantly degrade image quality and in stroke patients who may have involuntary movement or are unable to follow commands an MRI can be difficult to perform. It is also difficult to check if the patient has a biomedial implant if the level of consciousness is decreased.

Other neurological conditions

Neurodegenerative disease; MS; and metabolic, inflammatory, infectious and toxic conditions can all be seen in good detail on tailored MRIs.

Some pathologies of the neck, especially the thyroid, can be well demonstrated with ultrasonad. MRI can also be used to facilitate accurate needle biopsy of neck masses.

Cervical spine

In patients younger than 16, a Medicare-rebatable MRI may be requested following an X-ray where there is significant and/or clinically suspected trauma; unexplained neck or back pain with neurological signs; or unexplained back pain where significant pathology is suspected.

In patients over the age of 16, suspected trauma and cervical radiculopathy are the indications for an MRI scan. While an MRI may provide more details on the soft tissue structures in the neck, the protocol for trauma in ED usually requires ‘clearance’ of significance fracture with a CT first. Trauma may also be initially screened with a single lateral cervical spine X-ray, so despite the given indications, MRIs are not the first-line investigation for suspected trauma.

In MRI investigation of the patient with radiculopathy, assuming ‘red flag conditions’ have also been assessed (including tests with other modes of imaging), MRI is particularly relevant in excluding a major surgically treatable cause, such as a large disc herniation.

This can sometimes be difficult to detect even with a good CT scan. This is particularly the case in the lower cervical region, below C4–5, as a result of scan artifacts from shoulders, especially in large body habitus.

False-negative and false-positive findings

A full MRI scan series can be long and any patient motion can compromise image quality. This may lead to a false-negative diagnosis in cases of disc herniation or cord oedema because motion can create artifacts in critical areas (eg, in the spinal cord) and subtle imaging changes may not be identified as a result.

Furthermore, ageing creates its own morphological (eg, spur, osteophyte and ‘disc bulge’) and physiological changes (increased facet joint fluid and peri-articular ‘degenerative cysts’). This can be variably reported as observations or as significant findings.

However, these findings do not always correlate with the case of the presenting symptoms, especially if an explanation for pain or radiculopathy is sought, giving rise to false-positive radiological findings.

Effect on management

Finally, even if the patient were to have typical signs of radiculopathy and a corresponding imaging demonstrated disc herniation, conservative management is still commonly preferred because a small percentage of patients with non-sequestrated herniated discs (especially in the lumbar region) show spontaneous, sometimes complete regression over time (weeks to months).

At this time, there are no Medicare rebates for GP-referred MRI scans of the thoracic or lumbar-sacral regions.

The limbs

Knee

Patients under 16

FOR patients under 16 years of age the clinical indication for an MRI according to Medicare is suspected ‘internal derangement’ of the knee joint. There is no clear and universally accepted definition of what ‘internal derangement’ entails clinically. It is a catch-all phrase with a similar implication in meaning as the term ‘lumbago’ (and even ‘sciatica’) has to the back; that is, it is simply required that something abnormal and potentially surgically treatable must be present within the joint. The generally accepted paradigm when determining whether a presentation satisfies this clinical requirement is a finding of significant pain and/or instability implying significant cruciate and/or meniscal injury which may need surgical intervention. This item also mandates an X-ray be performed before MRI.

Patients over 16

For patients over the age of 16, the main clinical indication for an MRI under Medicare is to assess the knee joint following acute knee trauma, specifically to exclude acute meniscal and ACL tears, where a clear clinical diagnosis cannot be made (see figure 4).

An X-ray is not mandatory before the MRI, although radiologists do commonly prefer to request one for correlation with the MRI, to assess the status of the knee, to define additional changes of arthrits, the presence of small bony avulsions or calcified intra-articular structures, or loose bodies, which may be difficult to define with MRI.

Again the prevalence of morphological changes in the soft tissue of the knee and relevant bony structures increases as one ages, and may be demonstrated on MRI images (eg, bony spurs, cartilage degeneration, subchondral degenerative cysts). However demonstration of an ‘abnormality’ does not imply it is symptomatic.

Hip

Medicare rebates apply for MRI in patients under the age of 16.
from previous page

after an X-ray has been performed to specifically exclude suspected septic arthritis, slipped capital femoral epiphysis (SCFE) or suspected Perthes’ disease. The initial X-ray may not show early SCFE or early Perthes’ changes and typically does not show an effusion or bone changes in a septic hip. However, these conditions commonly only show changes associated with abnormal narrow oedema as the earliest signs, which are well demonstrated with MRI.

**Elbow**
Under Medicare, a rebate is available for MRI in patients under the age of 16 after an X-ray has been taken, specifically to exclude a fracture or avulsion that can significantly alter management. MRI will best define a cartilage fracture, as this structure is not seen on X-rays nor is it well defined with CT.

**Wrist**
Magnetic resonance examination attracts a Medicare rebate specifically to exclude a scaphoid fracture post X-ray in patients under the age of 16. It can take 7-10 days to demonstrate early X-ray changes in an initially occult scaphoid injury and an MRI may be requested if there is strong clinical suspicion of a fracture despite a normal X-ray. Other imaging modalities (eg, radionuclide bone scan) may be ordered for this assessed with MRI. These include uterine, cervical and increasingly, ovarian cancer.

MRI is also an important investigatory tool in local rectal cancer staging and anal fistula mapping. With the ever-increasing trend to more conservative management and surveillance for prostate cancer, prostate MRI is playing an increasingly significant role in watchful waiting.

There may be a time in the near future, where a short ‘prostate screening MRI’ examination will be cost-effective in detecting and localising small lesions that would be suited to targeted MRI-guided biopsies, needing 1-2 directed needle passes. This may overcome the need for multi-pass transrectal ultrasound-guided biopsy, now the most common method for histological assessment of an abnormally raised PSA level.

MRI can be used to aid prostate evaluation and staging if a needle biopsy result shows malignancy. It may help to eventually minimise the overtreatment of the lower grade prostate cancer.

Although not used to look for metastatic bony disease, there is current research into whole body orthoradial MRI (with limited sequences), which can demonstrate bony spread. A radionuclide bone scan is still typically the first investigation of choice for this indication.

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**Conditions better assessed by CT**

**Intracranial bleeding**
SMALL volumes of recent extra-axial bleeding can be difficult to detect with MRI, even with specialised sequences. Also, if the patient cannot keep still because of bleed-related central neural irritation, the motion can easily result in artefacts during the image acquisition.

Older residual products of bleeding within the brain are better seen with MRI, as well as chronic low-volume recurrent subarachnoid haemorrhage. The latter ‘coats’ the brain surfaces with haemosiderin, a by-product of red cell breakdown, which is well defined on MRI.

Acute intracranial blood typically still relies on CT to demonstrate acute change, particularly if the bleeding is subarachnoid and of a small volume. Of course, CT can be negative if there is insufficient active bleeding. Therefore, even with a negative CT a diagnostic lumbar puncture may be necessary if it is clinically indicated. If the haemorrhagic focus is large enough, it can be detected with MRI days to weeks after the initial event.

**Bone**
MRI is not primarily used to diagnose a fracture. It is an expensive investigation and not usually the first-line imaging test for a suspected fracture in typical clinical presentations.

The densely compact cortical bone creates a rigid meshwork of bound proteins in the hydroxyapatite matrix. Though the proton ‘seen with MRI’ is still stimulated in the magnetic field, its ‘signal energy’ is rapidly dissipated within the tightly bound structural matrix and no significant measurable signal is emitted. The lack of measurable signal then renders this structure black on most magnetic resonance images.

In contrast, cancellous or medullary cavity bone has abundant fatty and/or red marrow with water that contains freely excitable protons. The fatty and/or red marrow as well as any disease-associated alteration in this structure can be demonstrated well with MRI. For example, where the mass of a neoplasm involves marrow and breaches cortical bone, MRI is able to demonstrate the distinctions between intraosseous and extraosseous soft tissue components well, with the distribution of the neoplastic mass and adjacent intramedullary reactive oedema being seen clearly. This is more accurate in showing the...
Although MRI scanning is excellent breast and some abdominal areas, the musculoskeletal system, CNS, soft tissue and investigation of disease in the musculoskeletal system, MRI is most frequently used in the clinic. MRI machines are the best investigation for assessing small metastases in John’s lungs, given the potential for injury to the developing fetus and the modality of choice in assessing stage cancers involving the lung. High-resolution CT is the investigation of choice, not MRI, for interstitial disease patterns.

**Conclusion**

MRI is most frequently used in the investigation of disease in the musculoskeletal system, CNS, soft tissue and in most parts of the body, its impact on clinical outcomes is still evolving. Since its initial clinical use in the early 1980s, MRI has revolutionised the diagnosis and treatment of a wide variety of medical conditions. Over the past 30 years, different MRI techniques, pulse sequence acquisition strategies and novel hardware components have been developed to shorten image acquisition times, improve image quality, and facilitate advanced functional and anatomical imaging.

There continue to be developments in techniques of scanning, usually in an attempt to reduce acquisition time, improve resolution and assess other technological parameters that may help improve the diagnostic result. Today, MRI serves as a powerful adjunct to more traditional medical imaging solutions and in certain clinical conditions, is now the primary diagnostic modality.

**How To Treat – MRI in general practice**

**InSTRUCTIONS**

Complete this quiz online and fill in the GP evaluation form to earn 2 CPD or PDP points.

We no longer accept quizzes by post or fax. However, we have included the quiz questions here for those who like to prepare the answers before completing the quiz online.

The mark required to obtain points is 80%. Please note that some questions have more than one correct answer.

**GO ONLINE TO COMPLETE THE QUIZ**


**INQUIRIES**

Email: steve.liang@cirrusmedia.com.au

How To Treat – MRI in general practice

27 June 2014

1. Which TWO statements are correct regarding the basic physics behind MRI?  
a) MRI uses ionising radiation  
b) In an MRI, different signals are acquired because the energised protons emit a characteristic signal specific to their chemical composition  
c) MRI captures images by magnetising atoms in the body and sensing their orientation  
d) Black represents absence of signal, while white maximal

2. Which THREE statements are correct regarding the imaging techniques used in MRI?  
a) Water is dark on T1-weighted images but bright on T2-weighted images  
b) Diffusion-weighted images can detect arterial occlusion of parts of the brain by mapping molecular movement of water molecules  
c) Gadolinium chelates work as contrast agents in MRI by shortening both T1 and T2 relaxation times  
d) The skin manifestations of nengrogenic systemic fibrosis may take months to be observed  
e) MRI is contraindicated in pregnancy because of the potential for injury to the developing fetus

3. Which TWO statements are correct regarding the practical considerations when performing an MRI?  
a) Fixed implanted devices such as cardiac pacemakers and cochlear implants are safe in MRI machines  
b) The potential for adverse effects with sedation should be considered in children and those with cerebral irritation  
c) Patient monitoring devices with no ferrous metal-containing component are safe to use in an MRI machine  
d) Past eye injury does not need clinical assessment prior to an MRI

4. Which TWO statements are correct regarding safety and potential adverse effects of MRI?  
a) About 4% of patients experience feelings of claustrophobia in MRI scanning  
b) IV gadolinium can be safely given to any patient with an eGFR below 30mL/minute/1.73m²  
c) The skin manifestations of nengrogenic systemic fibrosis may take months to be observed  
d) MRI is contraindicated in pregnancy because of the potential for injury to the developing fetus

5. Which TWO statements are correct regarding the use of MRI in brain, head and neck areas?  
a) Suspected lesions at the base of the skull and soft tissues of the neck are best defined by MRI  
b) The usefulness of MRIs to image the neck below C4-5 is limited because of scan artefacts from the shoulders  
c) CTs, when indicated, are preferred over MRI as the first screening test for generalised seizures  
d) MRIs are the best investigation for assessing the sinuses

6. Which TWO statements are correct regarding the use of MRI in the limb areas?  
a) ‘Internal derangement of the knee’ as an indication for MRI refers specifically to a suspicion for a meniscal tear  
b) MRI may be useful in excluding a seacopd fracture early when X-ray is negative despite strong clinical suspicion  
c) MRI cannot see changes associated with Perthes’ disease of the hip  
d) MRI of the elbow is more sensitive than X-rays and CTs in picking up a cartilage fracture

7. Which TWO statements are correct regarding the use of MRI in the trunk areas?  
a) MRI follow-up in patients who had surgery for breast cancer have shown to increase five-year survival  
b) MRI is poor in delineating focal liver lesions  
c) MRI monitoring of Crohn’s disease in younger patients is a good alternative to small bowel follow-through radiographs  
d) MRI can be useful in the assessment of placenta praevia

8. Which TWO statements are correct regarding conditions or body areas that are better assessed by a CT than an MRI?  
a) Acute subarachnoid bleeding is better seen on CT than an MRI  
b) MRI is better than CT in demonstrating a malignancy that involves both marrow and cortical bone  
c) CT is better than MRI in visualising old intracranial bleeding  
d) High-resolution CT is the investigation of choice, not MRI, for interstitial lung disease

9. Charlie is a 21-year-old man who, while driving, was rear-ended by a car travelling at about 70km/h. He presents with back pain and tingling in the right foot. You consider imaging for his symptoms. Which TWO statements are correct regarding his assessment with an MRI?  
a) Blood oxygen level dependent functional MRI (BOLD-fMRI) is the MRI technique used to ascertain whether Charlie has a disruption to the vessels in his foot  
b) Charlie should be advised that if an MRI shows a corresponding non-sequestrated disc herniation, he may be managed conservatively in the first instance  
c) A negative result may not rule out cartilage oedema or disc herniation because of motion artefacts  
d) If Charlie has neck symptoms from being rear-ended, an MRI is the next investigation to exclude fracture-related pathology

10. John is a 72-year-old man with a significantly rising PSA and chronic heart failure who presented with a chronic cough and dyspnoea. Further investigation is ordered. Which TWO statements are correct regarding his assessment with an MRI?  
a) MRI is the gold standard of choice to assess for metastatic prostate disease in the bones  
b) It is possible that even an MRI may miss small metastases in John’s lungs  
c) If IV contrast is needed, John may be reassured that gadolinium is typically safer than IV contrast used for CT examinations  
d) MRI is contraindicated in John’s cardiac condition because it may induce fatal electrical cardiac activity

**CDP QUIZ UPDATE**

The RACGP requires that a brief GP evaluation form be completed with every quiz to obtain category 2 CPD or PDP points for the 2014-16 triennium. You can complete this online along with the quiz at www.australiandoctor.com.au. Because this is a requirement, we no longer accept the quiz by post or fax. However, we have included the quiz questions here for those who like to prepare the answers before completing the quiz online.

**NEXT WEEK**

Vasectomy is the only method of male contraception that is both highly effective and well accepted by patients. However, due to changed circumstances, men sometimes require a vasectomy reversal. The next How To Treat discusses the indications and clinical considerations for the procedures of vasectomy and its reversal. The author is Dr Robert Woolcott, reproductive microsurgeon, Vasectomy Reversal Australia, Sydney, and director, Genea, Sydney, NSW.