Australian Institute of Radiography

Medical Imaging Advisory Panel 1
MRI Resource Guide
Level 1 and Level 2

Edited April 2010

LEVEL 1 Accreditation

Introduction

Level 1 - Level 1 accreditation encompasses theoretical and clinical components. To be eligible for MRI accreditation, applicants must hold as Validated Statement of Accreditation issued by the AIR.

Level 1 accreditation is available to candidates who have attained a grade exceeding 75% in an examination set by the Medical Imaging Advisory Panel 1 (Part A) and performed the required clinical component as outlined below (Part B).

Part A The formal examination will involve a paper not exceeding 200 multiple choice questions covering topics such as - Safety , patient screening , Equipment , Pulse sequences , Basic theory of NMR , MRI anatomy and pathology.
The approximate percentage of questions related to each module are listed below

- Anatomy and MR Pathology 20%
- Pt Care and Safety 15%
- (including contrast media)
- Physical Principles / Hardware 30%
- Pulse sequences / Artifacts 35%

Part B The clinical component requires the candidates Supervisor to acknowledge completion of the required clinical examinations (300 examinations in a 12 month period) within a 2 year period of completing Part A. The candidate must maintain this clinical component for reaccreditation.

Core Reading Material

These texts are considered by the MIAP 1 to provide the applicant with a sound understanding necessary to complete the theoretical component and assist with additional knowledge for the clinical aspects of Level 1.

Any additional texts and references are provided to give alternative sources of information that will assist all applicants and are not considered to be mandatory reading.

MCQ for all you really need to know about MRI Physics
NessAvier
University of Maryland Medical Centre

MRI in Practice – 3rd edition
Westbrook & Kaut
Blackwell ISBN 10:1-4051-2787-2

Handbook of MRI Technique – 3rd edition
Westbrook
Blackwell ISBN 978-1-4051-6085-8

Magnetic Resonance Bioeffects, Safety and Patient Management.
Shellock F G, Kanal E,
2010 Edition, Raven Press USA

Magnetic Resonance Imaging
Question and Answers -2nd edition
Elster
Mosby ISBN 10: 0-01184-5

MRI The Basics – 3rd Edition
Hashemi & Bradley

Clinical Magnetic Resonance Imaging – 3rd edition
Edelman , Hesselink , Zlatkin Saunders
Magnetic Resonance Imaging – 3rd Edition
Stark , Bradley
Mosby

Additional Supplementary Texts / Resources

Magnetic Resonance in Medicine
Basic textbook of European MR Forum 5th Edition
Ed P Rinck
Blackwell

Magnetic Resonance Imaging
Physical and Biological Principles – 3rd Edition
Bushong
Mosby

Review Questions for MRI 2nd Edition
Kaut & Faulkner
Blackwell ISBN 0-632-03905-1

Magnetic Resonance Imaging of the Brain & Spine 4th Edition
Atlas
Raven

Magnetic Resonance Imaging in Orthopaedics and Sports Medicine – 3nd edition
Stoller

Computer Based Teaching Modules

MRI Safety Homepage
Dr E Kanal
http://kanal.arad.upmc.edu/mrsafety.html

The Basics of MRI
(Internet or CD ROM)
J Hornak
Rochester Institute of Technology

MRI Tutor - PC Based
http://ballingerrr.xray.ufl.edu/mritutor/index.html

Outsource Inc
MRI Education Modules
Kaut-Roth , Faulkner
http://www.t2star.com/

MR Anatomy / Pathology and Imaging Protocol Module

AIM

To achieve a basic understanding of routine imaging procedures. To recognise image weighting and relevant 3D anatomy/pathology on an MRI image.

TOPICS

- **3D Anatomy:**
    a) Neuro-anatomy, including grey/white matter differentiation, the ventricular system and vascular structures
    b) Spinal anatomy - spinal column, spinal canal & contents
    c) Joint anatomy - knee, shoulder, hip
- **Pathology** - Commonly Imaged Pathologies and their MRI appearance
- **Patient Positioning**
- **Coil Positioning & Placement**

SAMPLE QUESTIONS

1. The practitioner will be asked to identify anatomical structures such as:

a) Hippocampus
b) Corpus Callosum
c) Grey & White Matter
d) Middle Cerebral Artery
e) Internal Capsule
f) Supraspinatous Muscle
g) Anterior Cruciate Ligament
h) Psoas Muscle
i) Cauda Equina
j) Intervertebral Disc

2. When imaging the pituitary fossa for microadenoma, the optimal scanning planes are:

a) Sagittal/Coronal
b) Sagittal/Axial
c) Axial/Coronal

Answer(a)

MR System Hardware Module

The candidate should have a basic knowledge of:

- Design of the various magnets used in M.R.I.
- Magnetic and RF shielding and its consequences.
- The various gradient systems and their implications.
- The basic radio-frequency system design including phased array.
- The basic design and use of R.F. coils including phased array.
- The basic computer architecture.

SAMPLE QUESTIONS

1. The amount of radio-frequency energy necessary to produce a 40 degree flip angle is determined by:

a) The strength of the external magnetic field.
b) The coil being used.
c) The amplitude and duration of the R.F. pulse.
d) All of the above.

Answer (d)

2. The gradient that is on during the sampling of the echo is:

a) The phase encoding gradient.
b) The frequency encoding gradient.
c) The slice selecting gradient.
d) a. and b.

Answer (b)

3. If the radio-frequency shielding in the scanner environment is disrupted, it may result in:

a) A reduction in slice thickness.
b) More use of cryogens.
c) A generalised reduction in image signal.
d) Slower image reconstruction times.

Answer (c)

MR SAFETY Module

AIM

The MR Radiographer should have a sound knowledge of the safety considerations of MRI. This section aims to highlight the potential biological effects and hazards associated with both the static magnetic field and time varying radiofrequency magnetic fields. On completion of this section the MR Radiographer will have examined all areas associated with preparation of persons entering the magnetic field and be familiar with safety aspects related to the hardware of a MR scanner.

Questions will be related to the following topics:

- Patient Screening
- Static Magnetic Fields
- Gradient Magnetic Fields
- Rf
- Specific Absorption Rate
- Basic Emergency Procedures

SAMPLE QUESTIONS

1. An unconscious patient presents for a spinal MRI examination with a suspected history of previous brain surgery. The patient should therefore:-

a) go through a thorough screening process including inspection for other surgical scars and performing spot radiographs.
b) not undergo an MRI scan
c) only be admitted to the MR scan room if the referring doctor has signed the request
d) be scanned feet first

Answer (a)

2. A quench refers to the sudden loss of magnet superconductivity when its temperature is raised. Associated with this there is:-

a) rapid boil off of cryogens into the atmosphere associated with a loud roaring noise.
b) cryogenic gasses may be released into the MR room resulting in a drop of temperature and increased pressure.
c) a) and b)
d) rapid boil off of cryogens into the MR room and a fire within the magnet bore.

Answer (c)

3. A patient with an implanted cardiac pacemaker should not be taken into the MR scan room. Reasons for this include:-

a) The pacemaker may undergo motion and/ or modification of function by the static magnetic field.
b) If the patient is also claustrophobic they are at an increased risk of suffering from an anxiety induced heart attack.
c) Thermal heating, voltages and currents may be induced in the pacemaker leads and myocardium during the MR imaging by the time-varying RF magnetic fields.
d) a) and c)

Answer (d)

Contrast Media Module

**** all applicants should read the product information sheets available from Schering and Nycomed Amersham**

INTRODUCTION

Although there is more than one type of contrast media used in MRI, the Australian setting doesn't afford the routine clinical use of them all. The main contrast agents used are Dimeglumine Gadopentate (Magnevist - Schering) and Gadodiamide (Omniscan - Nycomed Amersham). Historically its biggest application has been in the field of Neuroradiological based applications. In recent years however there has been an increase in the clinical applications of contrast media to include MR Angiography , Body and Musculoskeletal MR.

AIM

The aim is to understand the application of intravenous **paramagnetic** contrast media in MRI and why it is still used when MRI offers the best contrast between different tissues thus far. Issues that should be covered are:

What is the molecular make up and biological factor i.e. distribution, clearance and excretion and toxicity (contraindications).

The mechanisms of T1 (Spin Echo as well as Gradient Echo) relaxation and how does Gadolinium enhance the contrast between tissues under this scanning regime.

The blood brain barrier and how it interacts with contrast to alter the pooling of contrast media in pathological states.

SAMPLE QUESTIONS

1. Both Magnevist and Omniscan will cause a in T1 and T2 relaxation times of tissues where it is distributed

a) increase
b) decrease
c) no change

Answer (b)

2. Both Magnevist and Omniscan are contrast agents

a) ferromagnetic
b) diamagnetic
c) paramagnetic

Answer (c)

3. In clinical doses the resultant changes on T1weighted spin echo images of the tissues affected by the contrast media will be signal intensity

a) decreased
b) increased
c) no change in

Answer (b)

Physical Principles and Image Quality Module

AIM

The aim of this module is to promote a general understanding of the basic NMR phenomenon , spatial encoding , pulse sequences , image weighting ,basic QA and image quality optimisation . The information necessary to understand this module can be found in the recommended texts , additional information can be obtained from the texts mentioned below. The questions pertaining to this module will include subject matter from the areas listed below.

Principles of NMR

- Properties of Nucleus interaction
- Fourier Transformation
- Spatial Encoding
- K-Space analysis and sampling techniques
- Image weighting / Contrast
- Rf pulse diagrams - SE , GRE , FSE , IR
- T1 / T2 / T2*

Pulse Sequences

- Pulse sequence structure , design , imaging characteristics
- 2D / 3D ,SE , GRE , IR , FSE , EPI, fMRI (BOLD), Diffusion
- Ancillary pulse options
- Fat suppression , Mag transfer , FSE optimisation , Ernst angle correction
- Compensation techniques - Flow comp , Phase correction , Presaturation
- MR Angiography - Time of Flight (2D and 3D) Phase contrast, Contrast Enhanced MRA.

The applicant will be expected to understand the concepts of pulse sequence diagrams (recognise various types-SE vs GRE etc and identify the individual components) , the effects and implications of ancillary pulse / compensation options (implications to parameter choices , clinical applications and effects on overall impression of an image). The MRA component requires the applicant to understand the differences in 2D vs 3D Time of Flight MR techniques , relative advantages / disadvantages of each technique and an understanding of the implications of changing pulse parameters (TR , TE , Flip Angle, gating , Single slab vs MOTSA) , scan orientation and acquisition technique (eg stationary presat vs travelling presat).

Image Quality

- QA
- Signal to Noise Ratio
- Contrast to Noise Ratio
- Spatial resolution - implications to imaging parameters

SAMPLE QUESTIONS

1. What would be the appearance of CSF on a transverse image of the Brain using the following TR / TE / BW - 500 / 8 / 105kHz

a) Hyperintense to white matter (b) Isointense to Fat
b) Hypointense to white matter (d) none of the above

Answer (c)

2. Which one of the following alterations to a T1 weighted sequence will effect the minimum possible TE allowed

a) none of the options listed (b) addition of Presaturation pulses
b) Increasing TR (d) halving the bandwidth

Answer (d)

3. A T2 weighted sequence is characterised by parameters as listed below

a) Long TR / Short TE (b) Short TR / Long TE
b) Short TR / Short TE (d) Long TR / Long TE

Answer (d)

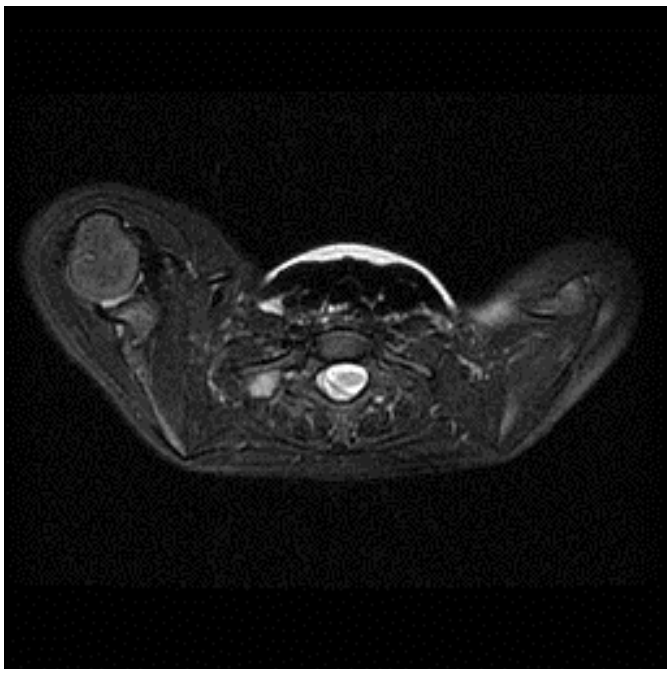
Artifact Module

AIM

The artifact module is designed to help the candidate recognise artifacts induced by the system hardware , pulse sequences , poor operator choices , physiological and patient motion. It is important that the candidate can not only recognise these faults but also suggest an alternative approach to imaging the patient in order to remove or reduce the effects of this artifact.

SAMPLE QUESTIONS

1. The T2 weighted Fat Suprressed FSE transverse scan through the proximal portion of the chest demonstrates water suppression as opposed to fat supression . Which of the following options listed below would not reduce this artifact thus reducing the diagnostic accuracy of this image



a. Swap Phase and Frequency and increase the number of acquisitions (Nex) used
b. Perform higher order shim prior to scanning
c. Use FSE (TSE) Inversion recovery sequence to enable a more even fat suppressed image
d. Use filler material (saline , Kaopectate , perfluorocarbon bags) to produce a more uniform tissue volume in order to gain a more uniform shim

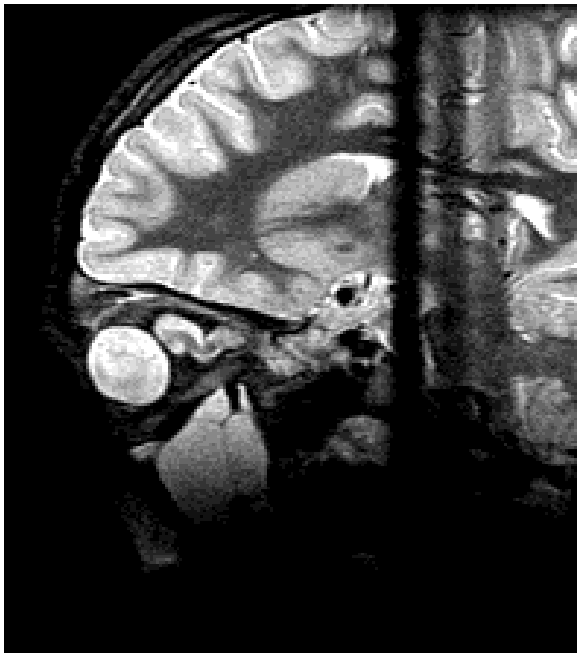
Answer (a)

2. The artefact demonstrated below is indicative of one caused by a ferromagnetic foreign body. The patient was quickly screened by another staff prior to the examination this person believed that the patient was not wearing anything that would induce such an artefact.

a. Recheck all patients prior to entering the scanning room - as the MR radiographer bears the ultimate responsibility for patient safety
b. Regular maintenance checks of sponges etc to ensure no foreign material present
c. Regular inspections / maintenance reports on coils for external damage which could explain internal failure
d. all of the above

Answer (d)

3. The artifact demonstrated on this multi slice / multiangle Sagittal Oblique T2 FSE is due to what



a. Coil failure
b. overlapping slice regional saturation
c. Dental hardware
d. Pt movement

Answer (b)

Points System for Level 2 Accreditation

A radiographer is not eligible to apply for level 2 accreditation until level 1 accreditation certification has been awarded by the A.I.R. The following are the guidelines for point's accrual for Level 2 accreditation

Other MRI related subject matter (eg collaborative research or academic projects) may be submitted for points accrual subject to prior approval from MIAP 1. The level of points accredited for these topics will be solely at the discretion of MIAP 1 and will reflect the component and structure of the applicants participation in the project

- The points can be accrued over a **5 year** period immediately prior to the date of application.
- Applicants must have **3 years equivalent full time** MRI experience before submission of documentation.
- Applicants must obtain ***100 points*** to obtain Level 2 Accreditation

The points allocated below represent the **maximum** number of points possible for each category and are subject to reclassification on a case by case review.
To be eligible for points accrual all papers , courses attended and work submitted for consideration **must** be relevant to MRI , MIAP 1 reserves the right to allocate points based on type of presentation , course content and delivery method.
To remain current the Level 2 accredited MR Practitioner must accrue 10 points per year averaged over a 3 year period. This does not include Clinical experience points.

The clinical component relevant to Level 1 Accreditation must also be maintained. **Points System Category**	**Max Points per Unit**	**Max Points**
Clinical Experience		
Full time MR Experience (max 5 years)	5	25
Full Time MR Supervisor (max 5 years)	8	40
MRI Related Courses		
Tertiary post-Graduate MR Course	60	60
Minor course / workshop	10	30
Thesis (max 1 unit)	**40**	**40**
Presentations at MR Conf / Meeting		
Major International Conference	15	45
Minor Conference (Seminar, National, Workshop)	8	24
Presentation / Organisation local Users group	2	10
Attendance MR Conference		
Major - max 3 units	3 points per day(Max 10 per conference)	30
Minor - max 5 units	2 points per day. (Max 8 per conference)	10
Local MR user group	1	5
Workshop , vendor user meetings, one day meetings	5	15
Publications		
Articles in Local / International journals (peer reviewed)	15	45
Non peer reviewed	4	15
Other related post-graduate courses eg Anatomy , management, education , computing etc… Will be access on merits and relevance	40*	