Australian Society of Medical Imaging and Radiation Therapy
The national professional organisation representing medical radiation practitioners
ABN 26 924 779 836

MIAP1

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MEDICAL IMAGING ADVISORY PANEL 1

Course Syllabus

Magnetic Resonance Imaging

Level 1

MRI Level 1 Course Syllabus Guide

Introduction

The MRI Level 1 Certification process is aimed at radiographers who have a minimum of 1 year full time equivalent experience in a broad range of MRI examinations. In order to pass the theoretical component, candidates are expected to undertake revision of text books and other relevant literature prior to sitting the exam.

The MRI Level 1 certification encompasses theoretical and clinical components. In order for a candidate to apply for a 'MRI Level 1Certificate', the candidate must meet all of the following requirements:

1. Achieve a pass grade for the MRI Level 1 Certification examination set by the Medical Imaging advisory Panel 1 (Part A)

2. 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 a range of topics (refer to the following study guide for details). The examination is divided into 4 modules. The sections and the approximate percentage* of questions related to each module is listed below:

- **Part A:** Hardware and Instrumentation – 12%
- **Part B:** Imaging Procedures and Relative Anatomy/Pathology – 30%
- **Part C:** Patient Care and Safety/Contrast Media – 15%
- **Part D:** Pulse Sequences/Artefacts & Physics - Physical Principles – 43%

* Percentage breakdowns are an indicative value only

Part B

This clinical component requires the candidate's supervisor to acknowledge completion of the required clinical examinations (300 examinations in a 12 month period within 3 years of completing Part A).

Reading material

These texts are considered by the MIAP1 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 – 4th Edition
Westbrook & Kaut
Blackwell ISBN 0-632-03587-0

*MRI from Picture to Proton – 3rd Edition
McRobbie et al
Cambridge University Press

*Handbook of MRI Technique – 4th Edition
Westbrook Blackwell

*Magnetic Resonance Bioeffects, Safety and Patient Management – 2014 Edition
Shellock F G, Kanal E,
2004 2nd Edition, Raven Press USA

*Magnetic Resonance Imaging: Question and Answers – 2nd Edition
Elster
Mosby ISBN 0-8016-7767-X

*MRI The Basics – 3rd Edition
Hashemi & Bradley ISBN 0-683-18240-4

*Clinical Magnetic Resonance Imaging – 3rd Edition
Edelman, Hesselink, Zlatkin, Saunders
ISBN 0-7216-5221-2

*Magnetic Resonance Imaging – 3rd Edition
Stark, Bradley
Mosby ISBN 0-8016-4930-7

Additional Supplementary Texts / Resources

Magnetic Resonance in Medicine: Basic textbook of European MR Forum - 4th Edition
Ed P Rinck
Blackwell ISBN 0-632-03781-4

Magnetic Resonance Imaging: Physical and Biological Principles – 4th Edition
Bushong
Mosby ISBN 0-8151-1342-0
Study Guide and Exam Review - Bushong

Understanding MRI
Newhouse / Wiener
Little, Brown ISBN 0-316-60474-7

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 ISBN 0-88167-694-2

Magnetic Resonance Imaging in Orthopaedics and Sports Medicine – 3rd Edition
Stoller

Magnetic Resonance Angiography: Concepts and Applications
Potchen, Haacke, Siebert
Mosby ISBN 1-55664-270-9

Computer Based Teaching Modules

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

Please refer to Medical Imaging Advisory Panel 1 (MIAP1) Policies & Procedures Manual for up to date information on MRI Level 1 Certification (Part A). This document can be found at: http://www.asmirt.org/mri.php .

Examination success

MRI Experience- this exam is not designed for candidates who have spent less than 1 year in an MRI room. You are not precluded from sitting the examination but past results have shown that it is extremely difficult to pass without hands on MRI experience.

Study period- A pass in this examination is dependent on a well-designed and lengthy study program. Successful candidates have recommended a minimum of 6 months concentrated study.

Mentors- successful candidates have involved their work colleagues, previous successful candidates and a mentor. It is also recommended to use study material that contains MCQ's or review questions. There is no requirement to answer the section in any particular order e.g. some candidates suggested answering section D first as this is the largest.

Part A: Hardware & Instrumentation

The candidate should have knowledge of:

- Design of the various magnets used in MRI
- Magnetic and radio-frequency (RF) shielding and its consequences.
- The various gradient systems and their implications.
- The basic RF system design including phased array.
- The basic design and use of RF 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)

Part B: Imaging Procedures & Anatomy & Pathology

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

TOPICS:

3D Anatomy:

- Neuro-anatomy, including grey/white matter differentiation, the ventricular system and vascular structures
- Spinal anatomy - spinal column, spinal canal & contents
- 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 structures such as:

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

2. When imaging the pituitary fossa for micro-adenoma, the optimal scanning planes are:

   a. Sagittal/Coronal
   b. Sagittal/Axial
   c. Axial/Coronal

   Answer: (a)

Part C: Patient Care, Patient Safety & Contrast Media

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
- Radiofrequency (RF)
- Specific Absorption Rate (SAR)
- Basic Emergency Procedures and patient monitoring

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:

** 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)

Part D: Physics & Physical Principles

AIM: The aim of this module is to promote a general understanding of the basic MRI phenomena, spatial encoding, pulse sequences, image weighting, basic QA and image quality optimisation.

Principles of NMR:

- Properties of Nucleus interaction
- Fourier Transformation
- Spatial Encoding
- K-Space analysis and sampling techniques
- Image weighting / Contrast
- T1 relaxation time, T2 decay time, T2* decay time

Image Quality:

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

Pulse Sequences:

- Pulse sequence structure, design, imaging characteristics
    - 2D/3D, Spin Echo (SE) , Gradient Echo (GRE) , Fast/Turbo Spin Echo (FSE/TSE) , Inversion Recovery (IR), Echo Planar Imaging (EPI), fMRI (BOLD), Diffusion
- Ancillary pulse options
    - Fat suppression, Magnetisation transfer, FSE optimisation, Ernst angle correction
- Compensation techniques - Flow compensation, Phase correction, Pre-saturation
- 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 (e.g. stationary pre sat vs travelling pre sat).

Artefacts:

The artefact module is designed to help the candidate recognise artefacts 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 artefact.

SAMPLE QUESTIONS:

1. The inversion time necessary to perform an equivalent inversion recovery spin echo sequence on a 1.5 Tesla system will be _____ than on a 3T system.

   a. The same
   b. Longer
   c. Shorter
   d. Does not matter

   Answer (c)

2. An inversion recovery spin echo sequence with TR 2000, TI 700 will give

   a. Heavily T1W image
   b. Heavily T2W image
   c. Heavily PD image
   d. None of the above

   Answer (a)

3. The "readout "gradient is also known as _____?

   a. Slice selection
   b. Phase
   c. Frequency
   d. Oblique

   Answer (c)

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
    c. Hypointense to white matter
    d. None of the above

    Answer: (c)

The image will have CSF hypointense (Black) as compared with white matter

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 Pre saturation pulses
    c. Increasing TR
    d. halving the bandwidth

    Answer: (d)

The other options will affect the number of slices available but will not result in changes directly to minimum TE.

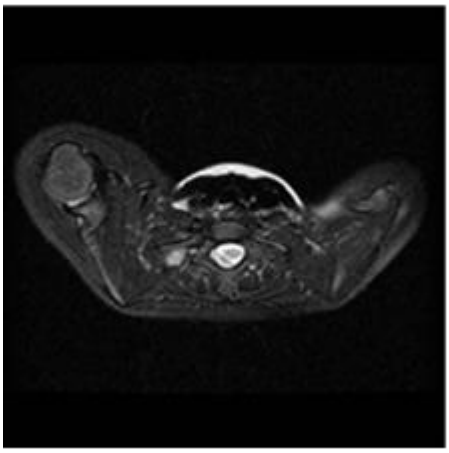
3. A T2 weighted sequence is characterised by parameters as listed below

    a. Long TR / Short TE
    b. Short TR / Long TE
    c. Short TR / Short TE
    d. Long TR / Long TE

    Answer: (d)

SAMPLE QUESTIONS:

1. The T2 weighted Fat Suppressed FSE transverse scan through the proximal portion of the chest demonstrates water suppression as opposed to fat suppression. Which of the following options listed below would not reduce this artefact 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)

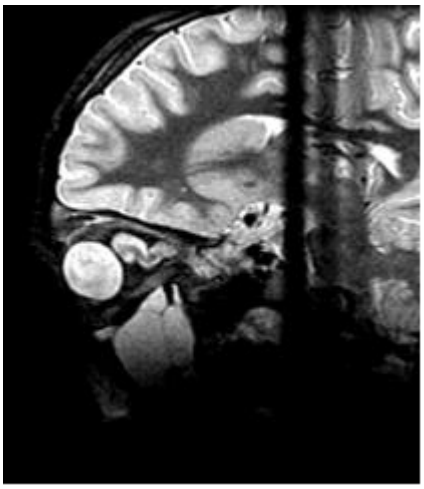
2. The artefact demonstrated below is indicative of one caused by a ferromagnetic foreign body. The patient was quickly screened by another staff prior to the examination. This person believed that the patient was not wearing anything that would induce such an artefact.

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)

Firstly exclude the patient, then restraining/comfort aides and then investigate the other options. This artefact was due to coil failure brought about by dropping it.

3. The artefact demonstrated on this multi slice/multi-angle Sagittal Oblique T2 FSE is due to what?



a. Coil failure
b. Overlapping slice regional saturation
c. Dental hardware
d. Patient movement

Answer: (b)