



HKCRRT

*The Hong Kong College
of Radiographers and
Radiation Therapists*

Standards of Practice for Magnetic Resonance Imaging

By

Magnetic Resonance Imaging Faculty

2022

First Version in 2022

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1. Brief information/background of magnetic resonance imaging

Magnetic resonance imaging (MRI) is a cross-sectional imaging technique that uses a strong external magnetic field, rapidly changing magnetic field gradients and a radiofrequency field. MRI provides excellent soft tissue contrast and high sensitivity to pathological tissues. These aforementioned characteristics are based on the high degree of inherent contrast due to variations in tissue magnetic relaxation properties (such as T1 and T2 relaxation times), appropriate settings of image acquisition parameters, and the wide spectrum of MRI pulse sequences which allows for various kinds of tissue contrasts. There is a plethora of MRI pulse sequences available that can be used to obtain, not only spectacular anatomical detail, but also biochemical, physiological, and functional information.

2. Safety and precautions

2.1 Safety specific to MRI

2.1.1 All MRI facilities including installations for diagnostic, therapeutic, research, and surgical applications must maintain MRI safety policies. Each site shall appoint an MRI safety officer whose responsibilities will include ensuring that MRI safe practice guidelines are established and maintained as current and appropriate for the site. Safety guidelines, practices, and policies will be written, enforced, documented, and reviewed by the MRI safety officer of the facility. All MRI practitioners, medical staff, nursing staff, and other supporting staff working in the MRI facility are expected to be educated in MRI safety by the MRI safety officer. It must be understood that these safety practices are important not only for the patients but also for others who will be accompanying the patient or entering the MRI scanner room. All MRI safety incidents or near-miss incidents must be reported to the MRI safety officer in a timely fashion, and should be analyzed and used for future quality improvement.

2.1.2 MRI safety guidelines shall take into consideration potential interactions of the strong static magnetic field with ferromagnetic objects in the MRI environment that may result in a projectile effect leading to injuries or damage. The MRI safety of any external devices must never be assumed if it is not clearly documented, and all necessary information must be obtained before bringing devices into the MRI scanner room.

2.1.3 Risks to patients during MRI examinations can be related to the strong static

magnetic field, radiofrequency exposure, or the time-varying gradient magnetic field. It is crucial to note that practices must be in place to decrease the possibility of patient burns during MRI scanning, such as optimization of the scanning protocol not to exceed the recommended specific absorption rate (SAR), proper padding between the patient and magnet bore, and positioning and proper placement of patient monitoring devices. Extra care must be taken with sedated patients and those unable to maintain communication with MRI professionals during MRI examination.

- 2.1.4 Patients are required to be thoroughly screened prior to scanning in order to exclude any biomedical implants and devices. It is recommended that referring physicians are aware of screening protocols. Screening should be done at the referring physician's clinic, reviewed at the booking office of the MRI facility, upon registration at the MRI facility, and again by MRI practitioners before entering the MRI scanner room. Even with four levels of screening, it is well known that patients will either forget to mention something, or not mention anything at all for fear of losing their scan slot. Patient implants or devices must be carefully screened to confirm whether they are MRI safe, MRI conditional, or MRI unsafe. In addition to MRI-unsafe implants and devices, MRI-conditional implants and devices may be also contraindicated for MRI examination, subject to the allowed imaging conditions of MRI-conditional devices; e.g., strength of the static magnetic field, spatial field gradient, and SAR, etc. It is the responsibility of MRI practitioners to confirm the exact type of device when consulting with the referring physician. It is suggested that screening should be done using the latest literature and version of the MRI safety reference book, as well as searching online at the recognized MRI safety web site for MRI safety information regarding the concerned implant or device. Moreover, MRI practitioners should consider contacting the implant or device manufacturer to obtain corresponding MRI safety information.
- 2.1.5 For MRI safety regarding pregnancy and gadolinium-based MRI contrast agents, please refer to the latest version of local/international guidelines for the recommended practices.

2.2 Risk – medical emergency

- 2.2.1 In case of a medical emergency during an MRI examination, for which emergency medical intervention or resuscitation is required, the patient should be quickly

removed from the MRI scanner room to a pre-determined, magnetically safe location. Quenching the magnet of the super-conducting MRI system is not routinely advised for medical emergencies, since quenching the magnet and having the magnetic field dissipate can take over a minute. Furthermore, intentionally quenching the magnet can theoretically be hazardous; all personnel and patients should be evacuated from the MRI scanner room as quickly as safely feasible. One should initiate life support measures in a location where the strength of the magnetic field is insufficient to be a medical concern.

- 2.2.2 MRI-unsafe defibrillators and emergency carts must not be taken into the MRI scanner room for emergency medical intervention or resuscitation. A contingency plan for medical emergencies during an MRI examination must be available in each MRI facility to ensure efficiency and MRI safety during management of patients requiring emergency medical intervention.
- 2.2.3 Emergency equipment/carts must be available and regularly checked. Emergency carts must contain equipment to provide the necessary age-appropriate drugs and equipment to resuscitate unconscious and apneic patients.

3. Role and responsibilities of radiographers

3.1 Data integrity

- 3.1.1 Understand the clinical management system (CMS), radiology information system (RIS), and picture archiving and communication system (PACS) workflow.
- 3.1.2 Avoid collecting inaccurate data.
- 3.1.3 Verify patient and study information before and after examination (e.g., time-out policy).
- 3.1.4 Ensure the necessary images are completely transferred to PACS.

3.2 Data privacy

- 3.2.1 Protect patient privacy.
- 3.2.2 Keep all patient information confidential, except when it is necessary to facilitate

the medical procedures of the patient, or when legally obliged.

3.2.3 Patient data is retrieved on an as-needed basis.

3.3 Patient identification

3.3.1 Correct patient identification.

3.3.2 Use at least two different personal identifiers to verify the patient's identity (e.g., patient's name, ID card number, date of birth, phone number, or residential address).

4. Requirements of radiographers

4.1 Academic qualifications

4.1.1 MRI is performed by radiographers/radiation therapists who are responsible for the use of radiofrequencies within a strong static magnetic field for diagnostic, therapeutic, or research purposes. The concerned health care professionals must demonstrate good understanding of MRI physics, MRI safety, human anatomy, physiology, pathology, pharmacology, and medical terminology so as to perform MRI examinations in a safe and effective way. Appropriate MRI pulse sequences should be selected for the corresponding MRI examination, with consideration given to the indications and pathology of the patient.

4.1.2 MRI practitioners must apply principles of MRI safety to minimize MRI examination risk to patients, themselves, staff members, and other accompanying personnel within the MRI environment. This includes screening of patients for any contraindication of MRI, patient preparation, and ensuring patient comfort during MRI examination. MRI practitioners are responsible for safety in the MRI scanner room by ensuring no unauthorized access. All personnel, including supporting/maintenance staff and accompanying personnel, must be screened before entering the MRI scanner room.

4.1.3 To operate the MRI system independently, MRI practitioners must comply with the requirements below:

4.1.3.1 Being a radiographer or radiation therapist registered under the Hong Kong

Radiographers' Board with a valid Annual Practicing Certificate; AND

4.1.3.2 In possession of a bachelor degree's in medical imaging or radiation therapy, or in a related field; AND

4.1.3.3 In possession of higher academic qualifications in MRI (e.g., master's degree or above in MRI) or other MRI specialist qualifications recognizable by HKCRRT (e.g., a pass in the MRI Certificate Examination of HKCRRT); AND

4.1.3.4 Completion of at least 300 MRI examinations within a two-year period, including:

- Not less than 120 examinations of the head and neck
- Not less than 80 examinations of the spine
- Not less than 60 examinations of musculoskeletal regions
- Not less than 40 examinations of the thorax, abdomen, and pelvis

4.2 Manner to handle patients

4.2.1 Provide clear and understandable information to the patient or patient's substitute decision maker prior to, during, and after the diagnostic or interventional procedure.

4.2.2 Ensure good communication includes verbal, written, and non-verbal actions, as well as active listening skills.

4.2.3 Provide the patient or patient's substitute decision maker with answers to their questions within the scope of the professional's responsibility.

4.2.4 Carry out diagnostic or interventional procedures only with the informed consent of the patient or the patient's substitute decision maker.

4.2.5 Make modifications to procedures based on the patient's physical, medical, and/or emotional status and needs based on the practitioners' assessment of the aforesaid characteristics of patients.

4.2.6 Instruct the patient to remove only clothing and items that will interfere with the diagnostic or interventional procedures.

4.2.7 Ensure patient privacy and keep all patient information confidential, except when necessary to facilitate diagnosis or interventional procedures of the patient, or when legally obliged or allowed to disclose such information.

4.2.8 Ensure patient comfort and safety

4.2.9 Should be kind, considerate, and compassionate, as well as precise, meticulous, and detail-oriented in work habits.

4.3 Collaboration

4.3.1 MRI practitioners should be responsible for collaborating with different ranks of staff, including other healthcare professionals, and administrative and support staff, to provide a quality imaging service.

4.4 Training and education

4.4.1 To accommodate technological advancement and expansion of imaging applications, MRI practitioners shall undergo continuous training and education by participating in relevant seminars and conferences. MRI practitioners must accrue at least 45 CPD credits in a period of three years.

4.4.2 MRI practitioners should continue their professional development to stay up-to-date with the latest cutting-edge MRI technology, as well as share their knowledge and experience with others to uphold MRI standards.

4.5 Research and development

4.5.1 MRI practitioners should actively participate in MRI-related research studies to allow for the continuous development of MRI technology.

5. Clinical applications

The currently accepted applications of MRI are enumerated based on clinical experience. Because the clinical application of MRI is still under development, it is not intended that the enumerated techniques be all-inclusive.

- Brain
- Head and neck
- Spine
- Musculoskeletal system
- Abdomen and pelvis (i.e., liver, pancreas, kidneys, adrenal glands, male and female genitourinary system, MR enterography, and MR colonography)
- Cardiovascular
- Breasts
- Fetal imaging

6. Examination routines

6.1 Examination and patient preparation

6.1.1 Correct patient identification

6.1.2 Cross-check for completion of the required preparation procedures; e.g., fasting, venipuncture, pre-medication, and hydration, etc.

6.1.3 Explain the imaging procedure to the patient and obtain the patient's informed consent, if applicable.

6.1.4 Give an account of related patient instructions, e.g., importance of keeping still or holding breath, etc., to ensure patient compliance during MRI examination.

6.1.5 Check for any infectious-related precautions for the patient.

6.1.6 MRI safety screening for any biomedical implants/devices and other contraindications of the patient.

6.1.7 Screen women of child-bearing age for pregnancy using the 28-day rule of last menstrual period (LMP) before permitting access to the MRI environment.

6.1.8 If necessary, check the renal function test results of patients who might require contrast administration to minimize the risk of contrast induced nephropathy or Nephrogenic Systemic Fibrosis (NSF).

6.1.9 Review relevant clinical information, including image data of previous radiological examinations, to optimize imaging protocols.

6.2 Setup of MRI examination

6.2.1 Use appropriate equipment for the corresponding MRI examination, including radiofrequency coils, immobilization devices, respiratory/ECG gating devices, and power injectors, etc., to optimize image quality.

6.2.2 Position the patient on the examination couch to ensure the region of interest is close to the magnet iso-center to optimize image quality.

6.2.3 Adjust patient position to tailor for the clinical conditions of the patient and ensure patient comfort.

6.2.4 Select appropriate imaging protocol and pulse sequences for the corresponding MRI examination to facilitate clinical diagnosis.

6.2.5 Adjust the technical parameters of pulse sequences to tailor for the clinical conditions of the patient to optimize image quality.

6.2.6 Ensure the orientation and laterality of the acquired images are correct and appropriate for clinical diagnosis.

6.2.7 Ensure the safety of the patient during MRI examination. Monitor the vital signs of the patient during MRI examination.

6.2.8 Maintain verbal contact with the patient via the MRI system intercom during examination to alleviate patient anxiety and claustrophobia.

6.2.9 Perform post-processing of image data, as appropriate, to facilitate clinical diagnosis.

6.3 After care

6.3.1 Check the clinical status of the patient after MRI examination and observe for at least 15 minutes before discharging the patient, especially following

administration of an MRI contrast medium.

6.3.2 Clean and disinfect the related equipment and examination room according to the prevailing infection control regime.

6.3.3 Archive the related image data for future reference, with regards to local guidelines and standards.

6.4 Quality control

6.4.1 Many MRI systems with different static magnetic field and gradient strengths are available on the market. The most prevalent magnetic field strengths are 1.5 Tesla and 3 Tesla. The higher the magnetic field strength, the greater the signal-to-noise ratio (SNR) and improved spatial and spectral resolution. The gradient field strength will directly influence image resolution and, partly, acquisition speed.

6.4.2 There are also a wide range of radiofrequency coils and pulse sequences available for purchase with the main MRI system to accommodate the corresponding clinical applications. To facilitate the imaging workflow, MRI safe or MRI conditional ancillary equipment will also be required in the MRI facility; e.g., power injectors, physiological monitors, an anesthesia system, wheelchairs, and stretchers, etc.

6.4.3 The objective of an MRI quality-control program is to provide a series of tests and measurements which may be performed on a regular basis to determine if the MRI system is performing in a reproducible and predictable manner. A quality-control test should be conducted by MRI professionals and a medical physicist at regular intervals to maintain a high level of scan quality. The quality-control program with written procedures and logs shall be maintained at the MRI facility so as to assess relative changes in system performance. A preventive maintenance program conducted by service engineers from the equipment supplier is also recommended as a means of minimizing unscheduled equipment down time.

6.4.4 The following quality-control tests should be performed and documented:

- Measurement of center frequency
- Measurement of SNR on a standard head or body coil
- Table positioning

- Geometric accuracy
- High- and low-contrast resolution
- Artifact analysis

7. Declaration

The contents of this SOP serve as a reference for radiographers, radiation therapists, and related professionals. It should not be considered comprehensive information for any related examination or procedure. Further elaboration of this document is subject to the decision of the council of the Hong Kong College of Radiographers and Radiation Therapists.

8. References

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