HONG KONG COLLEGE OF RADIOLOGISTS

SPECIALTY TRAINING : RADIOLOGY
TRAINING OBJECTIVES & REQUIREMENTS, EXAMINATION FORMAT, EXIT ASSESSMENT AND SYLLABUS

OBJECTIVES OF TRAINING

(A) *Basic Specialist Training*

1 To allow a medical graduate to acquire general radiological and radiation protection knowledge, skill and competence, with supervised responsibility for patient care.
2 To develop a disciplined habit of reasoning and a logical approach to specific medical problems with respect to radiology.
3 To appreciate the importance of radiology in the whole system of patient care and health.
4 To be conversant with the updated practice and current literature on relevant subjects.
5 To be able to communicate with clinical colleagues and render appropriate recommendation on imaging investigation and patient management.
6 To be confident to advise on the safest, and most cost-effective means of arriving at a diagnosis, and to counsel against unnecessary imaging investigation.

(B) *Higher Specialist Training*

1 To develop in-depth skill and knowledge, and practical experience in general radiology to be capable of independent practice in the specialty.
2 To be trained with initiation towards subspecialty development.
3 To be well versed in various imaging modalities to be an effective member of a team in the multidisciplinary approach on patient care.
4 To be capable of promoting efficient utilization of available radiological services at different settings.
5 To be trained to be a radiologist with the appropriate professional attitude.
6 To be motivated towards continuous professional development.

TRAINING REQUIREMENTS

(A) *Entry Requirement & Duration of Training*

1.0 All trainees need to be fully registered with The Medical Council of Hong Kong and must enrol with the Hong Kong College of Radiologists at the commencement of their training.
2.0 The duration of training shall last for a minimum of 6 years.

(B) *Basic Specialist Training*

1.0 At least one year of post-registration clinical experience outside radiology is required.
1.1 The post-registration clinical experience should appropriately be taken in disciplines with wide exposure to various clinical situations. In general, clinical exposure to

Internal Medicine, General Surgery, Paediatrics, Emergency Medicine, Obstetrics & Gynaecology, Orthopaedics, etc. could count up to a maximum of one year. Clinical exposure to Anaesthesiology, Pathology, Rehabilitative Medicine and Psychiatry training could only count up to a maximum of six months. For clinical exposure in Family Medicine, Intensive Care Unit and other clinical settings, the recognition of training duration shall be considered on individual basis and to be endorsed by the Education Committee and Council of the College.

2.0 Satisfactory attendance of the Fellowship Basic Training Course organized by the College is mandatory before trainees are allowed to attempt the Part I Fellowship Examination.

3.0 The trainee should receive a comprehensive grounding in all subjects related to the production of an organ image or providing the background towards radiological interpretation.

4.0 The topics of basic training includes radiological anatomy, radiographic techniques and equipment, practical radiological procedures, radiation protection, radiation biology, contrast media, relevant aspects of radioisotopes, the physics of radiography, ultrasound, computed tomography, magnetic resonance imaging, and the principles of digital systems as applied to radiology.

4.1 For *Physics*, emphasis is placed on a clear understanding of the physical basis of radiological practice in a qualitative manner, with sufficient knowledge of the basic principles of radiography, ultrasound, computed tomography, magnetic resonance imaging and radionuclide imaging. The trainee is expected to have a broad understanding of the function of the components in the main types of imaging equipment. Training should also cover interaction of radiation with matter, its effects on irradiated materials, interaction of radiation with the patient, and radiation protection including relevant legislation. The trainee is expected to learn to explain the radiation risk and radiation protection guidelines to medical and radiographic staff as well as to patients, both for clinical practice and research purposes.

4.2 For *Anatomy*, the basic anatomy and normal variants relevant to the common imaging examinations should be acquired, as well as the radiological techniques required to demonstrate this anatomy.

4.3 For *Radiography*, the trainee is expected to know the positioning, centering or tube angulation for standard radiographic projections. He/she should be able to give practical advice on improving the quality of the resulting image.

4.4 For *Radiological Techniques*, there should be general knowledge of the contrast investigations, including barium studies, and imaging with radionuclides, ultrasound, computed tomography, digital systems and magnetic resonance. For everyday conventional examinations, familiarity and experience are expected; for less common investigations, knowledge in outline is required. Where there are alternative methods of studying a region their comparative merits should be appreciated. The trainee should be familiar with radiographic apparatus and related equipment, relative merits and choice of contrast media, technique-related drugs and radiopharmaceuticals, standard methods of resuscitation and management of contrast reactions.

5.0 There should be general knowledge of current clinical medicine, surgery and pathology, especially in relation to radiology.

5.1 A sound basic knowledge and application of general and special imaging methodology, including ultrasound, nuclear medicine, computed tomography, magnetic resonance imaging, vascular radiology and interventional radiology.

5.2 Interpretative skill on and judgement of the end products of imaging modalities, including correlative appreciation of the various modalities.

5.3 Planning and decision-making in imaging work-up to solve clinical problems.

5.4 A general awareness of current trends is desirable, including updated radiological literature and relevant statutory radiation protection measures.

6.0 During the whole period of clinical training, emphasis would be put on the cultivation of a high level of professional conduct and ethics. Communication skills would be developed to ensure sound communication among professionals and good patient-doctor relationship.

7.0 Trainees need to hold a formal clinical radiology training post, in which they are actively receiving clinical radiology training, (or to have held such a post in the past) in order to enter the Part I Fellowship Examination.

8.0 Trainees need to hold a formal clinical radiology training post, in which they are actively receiving clinical radiology training, (or to have held such a post in the past), must have acquired 24 months in a formal clinical radiology training post and to have passed the Part I Examination in order to enter the Part IIA Examination.

9.0 Trainees who have passed the Part IIA Examination are permitted to enter the Part IIB Examination upon completion of three years in formal clinical radiology training. Each trainee's training supervisor is required to provide confirmation that the candidate has completed the required duration of training and received instruction covering the examination syllabus.

(C) *Higher Specialist Training*

1.0 This stage of training comprises the two years of Higher Training started immediately after the trainee has passed the Part II B Examination.

2.0 Emphasis will be made on providing the trainee with opportunities for practical experience, increased responsibility, independent thinking and action in various disciplines of Radiology through a system-based structured programme.

3.0 There should be in-depth knowledge and application of Conventional Radiology. Subspecialty development is also encouraged, with training and interest in more than one subspecialty.

4.0 All training programs (general or subspecialty training) should have prior accreditation by the College.

5.0 There should be knowledge of the ethical standards and legal responsibilities of radiology practice.

6.0 Active participation in intra- and inter-departmental clinico-radiology meetings is required.

7.0 **During the entire period of Basic and Higher Specialist Training, trainees should participate actively in research activities.**

1) **At least one project** must be accepted at College scientific meetings, or regional / international scientific conferences with the trainee as the oral presenter or first author of a poster presentation; and

2) **At least one radiological / oncological / nuclear medicine article** with the trainee as the first author, must be published / accepted for publication in the Journal of the College or other indexed medical journals.

Training centres should facilitate trainees to participate in research projects.

8.0 Training in relevant attributes including management, audit, quality assurance, research techniques, medicolegal responsibility, communication and resource application.

EXAMINATION FORMAT

1.0 The intermediate examination (Fellowship Examination) shall be in two parts.

2.0 *Format of Part I Fellowship Examination:*

2.1 Part I Examination comprises 2 modules: Anatomy and Physics. Anatomy is examined by an image viewing session delivered on individual workstations and Physics by a multiple choice written questions (MCQ) paper.

2.2 The examination shall test on the current ionising radiation legislation and practical elements of physic knowledge required to support clinical training and patient safety. Anatomy module covers anatomy across all body systems and modalities.

2.2.1 Trainee may attempt the modules at the same sitting or at separate sittings and may pass them either together or separately in any order. Trainee will be deemed to have achieved success at the Part I Examination once both modules have been passed.

2.2.2 No trainee will automatically be permitted more than six attempts at Part I Examination. In order to attempt an examination for a seventh, or further time, trainee will have to demonstrate additional educational experience.

3.0 *Format of Part II Fellowship Examination:*

3.1 Part IIA Examination comprises a single best answer (SBA) question paper, split into two separate papers. Each paper comprises 120 SBA questions. The paper comprises a mix of questions from across a wide range of the curriculum:
Cardiothoracic and Vascular
Musculoskeletal and Trauma
Gastro-intestinal
Genito-urinary, Adrenal, Obstetrics & Gynaecology and Breast
Paediatric
Central Nervous and Head & Neck

3.1.1 Questions will cover all imaging modalities and may include some anatomy and techniques. Questions will also be set on clinical subjects and pathology, within the general framework of Radiology.

3.1.2 Trainees need to hold a formal clinical radiology training post, in which they are actively receiving clinical radiology training, (or to have held such a post in the past), must have acquired 24 months in a formal clinical radiology training post and to have passed the Part I Examination in order to enter the Part IIA Examination.

3.1.3 Trainees need to pass both papers at one sitting in order to be deemed to have achieved overall success in the Part IIA Examination.

3.1.4 No trainee will automatically be permitted more than six attempts at Part IIA Examination. In order to attempt an examination for a seventh, or further time, trainee will have to demonstrate additional educational experience.

3.2 Part IIB Examination is currently only in the form of Joint Fellowship Examination organized by Hong Kong College of Radiologists and The Royal College of Radiologists. Trainees who have passed the Part IIA Examination are permitted to enter the Part IIB Examination upon completion of three years in formal clinical radiology training. The Part IIB Examination consists of a rapid reporting session, a reporting session and two oral examinations.

3.2.1 The reporting session comprises six cases, each of which require a written report, and it runs for 75 minutes. Each case may comprise multiple modalities including CT, ultrasound, radionuclide and MR scans. Cross-sectional imaging may comprise up to four sequences, which can be scrolled through. Brief case histories and other relevant

clinical data for each case will be displayed, and responses should be presented in a standard format as follows:

Observations: This section is for recording observations on the films from all the imaging studies available, including relevant positive and negative findings.

Interpretation: This section is for stating interpretations of the observed findings; for example, describing whether the mass or process observed in benign, malignant or infective rather than neoplastic, giving reasons.

Main or Principal Diagnosis: This single diagnosis should be based on the interpretations provided above. If a single diagnosis is not possible, then the most likely diagnosis should be stated with a list of other possibilities, in order of likelihood, supplied in the differential diagnosis section below.

Any Differential Diagnoses: For some cases there will be no differential diagnoses; in others a few may merit inclusion. These should be limited in number and brief, and the report should indicate why these were less likely than the main or principal diagnosis above.

Any Relevant Further Investigations or Management: This section is for indicating any further appropriate investigations or clinical management. For example, if a patient with a subdural collection is diagnosed then urgent referral is needed if there is evidence of brain compression. Similarly, if an abscess or tumour is diagnosed indicate if a drainage or biopsy is appropriate.

3.2.2 The cases vary in complexity and difficulty; some require more time for analysis and reporting than others. Trainees should ensure sufficient time is allocated to report each case adequately.

3.2.3 The rapid reporting session comprises 30 cases and it runs for 35 minutes. It requires trainees to identify those cases that show normal appearances and those that show an abnormality. Many cases are similar to those encountered in the reporting of A&E and GP-referred cases; the images are primarily plain radiographs. Where an abnormality is present, candidates are expected to briefly identify this or give a diagnosis. Each abnormal case shows one significant diagnosable abnormality. Abnormalities in the Rapid Reporting component are not complex and therefore differential diagnoses should not be given. Anatomical variants should be recorded as 'normal' and some cases may show minor age-related changes only which should also be recorded as 'normal'.

3.2.4 The oral examination lasts for 60 minutes in total, during which time the trainee spends 30 minutes with each of two pairs of examiners (and so will be assessed by four radiologists in 15-minute blocks).

3.2.5 During each of the two vivas a wide range of material of varying complexity will be shown. A higher level of performance will be expected in interpreting the common and routine examinations than will be the case with the highly specialized investigations.

3.2.6 Trainees will be given the opportunity to demonstrate their powers of observation and deduction. A logical and informed approach to image interpretation, as well as a clear ability to debate the merits, relevance, and role of techniques, that might assist in further investigation of diagnostic problems, will be expected.

3.2.7 Trainees fail any component of the Part IIB Examination will be required to re-sit all

three components.

4.0 *Review of Performance at Examinations*

4.1 Candidates who fail the Part IIB Examination will be informed of their performance at each paper/session. It is expected that the training head at each training centre will provide counselling.

4.2 After 2 unsuccessful attempts at Part IIB Examination, a candidate's performance will be reviewed by the Warden, one examiner of the examination together with the trainee and the respective supervisor, to advise on the required improvement areas and remedial actions.

4.3 The Review Committee of the College will consider queries and appeals.

EXIT ASSESSMENT FOR COLLEGE FELLOWSHIP

1.0 After completion of the required period of Higher Specialist Training, a trainee can apply for consideration of the Fellowship of the College.

2.0 Exit Assessment exercises are conducted by the College twice a year, normally in January and July.

3.0 A panel of assessors comprising the following members would carry out a formal assessment of the trainee's completion of training:

(i) The Warden.

(ii) Two other experienced College Fellows of the trainee's profession, who should NOT be the trainee's supervisors, appointed by the Education Committee and approved by the Council.

4.0 The procedure of assessment would include:

(i) Scrutiny of the training records of the trainee for completeness of training.

(ii) Appreciation of the regular continuous appraisal reports of the respective supervisor.

(iii) Further supportive documents may need to be furnished by the trainee or the respective training centre on request.

(iv) A 40-minute oral assessment of the trainee by the panel of assessors will be held to evaluate the trainee's professional attitude, ability in communication skill, solving clinical or management issues and appreciation of radiology literature.

5.0 After an unsuccessful attempt at Exit Assessment, a candidate's performance will be reviewed by the Warden, one assessor of the Panel together with the trainee and the respective supervisor, to advise on the required improvement areas and remedial actions.

SYLLABUS

1. PART I EXAMINATION

1.1 Module: Anatomy

The candidate should be able to describe and recognise:

- The bony and soft tissue anatomy visible on radiographs, including common normal variant. This will include children of all ages.
- The radiological anatomy visible on CT, including multiplanar reformats. This will include solid organs such as the heart and lungs, bones, vessels and muscles.
- The radiological anatomy visible on ultrasound imaging, including first trimester antenatal ultrasound. This will include solid viscera such as the liver and spleen, bones, vessels, major ligaments and tendons. Endocavitory ultrasound, such as transvaginal, transrectal and endoscopic ultrasound will be excluded.
- The radiological anatomy on MRI, including solid viscera such as the brain and abdominal organs, bones, joints, muscles and vessels.
- The radiological anatomy of fluoroscopic studies of the gastrointestinal, biliary, genitor-urinary and vascular systems.

Nuclear medicine, including positron emission tomography, is excluded from the anatomy curriculum.

1.1.1 Head and Neck

a. Brain

- Ventricles and CSF spaces
- Arteries and venous sinuses
- Basal nuclei and major white matter tracts
- Cerebrum and cerebellum
- Cranial nerves
- Pituitary and juxtasellar structures

b. Skull

- Calvaria and base of skull

c. Face and neck

- Arteries and veins
- Sinuses
- Orbits and contents
- Facial skeleton
- Tongue and oral cavity
- Lymph node groups
- Larynx and pharynx
- Thyroid and parathyroid
- Salivary glands

1.1.2 Thorax

a. Cardiac

- Mediastinum, pericardium and lymph nodes groups
- Cardiac chambers, valves, arteries and veins

b. Great vessels and azygos/hemiazygos system

c. Bronchopulmonary

- Trachea and major bronchi

- Pulmonary vasculature
- Pleura and fissures

d. Chest wall and diaphrgam

e. Breast and axilla

1.1.3 Abdomen and pelvis

a. Bowel

- Oesophagus and stomach
- Duodenum, small bowel and appendix
- Colon, rectum and anus

b. Upper abdominal viscera

- Liver segments and blood vessels
- Biliary tree and gallbladder
- Pancreas, adrenal and spleen

c. Abdominal wall

d. Spaces and planes

- Perirenal and pararenal spaces and fasciae
- Peritoneal reflections and spaces

e. Genitourinary tract

- Kidneys and pelvicalyceal systems
- Ureters and bladder
- Prostate, seminal vesicles and urethra
- Testes and epididymides

f. Gynaecology

- Ovaries and fallopian tubes
- Uterus and cervix
- Vagina

g. Vascular supply

- Portal venous system
- Aorta and major branches
- IVC and tributaries

h. Lymph node groups

1.1.4 Musculoskeletal system

a. Spine

- Vertebrae, sacrum and joints
- Paraspinal muscles and ligaments
- Spinal cord, cauda equine and nerve roots

b. Upper limb

- Bones and joints, including shoulder
- Muscles and nerves
- Blood vessels

c. Lower limb

- Bones and joints, including pelvis
- Muscles and nerves
- Blood vessels.

1.2 Module: Physics

Those who have followed the curriculum should be able to:

- Describe the structure and properties of matter, the phenomena of radioactivity

and magnetism, the nature of ionising radiation, radiofrequency radiation and ultrasound and how they interact with matter.
- Distinguish between different types of diagnostic medical image and understand how such images are created, reconstructed, processed, transmitted, stored and displayed.
- Describe the construction and function of medical imaging equipment including the radiation or ultrasound source, image-forming components and image or signal receptor.
- Indicate how imaging equipment is operated and describe the imaging techniques that are performed with such equipment.
- Identify the type of information contained in images from different modalities.
- Distinguish between different indices of image quality, explain how they are inter-related and indicate how they are affected by changing the operating factors of imaging equipment.
- Identify agents that are used to enhance image contrast and explain their action.
- Explain how the performance of imaging equipment is measured and expressed.
- Describe the principles of quality assurance and outline how quality control tests of imaging equipment are performed and interpreted.
- Recognise artefacts in medical images and identify how they are removed or their impact is reduced.
- Recognise the hazards and risks to patients, members of staff and members of the public associated with medical imaging and describe how their impact is reduced without compromising diagnostic image quality.
- Identify the major pieces of UK legislation and guidance that affect the practice of medical imaging and interpret their requirements.

1.2.1 Principles of medical diagnostic imaging

- Projection (planar) and tomographic images
- Analogue and digital images
- Structure of digital images
- Digital image processing, fusion, transmission and storage
- Display and viewing of analogue and digital images
- Picture Archiving and Communications Systems (PACS)
- Quality assurance

1.2.2 Common themes for all imaging modalities

- Image formation
- Image quality - contrast, noise, contrast resolution and spatial resolution
- Contrast agents
- Image processing and analysis
- Equipment performance measurement, test objects and quality control
- Image artefacts
- Hazards, risks and safety

1.2.3 Matter and radiation

- Structure of matter, the atom and the nucleus
- Nature and properties of charged particle and electromagnetic radiation
- Interaction of electrons with matter
- Production of x-rays

- Interaction of high energy photons with matter
- Filtration of x-ray beams
- Electron energy in solids
- Luminescence

1.2.4 Ionising radiation dose

- Absorbed dose and kinetic energy released to matter
- Effects of ionising radiation on living tissue
- Equivalent dose and effective dose
- Radiation risk
- Population dose from natural and artificial sources

1.2.5 Radiography with x-rays

- Construction, function and operation of computed and digital radiographic systems
- X-ray tube and x-ray beam
- Image receptors for computed and digital radiography
- Scatter rejection
- Contrast media – iodine, barium and air
- Dual energy radiography
- Film-screen radiography
- Mammography
- Radiographic tomography and tomosynthesis

1.2.6 Fluoroscopy with x-rays

- Construction, function and operation of a fluoroscopy system
- Image receptor – image intensifier and flat panel detector
- Scatter rejection
- Automatic brightness control
- Image digitisation
- Angiography with contrast media, including digital subtraction techniques

1.2.7 Safety in radiography and fluoroscopy with x-rays

- Radiation detectors and dose meters
- Measurement of absorbed dose and dose rate in air
- Estimation of patient absorbed dose
- Typical dose-area products, entrance surface doses and effective doses in radiography and fluoroscopy
- Detector dose indicators
- Factors affecting radiation dose
- Time, distance and shielding for dose reduction
- Children and pregnant patients
- Estimation and control of radiation dose to staff and members of the public
- Operational dose quantities
- Personal dosimetry
- Pregnant staff

1.2.8 Radioactivity

- Nuclear stability

- Mechanisms of radioactive transformation
- Nuclear energy states and gamma emission
- Activity and radioactive decay
- Natural radioactivity
- Artificial radionuclides and their production
- Radiopharmaceuticals and their production

1.2.9 Planar radionuclide imaging

- Construction, function and operation of a digital gamma camera
- Imaging collimators
- Image receptor – scintillation detector
- Scatter rejection
- Static, whole-body, dynamic and gated imaging

1.2.10 Safety in planar radionuclide imaging

- Activity measurement with radionuclide calibrator
- Estimation of patient absorbed dose
- Typical activities and effective doses
- Factors affecting radiation dose
- Time, distance and shielding for dose reduction
- Children and conception, pregnancy and breast-feeding in patients
- Estimation and control of radiation dose to staff and members of the public
- Pregnant staff
- Contamination and environmental dose rate monitoring
- Storage, handling and transportation of radioactive substances
- Storage and disposal of radioactive waste

1.2.11 UK framework for ionising radiation protection

- Hierarchy of recommendations, legislation and guidance
- Justification, optimisation and dose limitation
- Ionising Radiations Regulations 1999 and Approved Code of Practice
- Risk assessment, restriction of exposure and dose monitoring
- Radiation Protection Adviser and Radiation Protection Supervisor
- Local Rules and work procedures
- Designation of working areas and classification of workers
- Dose limits and dose constraints
- Comforters and carers
- Ionising Radiation (Medical Exposure) Regulations 2000, Notes on Good
- Practice and 2006 amendment
- Duty holders and their training and responsibilities
- Employer’s procedures
- Diagnostic reference levels
- Exposures for research, health screening and medico-legal purposes
- Medicines (Administration of Radioactive Substances) Regulations 1978 and
- 1995 and 2006 amendments
- Administration of Radioactive Substances Advisory Committee and Notes for
- Guidance
- Radioactive Substances Act 1993

- Registration to hold radioactive substances
- Authorisation to store and dispose of radioactive waste
- Medical and Dental Guidance Notes
- Notification and reporting of radiation incidents

1.2.12 Tomographic reconstruction

- Angular and linear sampling of projection data
- Filtered back-projection and reconstruction filters
- Iterative reconstruction

1.2.13 X-ray computed tomography

- Construction, function and operation of a CT scanner
- Helical and multi-slice scanners
- Image reconstruction
- CT angiography, CT fluoroscopy and gated imaging
- Radiation dose to patients, staff and the public
- Radiation safety and factors affecting radiation dose

1.2.14 Single photon emission computed tomography

- Construction, function and operation of a rotating multi-head gamma camera
- Image reconstruction
- SPECT/CT
- Radiation safety and factors affecting radiation dose
- Typical activities and effective doses to patients, staff and the public

1.2.15 Positron emission tomography

- Construction, function and operation of a multi-detector ring system
- 2D and 3D acquisition
- Image reconstruction
- PET/CT
- Radiation safety and factors affecting radiation dose
- Typical activities and effective doses to patients, staff and the public

1.2.16 Nuclear magnetic resonance

- Nuclear spin angular momentum and nuclear magnetic moment
- Bulk magnetisation and the effect of magnetic field strength
- Precession in a magnetic field and the Larmor equation
- Resonance with radiofrequency pulses
- Relaxation mechanisms and relaxation times
- Free induction decay signal

1.2.17 Magnetic resonance imaging

- Construction, function and operation of a superconducting MRI scanner
- Permanent and resistive magnets
- Radiofrequency receiver coils
- Spin-echo pulse sequence
- Spatial localisation of the signal
- K-space, image acquisition and image reconstruction
- Multi-echo, fast spin-echo and single shot techniques

- Gradient echo imaging – basic spoiled and non-spoiled techniques
- Tissue suppression methods – short TI inversion recovery (STIR), fluid attenuated inversion recovery (FLAIR) and fat saturation
- Basic principles of diffusion techniques
- Standard gadolinium extracellular space contrast agents
- MR angiography
- Spatial misregistration, chemical shift, susceptibility, motion, flow and other artefacts

1.2.18 Safety in magnetic resonance imaging

- Static magnetic field – projectiles, induced voltage, implants
- Fringe field and controlled area
- Time-varying gradient fields – eddy currents, stimulation, implanted devices, acoustic noise
- Radiofrequency fields – specific absorption rate, heating
- Safety of patients, staff and members of the public
- Pregnant patients
- Shielding and imaging room design
- Safety Guidelines for Magnetic Resonance Imaging Equipment in Clinical Use

1.2.19 Physics of ultrasound

- Nature and properties of ultrasound
- Propagation and interaction of ultrasound in matter
- Scattering of ultrasound waves
- Piezoelectric effect
- Design and construction of ultrasound transducers
- Continuous and pulsed wave ultrasound
- Beam shape from a single transducer and an annular array
- The Doppler effect

1.2.20 Ultrasound imaging

- A-mode and B-mode imaging
- Time-gain compensation
- Construction, function and operation of a real-time B-mode scanner
- Image acquisition and reconstruction
- M-mode
- Microbubble and particle suspension contrast agents
- Harmonic imaging
- Measurement of flow with continuous and pulsed Doppler ultrasound
- Duplex scanners
- Colour-flow and power Doppler imaging

1.2.21 Safety in ultrasound imaging

- Physical effects - heating, streaming, cavitation and mechanical damage
- Intensity and energy limits
- Thermal and mechanical indices
- Measurement of power output
- Safety of patients, staff and members of the public
- Safety guidance

2. PART II EXAMINATION

2.1 Clinical Radiology

- In both parts of the Final Examination for the Fellowship, candidates will be examined in all aspects of clinical radiology. The Final FRCR Part A Examination also addresses the basic sciences of physics, anatomy and techniques.
- Candidates will be expected to demonstrate a sound knowledge of those common aspects of clinical radiology that comprise the routine general work in most hospitals.
- A detailed knowledge of highly specialised radiology will not be required. However, candidates will be expected to exhibit an appreciation of the role and scope of all available techniques in relation to the management of clinical problems.
- The main emphasis of the examination is the imaging of disease. However, candidates will be expected to demonstrate a knowledge of the following:
    - Clinical conditions in which radiology has a role in diagnosis or management
    - Applied pathology where it contributes to better understanding of radiological signs and methods of investigation
    - Those aspects of clinical medicine and pathology that are essential to the safe and effective conduct of interventional procedures, either diagnostic or therapeutic
    - The definition and meaning of the basic statistical terms that are necessary for understanding and evaluating statistical claims in published papers
    - Current trends and recent advances in all fields of clinical radiology
    - Normal variants and normal features of x-ray examinations

2.2 Radiological Anatomy

MODULE 1: Thorax and Cardiovascular

- Anatomy of the heart, coronary arteries, aorta, vascular structures of the thorax and mediastinum, as demonstrated by radiography, contrast studies and cross sectional imaging
- Anatomy of the lungs, including segmental anatomy, bronchial tree and pleura, as demonstrated by radiography, bronchography and cross-sectional imaging
- Anatomy of arterial, venous and lymphatic systems of the whole body

MODULE 2: Musculoskeletal

- Anatomy of the skull and facial bones
- Anatomy of the axial skeleton, thoracic rib cage and pelvis, including knowledge of the major ossification centres with times of fusion and the common anomalies and variants that may mimic disease
- Anatomy of the muscles and other soft tissues, as demonstrated by ultrasound, CT and MRI

MODULE 3: Gastro-intestinal

- Anatomy of the salivary glands, as demonstrated by sialography and cross-sectional imaging

- Anatomy of the oropharynx, oesophagus, stomach, duodenum, small bowel and colon, as demonstrated by radiography, contrast studies and cross-sectional imaging
- Cross-sectional anatomy of the liver, gall bladder and biliary tree, pancreas and spleen, as demonstrated by ultrasound, CT and MRI
- Anatomy of the peritoneum and retroperitoneum, as demonstrated by cross sectional imaging
- Anatomy of the biliary tree, as demonstrated by direct cholangiography and ERCP, ultrasound and MRCP
- Anatomy of the vascular supply of the upper abdominal viscera, as demonstrated by ultrasound, CT, MRA and angiography

MODULE 4: Genito-urinary, Adrenal, Obstetrics & Gynaecology and Breast

- Anatomy of the kidneys, ureters, bladder, male and female genital tracts, including the pregnant uterus
- Anatomy and dating of the developing normal fetus
- Anatomy of the female breast

MODULE 5: Paediatrics

- The normal appearances of the growing child, including epiphyseal ossification and common variants that may mimic disease. (Detailed knowledge of appearance of ossification centres is not required.)
- The neonatal brain, particularly as demonstrated by cranial ultrasound

MODULE 6: Central Nervous & Head and Neck

- Anatomy of the skull, facial bones and spine
- Anatomy of the brain, spinal cord and meninges, including cerebral and spinal vascular anatomy
- Anatomy of the thyroid and parathyroid glands
- Anatomy of the paranasal sinuses, teeth, pharynx and larynx
- Anatomy of the orbit, including the lacrimal apparatus

2.3 Radiological Techniques

Knowledge is required of the techniques listed below

MODULE 1: Thorax and Cardiovascular

- Plain film techniques for imaging the thorax, with knowledge of how variation in exposure factors influences the final image
- Basic knowledge of bronchography, coronary angiography and magnetic resonance angiography
- Cross-sectional imaging techniques in the thorax with specific reference to high resolution CT (HRCT)
- Angiographic techniques for imaging the aorta, great vessels and peripheral vascular system, with a knowledge of common interventional procedures
- Contrast venography of arms, legs and central veins
- Ultrasound imaging of arterial and venous systems, including uses and applications of Doppler, colour Doppler and power Doppler imaging
- Imaging of the lymphatic system, especially with radionuclide techniques

MODULE 2: Musculoskeletal

- Plain film techniques for imaging the skeletal system, including specific projectional techniques
- Ultrasound, CT and MRI techniques for the examination of the skeletal system and soft tissues
- Arthrographic techniques, including CT
- The use of radionuclide imaging in the skeletal system
- Interventional techniques

MODULE 3: Gastro-intestinal

- Plain film radiography of the abdomen
- Contrast studies of the intestinal tract and salivary glands, including video studies of the upper gastro-intestinal tract and sialography
- Techniques for imaging the biliary tract, including ERCP and MRCP
- Common techniques for cross-sectional imaging of the gastro-intestinal tract and upper abdominal organs
- Optimisation of cross-sectional imaging for specific applications by manipulation of physical variables, e.g. ultrasound frequency, CT pitch
- Use of contrast agents in cross-sectional imaging of the abdomen
- Common diagnostic and therapeutic interventional procedures.
- Common radionuclide imaging techniques

MODULE 4: Genito-urinary, Adrenal, Obstetrics & Gynaecology and Breast

- Plain film radiography of abdomen and pelvis
- Common contrast techniques for the examination of the renal tract, including intravenous urography, antegrade and retrograde pyelography, cystography, urethrography and nephrostogram
- CT and MRI examinations of the kidneys, adrenals and male and female pelvis
- Radionuclide techniques for revaluating renal function, excretion and micturition
- Ultrasound techniques for examining the male and female genital tracts, including endocavity examination of prostate and female pelvis and Doppler techniques
- Ultrasound of early pregnancy complications, e.g. ectopic pregnancy
- Ultrasound and contrast hysterosalpingography
- Mammography, ultrasound and MRI of the breast
- Nephrostomy insertion, ureteric stenting and renal biopsy procedures
- Breast biopsy techniques

MODULE 5: Paediatrics

- Plain radiographic techniques of chest, abdomen and skeleton
- Contrast studies of the gastro-intestinal and urinary tracts
- Common paediatric ultrasound techniques, including cranial, musculoskeletal, abdominal and pelvic studies
- CT and MRI examinations of the child
- Radionuclide imaging techniques
- Interventional procedures

MODULE 6: Central Nervous & Head and Neck

- Plain radiography of the skull, facial bones and teeth

- Cross-sectional imaging with CT, MRI and ultrasound
- Imaging of the intracranial circulation, including intra-arterial angiography and CT and MR angiography
- Radionuclide imaging
- Contrast examinations, e.g. barium studies
- Interventional techniques

2.4 Physics

2.4.1 Computed Tomography

- Basic principles and components of the system, and detector types
- Helical scanning and multi-slice scanners
- Operator-controlled variables and their effects on image quality and patient dose
- Recognition and explanation of common artefacts

2.4.2 Diagnostic Ultrasound

- Basic principles and components of an ultrasound system
- Types of transducer and production of ultrasound with emphasis on operator-controlled variables
- Interaction of ultrasound with tissue, including biological effects
- Basic principles of A, B, M, real-time and duplex scanning
- Basic principles of pulsed, continuous wave and colour Doppler ultrasound
- Principles of contrast agents
- Recognition and understanding of common artefacts

2.4.3 Magnetic Resonance Imaging

- Basic principles and components of an MR system
- Origin of the MR signal
- Concept of T1, T2 relaxation times and proton density
- Basic principles of common sequences in clinical use (spin echo and generic gradient echo), including MR angiography techniques
- Principles of contrast agents
- Recognition and understanding of common artefacts
- Knowledge of guidance on a safety framework for MR
- Knowledge of magnetic field and radiofrequency hazards to patients and staff

2.4.4 Radionuclide Imaging

- Static and dynamic imaging
- Introduction to single photon emission computed tomography (SPECT) and positron emission tomography (PET)
- Recognition and explanation of common artefacts

2.4.5 Digital Imaging and Interventional Procedures

- Basic principles of picture archiving and communication systems
- Digital fluoroscopy units
- Digital and computerised radiography
- Digital subtraction angiography
- Digital image manipulation

2.5 Clinical Radiology

2.5.1 All aspects of Radiology, with emphasis on imaging management of patients.

2.5.2 General Radiology: A sound knowledge of the common aspects of Radiology that comprise the routine general work in most hospitals.

2.5.3 An appreciation of the role and scope of all available techniques, including highly specialized radiology in relation to the management of clinical problems.

2.5.4 Trainees will also be expected to demonstrate knowledge of:

(A) Clinical conditions in which radiology has a role in diagnosis or management.

(B) Applied pathology, where it contributes to a better understanding of radiological signs and methods of investigation.

(C) Aspects of the radiological sciences (e.g. physics and equipment), anatomy and techniques, sometimes to a level well beyond that which is required for the basic training, but only where relevant to the management of clinical cases or to the solving of diagnostic problems.

(D) Aspects of clinical medicine and pathology which are essential to the safest and effective conduct of interventional procedures performed for diagnosis or for treatment.

(E) The definition and meaning of the basic statistical terms which are necessary for understanding and evaluating statistical claims in published papers. Attendance of the medical statistics sessions in the Clinical Oncology Part I Training Course, or equivalent courses, is advisable.

(F) Current trends and recent advances in all fields of Radiology.

2.5.5 A trainee on completion of training is expected to be able to undertake and report most ultrasound examinations without direct supervision.

(A) A broad experience of ultrasound examinations of various regions of the body should be gained, including abdominal, gynaecological, obstetric, urogenital, vascular, joint and neonatal cranial ultrasound examinations.

(B) The trainee should at least observe or perform 100 cases in obstetric ultrasound, including the technique for examination of first trimester pregnancies.

2.5.6 The trainee should receive basic instruction in the frequently performed angiograms such as aortogram, lower limb angiogram and selective visceral angiogram; and interventional procedures such as percutaneous nephrostomy and abscess drainage.

3.0 HIGHER TRAINING PRIOR TO EXIT ASSESSMENT

3.1 The two years of Higher Training should consist of General Radiology Training,

Subspecialty Training (this refers to training for knowledge and skill in a subspecialty, and not total training for accreditation in that subspecialty), and training in relevant attributes.

3.2 For a broad knowledge-based exposure, the two years of training should consist of:

(A) Minimum of 9 months full time training in General Radiology.

(B) Minimum of two Category A subspecialty subjects (well-recognized radiology subspecialties including Breast Radiology, Cardiovascular Imaging, Thoracic Radiology, Gastrointestinal and Hepatobiliary Radiology, Genitourinary Radiology, Head & Neck Radiology, Interventional & Vascular Radiology, Musculoskeletal Radiology, Neuroradiology, Obstetric & Gynaecological Radiology and Paediatric Radiology), of which one subject should be of 6-month duration.

(C) Remaining period of training in General Radiology, Category A subspecialty subjects, Category B subspecialty subjects (technique-based subspecialties including Ultrasonography, CT, MRI and Radionuclide Imaging) or Category C subspecialty subjects (subjects related to clinical subspecialties particularly strong at a hospital, for instance Transplantation Radiology, Intensive Care Imaging, Oncologic Radiology).

3.3 Higher General Radiology Training:

(A) The program should differ from Basic General Radiology Training, with emphasis on independent performance and supervising responsibility.

(B) The program should be arranged with designated assignments and rotations.

(C) Teaching activities (to clinicians, younger trainee radiologists, radiographers, nurses and medical students) to attain in-depth knowledge of a subject and to improve on presentation skills.

(D) Management of and contribution to film museum and teaching files.

(E) Audit and quality assurance activities.

(F) Academic radiology: research techniques, presentation skills, literature review.

(G) Nurture of professional attitude (ethical standards, legal responsibility, professional image, contribution towards professional organizations and activities, co-ordination with clinical colleagues for better healthcare).

(H) Administrative skills and practice.

3.4 Subspecialty Training:

(A) Structured program conforming to the College guidelines for the specific subspecialty, including the defined minimum workload.

(B) Five or more service sessions weekly specific for the subspecialty is advisable.

(C) For Category A subspecialty subjects, related application with multiple imaging modalities should be built into the program. If certain modalities are not available at the specific hospital, sessional attachment to another hospital is advisable.

(D) A minimum of two subspecialty trainers, or one subspecialty trainer plus one subspecialty co-trainer (who must be a radiologist) are required for each subspecialty.

(E) A subspecialty trainer of a subspecialty program should have previous training in the subspecialty, reasonable years of experience in the subspecialty, major portion of clinical practice being in the subspecialty, related publications and lectures/presentations, and regular attendance of related subspecialty conferences in recent years.

(F) Subspecialty clinico-radiological conference related to Category A subjects should be available on a regular basis, at least once every fortnight, with presentation by the trainee of at least 2 cases per conference.

3.5 Trainees should participate actively in research activities.

[HKCR/EC/DR – January 2020]

Last version endorsed by HKAM Council on 8 December 2015 and effective from 1 January 2016
Revised version endorsed by HKAM Council on 16 January 2020 and effective from 1 January 2020