DIPLOMA IN ADVANCED

MEDICAL IMAGING TECHNOLOGY

Duration 2 years

BOARD OF STUDIES

DEPARTMENT OF IMAGING SCIENCES

AND INTERVENTION RADIOLOGY

INDEX

1. GENERAL PROGRAMME AIMS

The knowledge and practice of advanced medical imaging technology comprise acquiring applied skills in radiological techniques including Digital radiography, CT, MRI, and DSA. Special training and skills are required to enable the technologists to function as an expert practitioner and researcher. The goal of the program is to provide an organized, comprehensive, and supervised full-time educational cum job-oriented experience in the performance of advanced medical imaging technology

Guiding Principles

The following will be the guiding principles of this program

A. Technical Knowledge

1. Acquire advanced technical knowledge and practice-specific knowledge
2. Know and critically evaluate current medical and technical information

B. *Patient Care*

1. Patient interview and prepare for the procedure
2. Synthesis of performance skills
3. Treat patients, physicians, and staff courteously and professionally.
4. Keep the patient's comfort and safety in mind at all times before, during, and following the imaging. procedure.

C. *Interpersonal and Communication Skills*

1. Communicate effectively with other professionals and team members

D. *Professionalism*

1. Demonstrate self-awareness and knowledge of limits

2. Demonstrate high standards of ethical and moral behavior

3. Demonstrate reliability and responsibility

E. ***Practice-Based Learning and Improvement***

1. Engage in ongoing learning to improve knowledge and skills

2. Analyze one's practice to recognize strengths and deficiencies

3. Seek input to improve practice and quality care

F. ***Systems-Based Practice***

1. Promote patient safety within the system

2. Demonstrate effective practice management

At the end of his/her two -year training each student,

1. Should be well acquainted with the current literature on relevant aspects of the basic and advanced investigative techniques in CT, MRI, DSA, and radiography

2. Should have acquired performance skills and the ability to interpret relevant clinical details and apply them practically in imaging.

3. Gain an orientation in the evidence-based approach in acquiring and implementing technical skills in advanced radiological medical imaging

4. Should have learned the performance skills of common radiological procedures and post-processing of imaging data.

5. Should thrive for better knowledge and upheld his constitutional duties

The preparation of scientific manuscripts along with presentation skills is fostered with multi-disciplinary input and mentorship. Routine academic activities will include seminars and applied discussions which will be moderated by senior technologists and radiologists. Students will also be encouraged to present papers at various scientific forums both regional, national, and international levels.

Details of skills to be acquired

- Demonstrate basic knowledge of gross imaging anatomy of the human body with emphasis on brain, cardiac, joints, abdomen to help in the better acquisition of images, post-processing and give technical imaging inputs for radiologist if required

- Demonstrate proficiency in of advanced MR sequences and techniques such as SWI, diffusion tensor imaging, fMRI, BOLD imaging, phase-contrast MRI, MR angiography etc.

- Demonstrate proficiency in performing CT techniques including perfusion CT, CT in complex cardiac disease, triple-phase CT etc.

- Understanding the basics and need for 3D imaging including post-processing skills.

- Develop a thorough knowledge of the physical and physiological properties of contrast agents used in CT and MR; including contraindications and management of potential complications.

- Develop basic observational knowledge in identifying risks and actual preparation and performance of angiography, endovascular interventional.

- Be able to modify imaging protocols based on the identification of unexpected or novel findings.

- When appropriate, screen for non- use of contrast in consultation with the referring physicians.

- Supervise and screen patients for MR safety.

- Make decisions to modify a procedure when unexpected pathology or abnormalities occur, then follow through with the performance and supervision of the procedure.

- Discuss with radiologist regarding the appropriateness and applications of advanced imaging techniques and post-processing techniques
- Demonstrate altruism (putting the interests of patients and others above their own self- interest).

- Demonstrate compassion: Be understanding and respectful of the patients, patient families, and staff and physicians caring for patients.

- Be honest with patients and all members of the health care team.

- Interact with others without discriminating based on religious, ethnic, sexual, or educational differences and without employing sexual or other types of harassment.

- Demonstrate positive work habits, including punctuality and professional appearance.

- Demonstrate an understanding of the broad principles of biomedical ethics.

- Attend in-house and on-call duties as required by the rotations in compliance with regulations

2. ACADEMIC PROGRAM COMMITTEE

2.1 Duties of the Head of the Department:

1. Overall supervision of the conduct of academic programs and evaluation process in the department.
2. Assess the quality and adequacy of the content of the academic program.
3. He / She will assess the remedial measures taken to enhance the performance of the student.
4. Supervision of conduct of internal examinations.

2.2 Program In-Charge (PIC)

The Program In-Charge is accountable to the Head of the Department of IS&IR, the Board of studies, and the Academic council.

The Program In-Charge will ensure that the formal teaching available in the program is organized, relevant, and continually updated. Assistance and resources will be provided to faculty involved in educational programs. With the assistance of faculty and technologists, the Program In-Charge is required to have an ongoing awareness of the performance of students. He/She

1. Will be responsible for ensuring the implementation of academic programs as envisaged by the BOS.
2. Assign an equal number of academic programs for each student for each year and ensure it is conducted
3. Supervise the conduct of evaluation of academic programs by PC
4. Supervise the internal evaluation process
5. Organize internal examinations

6. Report to BOS/academic council, deficiencies, suggestions, and feedback on the upgraded curriculum and evaluation.

2.3 Program Co-Ordinator (PC):

The Program Coordinator will function as a personal educational supervisor for the students and will be accountable to the program In-Charge.

Specific duties of the program coordinator include:

1. Circulate monthly academic roster of the department and send a copy to the academic division for its records
2. Maintain dossier for each student till the end of the course
3. Circulate and collect evaluation forms after each academic program
4. Collect student feedback
5. Organize internal examination
6. Report to PIC periodically about progress and problems with implementation and resolve them. Can seek guidance from the academic council if needed

2.4 Project mentor:

Each student will have a mentor in the department. A mentor will be assigned for the project he does during the course.

3.EDUCATIONAL STRATEGIES

ELIGIBILITY

Essential

The applicant for the course should have passed a course in B.Sc (Radiography/ Radiology/ medical imaging and technology) or 2 year course in DRT(diploma in radiology technology) or equivalent course after 10+2 studies in India . The cut off marks will be more than 50% in their corresponding course.

Mode of Selection

Admission to the course is made on entrance examination conducted by the institute on an All India basis, followed by personal interview or counseling by the Interview Board constituted by the institution according to the norms.

Three candidates are selected per year. Intensive individual clinical training is provided.

They are monitored and trained by Radiologists and Senior Radiographers.

3.1 TRAINING

Clinical Training Modules

Modalities	Average Patients /Day
CT	15
MRI	20
CATHLAB	5

The training for 24 months will include CT, MRI, DSA. The division of the posting will be as follows

Section I	Computerized Tomography	SIX MONTHS
	General Principles of Hospital Practice and Care of patients in Radiology	
	Contrast media	
	CT Clinical training	
Section II	Magnetic Resonance Imaging	TWELVE MONTHS
	MRI Clinical training	
Section III	Biomedical Wing	SIX MONTHS
	Interventional radiologic Techniques	
	Quality Assurance and Radiation Safety	
	Equipment quality control (MRI, CT, DSA)	

TRAINING METHODS

Instructional Methodology: Self Study of Topics, Seminars, Demonstrations, Lectures by Radiologist (Cross Sectional Anatomy and Pathologic appearance of radiology images)

Education is accomplished with a combination of didactic and clinical learning experiences. This course is emphasized in clinical training in CT, MRI, and Cath lab.

Clinical Training is for 8 hours /day for 6 days a week and theory classes for 1 hour/day for 6days a week.

Hands-on clinical experience within the hospital. In addition to this, students are trained to do night and on-call duties.

After successful completion of the course, they can perform a range of radiographic examinations on patients to produce high-quality images.

The medium of instruction English shall be the medium of instruction for all the subjects of study and examination of the course.

In the end, there will be written and Oral Exams.

3.2 CURRICULUM

A well-defined preset curriculum will be implemented during the 2-year program. The trainee students are expected to actively participate in the academic activities conducted during their training period. The curriculum will be announced by the program In-Charge of DAMIT division at the commencement of the training period.

3.3.1 The record of experience - the logbook

Students will be expected to maintain a Logbook of academic activities and experiences. The logbook should be maintained and updated at the end of each posting

It provides trainees with a personal record of all procedural and other training experiences. It will be used by the Educational mentor to monitor the trainee's experience to ensure that it is appropriate. It will also act as a benchmark for getting admission to various jobs in the future

The procedure for completing the logbook:

- The student should enter the data regarding their academic experiences than a format of a weekly data entry chart.
- All charts must be preserved and produced for verification to the Program In-Charge of the course

3.3.2 Submission of Project :

- Submission of at least one project is required. The student should design the project under the guidance of a mentor. It will be recommended for the students to publish / present the project by the end of his/her

course

- Internal Examinations : Every 6 months internal exam which is both practical and theory based will be conducted and interim evaluation will be done

Logbook

Date	Type of activity Specify Seminar, Presentation,	Particulars

Radiological procedures performed

	Name	I D No.	Procedure

The above overall assessment sheet used along with the logbook should form the basis for certifying satisfactory completion of the course of study, in addition to the attendance

E-portfolio

The student will be evaluated, and the marks will be entered in the e-portfolio which will contain all academic activity , projects , posting , conduct of the student in the 2 years . Portfolio scoring will be done

(EVERY 6 MONTHS SCORING)

1	POSTING	SCORING
	MRI	
	CT	
	DSA	
2	SEMINARS PRESENTED	
3	PATIENT CARE AND MANAGEMENT	
4	PROJECTS	
5	MAINTAINENCE OF LOG BOOK	
6	OUTSTANDING PERFORMANCE	
7	POST PROCESSING SKILLS	
8	INTERNAL ASSESMENT	
9	ABILITY TO WORK IN TEAM	

EXIT EXAMINATION AND CERTIFICATION

At the end of 2 years, the exit exam will be there which will consist of theory and practical questions along with viva. The examiners will compromise with two radiologists and a senior technologist. A certificate will be issued on passing the exam by the institute

Syllabus

PART A- BASIC ANATOMY, GENERAL PRINCIPLES, PATIENT CARE AND ATTITUDE, EQUIPMENT QUALITY CONTROL

PART B- SPECIFIC IMAGING MODALITIES- CT, DSA, MRI, RADIOGRAPHY

PART A

1.Basic anatomy in radiography and cross-sectional imaging

- CT and MRI anatomy of the brain, head and neck thorax, heart, abdomen, pelvis, and extremities.
- Cross-sectional anatomy of the brain including cranial nerves, PNS, TMJ, Cerebral arteries, Cerebral vein
- Paranasal sinuses, facial bones, facial muscle, cranial bones, lobes of the brain and midline cerebral hemisphere structures, brainstem, ventricular system, meninges, basal ganglia,
- Spine-Cervical spine, brachial plexus, thoracic spine, lumbar, spine Sacroiliac joint, and limbs.
- Chest and mediastinum-Bony thorax, lung, mediastinum, Breasts
- Abdomen -Surface landmarks and regions, Abdominal organs, and structure.
- Pelvis -Bony structures, Pelvic vasculature, pelvic organs
- Musculoskeletal - Upper extremities - Shoulder, elbow, hand and wrist, Lower Extremities - Hip Knee, Foot, and Ankle
- Cardiac anatomy – 4 chamber view, 3 chamber view, short axis and anatomy of the heart

2. General Principles of Hospital Practice and Care of Patients

A. Definition of terminology relevant to the radiology department,

B. Categories of drugs used in the radiology department and the regulations applied to them**.**

- Basic Pharmacology of drugs commonly used in computed tomography, including contrast media and those used for conscious sedation.
- Patient reactions to contrast media will be explored and the medical interventions necessary for treatment provided.

The pharmacological **profile of contrast agents**-.

- Chemical composition, absorption characteristics ,distribution characteristics ,metabolic characteristics , elimination characteristics
- Indications, actions, and effects, interactions, and contraindications, patient reactions dosage preparation, routes of drug administration, and venipuncture techniques.
- Patient selection and preparation before contrast media administration, assess patient for contraindications to contrast media and respond
- Prepare contrast media, prepare patient and administer contrast media via the appropriate route
- Utilize power injector
- Contrast Medium pharmacokinetics, distribution of concentration medium within the body, contrast enhancement in humans, factors affecting contrast enhancement and scan timing, patient-body weight, mass, surface area, and mass index, cardiac output, and cardiovascular circulation sex and age venous access site, hepatic disease renal function.
- Contrast medium factors- injection duration, injection rate, injection bolus tracking, contrast medium concentration, saline flush during scanning
- Determination of contrast material arrival time: test bolus versus bolus-tracking method time to peak contrast enhancement, scan delay.
- Allergic reaction to contrast media, post-contrast acute kidney injury, and contrast-induced nephropathy in adults. the contrast in children, pregnant breastfeeding, diabetic patients gastrointestinal contrast media, adverse reactions to gadolinium-based contrast media, Nephrogenic systemic fibrosis, indications for renal function assessment before the intravascular administration of iodinated contrast medium, renal dialysis patients and the use of iodinated contrast medium
- A classification system for acute adverse reactions to iodinated and gadolinium containing contrast media., treatment, and management of contrast reactions.
- Contrast media reactions and support in the management

C. Infection control and sterilization methods-

- Preventing disease transmission, universal precautions, standard precaution, medical asepsis, hand washing, and house-keeping,

D. Patient management in diagnostic radiology(Patient Care, Assessment and Safety)

- Appreciate the technologist's role and that the importance of co-operation with wards and other departments.

E. Hospital procedure:

- Hospital staffing and organization; records relating to patients and departmental statistics; the professional attitude of the technologist to patients and other members of the staff
- Medico-legal aspects; accidents in the departments, appointments, organization; minimizing waiting time; out-patient and follow-up clinics; stock-taking and stock keeping.

G. Patient Care :

- Care of patient belongings, moving and transferring patient,
- Assessing the Patient's mobility, methods of moving patients, use of immobilizers, wheelchair transfer, paralyzed patients, precautions of the patient with hip replacement, stretcher transfer, draw sheet transfers, slide board transfers
- Safety straps and rails, restraints, and immobilization, assisting the patient to dress and undress, management of an unconscious patient, handling disabled patient, managing patient with an intravenous infusion, essential care of the patient who has a tracheostomy; essential care of the patient who has a colostomy
- Perform patient assessment - identification of the correct patient, interpret data systems, previous medical history, laboratory results-creatinine,
- Assess, monitor, and respond to various levels of patient status, physical status, cognitive status level of consciousness, emotional status.

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- **H.Departmental procedures:**
  - Department staffing and organizations; records relating to patients and departmental statistics; professional attitudes of the technologist to patients and other members of the staff

- Medico-legal aspects accidents in the department; appointments; organizations, minimizing waiting time; out-patient and follow-up clinics
- Stocktaking, and stock keeping.
- Emergencies in the Radiology department and management: External defibrillation, direct cardiac massage, internal defibrillation, defibrillation by drugs, cardiogenic shock, cerebral edema, complications; cardiac arrest, respiratory arrest. GI Bleed, local anesthetics; reactions, treatment.
- Emergency Equipment: Alarm system, oxygen cylinder, face mask, resuscitation set, and their use

3.Equipment quality control

- Improve the quality of imaging thereby increasing the diagnostic value; to reduce the radiation exposure;
- Reduction of film wastage and repeat examination
- Maintain the various diagnostic and imaging units at their optimal performance.
- Mode, Definition Quality Control - Qc Concerns Imaging Instrumentation and Equipment,
- MRI- Magnet homogeneity, Scanner performance, Performance of all individual coils – SNR, uniformity assessments of MR image quality were included- geometric accuracy, high-contrast resolution, slice thickness accuracy, slice position accuracy, image intensity uniformity, percent signal ghosting, and low-contrast object detectability, Table position, and other displays, Alignment lights, Horizontal smoothness of motion and stability, Vertical motion smoothness and stability, Laser camera, Lightboxes, RF door contacts, RF window-screen integrity, Operator console switches/lights/meters
- Patient monitor, Patient intercom Room temperature/room humidity, Emergency cart Safety warning signage, Cryogen level indicator, Signal to noise ratio, Center frequency
- CT number vs. algorithm selection, CT number vs. slice width, Radiation leakage and scatter.
- Quality assurance program in the radiological faculty level: Responsibility; Purchase; Specifications, Acceptance;
- Maintenance and care of equipment: Safe operation of equipment; routine cleaning of equipment and instruments; Cassette, screen maintenance; Maintenance of automatic processor and manual processing units; Routine maintenance of equipment; Recordkeeping and log book maintenance; Reject analysis and objectives of reject analysis program.
- Care and maintenance of diagnostic equipment: General principles and preventive maintenance for routine - daily, weekly, monthly, quarterly, annually: care in use, special care of mobile equipment.

- Quality Assurance and quality control of Modern Radiological and Imaging Equipment which includes Digital Radiography, Computed Radiography, CT scan, MRI Scan, Ultrasonography, and PACS related.

PART B

1.Computerized Tomography

a. Physics of CT

- Original scanner design, Generations of CT machine, x-ray tubes, CT image reconstruction -kernels, projection, Hounsfield, iterative, maximum intensity projection (MIP), minimum intensity projection (MinIP), algorithm, windowing. CT image quality- Resolution, Spatial resolution, Contrast Resolution, pitch, noise in CT. X-ray tube, filters, collimators, detectors, Imaging System, Gantry, Patient Couch, Ct Computer And Image Processing System, CT Software, Scanner Control, And Image Reconstruction, Image Display, Archiving, Recording Systems, CT Control Console Key Board Controls Room Layout For Ct Equipment, Equipment Specifications

b. CT Techniques and applications

- Technical parameter, practical overview of performing a CT scan
- Image acquisition protocols: CT of head and neck – thorax – cardiac-abdomen – pelvis – musculoskeletal – spine – PNS.
- Anatomy – clinical indications and contraindications – patient preparation – the unique

C. Spiral CT basic principles and applications Definition- Historical development, Differences between convention and spiral/helical, Advantages, Disadvantages, Scanner designs, High-voltage and low-voltage scanners, Slip-ring cylinders and slip-ring disk scanners, Composite and wire scanners.

Principles of multislice CT

- Detector design and terminology, focal spot tracking algorithm, flying focal spot, dose, factors affecting CT dose, automated scan assisted features, pitch and image quality, spatial resolution interpolation or reconstruction artifacts, protocol development, post-processing applications, future development.

Spiral CT advanced techniques

Applications of volume scanning, CT colonoscopy,3D image and visualization, CT angiography, CT endoscopy, CT Guided Biopsies, CT Densitometry.

C .CT Contrast media-

- Common types of Contrast Media - Intravenous, Oral, and Rectal.
- Indications and Contraindications for Contrast Media.
- Chemical Properties of Contrast Media.
- Routes of Drug Administration, Drug Dose Calculations , Contrast Media Reactins , venipuncture Techniques.

D. CT Radiation protection and Dosimetry

- Methods of Measuring Patient Dose
- Techniques of radiation reduction in the adult and pediatric population

E. Advanced CT imaging techniques

- CT perfusion in stroke, CT in complex congenital and adult cardiac diseases, Dual-energy CT

F. patient care in computed tomography

- Preparation of The Patient, Intra-procedure Patient Care, Post Procedural Patient Care, Patient Care In Ct Guided Diagnostic Procedure

g. **CT protocols for different parts of the body**

CT protocols in the brain, stroke imaging, CT perfusion, imaging of paranasal sinus, temporal bone, 4D CT, cardiac CT, CT coronary angiogram protocols in congenital heart disease, Multiphase CT, CT angiography

2.MAGNETIC RESONANCE IMAGING

MRI Technologists' competencies include, but are not limited to patient care, patient positioning, use of magnetic resonance imaging physics and technology, bioeffects and magnetic resonance safety, clinical and organizational responsibility for the examination, and quality assurance.

a. Basic Principles

- Magnetism Magnetic domains Ferromagnetic , Paramagnetic, Diamagnetic the laws of magnetism dipoles, The magnetic field, Electromagnetism, The electromagnet.
- Nuclear Magnetism - Classical mechanics deals with large objects, quantum mechanics, quantum mechanical description, classical mechanical description.
- Atomic Structure -Motion within the atom, MR active nuclei, Larmor Equation, Resonance, Net Magnetization, Vector Diagrams, net magnetization at equilibrium, control of net magnetization, Reference Frames, Stationery Frames Rotating Frames. Flip Angle , Rio Frequency Pulse , Return to Equilibrium, Free induction Decay , T1 recovery-Spin lattice relaxation, T 2 decay-Spin spin relaxation, Pulse timing parameters-Repetition tie Echo time.

b. Instrumentation and Equipment

- Magnetic resonance imaging hardware-The gantry superconducting magnetic resonance imaging system electromagnet imaging system, permanent magnet imaging system, operation console, start-up, Pre-scan calibrations, Image acquisition, Image processing/ Display/ Manipulation, The Magnetic Resonance Imaging Computer, Storage capacity, Computer speed
- Imaging coil technology-Introduction and objectives, Coil Configurations, transmit and receive coil, Receive only coils, General rules for surface coil use, Linear and quadrature design other coil configurations, coil safety. Shim coils, Gradient coils, Radio-Frequency coils, RF transmitters, Receiver coils, RF coil types, Volume coils, Surface coils, Phased array coils. The cooling system in MRI.

c. MRI safety

- Biological Effect of Static Magnetic Fields -Biological effect of MRI in pregnant patients, pregnant employees, Bio Effects of Oscillating Magnetic Fields

- Medical Emergencies, Implants and Prosthesis
- Artifacts from metallics, intracranial vascular clips, intravascular coils, filters and stents, extracranial vascular clips, vascular access ports, heart valves, dental devices and materials, penile implants, otologic implants, ocular implants, intra-ocular ferrous bodies, bullets, pellets and shrapnel, orthopedic implants, surgical clips and pins, halo vests and other similar externally applied devices, mechanically activated or electrically conducive implanted devices, biopsy needles and devices, breast implants and breast tissue expanders, pacemakers.
- Biological effects of time-varying gradient magnetic fields - mechanism of interactions , cell and nerve function , cardiac muscle and cardiovascular system, neural stimulations, rapid pulse sequences, acoustic noise, claustrophobia, and anxiety.

- Biological Effects of Radiofrequency fields- Radiofrequency irradiation, Specific absorption rate, RF antennae effects, Claustrophobia and Anxiety, Quenching, safety education
- Screening –Metallic objects, Implants/pacemakers, Renal disease, Asthma, Pregnancy, Breastfeeding, Dialysis, Claustrophobia
- Ancillary equipment - MR-safe, MR-conditional, MR-unsafe.
- Coils, call button, Earplugs/ headphones, Gating -ECG leads for gating, Peripheral gating, Respiratory bellows for respiratory triggering, Anesthesia equipment monitoring-monitors and devices ,physiologic Monitoring During MRI Procedure, Potential Hazards with Physiologic Monitors. Pulse oximeters, Blood pressure cuffs, Suction apparatus, Power injectors, Syringes, Tubing, Gas cylinders, Patient transportation, Intravenous supplies, Other MR-safe supplies.

<u>d. Image weighting and contrast</u>

- Contrast mechanisms-T1 recovery in fat, T1 recovery in water, T2 decay in fat, T2 decay in water, T1 contrast, T2 contrast, Proton density contrast.
- Weighting-T1weighting, T2weigting,Proto n density weighting, Typical values of TR and TE, T2* decay.
- Radiofrequency Pulse Sequences - Spin Echo, Timing parameters in spin echo, Spin echo using one echo, Spin echo using multiechoes, Gradient Echo, Gradients, gradients dephase and rephase,
- Advantages and disadvantages of gradient echo, Timing parameters in gradient echo, Weighting and contrast in gradient echo(T1, T,2 and Proton), Typical value in gradient echoes,

• Assessing the interaction of imaging sequence parameters--Introduction and objectives, What is image quality, Image contrast Factors which affect contrast, Pulse sequence repetition time (TR), echo time(TE) Effective echo time (ETE), Echo train length (ETL), Inversion time (TI) Flip angle (FA) Matrix Field of view ,Number of acquisition slice thickness , echo train spacing (ET Relaxation rates, Flow Contrast media , Spatial resolution, Inter slice gap, Matrix Field of view , Fast scan technique , Echo train length, Echo train spacing, Signal to noise ratio , Types of noise , Factors affecting SNR, Proton density,

Encoding and image formation

- Gradients-spatial encoding, Slice selection, Frequency encoding, Phase encoding, Sampling.
- K-space,- Fast Fourier transform, Matrix, Scan timing, K-space filling
- Parameters and Trade-offs
- Volume imaging –resolution and uses. Signal to Noise Ratio and Spatial Resolution, Pixel And Voxel Size, Snr Versus Spatial Resolution, Sampling The Signal, FOV, Resolution Artefacts Associated With Reduced Band Width Equations For SNR.
- Gradient echo pulse sequences-Conventional gradient echo, the Coherent and Incoherent gradient echo, RF spoiling, Gradient spoiling, Steady-state-free Precession.
- Ultrafast sequences Echo planar imaging.
- Uses and parameters of different pulse sequences.
- Comparison of acronyms used by manufacturers

- Flow phenomenon–Laminar, Turbulent, Vortex, Stagnant.
- Time of flight phenomenon, Entry slice phenomenon, Co-current flow, Counter current flow, Intravoxel Dephasing.
- Flow phenomenon compensation-Gradient moment rephrasing, Pre saturation, Fat and water saturation, Even echo rephasing.

Encoding and Image formation

- Spatial localization of magnetic field gradients-Slice Selective ,Frequency Encoding Gradient Rephasing Gradient Echo's and Spin Echo's ,Phase Encoding.
- K Space, Basic Properties of K Space, Echo Planar Imaging , partial Resolution, and Contrast , Spatial Resolution and ,Field Of View.

Artifacts and their compensation

- Image processing artifacts, Aliasing artifacts, Chemical shift artifacts ,Gibbs phenomenon, Partial volume artifacts, Remedies. Radio-frequency related artifacts, Cross talk, RF Zipper artifacts, FID artifacts, RF artifacts, RF noise, External Magnetic Field Artifacts, Magnetic susceptibility artifacts, Gradient related artifacts.

Contrast agents in MRI

- Uses and methodology ,Mechanism of action, Dipole-dipole interactions ,Man etic susceptibility,T1 aagentsT2 agents
- Types of MRI Contrast Agents-Positive and Negative
- Gadolinium safety, Gadolinium side effects and contra indications ,Gadolinium administration
- Safety in MR Contrast Administration -Patient history , Preparation
- Contrast administration –Manual ,pressure injector.
- Adverse reactions -. Treatment and follow-up guidelines
- Gadolinium-based MR contrast and NSF

Advanced Imaging Techniques

- MR perfusion – DSC, DCE
- Centric k space manipulated MR angiography
- Non-contrast MR angiography – TOF, TRANCE, SSFP based
- BOLD imaging
- fMRI and post-processing

- Acute stroke imaging
- SWI
- Silent MRA
- T1 mapping
- 4D flow
- IVIM
- DTI
- Advanced imaging in epilepsy and brain tumors
- Phase-contrast imaging of cardiac and pulmonary vasculature
- MR lymphangiography
- High-speed gradient systems, gradient amplitude ,gradient rise time, slew rate, duty cycle, balanced gradient systems , developments in fast spin-echo sequences, inversion recovery, gradient-echo, Applications in echo-planar imaging, diffusion, perfusion, and functional imaging.
- MRS
- MR perfusion , Non contrast MRI

PROTOCOL, PLANNING AND TECHNICAL SPECIFICATION

Head and Neck ,Thorax , Abdomen, Musculoskeletal System imaging, cardiac imaging protocols

Post processing of all imaging modalities in all workstations

3. DSA

a. Basic principles

- Neuro and peripheral vascular and non-vascular interventional Procedures,
- Patient Preparation and Monitoring, Screening Tests, Risk of Angiography, Interventional Radiology Suite
- Equipment selection.

Vascular and interventional material and Techniques

- Materials used- catheters and sheaths, catheter sizes, flow rates, catheter flushing, non-selective catheters, pigtail catheter, straight catheter, selective catheters, end hole vs side hole, end hole catheters, end, and side hole catheters, selective catheters, cobra, the sos omni, renal double curve, head hunter, microcatheters, guide catheters, vascular sheaths, the sheath kinks, embolization materials.
- Guidewires -basic properties, length, stiffness, stiffness of guidelines, floppy, normal diameters, non-steerable guide wires, straight wires, Benston wire, heavy-duty Rosen wire, amplatz super stiff, steerable guide wires, Hydrophilic guide wires, platinum plus.
- Other essential equipment - high-pressure connectors, 2-way taps, 3way taps, vascular snares
- Vascular access - Arterial puncture, Arterial puncture step by step guide the passage of the guidewire
- Commonly used arterial puncture sites - common femoral artery, antegrade puncture, brachial artery , radial artery, popliteal artery, axillary artery, trans lumbar aortogram, venous puncture.
- Commonly used venous access sites -common femoral vein ,internal jugular vein ,Ultrasound-guided puncture , jugular vein puncture , subclavian vein and axillary vein , subclavian vein , axillary vein puncture , median cubital vein
- Complication of angiography and vascular intervention -.
- Medications used- local anesthesia , lignocaine hydrochloride, analgesics ,sedatives , midazolam ,diazepam , vasodilators etc.
- Vascular anatomy of the Circulatory system , vascular wall, dissection, Peripheral vascular disease,

Intervention Radiological Techniques

- Basic Angiography and DSA - History, technique, patient care, Percutaneous catheterization, catheterization sites, asepsis , guidewire, catheters, pressure injectors, accessories, Use of digital subtraction single plane, and bi-plane. All forms of diagnostic procedures including angiography, angioplasty, biliary examination, renal evaluation and drainage procedure.
- Angiography: Carotid Angiography (4 Vessel angiography),Thoracic and Arch Aortography, Vertebral angiography, femoral arteriography, Selective studies: Renal, SMA, Coeliac axis.
- Venography: Peripheral venography, Cerebral venography, Inferior, and superior venocavography. Relevant visceral phlebography.

- Advanced techniques including 3D rotation angiography, stepping stair angiography
- Post processing techniques in 3D angiogram, temporal summation
- Maintenance of the proper stocks of the lab

Care of Patient in Interventional Radiology

1. Responsibilities of healthcare facility-responsibilities of the imaging technologist.

2. A general patient care, patient transfer technique-restraint techniques-aspects of patient comfort-specific patient conditions-security of patient property-obtaining vital signs laying up a sterile trolley-assisting in IV injection.

3. Surgical Asepsis: The Environment and Surgical Asepsis, Methods of Sterilization, Disinfection, Opening Sterile Packs, Changing Dressing.

4. Patient care during the investigation: GI tract, biliary tract, respiratory tract, Gynecology, cardiovascular lymphatic system, CNS, etc.

5. Infection control: definitions- isolation techniques-infection sources-transmission modes- procedures-psychological considerations – sterilization & sterile techniques.

6. Patient education: communication – patient communication problems – explanation of examinations-radiation safety/protection – interacting with terminally ill patients.

7. Medical Emergencies: Shock, Pulmonary Embolus, Diabetic Emergencies, Respiratory Failure, Cardiac Failure, Airway Obstruction, Stroke, Fainting, Seizures.