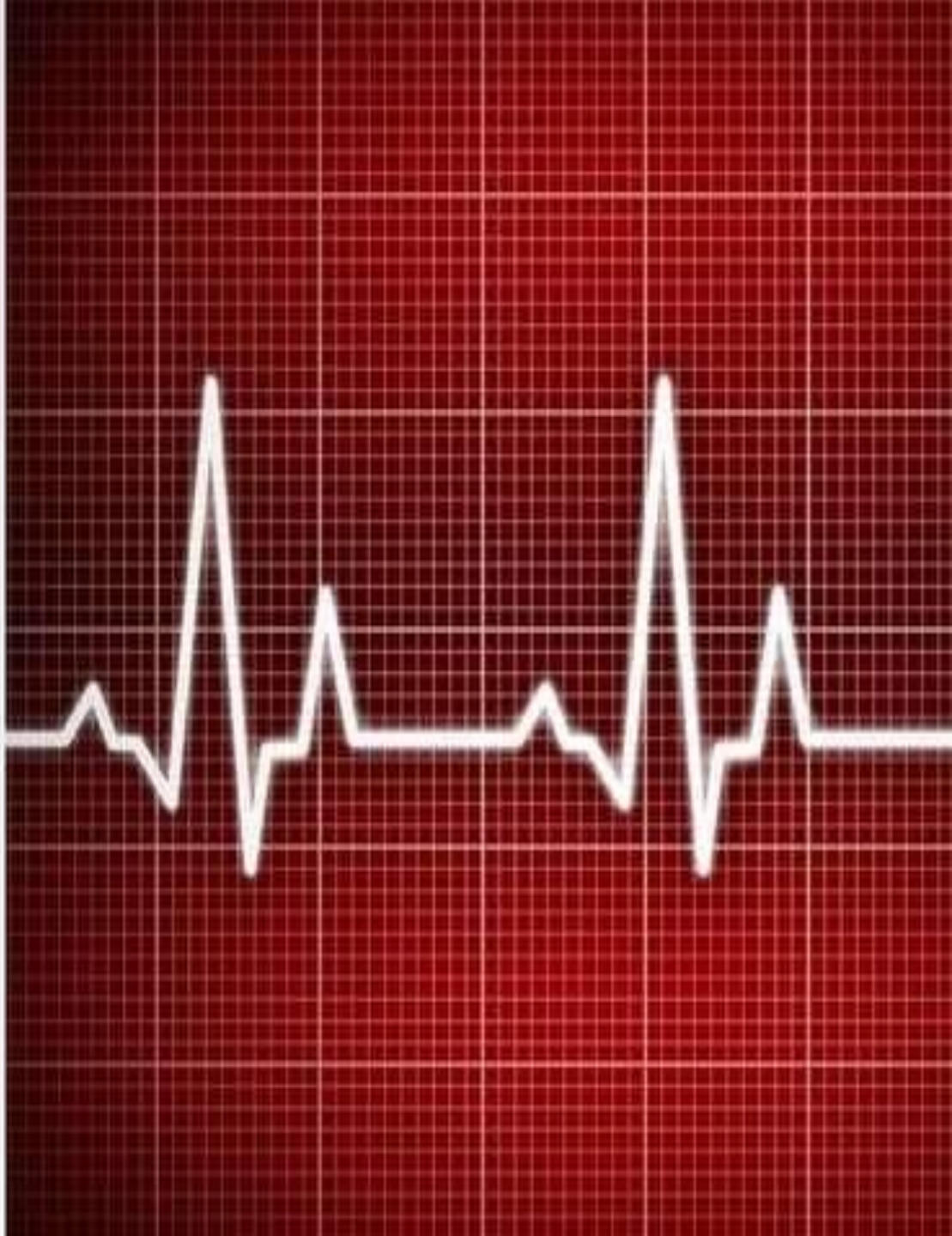
Emergency Radiology



Radiology Department

- Radiology is the science that uses medical imaging to diagnose and sometimes also treat diseases within the body.
- Department of hospital which uses a variety of imaging techniques such as X-ray radiography, ultrasound, computed tomography (CT), nuclear medicine including positron emission tomography (PET), and magnetic resonance imaging (MRI) to diagnose and/or treat diseases.
- Usually located in the ground or basement of a hospital near the emergency department for Radiation safety purpose and easy access during emergency.

Manpower in Radiology Department

- The acquisition of medical images is usually carried out by the radiographer, often known as a **Radiologic Technologist.**
- These images are interpreted by specially trained doctors who interprets the images and produces a report of their findings and impression or diagnosis, often known as a **Radiologist**.
- A **radiology nurse** is a registered nurse who cares for patients in the radiology department undergoing radiation treatment, getting ultrasounds and MRIs, or receiving radiation therapy for cancer.
- Other non-medical staffs are also enrolled in department.
- Strength of manpower can vary according to the daily workload.

Workflow

- Department usually functions 24 hours a day to provide health care facility during Routine and emergency cases.
- During any medical emergency patient is usually rushed to casualty department and for further management and diagnosis is sent to radiology department if indicated.
- Emergency in Radiology department may occur while handling the traumatic, vulnerable patients and in some other critical circumstances.

Emergencies in Radiology Department

1. Trauma/ Polytrauma

- Trauma is a sudden, unexpected, dramatic, forceful, or violent event.
- Blunt, penetrating, explosive and thermal forces are common causes of traumatic injuries.
- Trauma affects persons in all ranges.
- Radiographers in radiology department must be prepared for a variety of procedures on patient in all age groups.

Cont..

- Specialized trauma imaging system reduce the amount of time required to obtain diagnostic images.
  - *One type provides greater flexibility in IR/CR manoeuvrability.*
  - *Another type scans the entire body in few seconds*
- Imaging modalities like mobile radiography unit, mobile fluoroscopy unit, dedicated trauma c-arm unit, CT scan may be used in fractures/foreign body localizations.
- During trauma radiography, the primary necessity are immobilization devices as trauma patient cannot hold the required position and some of the injured parts requires external supports.

Imaging Modalities

Fig 1 : Mobile X-ray Machine

Fig 2 : CT Scan

STAT SCAN

Imaging Modalities –STAT Scan

- Lodox Stat scan is a whole body scan for skeletal and soft-tissue using low-dose x-ray scanner with digital enhancement and enlargement capabilities.
- It is recent advancement for examination of trauma patient..
- In India it is yet to be introduced but several trauma centres in abroad have incorporated this technology into their advanced trauma life support protocols.
- Anterior - Posterior and lateral images can be acquired in 3- 5 min with only 1/3rd of radiation required for conventional radiography.

Imaging Modalities –DSA

- Digital substraction angiography
- DSA can be a very useful modality for the visualization of any vascular injuries caused by trauma.
- Angioplasty can be done by the help of DSA.

Immobilization Devices

Fig 1 : Elbow Splint

Fig 2 : Finger splint

Fig 3 : Cervical Collar- Trauma

Best practices in Trauma Radiography

- Radiographer must always be conscious not to remove any immobilization devices like Cervical collar, Spine board, stabilizers, Polyurethane foam casts etc. during radiography.
- Removal of such immobilization devices may cause further fatal injury or sudden death of patient.

  - Role of Radiographer
    - Speed – Efficiency in producing quality images in shortest possible time.
    - Accuracy – Optimum image quality, minimum repeats.
    - Quality –
      - Quality cannot be sacrificed for speed

Cont.

- Positioning –
  - Important not to aggravate patient's condition when obtaining images.
  - Move tube and IR instead of patient whenever possible.
- Practice standard precautions –
  - Expect to be exposed to body fluids
  - Do not touch patient without gloves.

Trauma Radiographs

Fig 1 : Cervical spine lateral

Fig 2 : Tibia Fibula AP/LAT

Fig 3 : Skull LAT

STAT SCAN

C-spine imaging – Trauma Cases

- For trauma cases, the patient's condition usually requires the examination to be performed on casualty trolley.
- Lateral C-spine projection is taken first without moving the patient with the immobilization provided i.e. ; Cervical collar
- The resulting radiograph must be examined by medical officer to establish whether the patient's neck can be moved for another projection.
- Trans- lateral projection is usually performed.
- In trauma radiography, it is important that all the cervical vertebrae and the Cervico -thoracic junction are demonstrated.
- **Lateral swimmer's view** will produce an image that revels the alignment

C-spine imaging – Trauma Cases

Fig 1 : C-spine trans-lateral, Trauma imaging

Fig 2 : Lateral Swimmer's View, trauma Imaging

L-spine imaging – Trauma Cases

- Patient with suspected fracture to the lumbar vertebrae should not be moved from casualty trolley/Spine board without medical supervision.
- Patient should not be moved in lateral decubitus position in these circumstances.
- Imaging done in Trans-lateral position using vertical Bucky.
- If possible arms should be raised above head.
- Higher exposure will be required than supine lateral, due to effect of gravity internal organs lie on either side of spine.

L-spine imaging – Trauma Cases

Trauma Lateral Lumbar Spine

CR and IR positioned for trauma lateral projection of lumbar spine using dorsal

Skull Imaging- Trauma Radiography

- The value of skull radiography in identifying intracranial injury has not yet been satisfactorily defined.
- Skull trauma series in adult should include at least 3 views –
  - Skull AP
  - Skull LAT
  - Towne's View
- CT scan is better choice for detection and evaluation of injury requiring acute neurological interventions.

Skull Imaging- Trauma Radiography

Fig 1 : Skull AP

Fig 2 : Skull LAT

Fig 3 : Towne's View

Emergencies in Radiology Department

2. Radiation Emergency Situations

- Radiation Accident - A situation in which there is an unintentional exposure to ionizing radiation or radioactive contamination.
- Radiation accidents include -
  1. Radiological accidents
  2. Nuclear accidents

Main types of radiation accidents: involved groups

- Accidents during work - workers
  - Radiography
  - Irradiators (sealed sources and accelerators)
- Accidents due to loss of control over radiation sources - public exposure
  - Radiotherapy
  - Orphan sources
- Accidents in medical applications - patients
  - Misadministration of radiopharmaceuticals
  - Miscalculation of the dose for radiotherapy
  - Multiple radiography and CT procedures exceeding dose limit

Radiation accidents occur at -

- Irradiation facilities
- Material testing (sealed sources)
- Material testing (X-ray devices)
- X-ray and radiotherapy devices (medicine, research)
- Isotope production facilities
- Unsealed radionuclides (medicine, research)
- Nuclear reactors
- During Transportation of Radio nuclides

Radiation Induced injury

- Humans are affected externally and/or internally by ionising radiation.
- Severity of biological effects due to:
  - Dose
  - Dose rate
  - Shielding
  - Energy (degree affects penetration)
- Radiation pathophysiology –
  - Radio sensitivity varies directly with rate of cell proliferation (RBCs, G.I. Mucosa cells).
  - Radio sensitivity varies directly with number of future divisions (stem cells).
  - Radio sensitivity varies inversely with degree of morphologic and functional

Radiation Induced injury

Acute Radiation Syndrome (ARS)

- Responsible for most deaths during first 60 days post-exposure.
- Course affected by age, pre-existing health and nutritional status, concomitant illness/injury.
- Composed of 3-4 sub syndromes which are sequential.
- Sub syndromes includes-
  - Hematopoietic (1-5 Gy)
  - Gastrointestinal (6-30 Gy)
  - Cardiovascular (>30 Gy)
  - Neurologic (>30 Gy)

Radiation Induced injury

1. Hematopoietic

- All blood stem cells undergo radiation-induced cell death (lymphocytes, granulocytes, thrombocytes, & RBC precursors)
- Pancytopenia
- Sepsis usual cause of death
- Haemorrhage
- Recovery: Months-years

Radiation Induced injury

2. Gastrointestinal

Targets: G.I. stem cells, lymphocytes in Peyer's patches

Mucosal lining sloughs, mucosal integrity damaged, mucosal haemorrhage, exudation, ulceration, third spacing, fluid/electrolyte imbalance, paralytic ileus, impaired nutritional absorption, bacterial translocation (sepsis)

Radiation Induced injury

3. Cardiovascular/Neurologic

- Mixed
- Pyrexia, ataxia, decreased higher cortical and motor function, hypotension, increased intracranial pressures within minutes to hours of exposure.
- Necropsy: Micro vascular & endothelial damage, focal brain haemorrhage & necrosis, white matter oedema, demyelination

Radiation Induced injury

4. Miscellaneous conditions –

- Skin
  - Initial transient erythema for few days
  - Secondary erythema progressing to blisters to ulcers –
    - within 1 month
    - The greater the exposure the earlier the manifestations
- Pulmonary
  - Acute radiation pulmonitis
  - Significant crepitus
  - Significant mortality from hypoxic coma within 2-4 weeks later

Radiation Induced injury

Gy	Signs & Symptoms
0.05-0.25	Asymptomatic.
0.50-0.75	Asymptomatic; few with decreased WBC, platelets.
0.75-1.25	Within 2 days, 10-20% with nausea, vomiting,, fatigue; some with mild WBC/platelet, depression
1.25-2.0	Symptomatic; most with hematologic changes; lymphocytes drop 50% within 48 hrs.
2.5-3.5	Serious; 50% mortality if untreated; lymphocytes drop 75% within 48 hrs.
5+	GI sub syndrome within 2 weeks; death occurs in most
50+	CV, GI, CNS sub syndromes with death within 24-72 hrs.

Radiation Induced injury

Chronic radiation syndrome

- It is a constellation of health effects of radiation that occur after months or years of chronic exposure to high amounts.
- Chronic radiation syndrome develops with a speed and severity proportional to the radiation dose received, i.e., it is a deterministic effect of exposure to ionizing radiation, unlike radiation-induced cancer.
- It is distinct from ARS in that it occurs at dose rates low enough to permit natural repair mechanisms to compete with the radiation damage during the exposure period.
- The lower threshold for chronic radiation syndrome is between 0.7 and 1.5 Gy, at dose rates above 0.1 Gy/year.

Fig 1 : Radiation induced melanoma

Fig 2 : Radiation burn

Emergencies in Radiology Department

3. MRI Safety related emergency

- MRI is an imaging modality which uses strong magnetic field and RF pulses to acquire images.
- MRI scans typically take longer and are louder, and they usually need the subject to enter a narrow, confining tube. In addition, people with some medical implants or other non-removable metal inside the body may be unable to undergo an MRI examination safely.
- MRI may not be considered as threatening as other ionising radiation sources but can cause serious and life threatening accidents if safety guidelines are not followed.

MRI Safety related emergency

1. Biological effects (potential risk)
   - Exposure to static magnetic fields of up to 4T are not thought to be harmful

   Biological effects relevant to clinical imaging
   - Distorted ECG (magneto hydrodynamic effect)
   - Consider prudency with pregnancy

2. Mechanical effects (very real risk)
   - Translational or attractive forces on metallic objects when brought into the field

Effects due to Static Magnetic Field

Biological effects

Distorted ECG (magneto hydrodynamic effect)

- Caused by the effect of the static magnetic field on moving blood (systole) as a conducting fluid.
- The gradient and RF fields also affect the configuration of the ECG.
- Morphological ECG changes are therefore difficult to detect and diagnose, but rhythm is usually recognised.
- Any concern regarding rhythm, remove patient from scanner and perform 12 lead ECG

Effects due to Static Magnetic Field

Pregnancy

Patients

- 1st trimester –avoid MR where possible
- 2nd and 3rd trimester – decision made on a risk versus benefit determination. For example if it avoids the patient being subjected to x-rays.

Health Care Workers

- May enter MR scanning room regardless of trimester.
- Should not remain in the room when scanner is operational, avoiding exposure to gradient and radiofrequency fields

Effects due to Static Magnetic Field

Mechanical effects

- **Projectile or missile effect**
  - The attractive forces exerted by the static magnetic field present the greatest potential for patient injury
  - Objects will be pulled out of hands, pockets etc. and fly into magnet which has caused injury and death.
- **Effect on ferromagnetic implants**
  - Electro-mechanical e.g. pacemakers
  - Biomedical e.g. valves, stents

Effects due to Static Magnetic Field

Fig : Projectile effect due to strong magnetic field

Contraindications to MR

Implants & metal

- Cerebral aneurysm clips
- Metallic foreign body in the eye
- Shrapnel, bullets (in critical area)
- Ocular implants (containing metal)
- Swan- Ganz

Electromechanical implants

- Pacemakers /ICD's
- Pacing wires
- Cochlear implants
- Neuro-stimulators
- Hydrocephalus shunts

Effects due to Static Magnetic Field

Gradient fields – Auditory damage

- Hearing protection i.e; headphones mandatory above 90dB.

- Time averaged for:
  - patients
  - staff remaining in the scanner room
  - relatives accompanying children or patients

Effects due to Radiofrequency (RF) fields

Thermogenic effects

Physiological tissue heating response

- Most of the transmitted RF power is transferred into heat within the patient's tissue.
- All MR systems have safety thresholds to avoid dangerous levels.
- Patients with compromised thermoregulatory systems are at greatest risk

Effects due to Radiofrequency (RF) fields

Potential for burns

- 1°, 2°, 3° burns have occurred in the past in patients undergoing MRI.
- The magnetic field lines of a current-carrying loop of wire pass through the centre of the loop, concentrating the field there thus if it gets tangled around any part causes heating effects.
- This is a result of excessive heat developing in the devices or objects.
- ECG system is often the culprit.
- Interventional MRI poses greater risk.

Effects due to Radiofrequency (RF) fields

Prevention of burns

- Electrodes –
    - carbon fibre studs
    - placed close together
- ECG leads –
    - carbon fibre
    - Fibre optic
    - High impedance
    - Short as possible (plaited if necessary)
- All conductive leads should be placed in a linear fashion coming out of bore of scanner

Effects due to Radiofrequency (RF) fields

Fig 1 : Tattoo burn

Fig 2 : RF Burn from non-Carbon Electrode

Quench

Cryogens maintain the magnetic field – helium

Quenching refers to the events that occur when the liquid cryogens that cool the magnet coils boil off rapidly, which results in helium escaping very rapidly from the cryogen bath. This means that the coils cease to be superconducting and become resistive. A quench will in general be accompanied by a loud bang or thundering or hissing or rushing sound with the cold gas expulsion.

Causes –

- physical
- Human error (accidental)
- Intervention (elective)

Effects -

- if no ventilation is present, pressure build up

Quench

Elective Quenching

- The magnet should only be quenched in two situations:-
- If someone is trapped to the scanner by a ferromagnetic object and is injured and/or distressed (eg. O2 cylinder, piece of equipment)
- If there is a fire in the immediate vicinity on order to reduce risk to the Fire Brigade

Quench

Action to be taken in the event of a Quench

- Evacuate the room as quickly as possible.
- Ensure the door is kept open during evacuation.
- Close door after evacuation.
- If trapped in room stay close to floor level.
- Seek the advice of a senior physicist immediately.
- Call scanner engineer

Emergencies in Radiology Department

4. Contrast induced emergency

- Contrast media are the substances used to enhance the visibility of internal body structures during imaging investigations
- Contrast media are used in radiological procedure in X-rays ,CT scan, MRI and in Ultrasound as well.
- Ex- Barium sulphate, Water soluble iodinated contrast, Gadolinium based contrast media, air as negative contrast media.
- Iodinated contrast media are the main cause of contrast induced emergency.

Iodinated contrast media induced emergency

TYPE OF REACTIONS

- Mild: nausea, vomiting , cough, sneezing, warmth , headache, shaking, itching etc.

- Moderate: Tachycardia, Bradycardia, Hypotension , Hypertension, pronounced cutaneous reaction, wheezing.

- Severe: laryngeal oedema, convulsion, arrhythmias , cardiopulmonary arrest

Iodinated contrast media induced emergency

ADVERSE REACTION

The adverse reaction is divided into two group.

1. Acute adverse reactions
   - Occurs within few hours of injection
   - Allergy like reaction occurs followed by release of histamine from mast cell and basophils.
   - Majority reaction are mild.

2. Delayed adverse reaction
   - Occurs anywhere from 1 hours to 1 week of injection.
   - Majority reaction involve skin and subcutaneous tissue.

Emergency Drugs used in Radiology

- Whenever there is sudden onset of allergic reactions after the injection contrast, crash cart in rushed for management.
- The crash cart contains various emergency drugs and equipment for management for those crucial events
- Adrenaline – For allergic reactions
- Atropine - anti- arythmatic
- Buscopan - For pain reliving
- Hydrocortisone - For allergic reactions
- Dopamine - to increase blood pressure
- Sodium bicarbonate - for electrolyte imbalance
- Diazepam - for sedation

Acute kidney Injury (AKI)

Contrast-induced nephropathy (CIN)

- Contrast-induced nephropathy (CIN) is defined as the impairment of renal function measured as either a 25% increase in serum creatinine (SCr) from baseline or a 0.5 mg/dl increase in absolute SCr value within 48-72 hours after intravenous contrast administration.
- Usually reversible, S. Cr. usually returns to the baseline value after 1-3 weeks

Risk factors

- Individuals with chronic kidney disease, diabetes mellitus, high blood pressure, reduced intravascular volume, or who are elderly are at

Acute kidney Injury (AKI)

Incidence

- According to the US FDA, the incidence of renal failure after contrast administration, ranged from 0.6% to 2.3%.
- However, rates of CIN may be as high as 50%, depending on the presence of well characterized risk factors, the most important of which are baseline chronic renal insufficiency and Diabetes mellitus.
- Most of the studies indicate that the higher volume of CM is especially deleterious in the presence of other risk factors , with lower doses of contrast being safer, but not free of risk.

Acute kidney Injury (AKI)

Prevention

- There is no specific treatment once CI-AKI develops, and management must be as for any cause of Acute tubular Necrosis(ATN), with the focus on maintaining fluid and electrolyte balance.
- The best treatment of contrast-induced kidney injury is *prevention*.
- Consider alternate Imaging studies not requiring ICM, for patient with high risk.
- The use of lower doses of low- or iso- osmolal non ionic contrast agents and avoidance of repetitive studies that are closely spaced (within 48 to 72 hours).
- *Hydration* – to Maintain sufficient intravascular volume to increase renal perfusion, Establishment of adequate diuresis prior to contrast media,

Points To Remember

- Major emergency occurs in radiology if patient suddenly collapses on procedure table after injection of iodinated contrast media.
- Before administrating ICM proper patient history of allergic reaction must be taken and adequate preparation must be done prior to study.
- Radiologist, consultant physician must be informed about patient's condition and risk associated with injection of ICM.
- Radiology nurse must be prepared for any adverse reaction and medication must be kept ready.
- In case of sudden cardiac arrest, BLS and ALS protocols must immediately come in action and if required the hospital code for

THANK YOU!!!!

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