72 slide

Modified by: Tasnim Alabdulhamed
batch: 2021

# DEPARTMENT OF RADIOLOGY

Azmy Al-Hadidi, MD

# INTRODUCTION

- Radiology is medical specialty using medical imaging technologies to diagnose and treat the patient.

- Medical imaging : Is non-invasive visualization of internal organs.
  - Requires recognition of NORMAL anatomy.
  - It's primary purpose is to identify pathologic conditions.

his wifes hand

X-rays were first discovered in 1895 by the German physicist William Roentgen, when using a Crookes tube

He called them ‘x’ rays, ‘x’ for ‘unknown’.

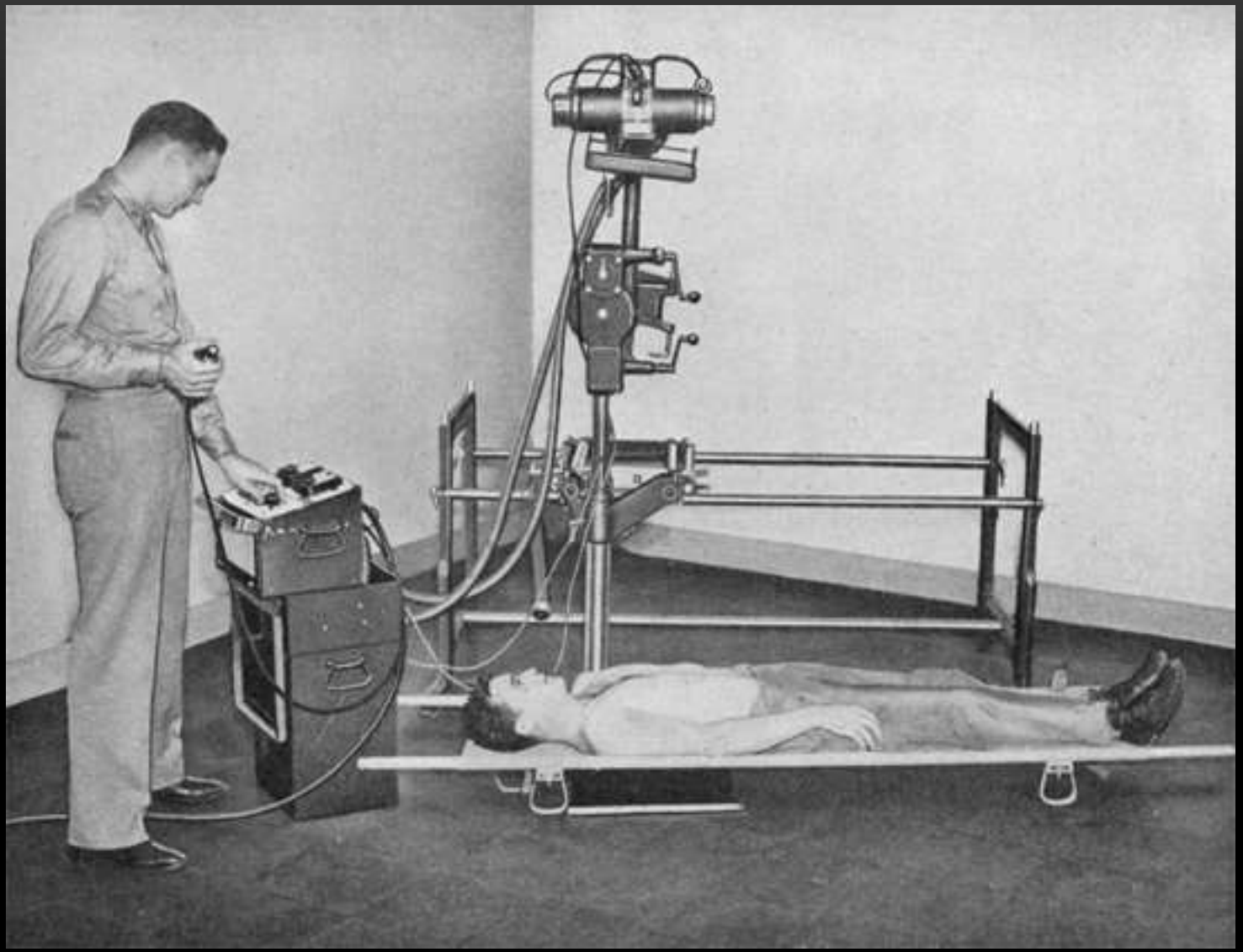
The first x-ray photograph: Roentgen’s wife Bertha’s hand

الزبدة

An X-ray is a form of high-energy electromagnetic radiation that can pass through the body to create images of internal structures based on their varying ability to absorb the rays.

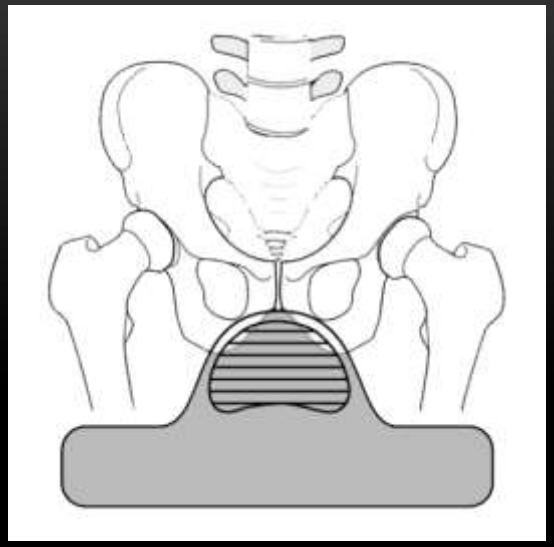
Dr. John Macintyre who set up the world's first radiology department in Scotland at Glasgow Royal Infirmary.

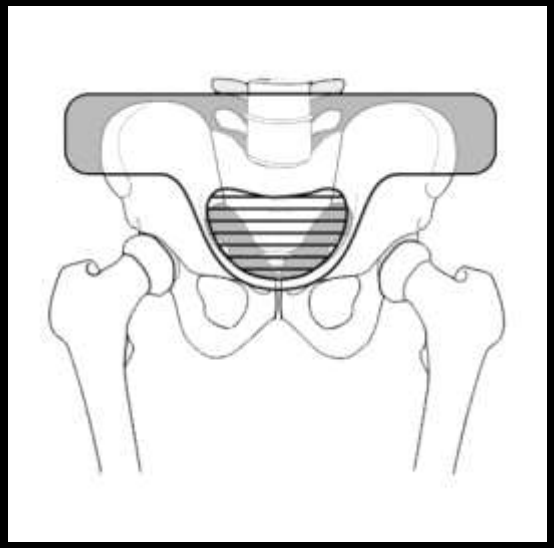

EXAMEN RADIOSCOPIQUE
RADIGUET
PARIS



Sheild

# Protects gonads



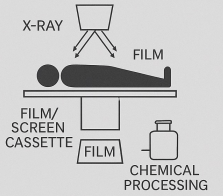


# RADIOGRAPHY

- CONVENTIONAL
  - not used anymore
  - INTENSIFYING SCREENS
  - FILMS
- DIGITAL

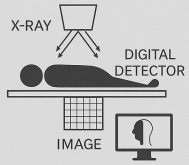
| Feature | Conventional radiography | Digital radiography |
|---|---|---|
| **Image capture** | X-rays expose **film** coated with photosensitive material. | X-rays captured by **digital detector** (solid-state or imaging plate). |
| **Processing** | Requires **chemical development** in a darkroom. | Processed **instantly by computer**; no chemicals. |
| **Image storage** | Physical films; bulky, prone to deterioration. | Stored digitally in PACS; easy retrieval and sharing. |
| **Image quality** | Good resolution but limited dynamic range. | Adjustable contrast, brightness, zoom; wide dynamic range. |
| **Radiation dose** | Often higher. | Can be lower with optimized settings. |
| **Workflow speed** | Slower due to film processing. | Faster; near-instant display. |
| **Cost over time** | Cheaper initially but ongoing film/chemical cost. | Higher initial cost but cheaper long-term. |

## CONVENTIONAL RADIOGRAPHY



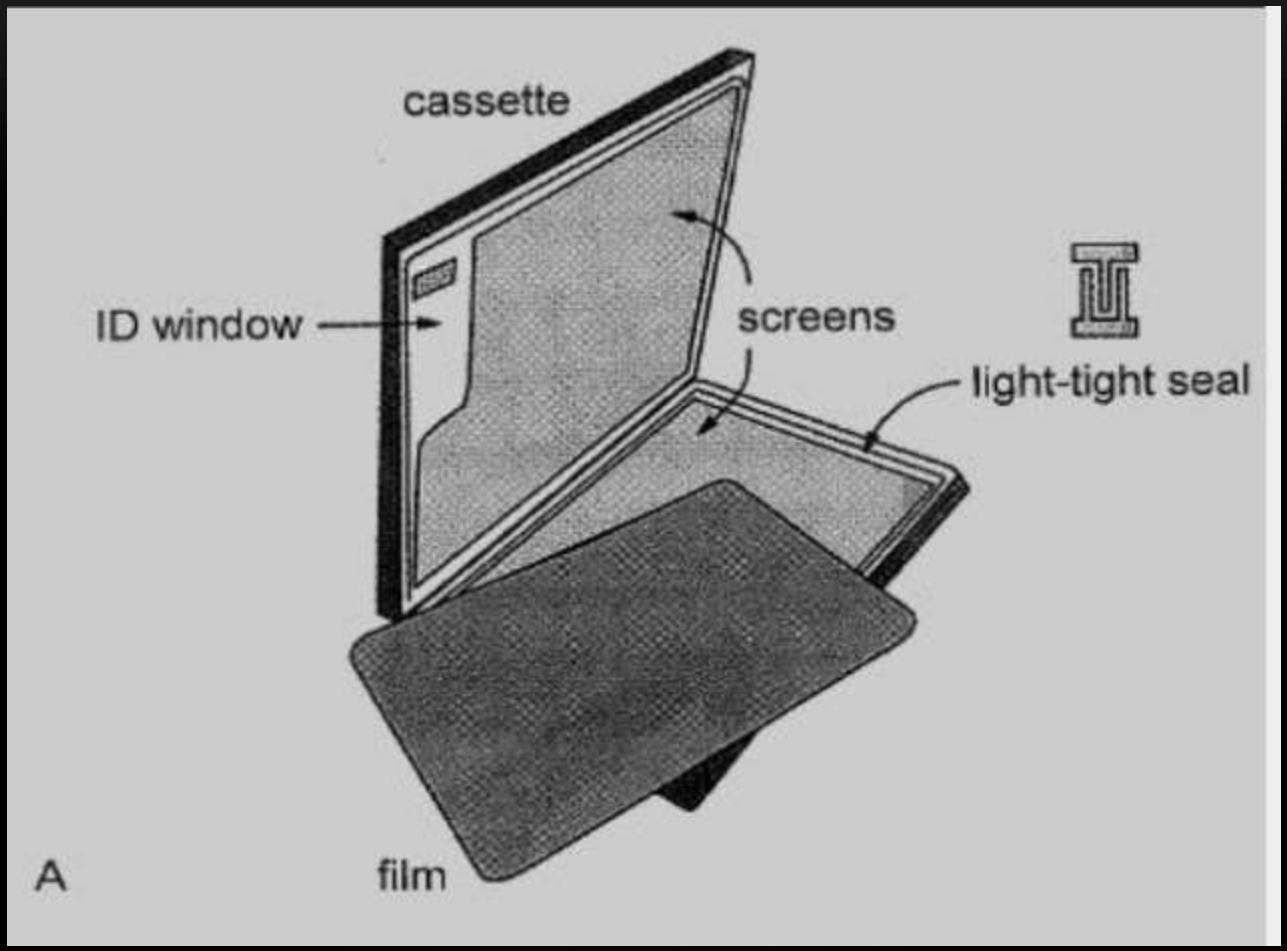

- IMAGE CAPTURE ON FILM
- CHEMICAL PROCESSING REQUIRED
- LIMITED IMAGE ADJUSTMENT
- FILM STORAGE

## DIGITAL RADIOGRAPHY




- IMAGE CAPTURE ON DIGITAL DETECTOR
- DIRECT DIGITAL PROCESSING
- IMAGE ADJUSTMENT POSSIBLE
- DIGITAL STORAGE

# conventional

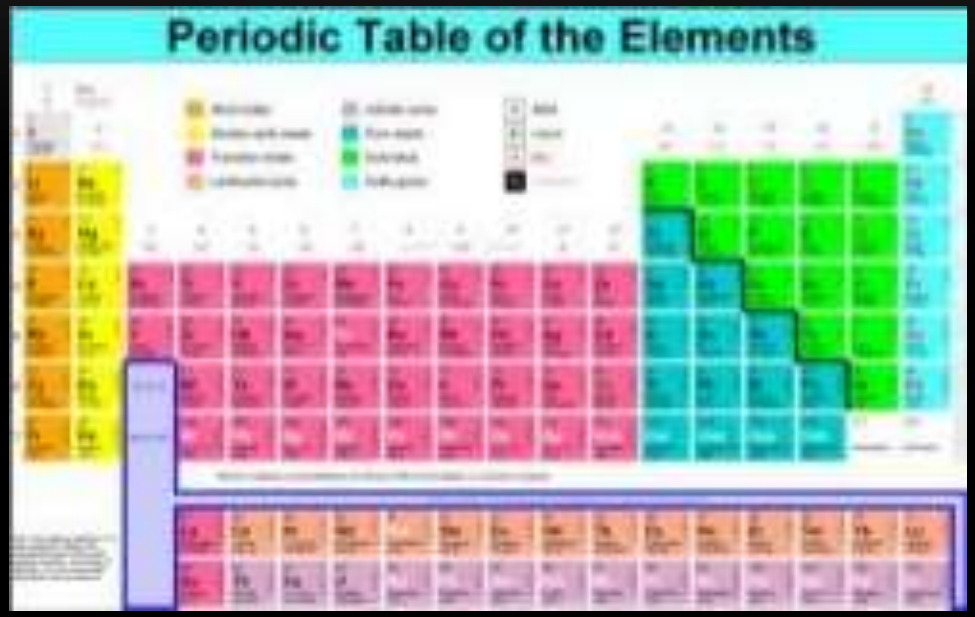


# INTENSIFYING SCREENS

- It is part of cassette, which converts x-ray energy into visible light spectrum (Fluorescent process).
- Initial screens used Calcium Tungustate.
- Modern screens use rare earth elements. ( Most efficient, and most common in use, provides better detail images)
- Advantages:
  - Reduce x-ray dose to the patient and provides short exposure time
  - Increase x-ray tube life

The rare earth group of elements include:

1-Lanthanum ( Z=57)
2-Gadolinium (Z=64)
3-Yttrium ( Z=39)
4-Terbium (Z=65)
5-Thulium (Z=69)



DEVELOPER → FIXER →WASHING → DRYER

similar to old photos processing

# AUTOMATIC PROCESSOR

- Less work load compared to manual processing.
- It maintains the time and temperature of the processing procedure.

ionizing radiation

# CR computed radiography

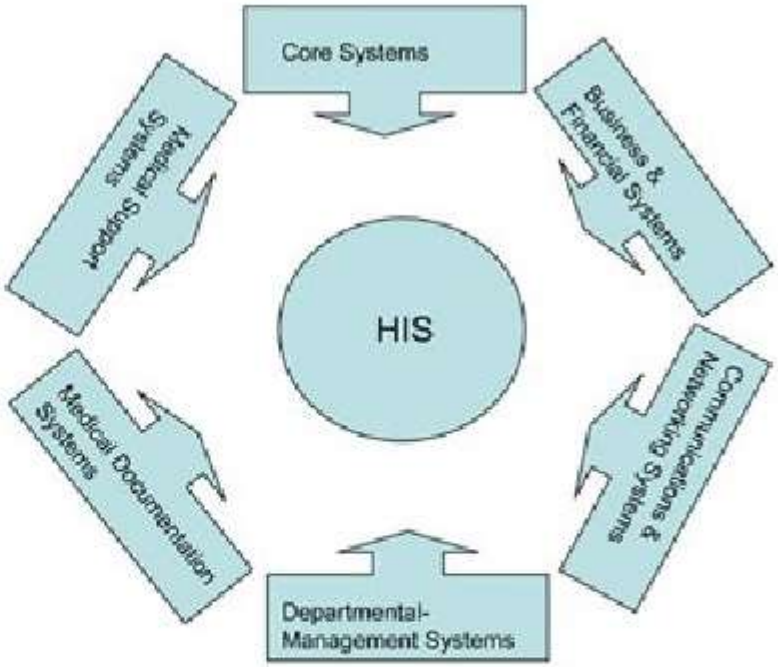
# PACS


Picture Archiving and Communication System

# RIS

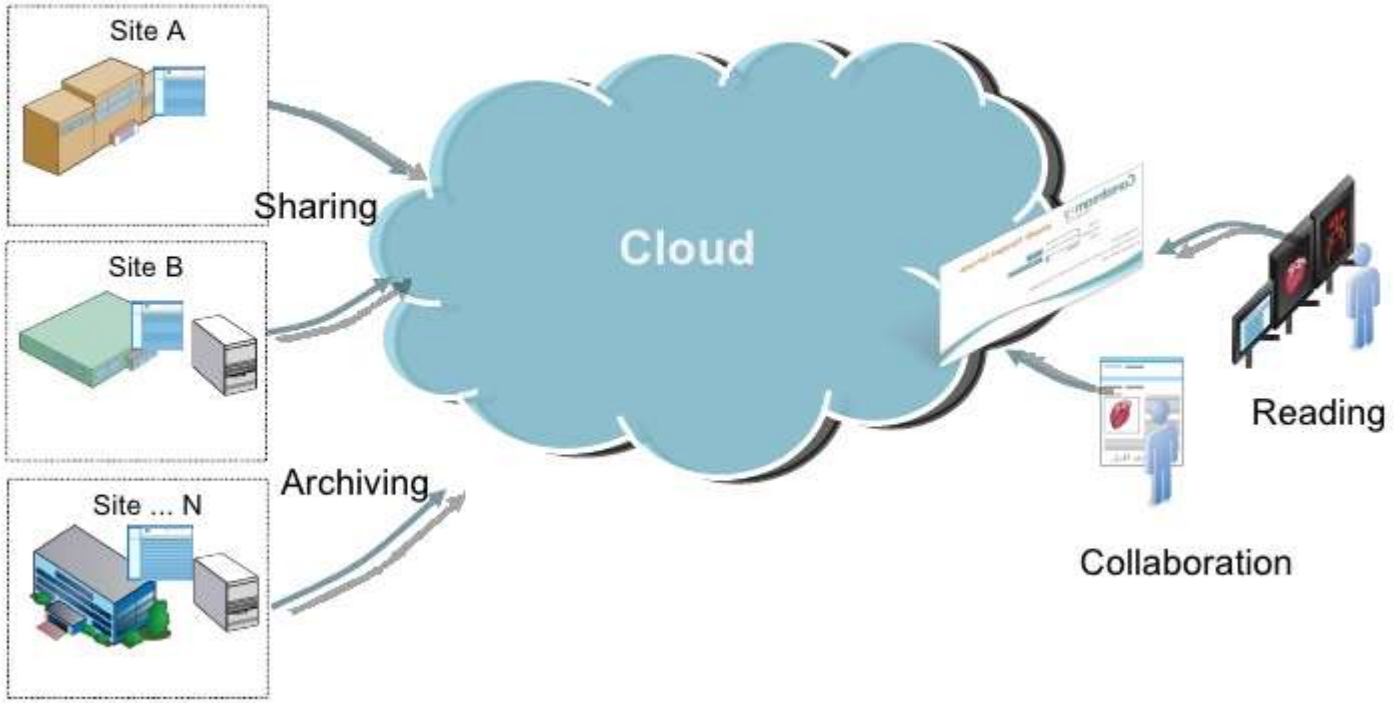

Radiological Information System

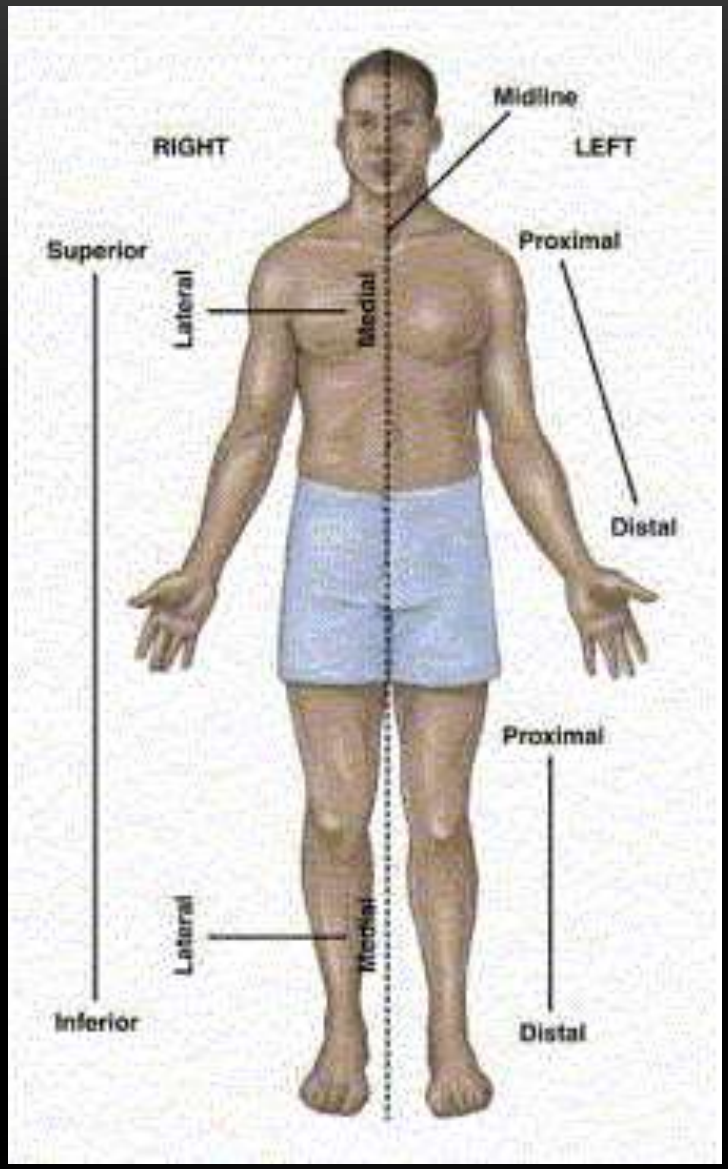
# HIS




Hospital Information System

# A New Approach: Cloud-based Services…




Midline
RIGHT
LEFT
Superior
Proximal
Lateral
Medial
Distal
Proximal
Lateral
Medial
Inferior
Distal

# IMAGING MODALITIES

## Ionizing Radiation

1-Conventional radiography (X-ray)
- Fluoroscopy
- Mammography

2-Computed tomography (CT)

3-Nuclear medicine (NM)

4-Angiography
CTA, Fluroscopy

## Non-ionizing Radiation

1-Ultrasound (US)

2-Magnetic resonance imaging (MRI)
- MRA, MRCP….etc.

Ionizing radiation is limited during pregnancy.

affects the baby's development + oncogenic to baby

don't memorize

# RADIATION DOSE

| Diagnostic Procedure | Typical Effective Dose (mSv)[1] | Number of Chest X rays (PA film) for Equivalent Effective Dose[2] | Time Period for Equivalent Effective Dose from Natural Background Radiation[3] |
|---|---|---|---|
| Chest x ray (PA film) | 0.02 | 1 | 2.4 days |
| Skull x ray | 0.1 | 5 | 12 days |
| Lumbar spine | 1.5 | 75 | 182 days |
| I.V. urogram | 3 | 150 | 1.0 year |
| Upper G.I. exam | 6 | 300 | 2.0 years |
| Barium enema | 8 | 400 | 2.7 years |
| CT head | 2 | 100 | 243 days |
| CT abdomen | 8 | 400 | 2.7 years |

# BIOLOGIC EFFECTS OF RADIATION (STOCHASTIC AND NON-STOCHASTIC EFFECTS ).
# ADULTS VS CHILDREN.

will be explained in lecture:
Biological Effects Of Radiation
↳page 13

NCBI Resources How To Sign in to NCBI

PMC US National Library of Medicine National Institutes of Health

PMC Search

Advanced Journal list Help

Journal List › Int J Environ Res Public Health › v.13(11); 2016 Nov › PMC5129267

International Journal of Environmental Research and Public Health — MDPI

Int J Environ Res Public Health. 2016 Nov; 13(11): 1057.
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PMCID: PMC5129267
PMID: 27801855

## Pediatric Exposures to Ionizing Radiation: Carcinogenic Considerations

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Helena Solo-Gabriele, Academic Editor and Alesia Ferguson, Academic Editor

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### Abstract

Go to:

Children are at a greater risk than adults of developing cancer after being exposed to ionizing radiation. Because of their developing bodies and long life expectancy post-exposure, children require specific attention in the aftermath of nuclear accidents and when radiation is used for diagnosis or treatment purposes. In this review, we discuss the carcinogenic potential of pediatric exposures to ionizing radiation from accidental, diagnostic, and therapeutic modalities. Particular emphasis is given to leukemia and thyroid cancers as consequences of accidental exposures. We further discuss the evidence of cancers that arise as a result of radiotherapy and conclude the review with a summary on the available literature on the links between computer tomography (CT) and carcinogenesis. Appropriate actions taken to mitigate or minimize the negative health effects of pediatric exposures to ionizing radiation and future considerations are discussed.

**Keywords:** radiation, children's health, cancer, computed tomography

**Formats:**

Article | PubReader | ePub (beta) | PDF (305K) | Citation

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Ionizing radiation, part 1: X- and gamma-radiation, and neutrons. Overall introduction. [IARC Monogr Eval Carcinog Risk...]

Cancer risks following diagnostic and therapeutic radiation exposure in children. [Pediatr Radiol. 2006]

Radiation dose features and solid cancer induction in pediatric computed tomography. [Med Princ Pract. 2012]

See reviews...

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**Cited by other articles in PMC**

A Review of the Field on Children's Exposure to Environmental Contaminants: A Risk Assessmen [International Journal of Envir...]

See all...

Int J Environ Res Public Health

# PATIENT ENCOUNTER

- History
- Clinical examination
- Labs
- Differential diagnosis and plan
- Indication to perform imaging study
- Choice of imaging modality
  - i.e ILD, Temporal bones → HRCT high-resolution CT
  - Looking for urinary tract stones → Urinary tract CT
  - Looking for causes of acute abdomen → Abdomen and Pelvis CT

With / without contrast??

# CONTRAST

- Contrast can be administered IV, IA, Oral or Rectal
  ↳ intra arterial
- IV contrast administration ?
  - Valid clinical indication for contrast medium administration
  - Justification ( Benefit VS Side effects allergic like and physiologic )
  - Imaging alternatives that would provide the same or better diagnostic information

# CONTRAST (CONT'D)

- Before administration IV contrast
  - Patient consent form
  - Check Serum Cr levels / eGFR ⟶ to assess kidney fnx
  - Check C/I's and the need for premedication. C/I : contraindications
    - C/I prior allergic like reactions to contrast medium
    - Premedication i.e Allergy to medications, Asthma…etc.

allergy cases : pre adminster with prednisolone

# IV IODINATED CONTRAST MEDIA

- Contrast side effects ← nephrotoxic, pregnancy, allergy
  - *Physiologic reactions* ( reactions related directly to contrast chemical composition and osmolarity or molecular binding to certain activators) which include:
    - Nausea
    - Vomiting
    - Feeling of warmth

don't confuse these normal SEs with allergic rxn which appears as:

1. urticaria
2. itching
3. wheezing
4. angioedema
5. anaphylactic shock

} mostly with 2nd exposure

# IV IODINATED CONTRAST MEDIA ( CONT'D )

1. arrhythmias
2. cardiogenic pulm. edema
3. seizures
4. vasovagal rxn
5. htn

- Cardiovascular effects (cardiac arrythmias, depressed myocardial contractility, cardiogenic pulmonary edema→ (more common and significant in patients with underlying cardiac disease) and seizures. These phenomena are likely related to either contrast media-related hyperosmolality and/or calcium binding leading to functional hypocalcemia.
- Vasovagal reactions ( Hypotension and bradycardia ) exact pathogenesis still unknown. Related to anxiety during obtaining informed consent or during placement of needle / catheter, or during IV administration of contrast media.
- Hypertension
- In children: physiologic side effects, may cause a child to move or cry. Such a response to contrast medium injection may result in the acquisition of a nondiagnostic imaging study, necessitating repeat imaging and additional exposure to contrast medium and radiation. can sedate them

# IV IODINATED CONTRAST MEDIA (CONT'D)

- *Allergic like reactions*
  - Hives (Urticaria)
  - Diffuse erythema
  - Bronchospasm
  - Laryngeal edema
  - Anaphylactic shock

# CONTRAST MEDIA PHYSIOLOGIC AND ALLERGIC LIKE REACTIONS

## Mild

Signs and symptoms are self-limited without evidence of progression. Mild reactions include:

| Allergic-like | Physiologic |
|---|---|
| Limited urticaria / pruritis | Limited nausea / vomiting |
| Limited cutaneous edema | Transient flushing / warmth / chills |
| Limited "itchy" / "scratchy" throat | Headache / dizziness / anxiety / altered taste |
| Nasal congestion | Mild hypertension |
| Sneezing / conjunctivitis / rhinorrhea | Vasovagal reaction that resolves spontaneously |

## Moderate

Signs and symptoms are more pronounced and commonly require medical management. Some of these reactions have the potential to become severe if not treated. Moderate reactions include:

| Allergic-like | Physiologic |
|---|---|
| Diffuse urticaria / pruritis | Protracted nausea / vomiting |
| Diffuse erythema, stable vital signs | Hypertensive urgency |
| Facial edema without dyspnea | Isolated chest pain |
| Throat tightness or hoarseness without dyspnea | Vasovagal reaction that requires and is responsive to treatment |
| Wheezing / bronchospasm, mild or no hypoxia | |

# Severe

| Allergic-like | Physiologic |
| --- | --- |
| Diffuse edema, or facial edema with dyspnea | Vasovagal reaction resistant to treatment |
| Diffuse erythema with hypotension | Arrhythmia |
| Laryngeal edema with stridor and/or hypoxia | Convulsions, seizures |
| Wheezing / bronchospasm, significant hypoxia | Hypertensive emergency |
| Anaphylactic shock (hypotension + tachycardia) | |

# GENERAL RULES FOR CONTRAST ADMINISTRATION

- Allergy to previous IV contrast examination is absolute contraindication for contrast re-administration.

- Pre-medication is required for patients with history of allergy using 13 or 12 hour regimen ( Allergy to food, medications, medical conditions like Asthma, seasonal allergy.....etc)
  - Corticosteroids
  - Chlorpheniramine ( Mandatory 13 hr regimen / optional 12 hr regimen )

PC

contrast induced nephrotoxicity

# POSTCONTRAST ACUTE KIDNEY INJURY & CIN

- PC-AKI: sudden deterioration in renal function that occurs within 48 hours following the intravascular administration of iodinated contrast medium.
- The exact pathophysiology of CIN is not understood. Etiologic factors that have been suggested include renal hemodynamic changes (vasoconstriction) and direct tubular toxicity.
- One of the most commonly used criteria has been an absolute increase of 0.5 mg/dL over a baseline serum creatinine.

# POSTCONTRAST ACUTE KIDNEY INJURY & CIN (CONT'D)

- According to Acute Kidney Injury Network (AKIN)-definition of acute kidney injury: "If one of the following occurs within 48 hours after a nephrotoxic event (e.g., intravascular iodinated contrast medium exposure) "
  - 1) Absolute serum creatinine increase ≥0.3 mg/dL (>26.4 μmol/L).
  - 2) A percentage increase in serum creatinine ≥50% (≥1.5-fold above baseline).
  - 3) Urine output reduced to ≤0.5 mL/kg/hour for at least 6 hours.

# POSTCONTRAST ACUTE KIDNEY INJURY & CIN (CONT'D)

- Risk factors:
  - The most important risk factor is pre-existing severe renal insufficiency.
  - Multiple iodinated contrast medium doses in a short time interval (<24 hours)
  - Other risk factors include diabetes mellitus, dehydration, cardiovascular disease, diuretic use, advanced age, multiple myeloma, hypertension, hyperuricemia

# POSTCONTRAST ACUTE KIDNEY INJURY & CIN (CONT'D)

- Prevention:
  - Avoidance of iodinated contrast medium administration.
  - Volume expansion.
    - Use Isotonic fluids (Lactated Ringer's or 0.9% normal saline). Normal saline ( 0.9% ) at rate 100 mL/hr 6-12 hours before and continued 4 to 12 after contrast administration.
    - Oral hydration has also been utilized.

# GADOLINIUM BASED CONTRAST MEDIA GBCM

- Most adverse reactions are physiologic and mild , however allergic like reactions are uncommon. Severe life threatening anaphylactic reactions are rare.
- Mild physiologic adverse reactions associated with GBCM administration:
  - Include coldness, warmth, or pain at the injection site; nausea with or without vomiting; headache; paresthesias; and dizziness.

**Safer**

# GADOLINIUM BASED CONTRAST MEDIA ( CONT'D )

- Important side effect →NSF (Nephrogenic Systemic Fibrosis)
  - Patients at risk are those with underlying kidney disease. (Patients with acute kidney injury or severe chronic kidney disease )
  - eGFR ( Normal => 60, not administrated if < 30 )
  - Thus its incidence was reduced significantly.

In patients with normal renal function.
New studies discussed long term accumulative effect on the brain.

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Japanese Journal of Radiology
January 2016, Volume 34, Issue 1, pp 3–9 | Cite as

# Brain gadolinium deposition after administration of gadolinium-based contrast agents

Authors Authors and affiliations

Tomonori Kanda, Hiroshi Oba, Keiko Toyoda, Kazuhiro Kitajima, Shigeru Furui

Review
**First Online:** 25 November 2015



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## Abstract

Gadolinium-based contrast agents (GBCAs) consist of gadolinium ions and a chelating agent that binds the gadolinium ion tightly so that its toxicity is not manifested. However, in 2013, an association between brain MRI abnormalities and a history of GBCA administration was first reported. Even in patients with normal renal function, increased signal intensity in the dentate nucleus and globus pallidus on unenhanced T1-weighted images showed a positive correlation with previous exposure to linear chelate type GBCAs, but not to macrocyclic chelate type ones.

# ADMINISTRATION OF CONTRAST TO PREGNANT / POTENTIALLY PREGNANT PATIENTS

- All IV iodinated and gadolinium-based contrast media behave in a similar fashion and cross the blood-placental barrier and into the fetus.
- Their administration to pregnant and potentially pregnant patients should be limited.

iodinated
contrast can cross placenta & cause thyroid problem on the fetus

# CONVENTIONAL RADIOGRAPHY (X-RAY)

i.e Most common radiologic test→ Chest-X-ray

Indications:

- Cough
- Fever
- Chest pain
- Follow-up on known disease to asses progress
- Trauma, , post-operative, monitoring ICU patients, checking position of NG tubes, ETT, central lines and screening tool for immigrants….etc.

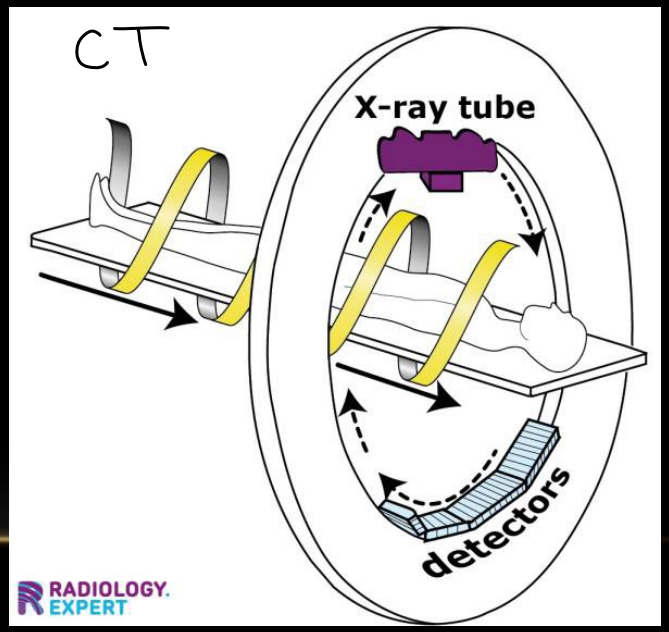
↳ CT risk

# COMPUTED TOMOGRAPHY (CT)

- CT scan machines uses X-rays, a powerful form of electromagnetic energy.
- CT combines x radiation and radiation detectors coupled with a computer to create cross sectional image of any part of the body.
- The internal structure of an object can be reconstructed from multiple projections of the object.

# CONVENTIONAL RADIOGRAPHY VS CT

- Conventional radiography is basically a shadow , that gives incomplete picture of an objects shape.
- CT (computed aided tomography) : In CT scan machine the x-ray beam moves all around the patient scanning form hundreds of different angles.




SOMATOM
Definition AS

# CT (CONT'D)

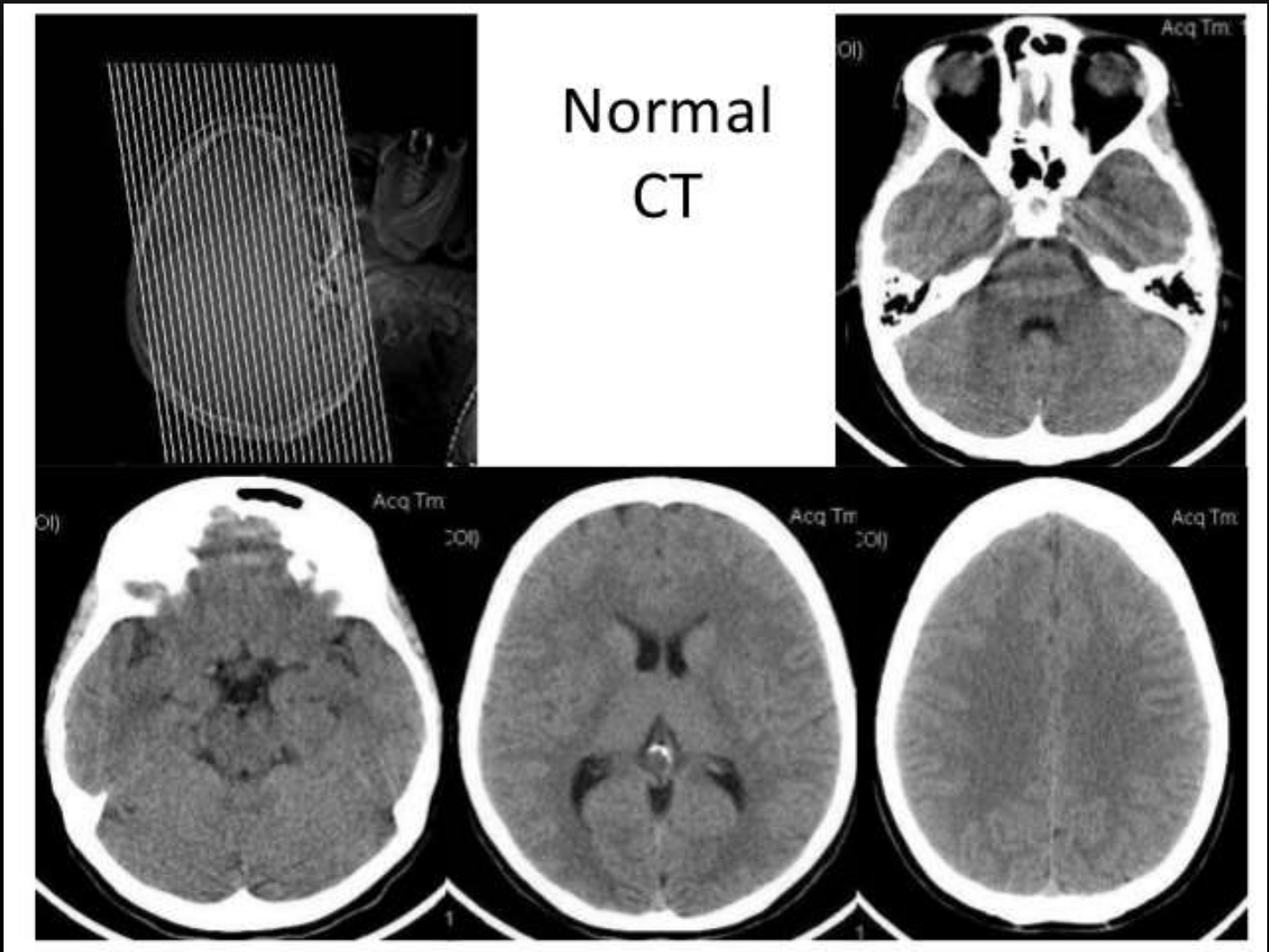
- Common CT radiologic examinations:
  - Head CT (Brain, skull vault, sinuses and orbits) with/without contrast
    - Indications:
      - Seizures
      - Headache
      - Acute stroke, GCS < 13, FND (→ functional neurological disorder), skull fracture
      - > 1 episode vomiting especially in patients with coagulopathy or on anticoagulants in adults 3 more episodes of vomiting in children, features of increased ICP, hydrocephalus, suspected space occupying lesions…..etc.

# CT (CONT'D)

- Chest CT with/without contrast
  - Indications: To evaluate abnormalities on CXR, evaluate pulmonary and pleural masses, diffuse pulmonary disease (diagnosis and extent), evaluation of mediastinum, bronchiectasis (suspected, extent, and severity) , Suspected PE

- Abdomen and Pelvis CT with / without contrast
  - Indications: acute appendicitis, diverticulitis, acute pancreatitis and pseudocyst "chronic pancreatitis without contrast), cancer staging, evaluation of urinary tract ( with or without contrast), abdominopelvic blunt trauma (echymosis, drop Hb/HCT.

# NORMAL ANATOMY



# FLUOROSCOPY

# FLUOROSCOPY (CONT'D)

- FLUOROSCOPY primary function is to perform dynamic studies. → video
- It's purpose, to visualize in real time
    - Organ motion
    - Ingested or injected contrast agents
    - Therapeutic interventions: insert stents, catheterize small vessels

# FLUOROSCOPY (CONT'D)

- Visualization of vessels is called angiography. Opacification of blood vessels using contrast, which include arteriograms and venograms. Used for diagnostic and therapeutic purposes.
  - Diagnostic: aneurysm, thrombosis, AVM, AVF → fistula
  - Therapeutic: embolization, stenting, thrombectomy, thrombolysis

# FLUOROSCOPY (CONT'D)

- Other common examinations:
  - Barium Swallow, meal, follow through and enema
  - MCUG / VCUG ⟶ urology
  - Hysterosalpingogram ⟶ gyne
  - Other like sialography…..etc. ⟶ Parotid gland

- Some examination require patient preparation, i.e enema and hysterosalpingogram studies.
- Before the examination begins the patients is asked to remove radio-opaque clothing or jewelry. Then they are provided with a gown to wear. Then depending on the procedure being done contrast is given either orally, rectally, or intravenously…etc.

# MCUG/ VCUG

- INDICATIONS:
  - VUR vesicoureteric reflux
  - Study urethra during voiding
  - Bladder leak after trauma, or post-surgery
  - Urodynamic studies i.e incontinence
- Patient encounter:

History: indication, S&S urinary infections

C/I→ Acute UTI

Patient preparation →Foley's catheter insertion, Empty UB


VUR

NL

# FLUOROSCOPY (CONT'D)
# HYSTEROSALPINGOGRAPHY

uterus fallopian

Patient encounter: History, making sure patient is prepared for exam and no C/I exists.

- INDICATIONS:
  - Infertility
  - Recurrent abortions ( congenital anomaly, incompetent cervix)
  - Assessment fallopian tubes (following tubal surgery, post-sterilization)
  - Assessment integrity of caesarean uterine scar

Patient preparation:

-Abstain from intercourse

-Examination done before day 21 of menstrual cycle between $4^{th}$-$10^{th}$ day.

C/I 's:

-Pregnancy

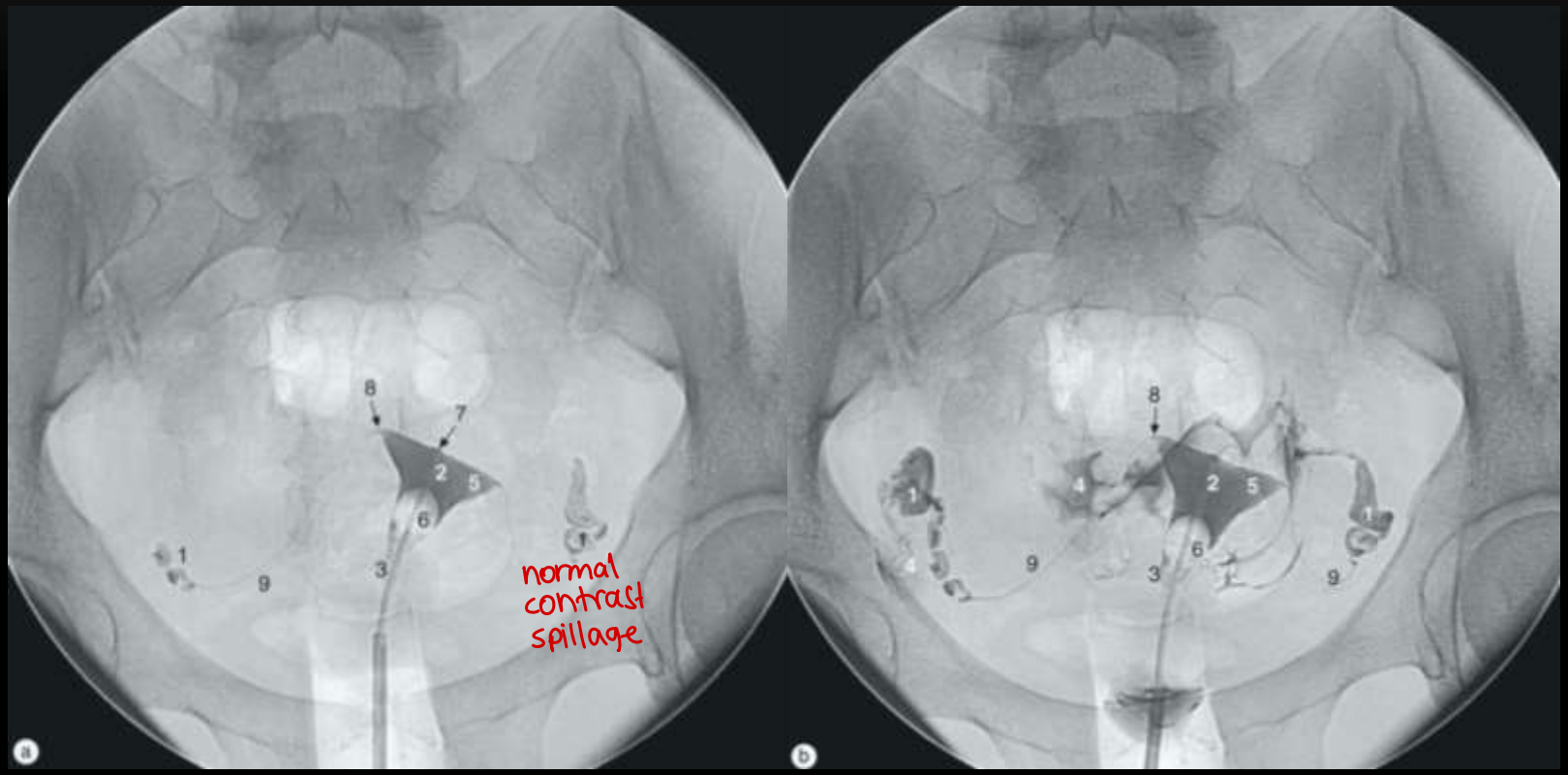
-Bleeding ( during menstruation)

-Purulent discharge, or PID in preceding 6 months

-Recent abortion / dilatation

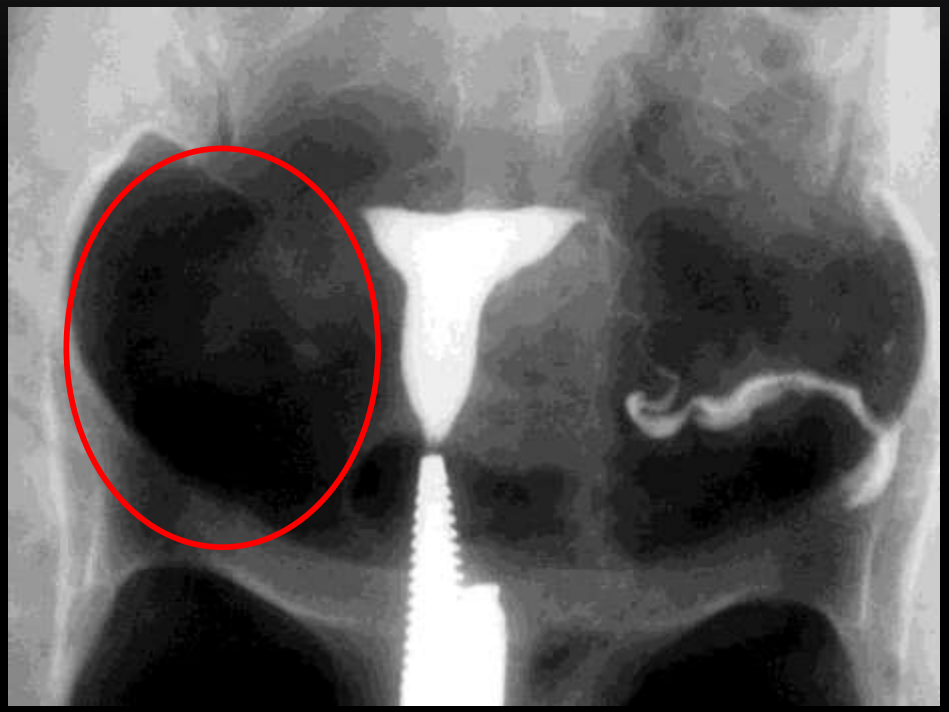
# EQUIPMENT

water soluble contrast to prevent peritonitis

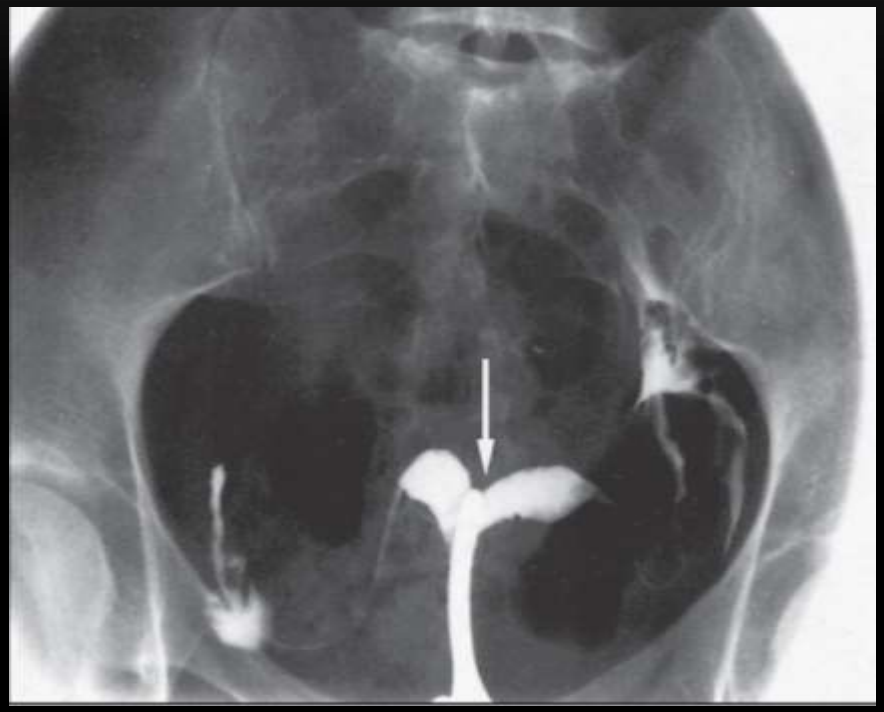



Early phase and late phase of uterine filling demonstrating peritoneal spillage bilaterally, suggesting patent fallopian tubes.

# DIAGNOSIS?




Unilateral cornual block



Bi-cornuate uterus

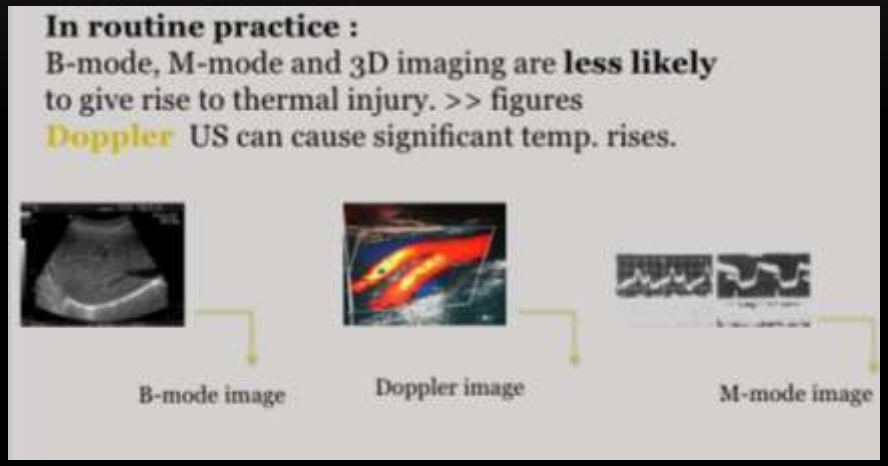
# ULTRASOUND

- Also known as as sonography, provides real time examination showing the structure and movement of internal body organs as well as blood flowing through the vessels.
- Ultrasound examinations do not use ionizing radiation ( as used in x-ray ).

# ULTRASOUND ( CONT'D )

- It is the most widely used imaging technology worldwide due to
  - Availability
  - Speed
  - Low cost
  - Non-invasive
  - No radiation.

# ULTRASOUND (CONT'D)




Doppler examination during early pregnancy is limited for long time application due to thermal induced effects on the embryo.

# ULTRASOUND (CONT'D)

- Ultrasound images quality depends on three major factors:

  A- Operator

  B- Machine → Transducer used, incorrect calibration

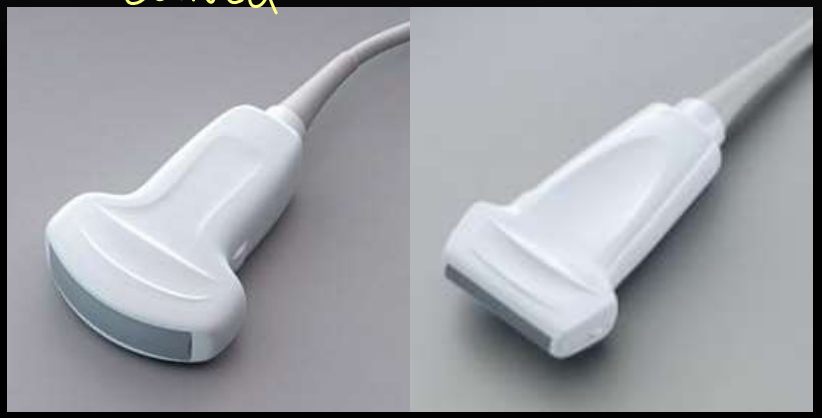
  C- Patient → BMI ( examination of patients with high BMI reduce image quality ), depth of adipose tissue, pediatric vs adult, superficial vs deep organs, gaseous abdomen ( reduce image quality), Fluid ( i.e provides great window for better examination, prerequisites of pelvic ultrasound exam is to have full urinary bladder, gallbladder examination requires fasting patient).

# ULTRASOUND (CONT'D)

- The image is created based on the amplitude, frequency and time it takes for the sound signal to return from area examined to the transducer.
- When a sound wave strikes an object, it bounces back or echoes.
- By measuring these echo waves it is possible to determine how far away the object is and its size, shape and consistency (solid, fluid or both)
- The transducer both send the sound waves (high frequency, inaudible range) and receives/records the echoing waves which are measured instantly and displayed by the computer creating real time picture n the monitor.
- Ultrasound imaging is based on the same principles involved in the sonar used by bats, ships and fisherman.

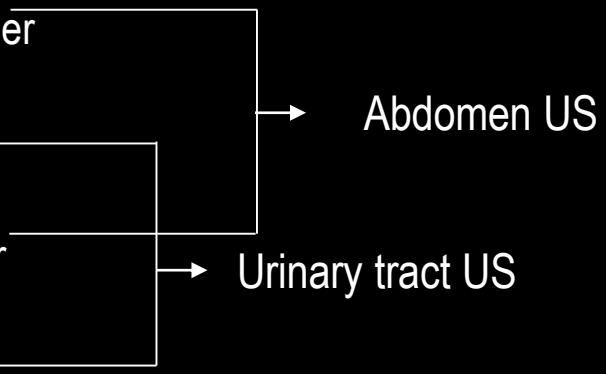
# ULTRASOUND (CONT'D)

- Probes:
  - Linear→ low penetration →high frequency and resolution used to examine superficial organs i.e thyroid, breast, scrotum and infant
  - Curved (curvilinear)→ high penetration→ low frequency and resolution used to examine deep organs like Abdomen
- Gel→ For the transducer to make <u>secure contact with the skin and eliminate air pockets</u> that block sound waves into patients body.




# ULTRASOUND (CONT'D)

- It is a useful way of examining many of the body's internal organs, such as:
  - Heart, blood vessels
  - Liver, gallbladder
  - Spleen
  - Kidneys
  - Urinary bladder
  - Prostate gland
  - Thyroid and parathyroid glands
  - Unborn fetus in pregnant→ follow the fetal development, and detect pathologies
  - Uterus and ovaries, and testes
  - Brain and hips in infants



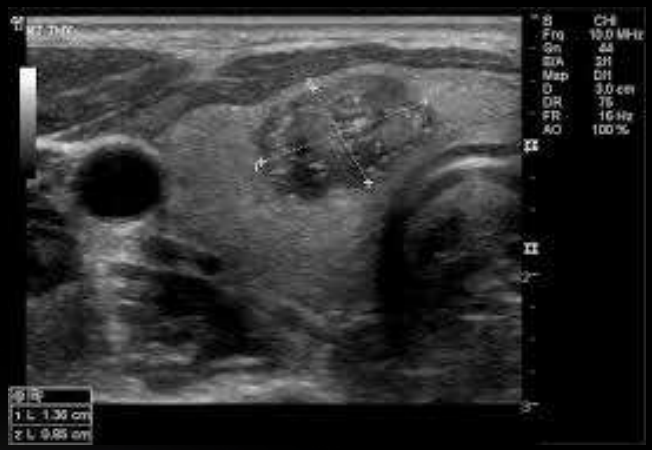
# ULTRASOUND (CONT'D)

- It is also useful also :
  - To guide procedures like needle biopsies, and breast biopsies
  - Diagnose variety of heart conditions, and valvular heart disease.

- Doppler ultrasound is a special application of US which measures the direction and speed of blood cells through blood vessels.

- Doppler ultrasound:
  - Blockage to blood flow (clots)
  - Narrowing of vessels (Plaque)
  - Tumors and congenital vascular malformations


MI: 1,3


1 L 1.36 cm
2 L 0.85 cm

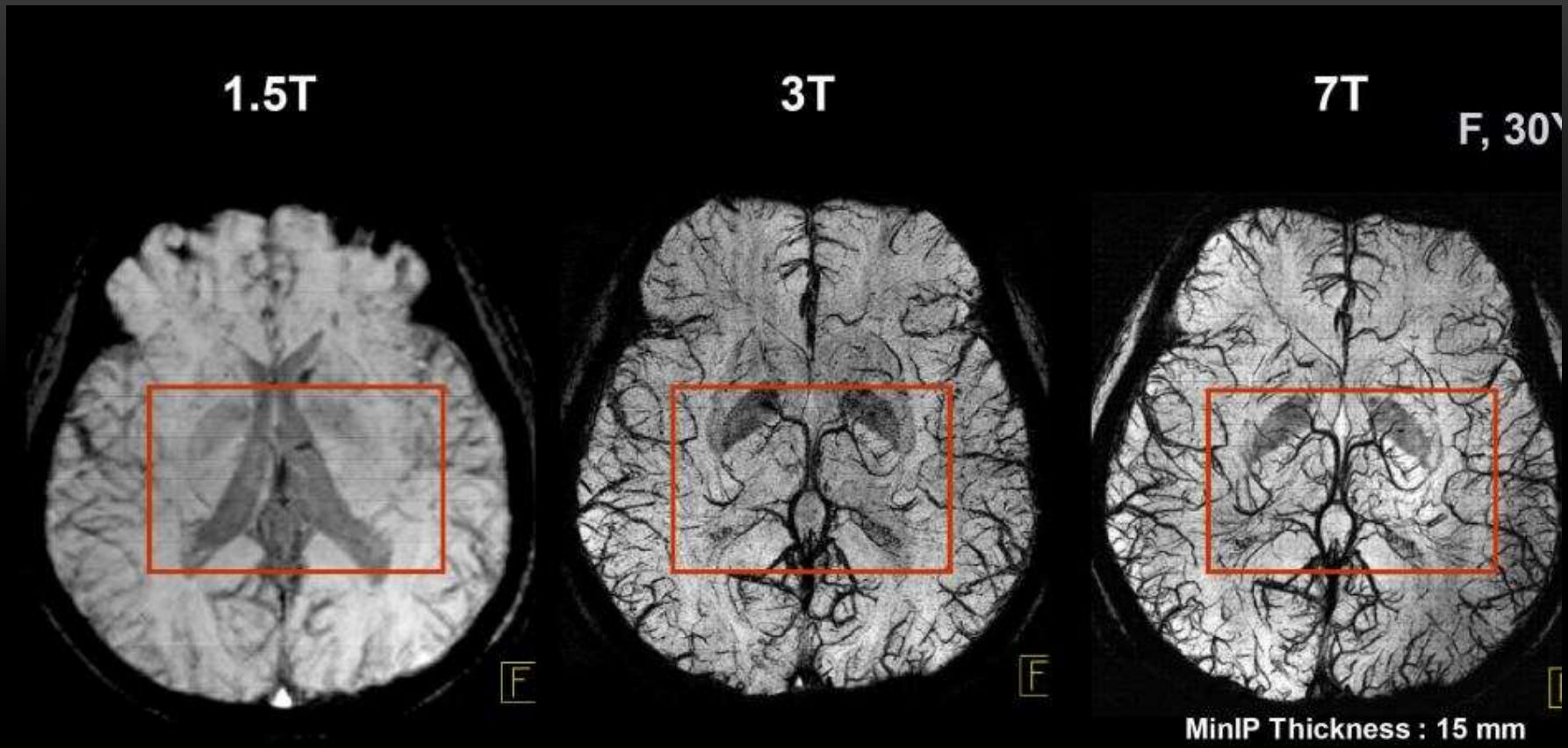
# MRI

- Is very important diagnostic tool in neuroimaging.
- Advantages:
  - Superior soft tissue contrast
  - Multiplanar capability
  - Non ionizing radiation
  - Relatively safe contrast media. ( As discussed before )
- Disadvantages:
  - Expensive
  - Not widely available
  - Claustrophobia →Requires time to be executed
  - Certain contraindications i.e pacemaker…etc.

Common indications for Brain MRI:

-Infarction
-Certain chronic conditions such as MS
-Brain tumors
-Causes of seizures
-Developmental anomalies
-Infections
……
……
……
Etc.

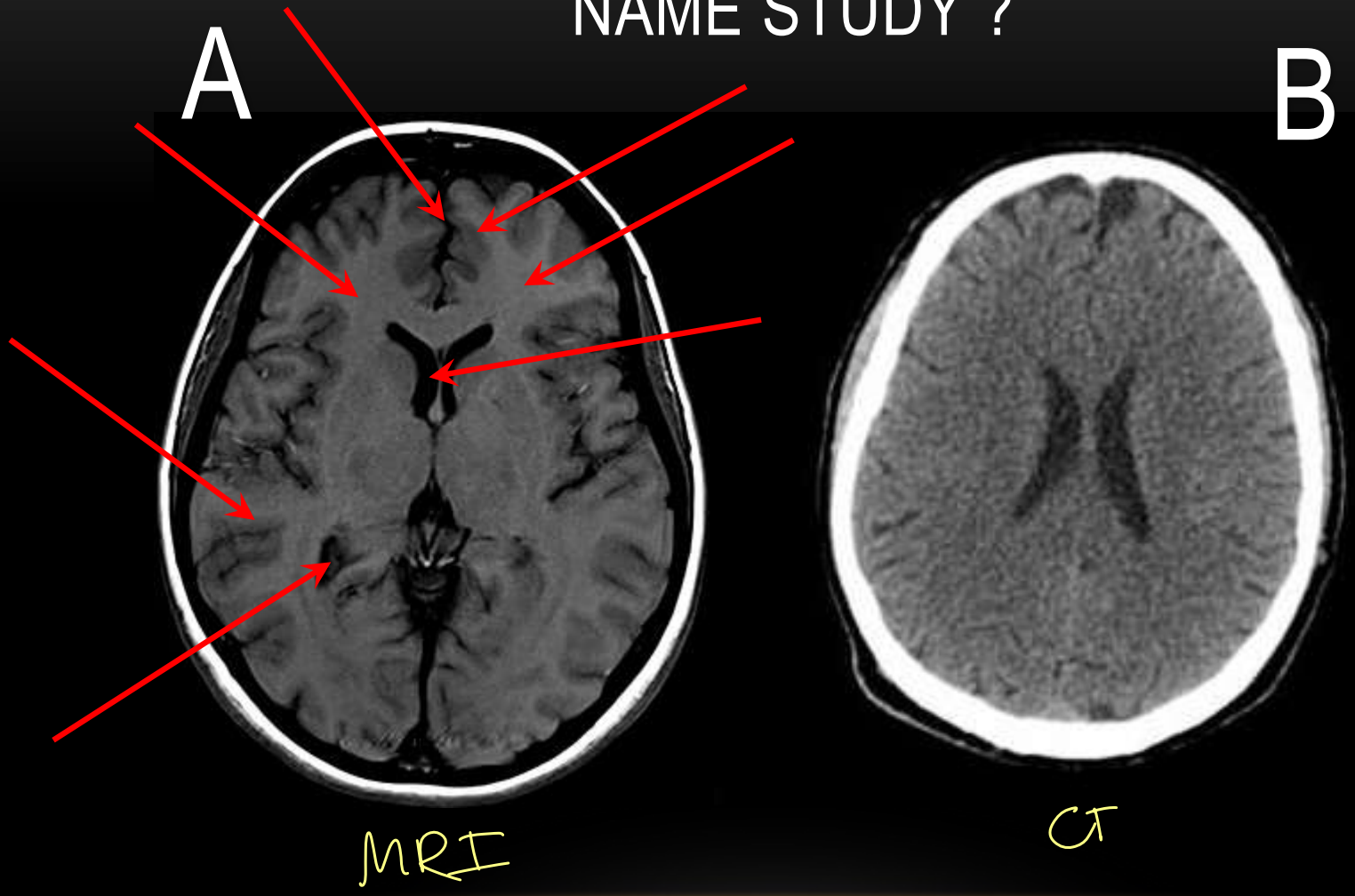

Signa EXCITE




* Works in Progress. The information about this product is preliminary. The product is under development and is not commercially available in the U.S. and its future availability cannot be ensured.

Gachon Medical School, Kore

# NAME STUDY ?



# THANK YOU