

DEPARTMENT OF RADIOLOGY

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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.
-



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



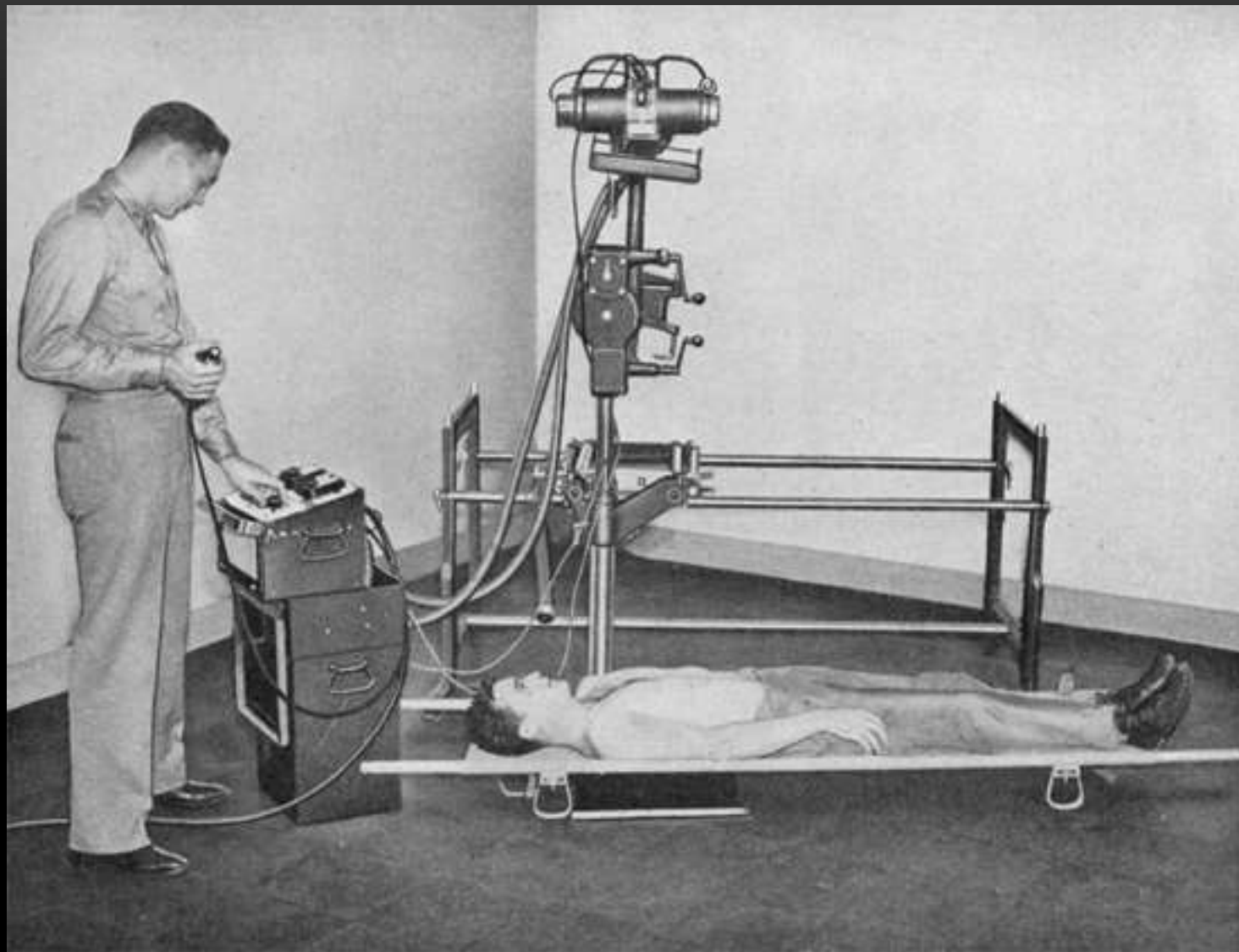
Dr. John Macintyre who set up the world's first radiology department in Scotland at Glasgow Royal Infirmary.



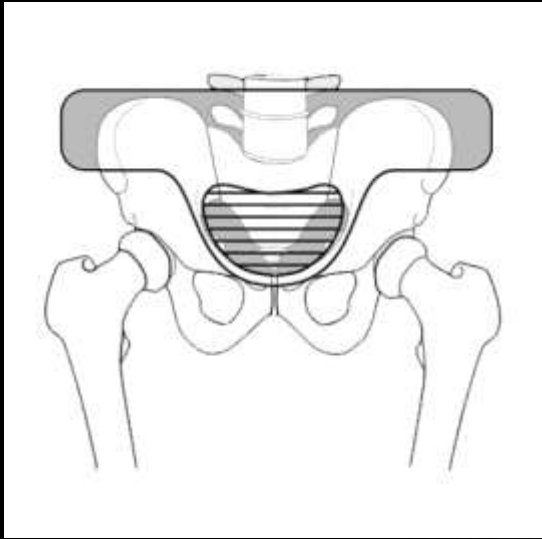
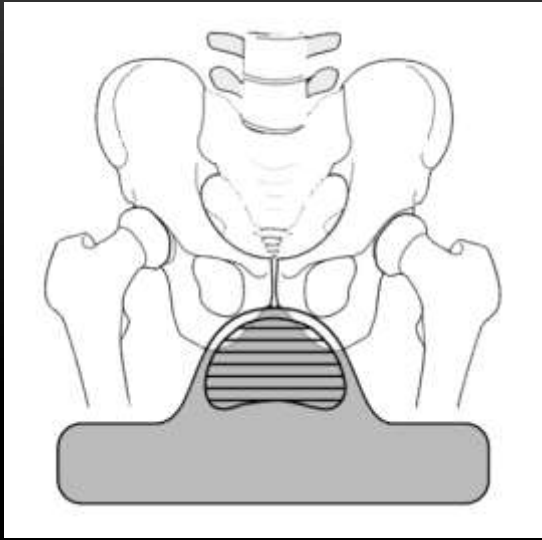
EXAMEN RADIOSCOPIQUE RADIGUET

10, rue des FILLES du CALVAIRE, PARIS

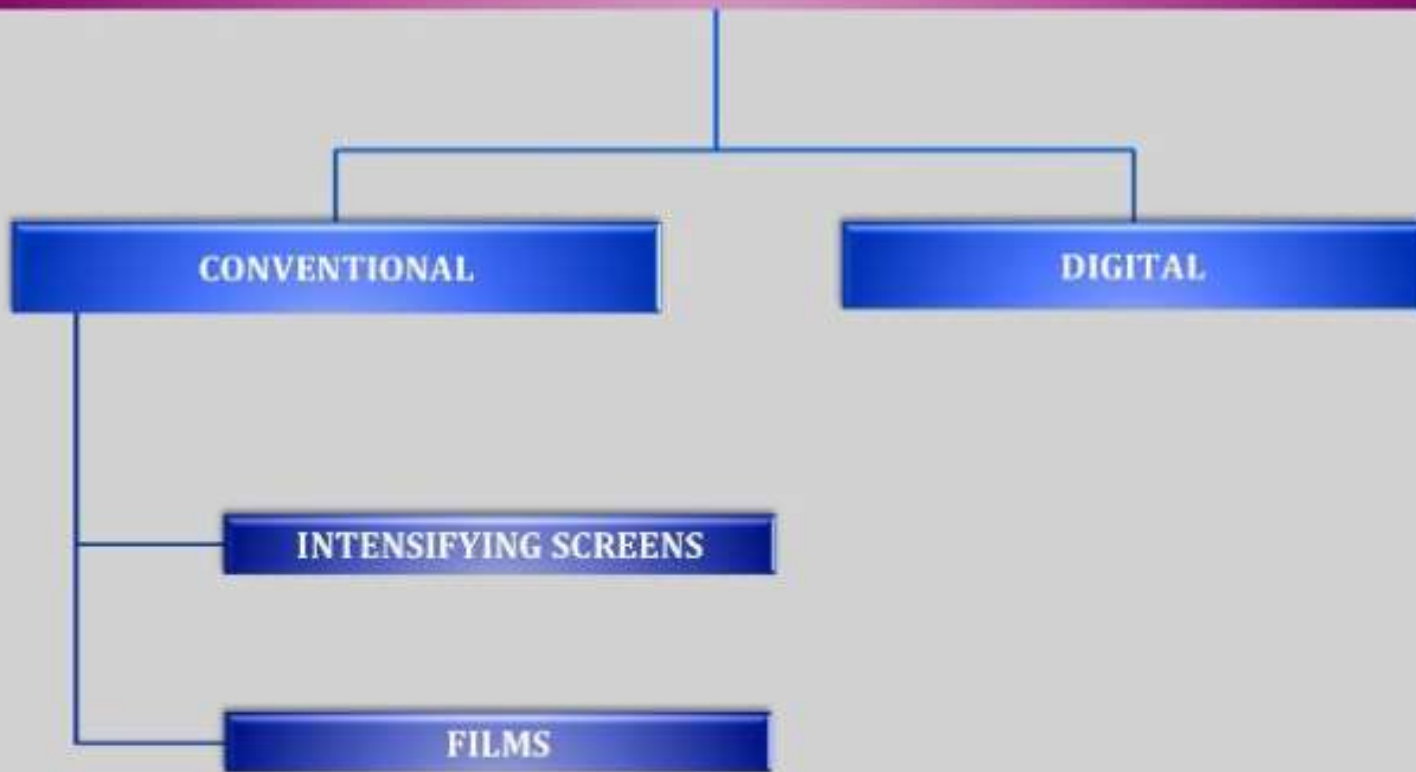


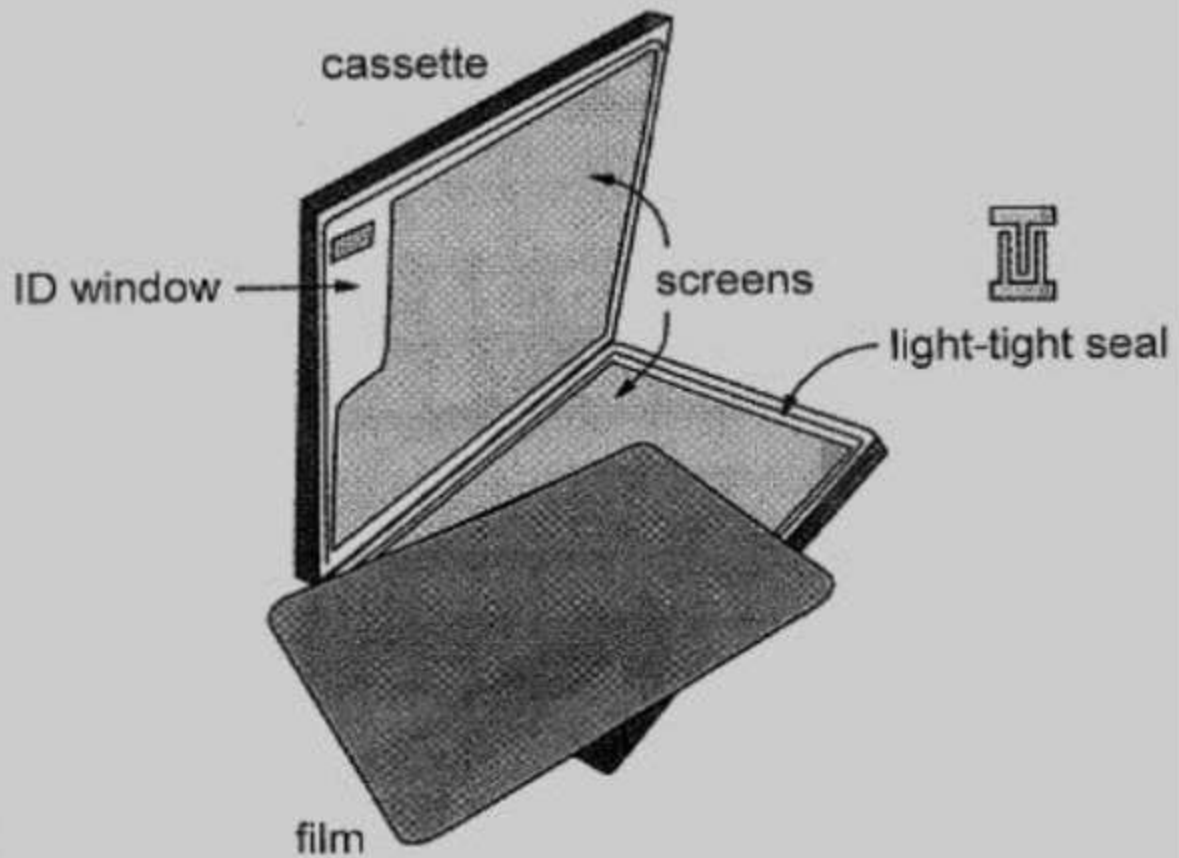






RADIOGRAPHY





A

INTENSIFYING SCREENS

- It is part of cassette, which converts x-ray energy into visible light spectrum (Fluorescent process).
- Initial screens used Calcium Tungstate.
- 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)

The image shows a periodic table titled "Periodic Table of the Elements". The table is color-coded to show different groups of elements. The rare earth elements (lanthanides and actinides) are highlighted in green. The table includes a legend at the top with color-coded boxes for various groups: Alkali metals (yellow), Alkaline earth metals (orange), Transition metals (pink), Halogens (light blue), Noble gases (dark blue), and Lanthanides/Actinides (green). The lanthanide series is shown as a separate row below the main table, and the actinide series is shown as a separate row below the lanthanide series.



DEVELOPER → FIXER → WASHING → DRYER

AUTOMATIC PROCESSOR

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



CR



PACS



Picture Archiving and Communication System

RIS

MED/FM Appointment Scheduling

Display Date For: 05/19/2005, Wednesday

Time	Physician	Location	Physician	Location	Physician	Location	Physician	Location
08:00 AM	WANG, RONALD	FLMCCS, MEDICAL	FLMCCS, MEDICAL	FLMCCS, MEDICAL	FLMCCS, MEDICAL	FLMCCS, MEDICAL	FLMCCS, MEDICAL	FLMCCS, MEDICAL
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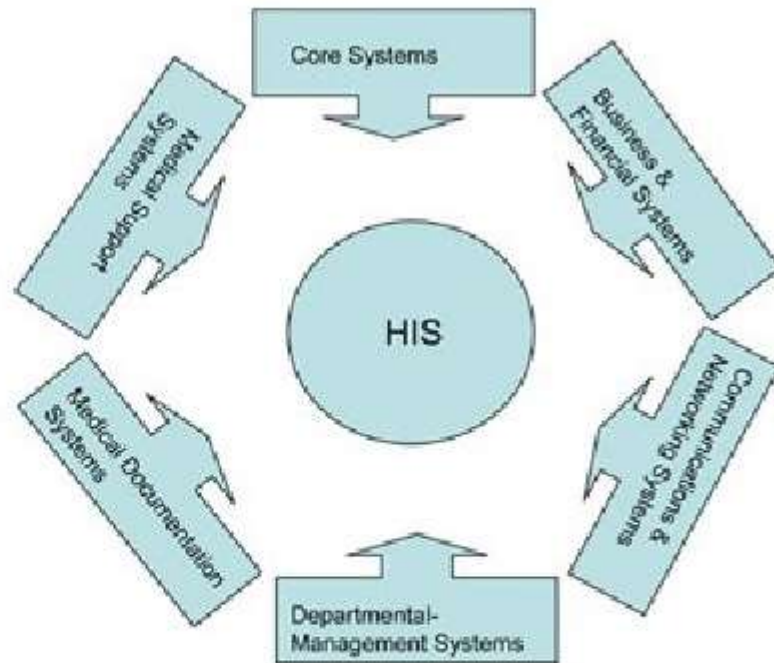
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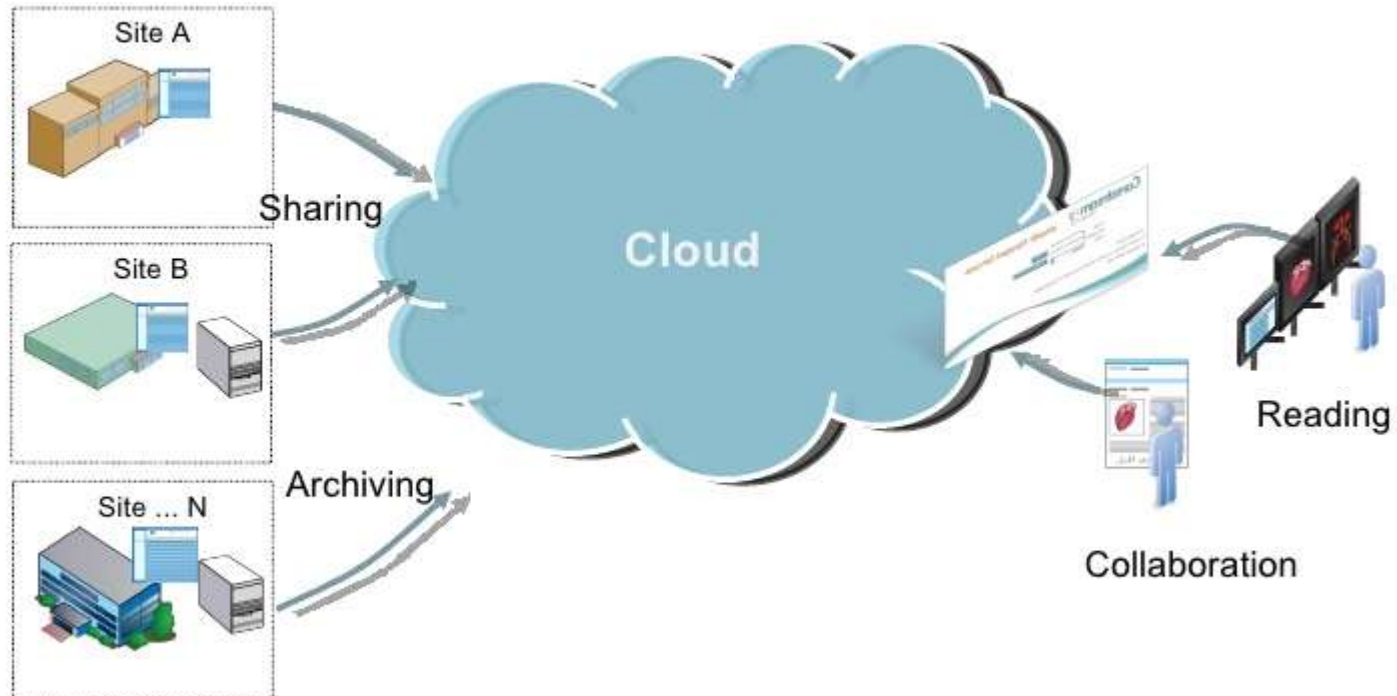
Radiological Information System

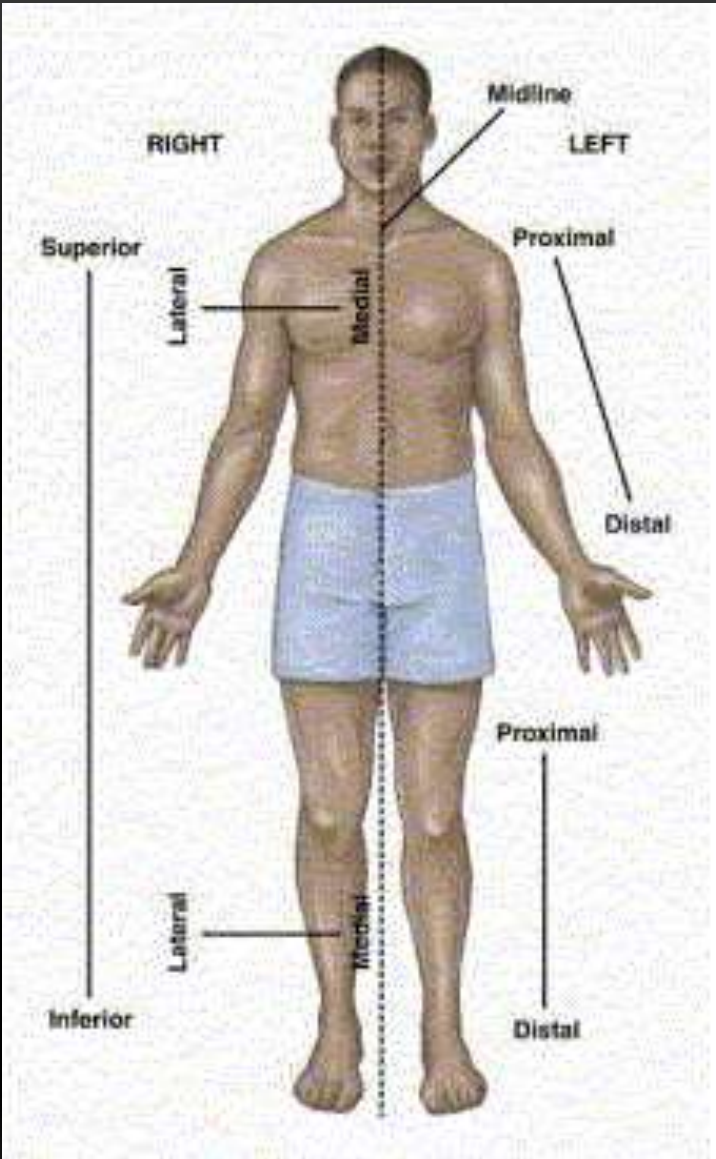
HIS.



Hospital Information System

A New Approach: Cloud-based Services...





IMAGING MODALITIES

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graph TD; A[IMAGING MODALITIES] --> B[Ionizing Radiation]; A --> C[Non-ionizing Radiation]; B --> B1[1-Conventional radiography (X-ray)]; B --> B2[Fluoroscopy]; B --> B3[Mammography]; B --> B4[2-Computed tomography (CT)]; B --> B5[3-Nuclear medicine (NM)]; B --> B6[4-Angiography]; B --> B7[CTA, Fluoroscopy]; C --> C1[1-Ultrasound (US)]; C --> C2[2-Magnetic resonance imaging (MRI)]; C --> C3[MRA]; C --> C4[MRCP....etc.]
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Ionizing Radiation

- 1-Conventional radiography (X-ray)
 - Fluoroscopy
 - Mammography
- 2-Computed tomography (CT)
- 3-Nuclear medicine (NM)
- 4-Angiography
 - CTA, Fluoroscopy

Non-ionizing Radiation

- 1-Ultrasound (US)
- 2-Magnetic resonance imaging (MRI)
 - MRA,
 - MRCP....etc.



Ionizing radiation is limited during pregnancy.

RADIATION DOSE

Diagnostic Procedure	Typical Effective Dose (mSv)¹	Number of Chest X rays (PA film) for Equivalent Effective Dose²	Time Period for Equivalent Effective Dose from Natural Background Radiation³
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.

NCBI Resources How To Sign in to NCBI

PMC US National Library of Medicine National Institutes of Health

Advanced Journal list Search 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. PMID: PMC5129267
Published online 2016 Oct 28. doi: 10.3390/ijerph13111057 PMID: 27801855

Pediatric Exposures to Ionizing Radiation: Carcinogenic Considerations

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Helena Solo-Gabriele, Academic Editor and Alesia Ferguson, Academic Editor
Author information Article notes Copyright and License information Disclaimer

This article has been cited by other articles in PMC.

Abstract

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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- Epidemiology of accidental radiation exposures. [Environ Health Perspect. 1996]
- Medical exposure to radiation and thyroid cancer. [Clin Oncol (R Coll Radiol). 2011]
- 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... See all...

Cited by other articles in PMC

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

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
 - 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
- 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
 - Check C/I's and the need for premedication.
 - C/I prior allergic like reactions to contrast medium
 - Premedication i.e Allergy to medications, Asthma...etc.

IV IODINATED CONTRAST MEDIA

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

IV IODINATED CONTRAST MEDIA (CONT'D)

- Cardiovascular effects (cardiac arrhythmias, 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.

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

Limited urticaria / pruritis
Limited cutaneous edema
Limited "itchy" / "scratchy" throat
Nasal congestion
Sneezing / conjunctivitis / rhinorrhea

Physiologic

Limited nausea / vomiting
Transient flushing / warmth / chills
Headache / dizziness / anxiety / altered taste
Mild hypertension
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

Diffuse urticaria / pruritis
Diffuse erythema, stable vital signs
Facial edema without dyspnea
Throat tightness or hoarseness without dyspnea
Wheezing / bronchospasm, mild or no hypoxia

Physiologic

Protracted nausea / vomiting
Hypertensive urgency
Isolated chest pain
Vasovagal reaction that requires and is responsive to treatment

Severe

Allergic-like

Diffuse edema, or facial edema with dyspnea

Diffuse erythema with hypotension

Laryngeal edema with stridor and/or hypoxia

Wheezing / bronchospasm, significant hypoxia

Anaphylactic shock (hypotension + tachycardia)

Physiologic

Vasovagal reaction resistant to treatment

Arrhythmia

Convulsions, seizures

Hypertensive emergency

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)

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 $\mu\text{mol/L}$).
 - 2) A percentage increase in serum creatinine $\geq 50\%$ (≥ 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

- 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 administered if < 30)
 - Thus its incidence was reduced significantly.

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

The screenshot shows a web browser window with the URL link.springer.com. The page is for an article in the *Japanese Journal of Radiology*, January 2016, volume 34, issue 1, pp 3-9. The article title, "Brain gadolinium deposition after administration of gadolinium-based contrast agents", is highlighted with a red box. The authors listed are Tomonori Kanda, Hiroshi Oba, Keiko Toyoda, Kazuhiro Kitajima, and Shigeru Furui. The article has 5 reviews, 5.1k downloads, and 45 citations. The abstract discusses the use of gadolinium-based contrast agents (GBCAs) and their potential toxicity, noting an association between brain MRI abnormalities and GBCA administration in 2013. A sidebar on the right contains navigation options like "Download PDF", "Cite article", and "Share article", along with a table of contents. A cookie consent banner is visible at the bottom of the page.


Springer Link

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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

5 Shares 5.1k Downloads 45 Citations

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.

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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.



CONVENTIONAL RADIOGRAPHY (X-RAY)

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

Indications:

Cough

Fever

Chest pain

Follow-up on known
disease to assess progress

Trauma, , post-operative,
monitoring ICU patients,
checking position of NG
tubes, ETT, central lines
and screening tool for
immigrants....etc.



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.



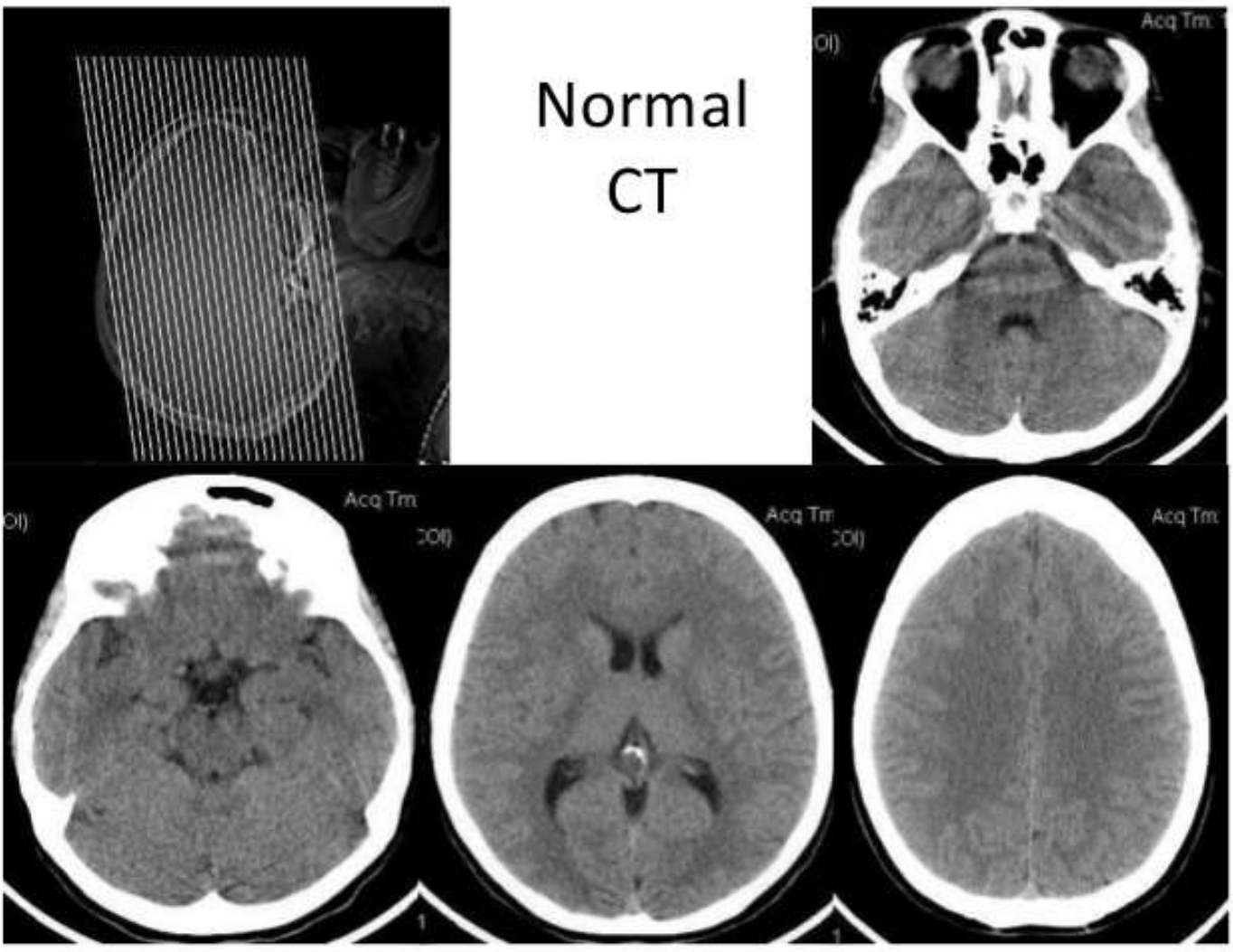
CT (CONT'D)

- Common CT radiologic examinations:
 - Head CT (Brain, skull vault, sinuses and orbits) with/without contrast
 - Indications:
 - Seizures
 - Headache
 - Acute stroke, GCS < 13, FND, 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.
- 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
 - Therapeutic: embolization, stenting, thrombectomy, thrombolysis

FLUOROSCOPY (CONT'D)

- Other common examinations:
 - Barium Swallow, meal, follow through and enema
 - MCUG / VCUG
 - Hysterosalpingogram
 - Other like sialography.....etc.
- 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
 - 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





FLUOROSCOPY (CONT'D)

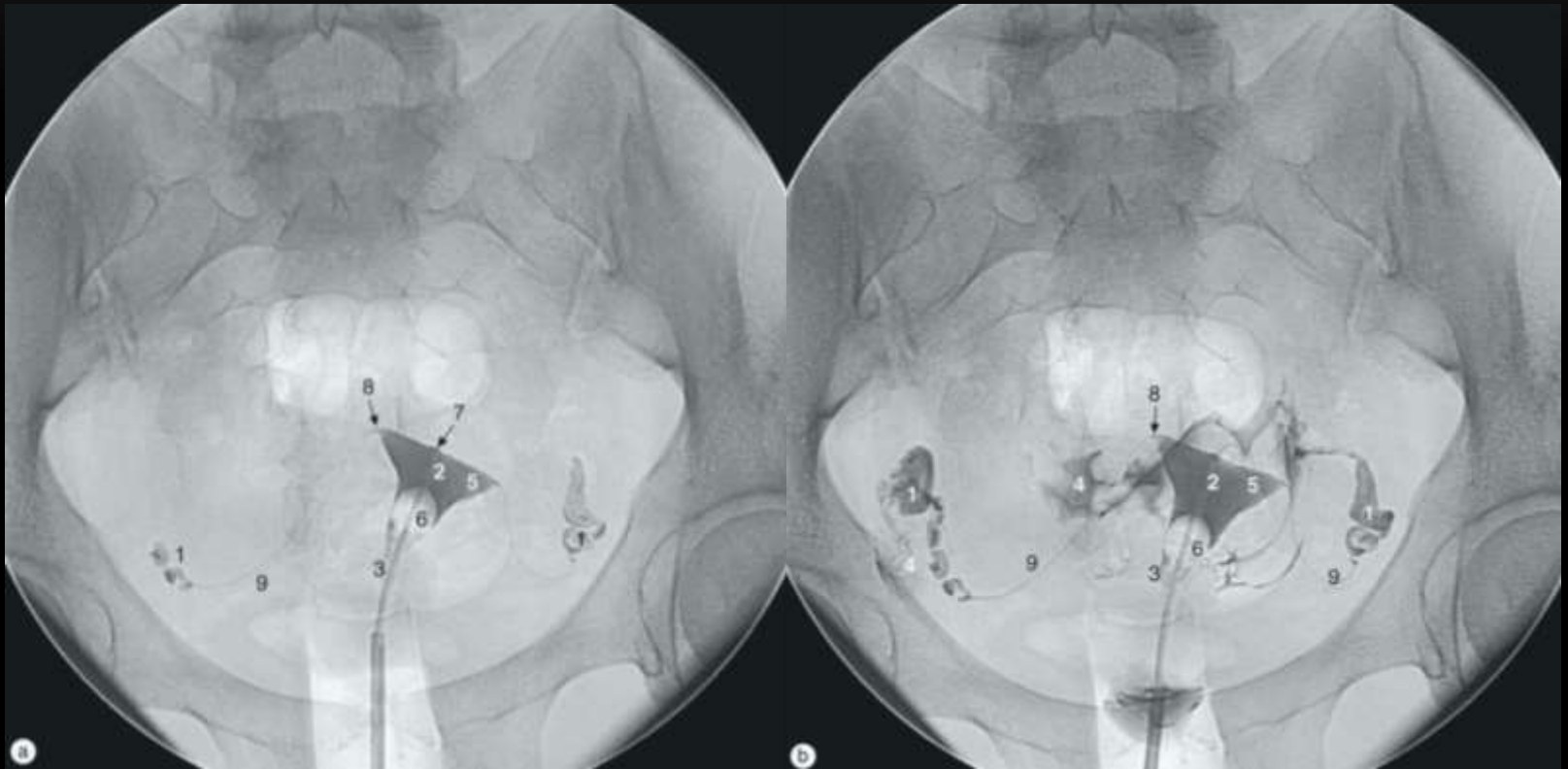
HYSTEOSALPINGOGRAPHY

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

INDICATIONS:	Patient preparation:	C/I 's:
<ul style="list-style-type: none">• Infertility• Recurrent abortions (congenital anomaly, incompetent cervix)• Assessment fallopian tubes (following tubal surgery, post-sterilization)• Assessment integrity of caesarean uterine scar	<ul style="list-style-type: none">-Abstain from intercourse-Examination done before day 21 of menstrual cycle between 4th-10th day.	<ul style="list-style-type: none">-Pregnancy-Bleeding (during menstruation)-Purulent discharge, or PID in preceding 6 months-Recent abortion / dilatation

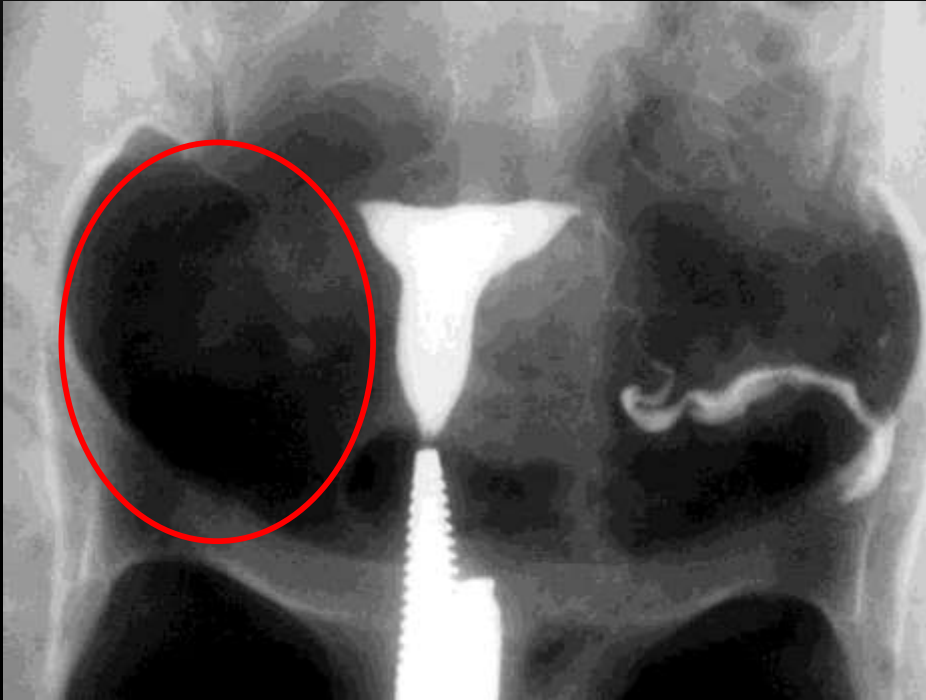
EQUIPMENT





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)

In routine practice :

B-mode, M-mode and 3D imaging are **less likely** to give rise to thermal injury. >> figures

Doppler US can cause significant temp. rises.



B-mode image



Doppler image



M-mode image

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



ULTRASOUND (CONT'D)

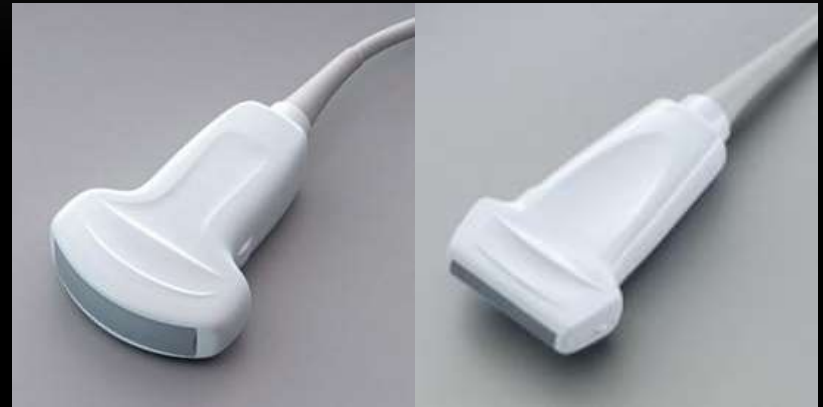
- Ultrasound images quality depends on three major factors:
 - A- Operator
 - B- Machine → Transducer used, incorrect calibration
 - C- Patient → BMI (examination of patients with high BMI reduce image quality), depth of adipose tissue, pediatric vs adult, superficial vs deep organs, gaseous abdomen (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 secure contact with the skin and eliminate air pockets that block sound waves into patients body.



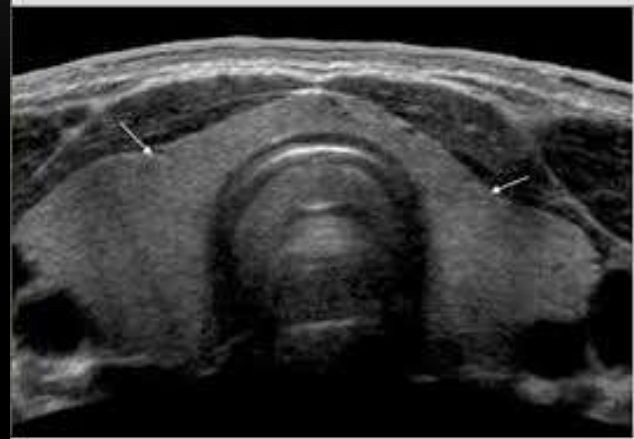
ULTRASOUND (CONT'D)

- 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
-
- The diagram consists of two main labels on the right: 'Abdomen US' and 'Urinary tract US'. On the left, there is a list of organs. Lines connect 'Liver, gallbladder' and 'Spleen' to 'Abdomen US'. Lines connect 'Kidneys', 'Urinary bladder', and 'Prostate gland' to 'Urinary tract US'.

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



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.

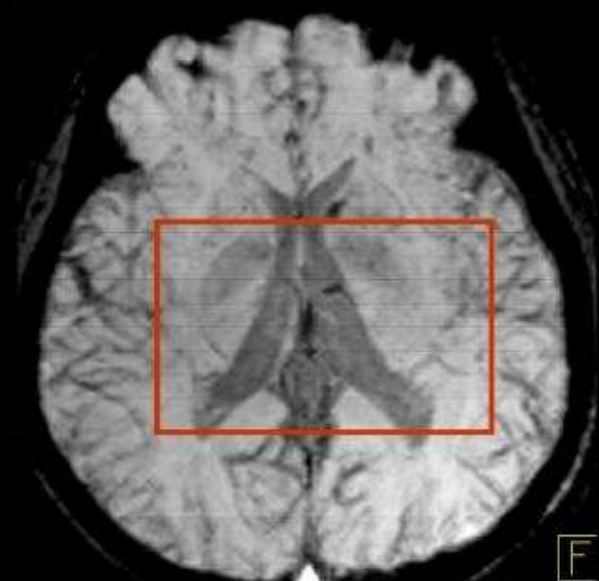


1.5T

3T

7T

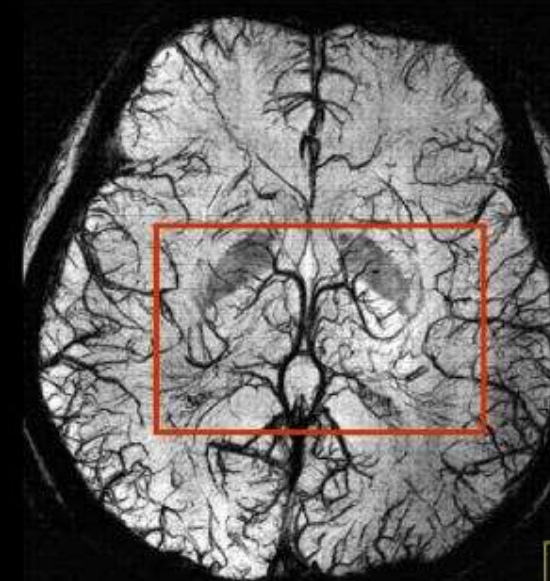
F, 30°



1.0 mm³, TA = 4:51
TR = 57 ms
TE = 40 ms



0.43 mm³, TA = 8:58
TR = 57 ms
TE = 35 ms



MinIP Thickness : 15 mm

0.3 mm³, TA = 12:10
TR = 25 ms
TE = 14 ms

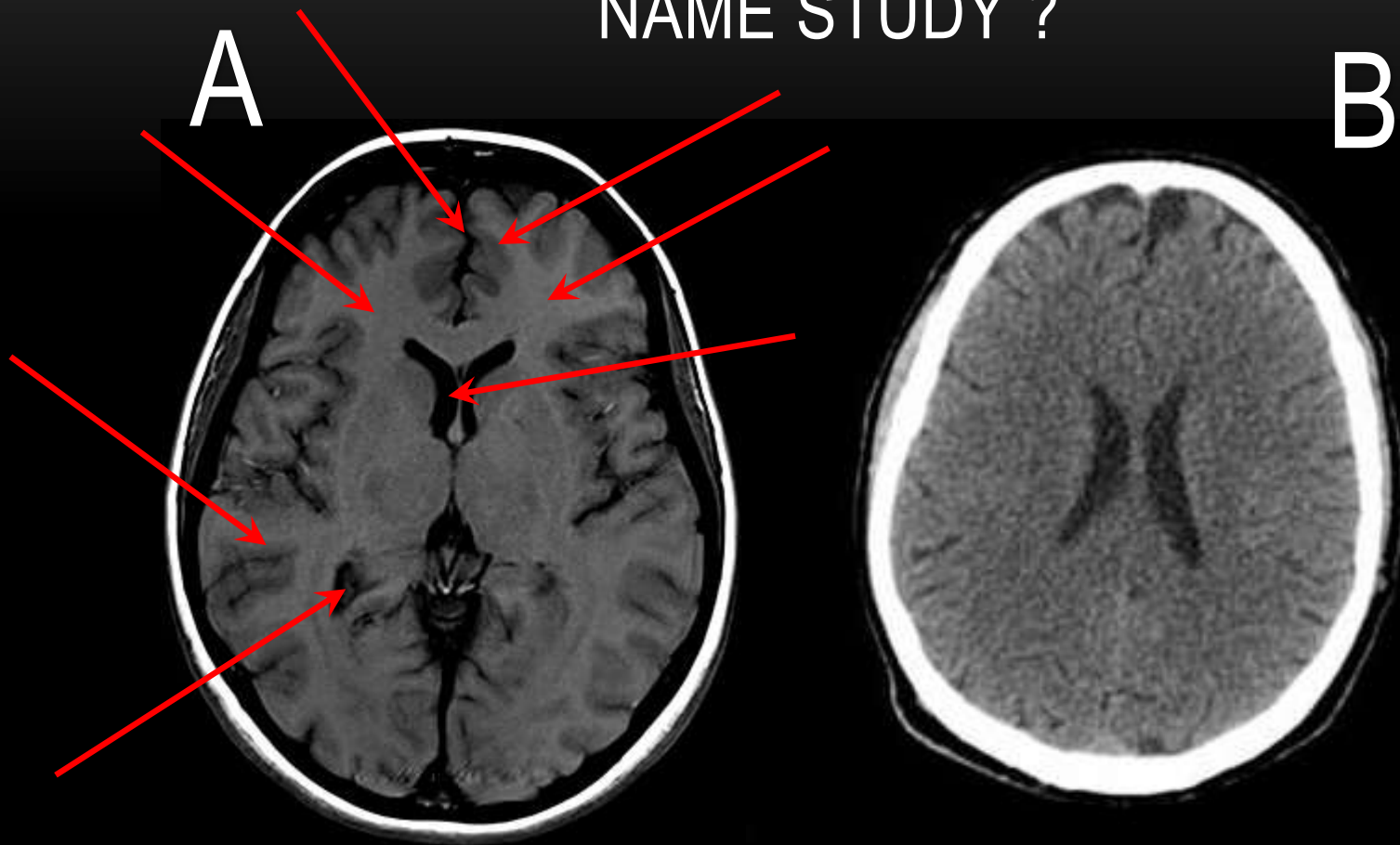
* Works in Progress. The information about this product is preliminary. The product is under development and is not commercially available in the U.S. and its future availability cannot be ensured.

Gachon Medical School, Korea
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NAME STUDY ?

A

B



THANK YOU

