Radiology
Team 438

Radiological Anatomy & Investigations of hepatobiliary System

Lecture 12

Objectives

- What is hepatobiliary system HBS?
- Radiological modalities used in imaging HBS.
- Advantages and disadvantages of each radiology modality.
- Indications of imaging HBS.

Color Index: -Main text -Males slides -Female slides -Dr's notes -Important -Golden note -Extra

Team Leaders :

Reem Alamri

Nouf Alsubaie

Bander Alharbi

Done by :

Mohammed Alkathiri

Note taker :

Norah Almasaad

REVISED BY
MISHAL ALTHUNAYN & MUNEERAH ALSADHAN

Introduction

What is hepatobiliary system (HBS)?

- It includes **liver** , **gallbladder** and **biliary ducts**.

what are the modalities used in imaging (HBS)?

X-Ray | Computed Tomography (CT) | Magnetic Resonance Imaging (MRI) | Ultrasound (US) | Nuclear Scan

we can use them all

- each one has different indications and uses depend on what we are looking for
- You need to know why I imaging first or what's the indication
- You need to know the advantages and disadvantages of each modality

1. X-Ray Radiograph is another name for X-ray

- what is X ray? It is energetic form of electromagnetic and ionizing radiation that can penetrate solid objects and used to take images of the human body.
- **Uses:** it can detect **radiopaque stones** depending on its composition size and location and it also can detect **enlargement** in the liver and **calcifications** in the **gallbladder wall.**

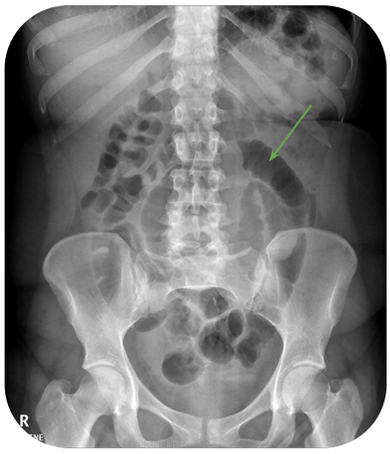
X-ray language

- **Radio-lucent = black = air**
- **Radio-opaque = white = bone**

Advantages	Disadvantages
• Cheap. • Quick and widely available. • Can be done bedside (portable) for sick patients like patients in ICU. • Not skill based	• **Use ionizing radiation >** avoid in pregnant & pediatric. • Very poor in tissue details including hepatobiliary system. You can't tell where is the liver or spleen. • Very limiting in detecting gallbladder stones b/c they're usually radiolucent due to their composition of fat, bile secretions, cholesterol and pigmentations. Usually these materials aren't dense enough like the bone or like the calcium. We only start seeing gallbladder stones when they start containing calcium. So if you suspect patient with gallstones? **Don't do X-ray** • Won't show bile duct dilatation.

X-Ray and Ultrasound

What is this?
This is an Abdominal x-ray" or "Abdominal radiography"
We can see the edge of the liver here. (not always visible)
Gas inside the bowel "radiolucent"



what is this?
X-ray was first observed and documented in 1895 by Wilhelm Conrad Roentgen, and this is The First x ray taken in history

2. Ultrasound

- what is US? A diagnostic technique in which high-frequency sound waves penetrate the body and produce multiple echo patterns.
- It is diagnostic Medical applications in use since late 1950's.

- The High frequency sound waves will pass through the body, and will be reflected according to the density of the structure.
- Dense structure e.g. bones, calcifications will reflect all sound waves (giving white color on the image).
- Fluid will pass without reflection (giving black color).
- Anything in between such as abdominal organs (as it's dense as it reflects more waves).

Echo patterns we use it to describe the organs

- **Hyper-echoic = White**

(bones for example)

- **An-echoic = Black**

No echoes are reflected from that area (fluid for example)

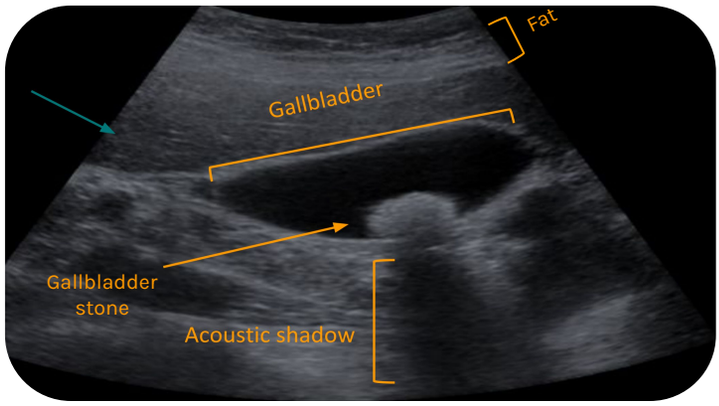
- **Hypo-echoic = Light Grey**

(in between hyper and anechoic)

- **Acoustic shadow:** black band behind dense object. **Very IMP to know**

(e.g. stone) (acoustic shadow occurs because all/most sound waves that will travel & hit the stone will be reflected).any dense object like stones, bones usually you will see shadow behind it

All organs/structures are not **hyper**echoic/**hypo**echoic all the time.
For ex: Fat is **hyper**echoic in relation to the liver but it is **hypo**echoic in relation to stone.
Acoustic shadow is very important to diagnose stones.



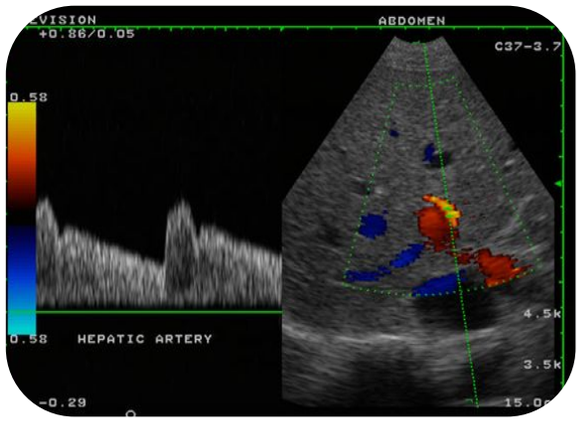
Green Arrow: this is the liver (part of it)

2. Ultrasound

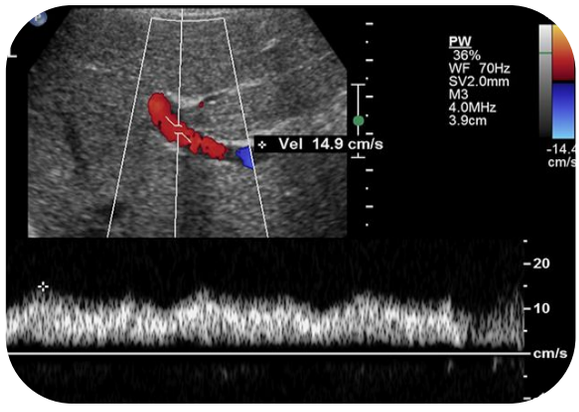
Advantages	Disadvantages
• No radiation > used in pregnant & Pediatric • Widely available. • Relatively cheap. Cheaper than MRI and CT. • Very good in evaluating abdomen solid organs. Soft tissues in general • Can be done bedside (portable).You can take the machine to the patient • Real time scan e.g. when scanning a pregnant lady, you will be able to see the fetus moving. • Good in assessing soft tissue compared to X-ray. ex, gallbladder inflammation. • Excellent in picking up stones. • **The modality of choice to start with in HBS**	• Operator dependent means that if you have an expert in doing US he will give you a good image but if not you may not get a good study & may miss some important findings • Very limited in evaluating structures with air (e.g. bowel, lung) or calcification (e.g. bone like skull which makes it difficult to look at the brain except in newborns b/c they have sutures/fontanelles that you can penetrate & see the brain) why? B/c US waves won't pass through air or calcifications

Dúplex:

- When it's difficult to know by a doppler whether it's an artery or a vein we use duplex
- Shows waves that differentiate between arteries and veins.
- An artery wave usually contain systolic & diastolic while a vein is usually monophasic wave
- One of duplex techniques is the ability to use the probe that allows to hear the sound but not seeing the image.
- Here we see the pulse of an artery (notice the upstroke & downstroke waves in the graph).



This is a normal patent vein going toward the liver b/c it's red.
Since this is a large vein entering the liver then most likely it's **portal vein**
(Notice that the wave here is continuous because we are looking at a vein)



B-Mode

Normal gallbladder (anechoic gallbladder lumen)

This is **portal vein** without flow known as B-MODE or greyscale

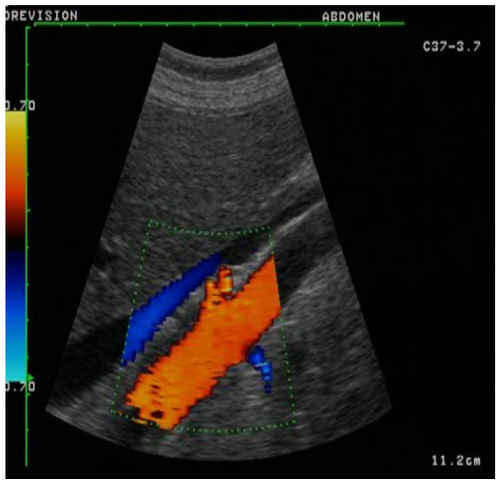
Another example of B-Mode

Color Doppler

Doppler allows us to see vessels, blood flow, and its direction. **what does these colors indicate?**

- they represent vessels. If the direction of the flow is toward the probe it will be red “artery”; if it’s moving away from the probe it will be blue “vein”.
- In liver for example, the portal vein is going into liver so it will be red and hepatic veins is going away from liver so it will be blue.
- In liver cirrhosis blood will flow to the opposite direction.
- If I ask you if the portal vein has thrombosis? Is the direction of the flow normal or not, is the wave normal or not? You can detect by duplex

- Color Doppler is not of that help in biliary tree because the bile flow normally is slow to the degree that it won't be detectable; Doppler only shows faster flow



3. CT scan

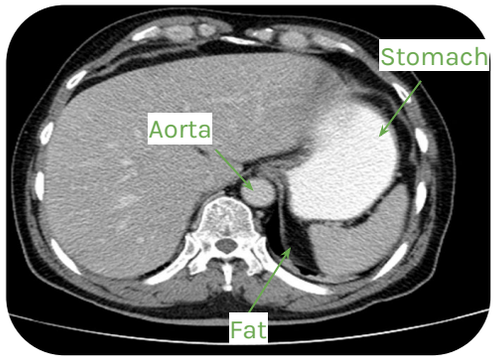
- what is a CT scan? A CT scan (Advanced technique of x-ray) makes use of computer-processed of many x-ray images taken from different angles to produce cross-sectional tomographic images = Create 3D image of specific areas of a scanned object.
- CT scan can be done with and without intravenous IV contrast.
- CT scan is **limited** in evaluating gallstones, Why?(1) **(Important)**
  - 1-The composition of gallbladder is cholesterol which is fat which is black in CT, also fluid will be black “ gallbladder also filled with fluid”. And most of the stones are black or grey so you can’t see it. The same problem occurs with X-Ray. So you have to use US rather than exposing the patient to radiation for nothing
  - When I will start to see stones? When some minerals like calcium start to to accumulate or deposit inside

3. CT scan

CT language:

- **Hypo-dense** = black to grey
- **Hyper-dense** = white

e.g. Aorta is **hyper**-dense in comparison to the fat but **hypo**-dense in comparison to the bone or stomach. Also Spleen is hyper-dense in comparison to fat and hypo-dense in comparison to stomach. **(We compare organs with each other).** -How to differentiate between CT and MRI? Bone will appear dense white in CT. However in MRI it will be grey to black.



Advantages	Disadvantages
• It's very good at evaluating solid organs especially if we use IV contrast. • Available more than MRI. • Cheaper & faster than MRI and more readily used. • **Good assessing tumor.**	• It uses ionizing radiation (risk of cancer). • intravenous contrast maybe harmful in patient with impaired renal function b/c contrast in normally cleared by the kidneys. or allergy. • It is not widely available as U/S or X-ray. • It's relatively expensive. • Will not show stones

What is the difference between the two images?

CT **with** IV contrast

CT **without** IV contrast

- **How you know if there is contrast?** You see more details of vessels and organs like liver and spleen.
- It shows how good the image with contrast, which circulates in the body then into the vessels.
- Contrast is also taken up by the liver so you can easily see details and this helps in case of mass in liver, which can be missed as it has a similar density to liver. But with contrast, liver will take it up in different way from the mass.

*these are vessels. before the contrast we weren't able to see them clearly. (the arrow)

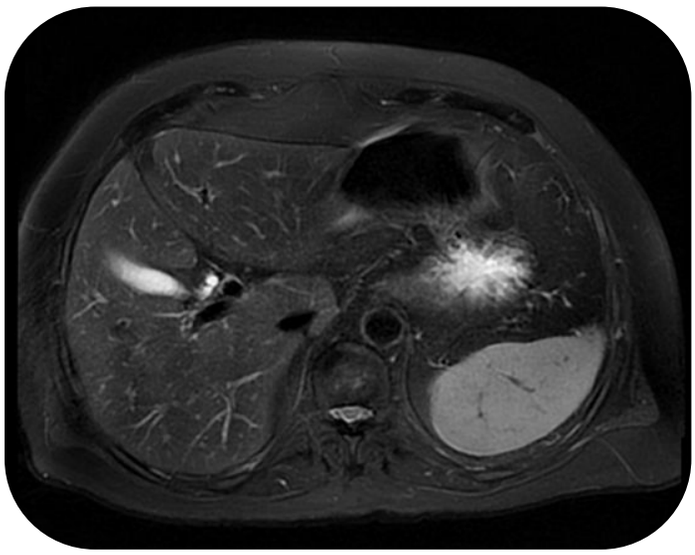
4. MRI

What is MRI?

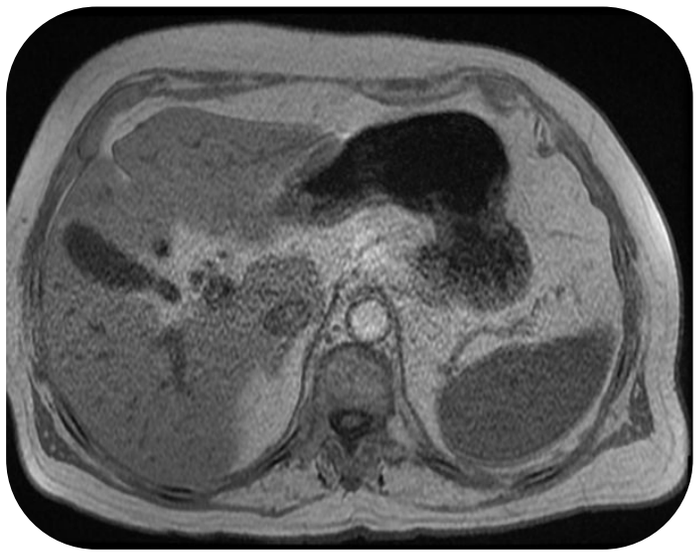
- A medical imaging technique using strong magnetic field and radio waves to form pictures of the anatomy.
- It has no radiation.
- It is more complex than CT scan and produces different images (or what called sequences), that can be taken like T1 and T2 etc.
- It gives a far more great detail of information when compared to a CT scan as it uses a sequence system.

MRI language:

- **Hyperintense signal**= more white
- **Hypo-intense signal** = more grey/black



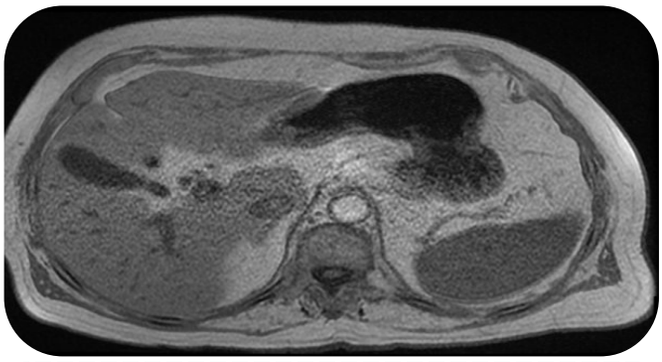
T1: The fluid will appear black



T2: The fluid will appear white

Advantages	Disadvantages
• Excellent in tissue details. • No ionizing radiation. Major advantage • Better than CT • Can pick up almost all stones, but US requires less time and money. • Good option for pregnant ladies but it is not used in the first weeks of pregnancy	• Expensive. • Long scan time. Takes 25-45 minutes CT is shorter (5 - 10 minutes) • Less available than other modalities. • Intravenous contrast is not safe with poor renal function. • Not for all patient (such as: patients with pacemaker, claustrophobia etc).

- How to differentiate between a CT and an MRI?
- Always look at bone:



MRI: grey to black

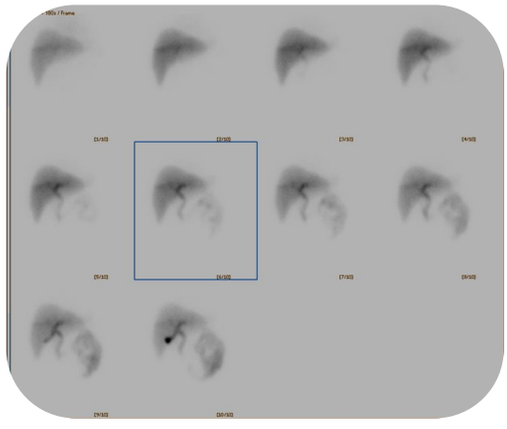
CT: always white

5. Nuclear medicine

- It's a Medical specialty involving the application of radioactive substances in the diagnosis and treatment of a disease.

How is this procedure carried out?

- Radioactive material given intravenously is labeled with a material that mimics normal physiology of the body e.g if we wanted to scan the liver or bile duct, to be sure this radioactive material reached the organ we label it with something like bilirubin "because it is metabolized in liver" so this will make all radioactive material directed to liver, then start to scan. But if we want to image the bone we will give a radioactive material that is labeled with phosphate or calcium. so it will only target the bone and it will reflect the physiology or the function of the bone.



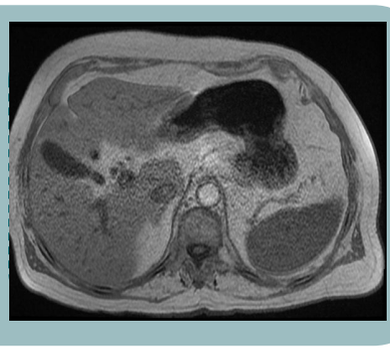
Advantages	Disadvantages
• Excellent in evaluating organ function/physiology. • Assessing HBS obstructions. ancy	• Use ionizing radiation (gamma rays). • Not widely available only big hospitals. • Very poor in evaluating anatomy. • Expensive

Radiological modalities used in hepatobiliary system

Modalities	Advantages	Disadvantages
X-RAY	• Cheap. • Widely available.	• Radiation. • Poor soft tissue details.
COMPUTED TOMOGRAPHY (CT)	• Good at evaluating abdominal solid organs.	• Contrast can be contraindicated.
MRI	• Good at evaluating solid organs. • No radiation	• Long scan time. • Less available than other modalities
ULTRASOUND	• No radiation. • Very good soft tissue details.	• Operator dependant. • Limited in evaluating bowel and calcification. • Radiation
NUCLEAR MEDICINE	• Excellent in evaluating organ function.	• Radiation. • Very poor in evaluating anatomy. • Not widely available.

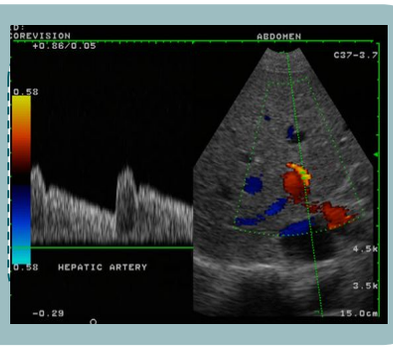
1- which one of the following modalities you think had been taken?

a. CT
b. MRI
c. X-Ray
d. Ultrasound B. Mode



2-which one of the following modalities you think had been taken?

a. Ultrasound Dúplex
b. Ultrasound B. Mode
c. CT
d. MRI



3- Patient presented to ER with Right upper quadrant pain aggravated by fatty food, what is the first choice modality

a. MRI
b. CT
c. Ultrasound
d. Nuclear medicine

4- Which one of the following is the appropriate test to assess tumors?

a. Ultrasound
b. CT
c. MRI
d. Nuclear medicine

5- Which one of the following has no radiation

a. CT
b. X-Ray
c. Nuclear medicine
d. Ultrasound

6- Which one of the following gives a far more great detail of information when compared to a CT scan?

a. MRI
b. Nuclear medicine
c. Ultrasound
d. X-Ray

Answers
1) b
2)a
3)c
4)b
5)d
6)a

1- Which one of the following is the modality of choice to start with in hepatobiliary system:

a. CT
b. MRI
c. X-Ray
d. Ultrasound

2-Which one of these modalities is limited to evaluate the gallstones?

a. CT
b. MRI
c. X-ray
d. US

3- Which of the following is an alternative modality to US to assess the gallbladder stones?

a. x-ray
b. CT
c. MRI
d. Nuclear medicine

4- Which one is the advantage of nuclear medicine?

a. Can't assessing the anatomy.
b. Use gamma radiation.
c. Excellent in evaluating organ function/physiology.
d. Not widely available.

Answers
1) D
2)A
3)C
4)C