MED437
King Saud University

RADIOLOGY 437 TEAM

Radiological anatomy and investigation of hepatobiliary system

Color Index:

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Editting File

Objectives:

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

Sources

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Introduction:

What is hepatobiliary system (HBS)?
- It includes **liver** , **gallbladder** and **biliary ducts**.

What are the Radiological modalities used in imaging HBS ?
1. X Ray. Can be used but it is limited.
2. Ultrasound.
3. Computed tomography (CT) scan.
4. Magnetic resonance imaging (MRI).
5. Nuclear scan. All are usable.

we can use them all, each one has different indications and uses depend on what we are looking for.

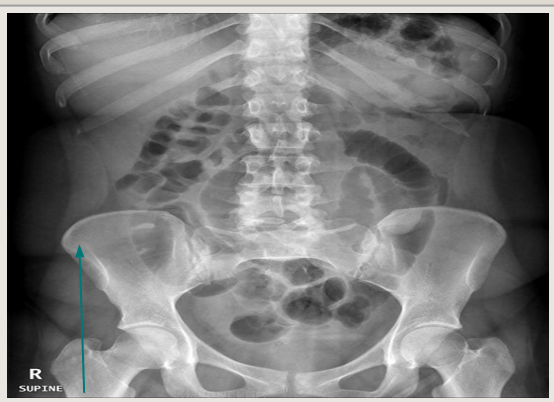
1. X-Ray:

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.

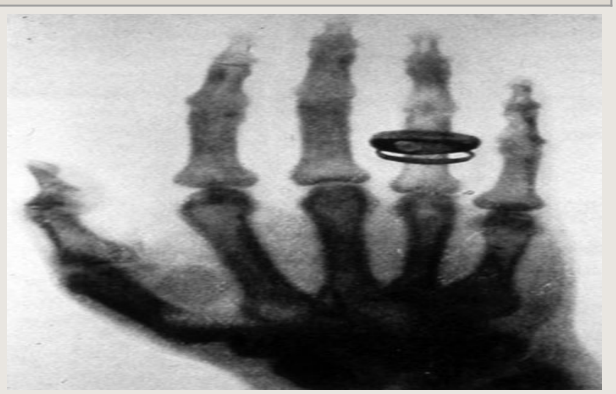
Is it worth it to use X-ray in assessing hepatobiliary? Very limited.
Uses: it can detect radiopaque stones depending on its composition size and location and it also can detect enlargement in the liver and calcifications in the gallbladder wall.

X-ray language:
Radio-lucent = black = air
Radio-opaque= white= bone

Advantages	Disadvantages
Cheap. - Quick and widely available. - Can be done bedside (portable). - Don't need skills	Use ionizing radiation > avoid in pregnant & pediatric. - Very poor in tissue details including hepatobiliary system. - Very limiting in detecting gallbladder stones. - Won't show bile duct dilatation. - Can't detect radiolucent stones.



''This is an Abdominal x-ray''
or
''Abdominal radiography''
We can see the edge of the liver here. (not always visible)



The First x ray taken in history.
- X-ray was first observed and documented in 1895 by Wilhelm Conrad Roentgen

2. Ultrasound:

What is US?

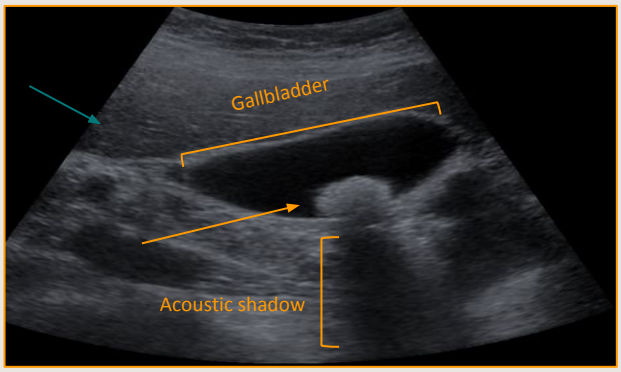
- A diagnostic technique in which high-frequency sound waves penetrate the body and produce multiple echo patterns.
- It is diagnostic Medical applications in use since late 1950's.
- The High frequency sound waves will pass through the body, and will be reflected according to the density of the structure.
- 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)
- Hypo-echoic = Light Grey (in between hyper and anechoic)
- An-echoic = Black (fluid for example)

We compare structures to each other (liver is hyperechoic compared to gallbladder)

- **Acoustic shadow**: black band behind dense object (e.g. stone) (acoustic shadow occurs because we can't see behind dense objects).



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

the liver is **hyper**echoic compared to the gallbladder and **hypo**echoic compared to the stone

Advantages	Disadvantages
No radiation > used in pregnant & Pediatric - Widely available. - Relatively cheap. Cheaper than MRI and CT. - Very good in evaluating abdomen solid organs. - Can be done bedside (portable). - 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 - Very limited in evaluating structures with air (e.g. bowel) > can't see under it or calcification (e.g. bone) > can't see structure behind the bone because it can't pass the bone (ex, ribs > can cause acoustic shadow) - Very limited in patient who is not cooperative. Can see calcification it self but not behind it. #Extra info about US

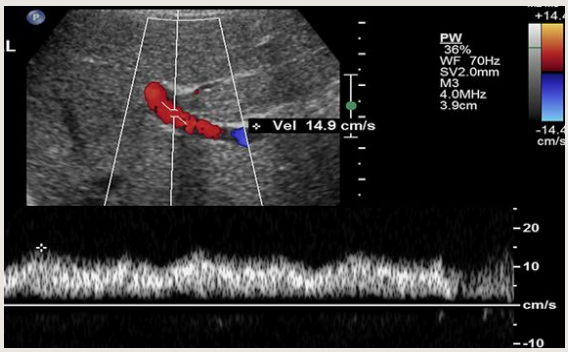
B-Mode:

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

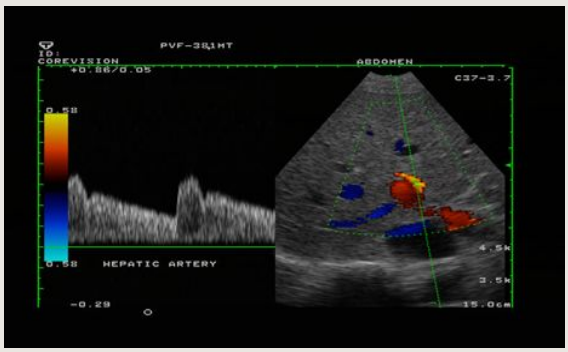
Normal gallbladder
(anechoic, it contains clear fluid)

Another example of B-Mode

Dúplex:

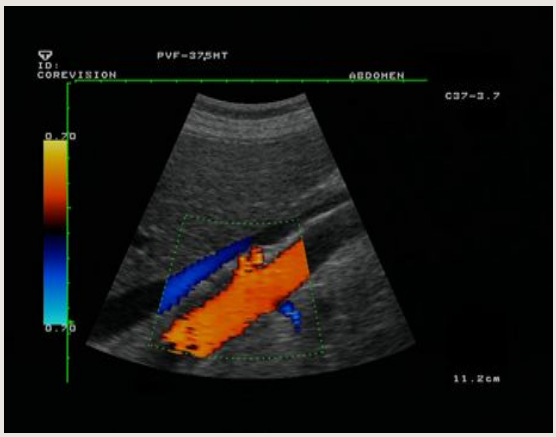


you can see the flow in this image.
(Notice that the wave here is continuous because we are looking at a vein)



- Shows **waves** that differentiate between arteries and veins.
- 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).

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.

-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 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)

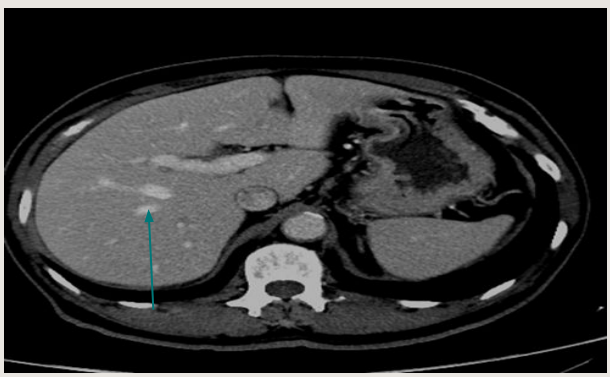
1-The composition of gallbladder is cholesterol which is fat which is black in CT, also fluid will be black " gallbladder also filled with fluid". And most of the stones are black or grey so you can't see it. The same problem occurs with X-Ray. So you have to use US rather than exposing the patient to radiation for nothing.

CT language:
- Hypo-dense = black to grey
- Hyper-dense = white

e.g. Bones are more hyper-dense when compared to the aorta or liver **(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). - The use of a contrast can be harmful for certain Patients like those with kidney disease (Renal impairment) or allergy. - It is not widely available as U/S or X-ray. - It's relatively expensive.

CT without IV contrast



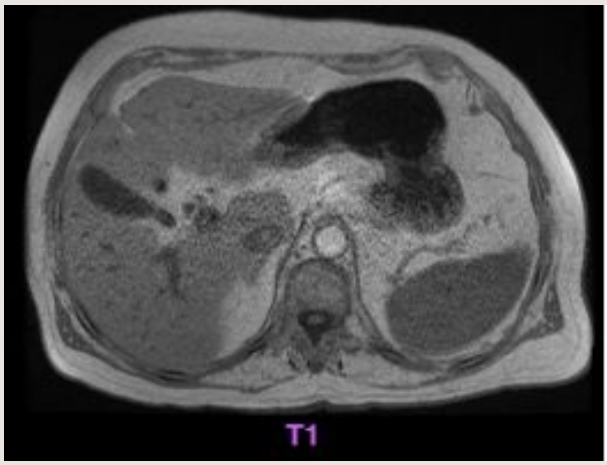
CT with IV contrast

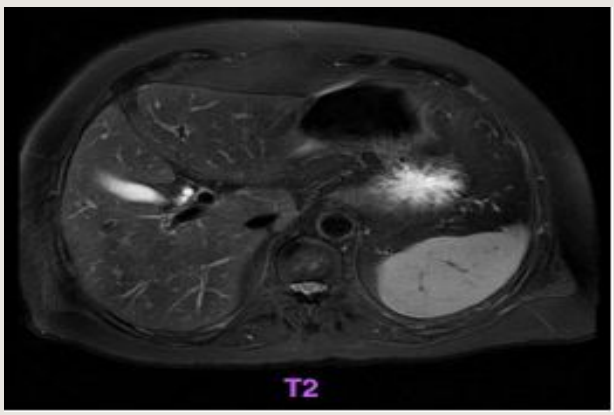
How you know if there is contrast? You see more details and vessels.
- It shows how good the image with contrast, which circulates in the body then into the vessels.
- Contrast is also taken up by the liver so you can easily see details and this helps in case of mass in liver, which can be missed as 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 used in radiology to form pictures of the anatomy using strong magnetic field and radio waves.
- 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.





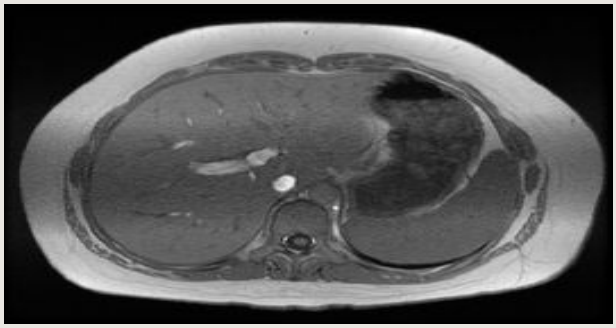
MRI language :

- Hyper-intense 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. - 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? *(This is extra but very helpful)*

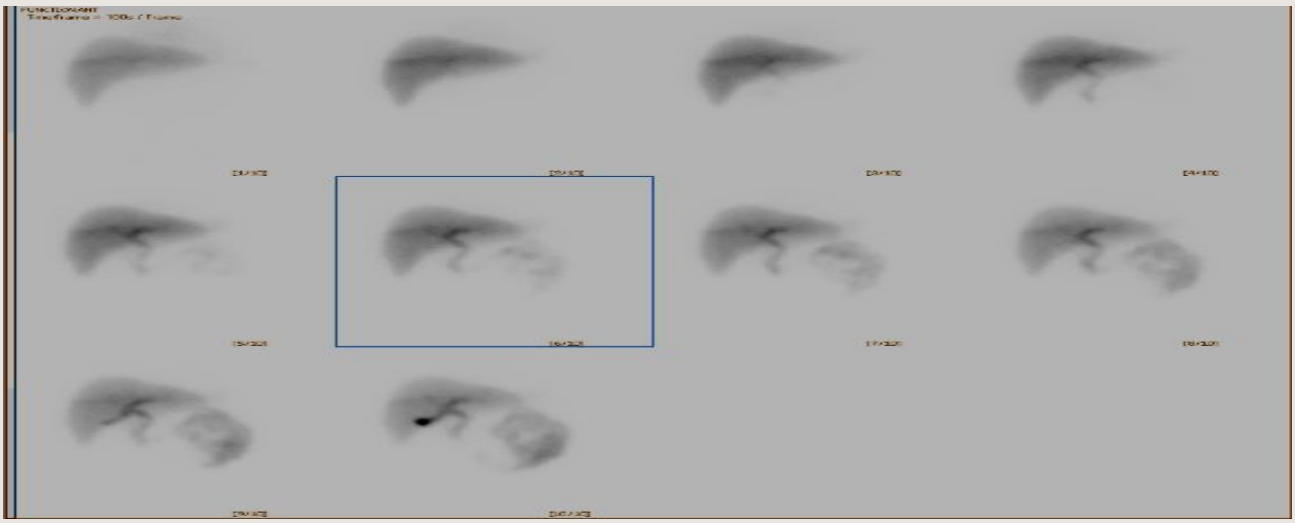


Always look at bone:
MRI: grey to black, CT: always white

5. Nuclear Scan:

What is a nuclear medicine?

- It's a Medical specialty involving the application of radioactive substances in the diagnosis and treatment of a disease.
- It is good at assessing the function (physiology), but poor at assessing the anatomy.



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.

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

SUMMARY

Radiological modalities used in hepatobiliary system	Advantages	Disadvantages
X-Ray	- Cheap. - Widely available.	- Radiation. - Poor soft tissue details.
Ultrasound	- No radiation. - Good at evaluating abdominal solid organs.	- Operator dependant. - Limited in evaluating bowel and calcification.
CT scan	- Good at evaluating solid organs.	- Radiation. - Contrast can be contraindicated.
MRI	- No radiation. - Very good soft tissue details.	- Long scan time. - Less available than other modalities.
Nuclear scan	- Excellent in evaluating organ function.	- Radiation. - Very poor in evaluating anatomy. - Not widely available.

QUESTIONS

1.Abdominal X-ray was taken from a patient , which one of the following you think he has based on the X-ray:

a) Large bowel obstruction.

b) Perforation.

c) Scoliosis.

d) Normal abdominal X-ray.

2.Which one of the following is the appropriate test to assess tumors:

a) MRI

b) CT

c) Ultrasound

d) Nuclear medicine.

3. Which one of the following is the modality of choice to start with in hepatobiliary system:

a) MRI

b) CT

c) Ultrasound

d) Nuclear medicine.

1-A 2-B 3-C

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