THE LIVER

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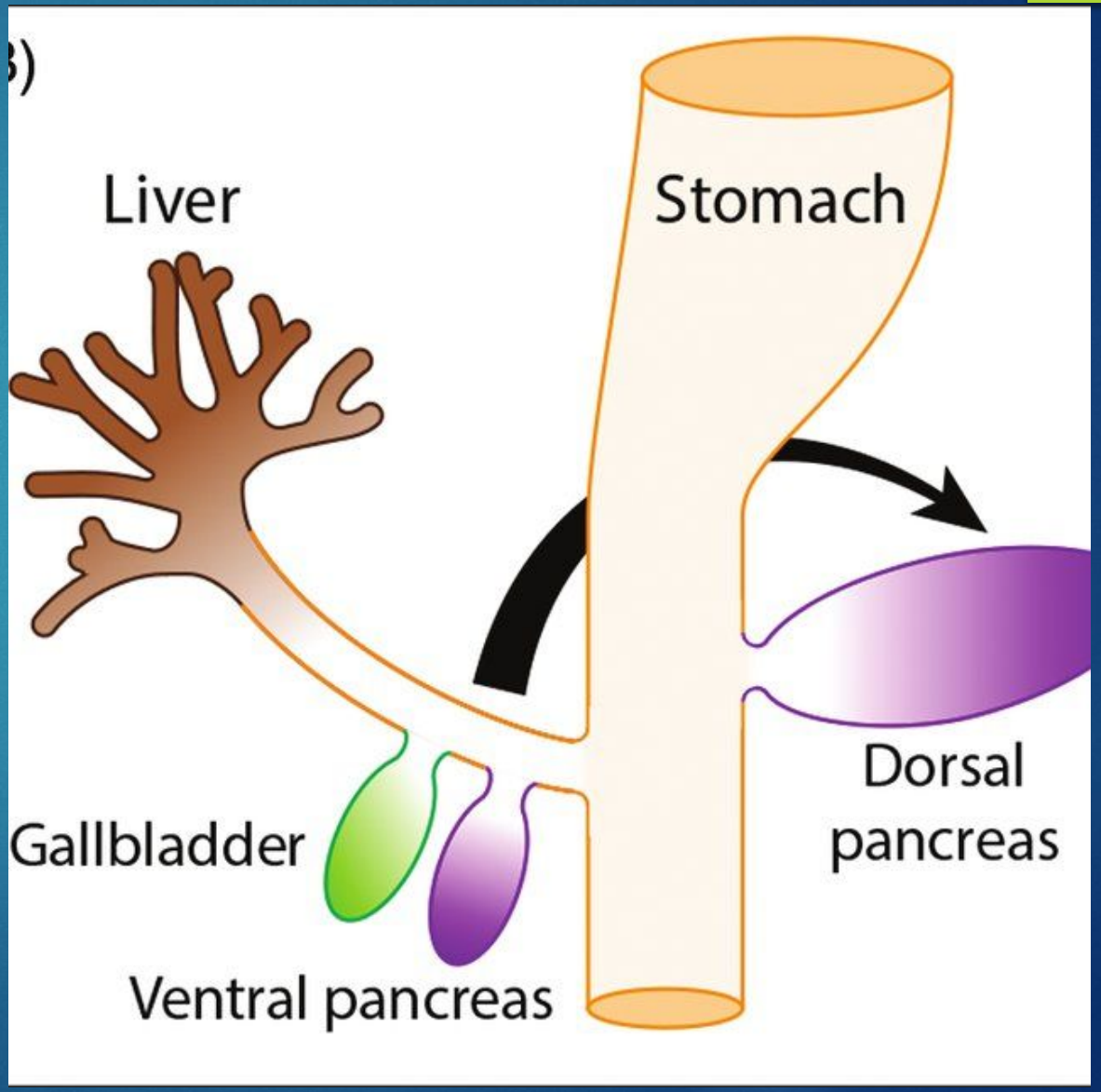
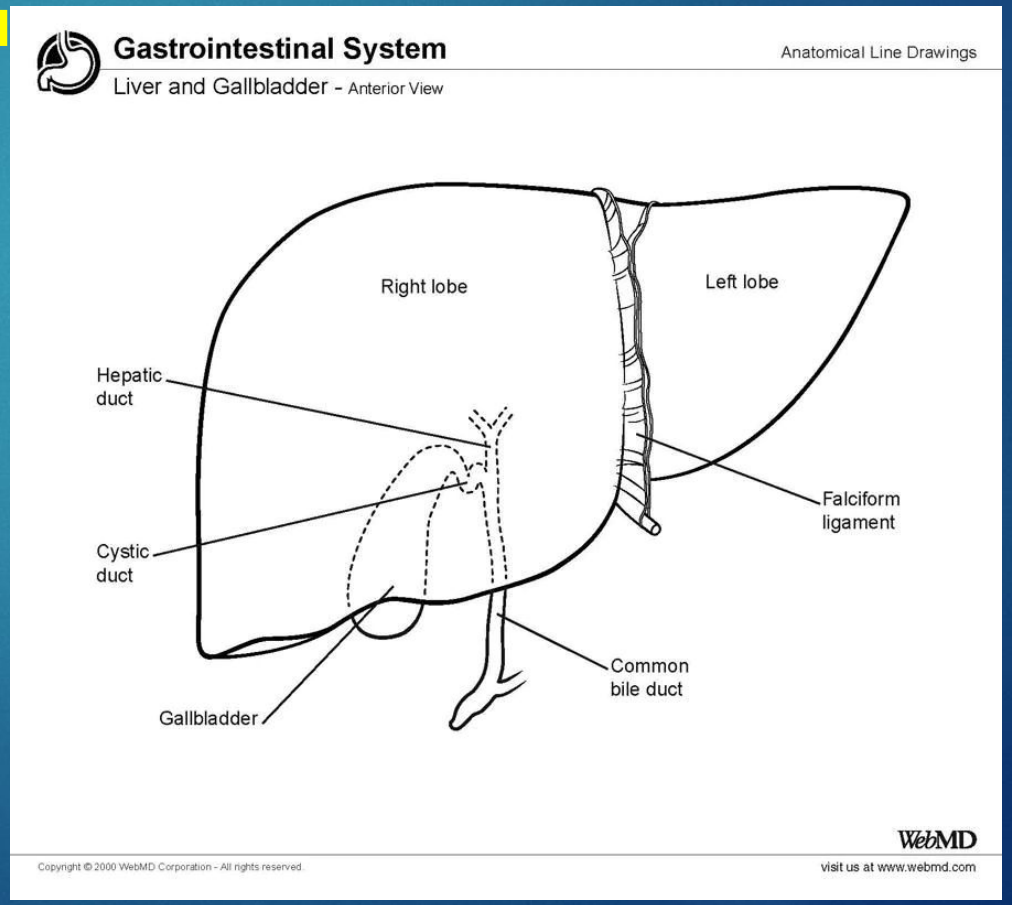
Emberyology



ANATOMY

- The International Hepto-Pancreato-Biliary Association (IHPBA) terminology of liver anatomy and resections is followed by most liver su



Hepatic Recesses

spaces between the liver and surrounding structures. They are of clinical importance as infection may collect in these areas, forming an abscess

Subphrenic spaces – located between the diaphragm and the anterior and superior aspects of the liver. They are divided into a right and left by the falciform ligament.

- **Subhepatic space** – a subdivision of the supracolic compartment (above the transverse mesocolon), this peritoneal space is located between the inferior surface of the liver and the transverse colon.

- **Morison's pouch** – a potential space between the visceral surface of the liver and the right kidney. This is the deepest part of the peritoneal cavity when supine (lying flat), therefore pathological abdominal fluid such as blood or ascites is most likely to collect in this region in a bedridden patient.

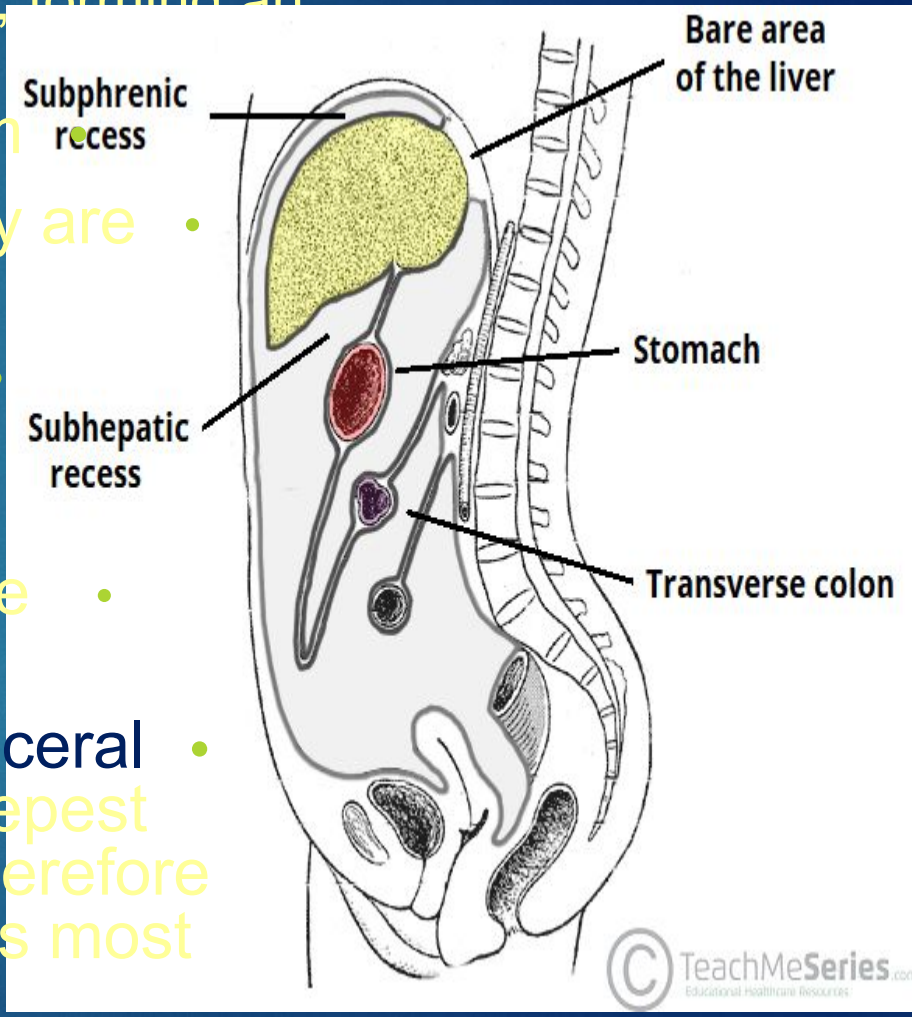
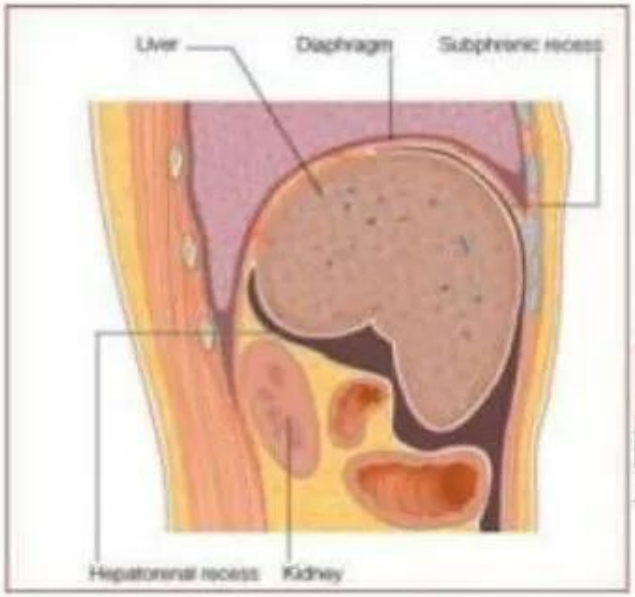
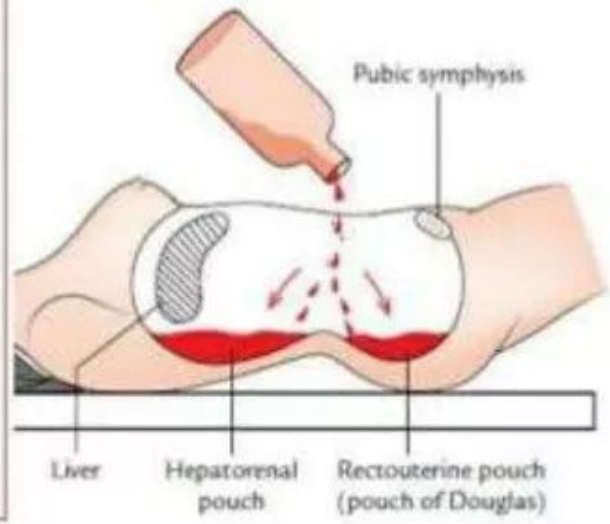


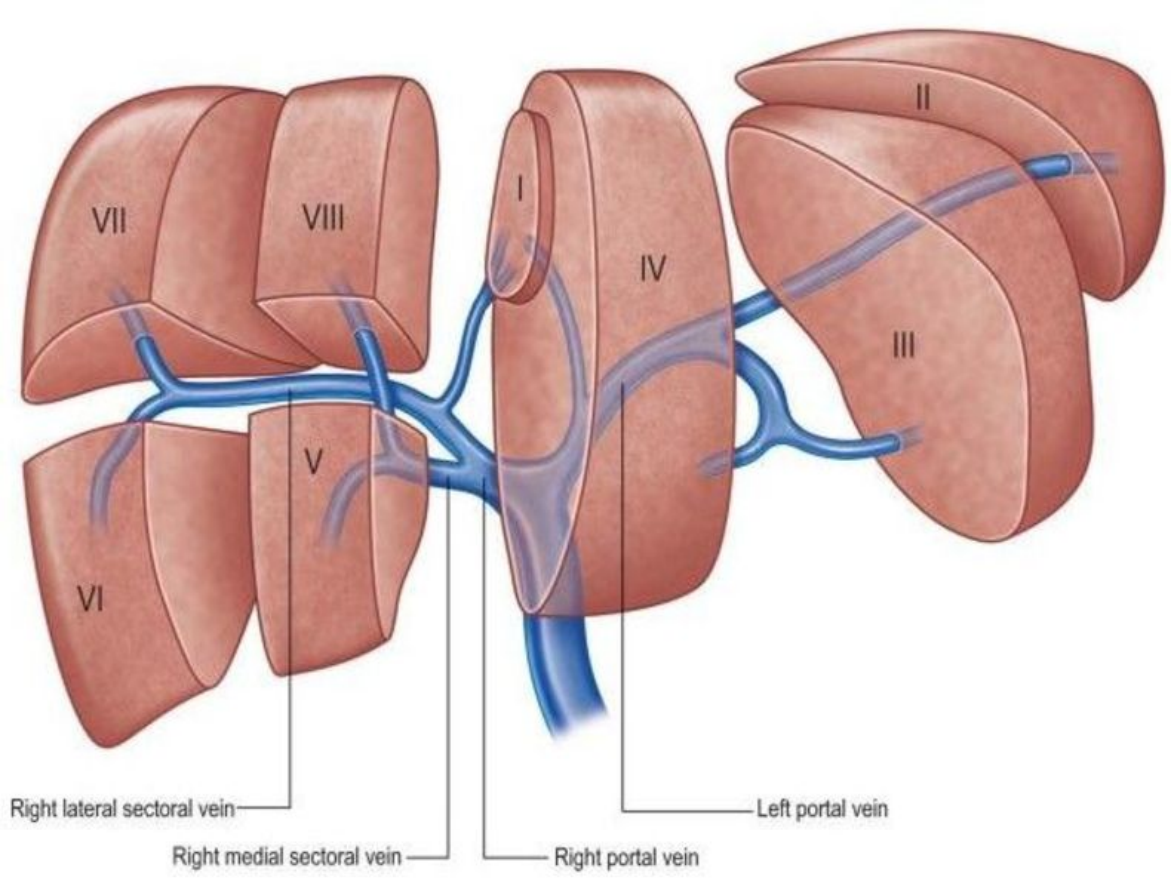
Fig. 1. Right upper quadrant view depicting a positive FAST scan obtained during the study period with free fluid visible in Morrison's pouch.

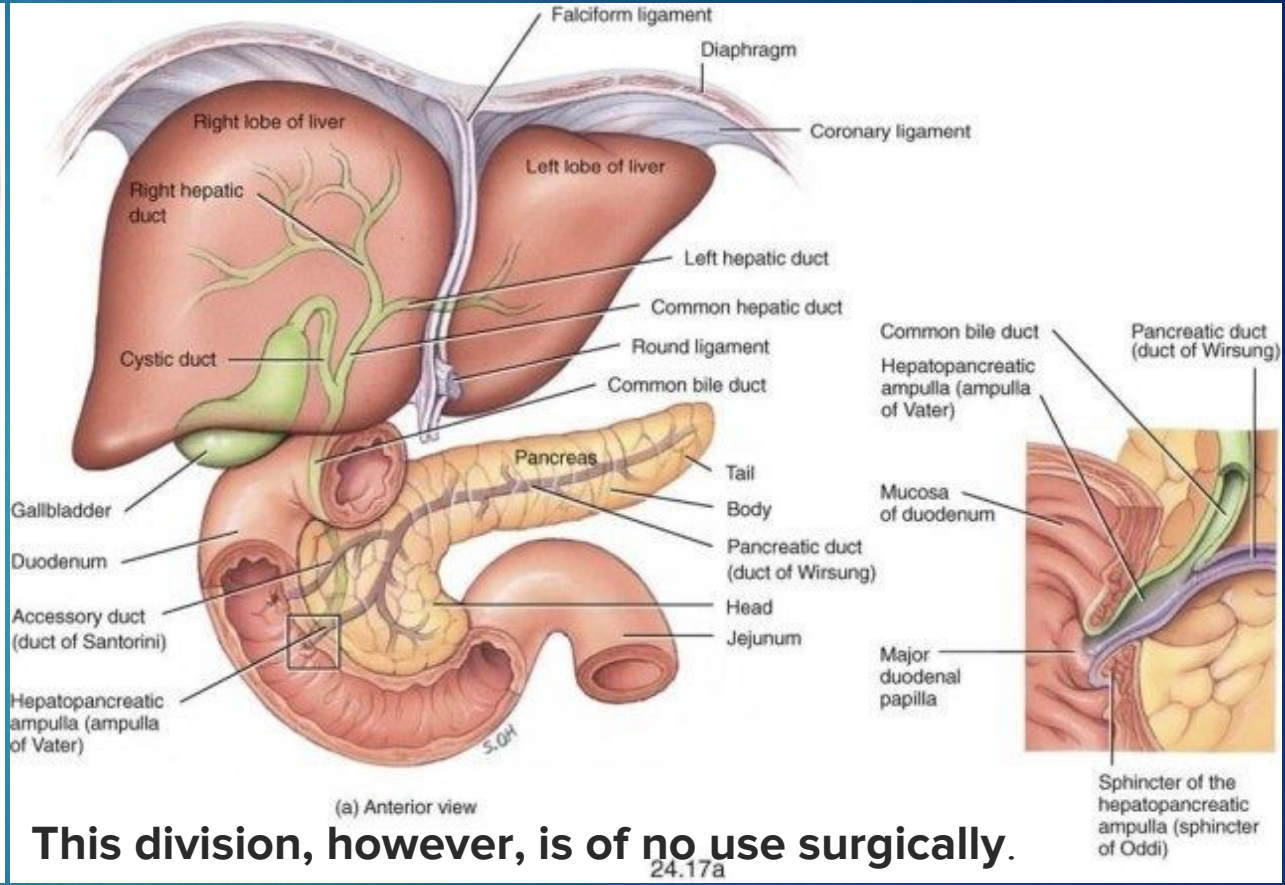




- Most dependent part of the peritoneal cavity in supine position
- Most common site of subphrenic abscess

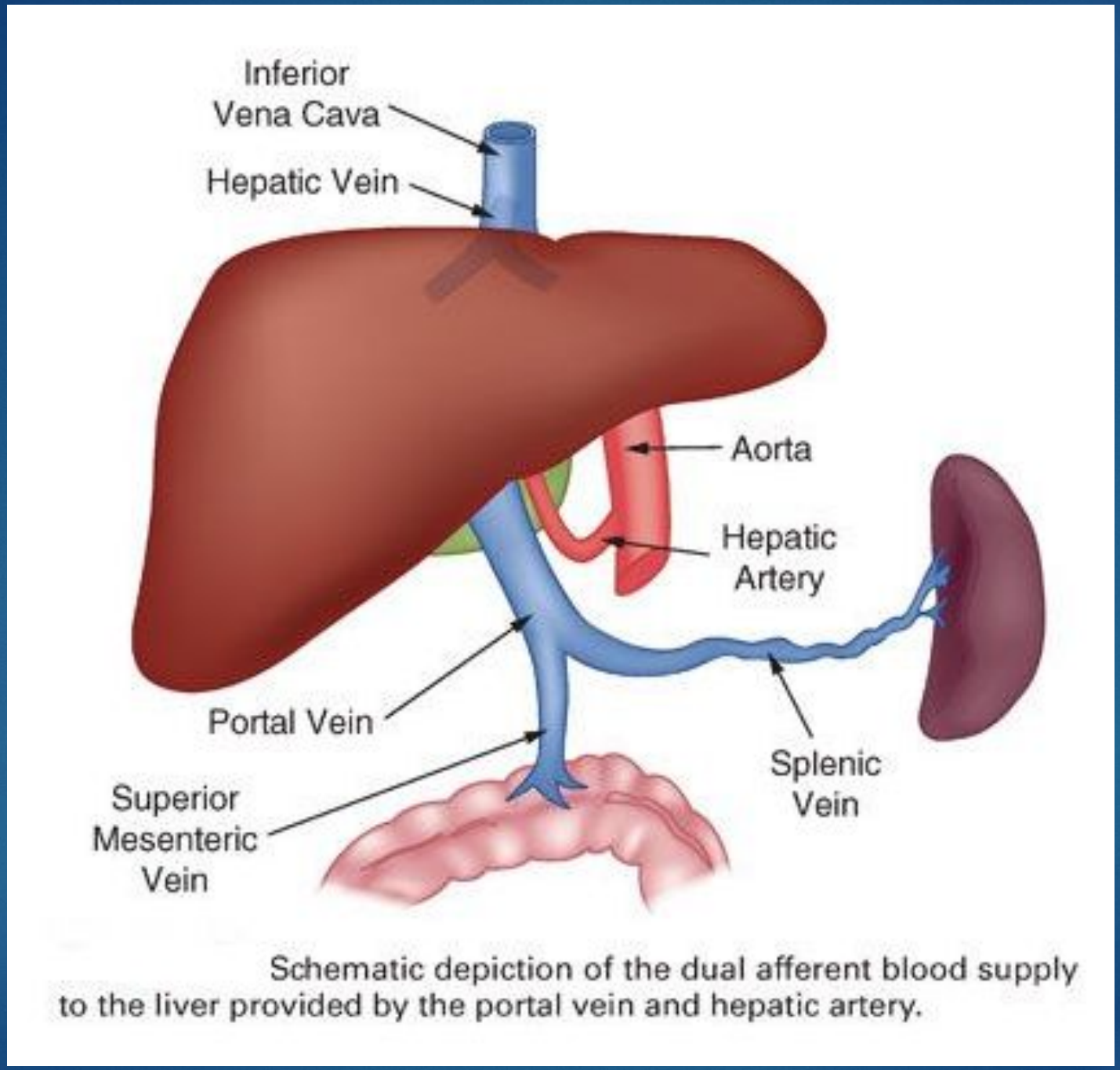
Anatomy And Physiology



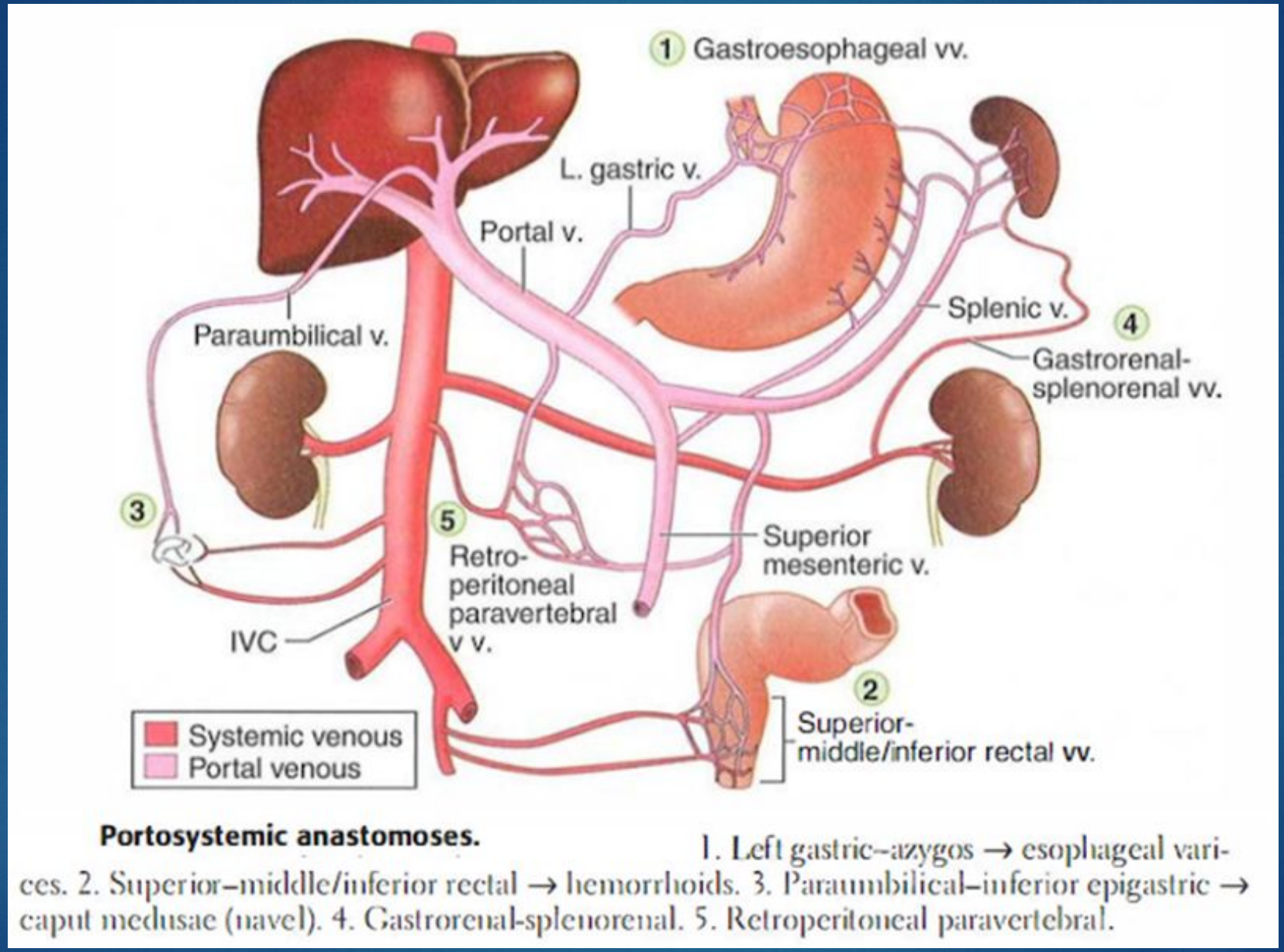


This division, however, is of no use surgically.

Liver Structure
and the
Flow of Blood & Bile

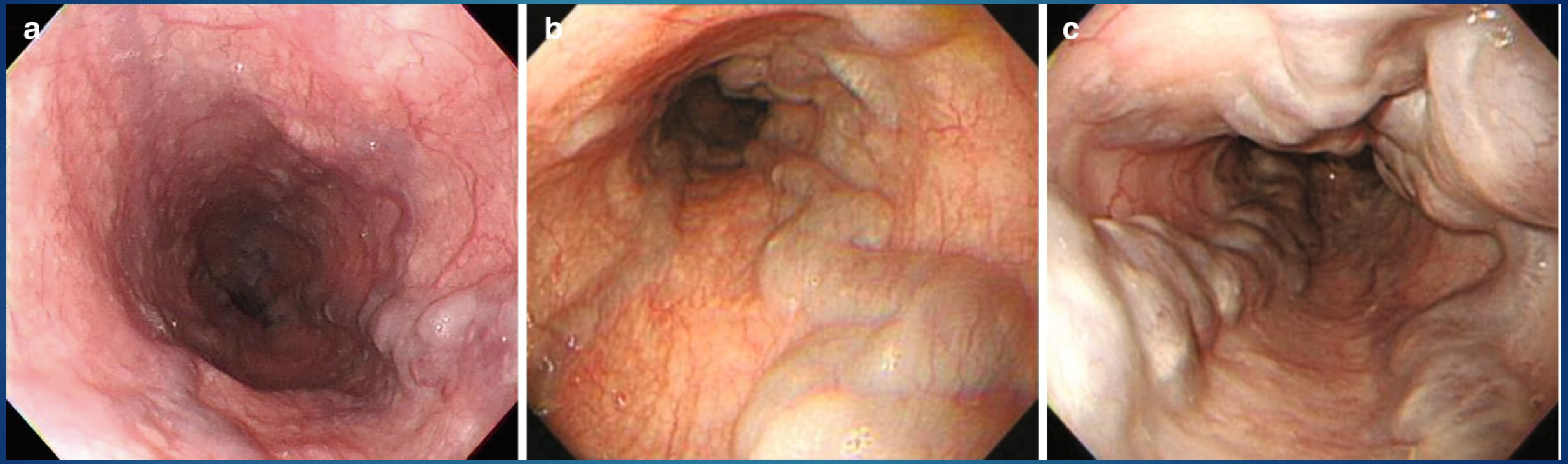


Schematic depiction of the dual afferent blood supply to the liver provided by the portal vein and hepatic artery.



Portosystemic anastomoses.

1. Left gastric–azygos → esophageal varices. 2. Superior–middle/inferior rectal → hemorrhoids. 3. Paraumbilical–inferior epigastric → caput medusae (navel). 4. Gastrorenal-splenorenal. 5. Retroperitoneal paravertebral.


a
b
c

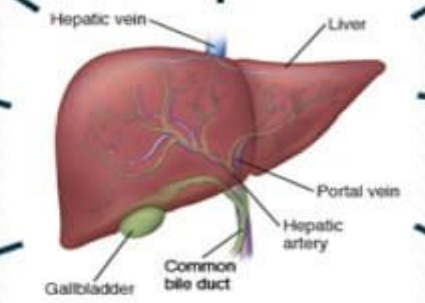
Functions of the Liver

Detoxification:
- Drugs/Alcohol
- Fatty acids
- Steroid hormones
- Ammonia → Urea
- Environmental toxins/allergens

Production of Cholesterol:
- Precursor to sex hormones, Vitamin D

Storage of Micronutrients:
- Minerals: Copper, Zinc, Magnesium, Iron
- Vitamins: Vitamin A, D, E, K, B12

Metabolism:
- Conversion of T4 → T3
- Detoxification of fat

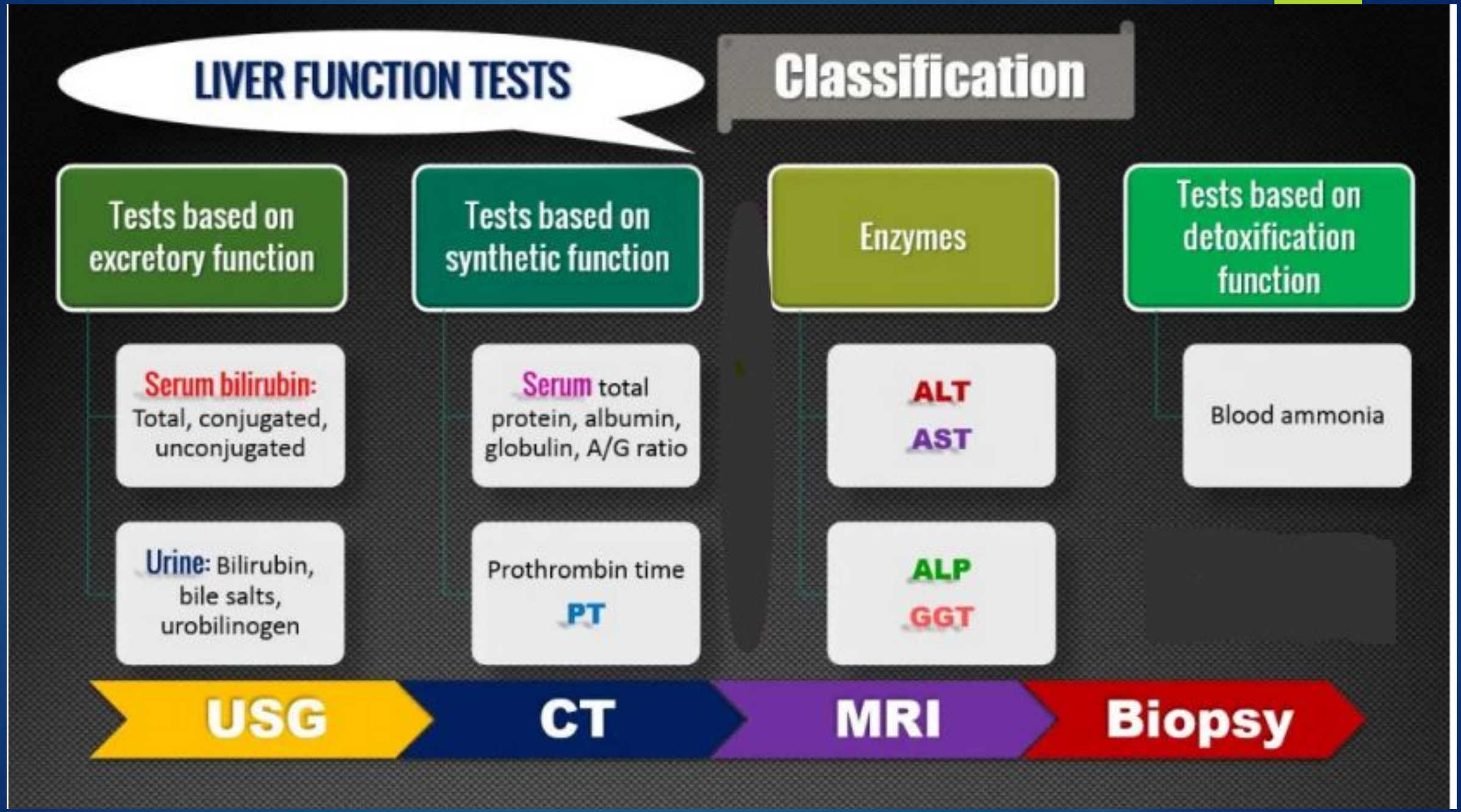


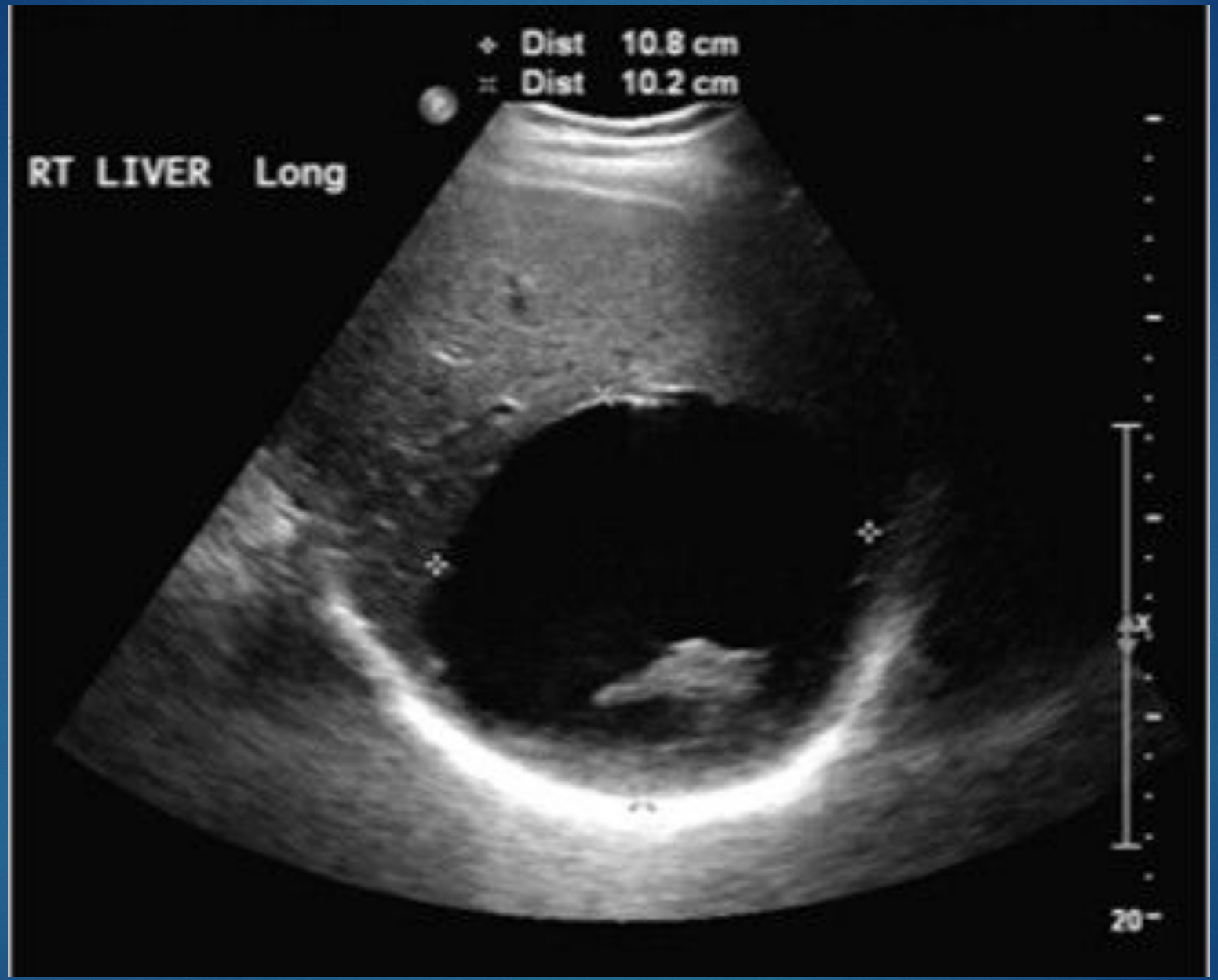
Blood Sugar Balance:
- Storage of glycogen

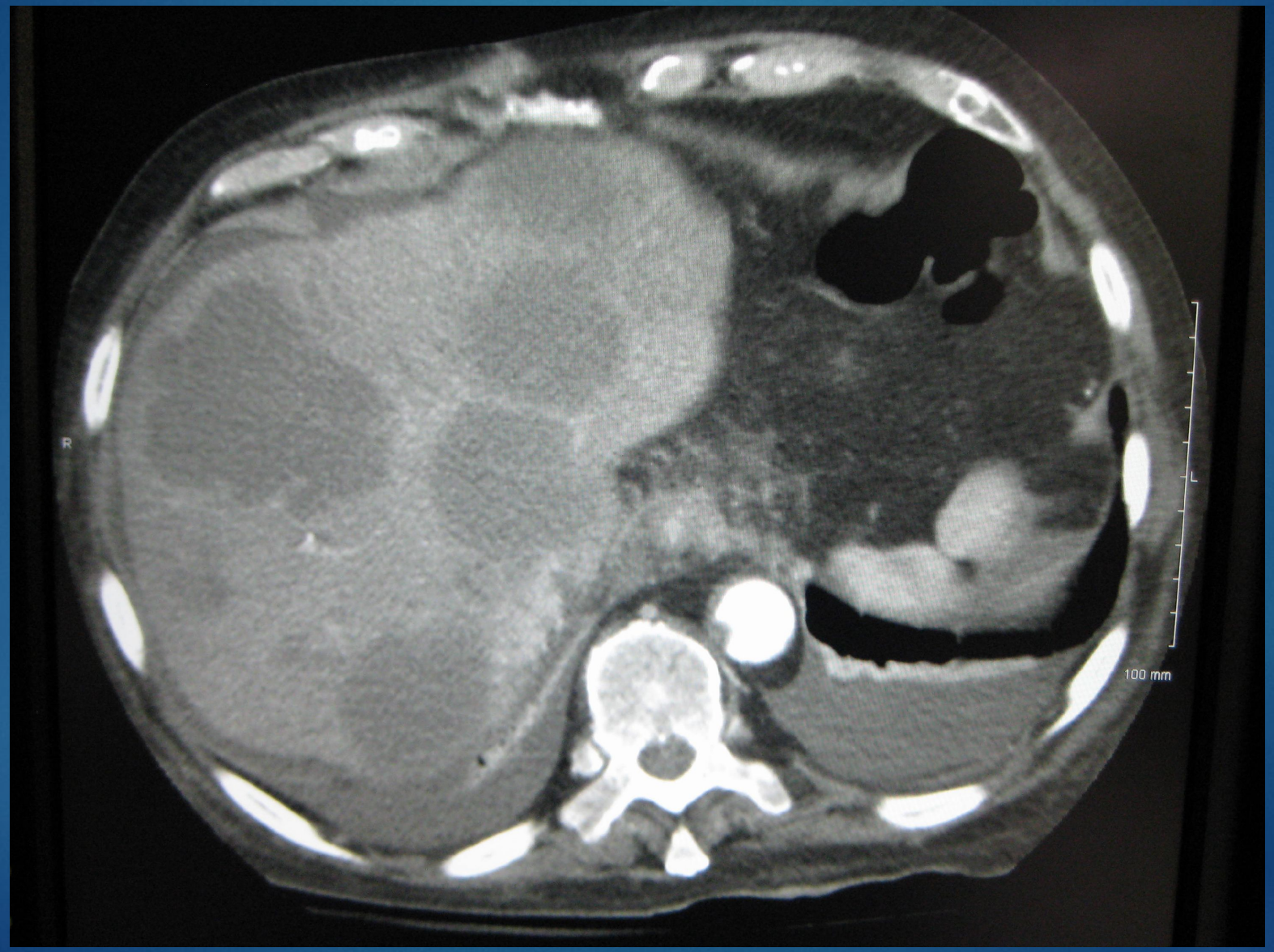
Immune System:
- Contains viruses and pathogens
- Maintenance of the hepatic and portal vein immune system

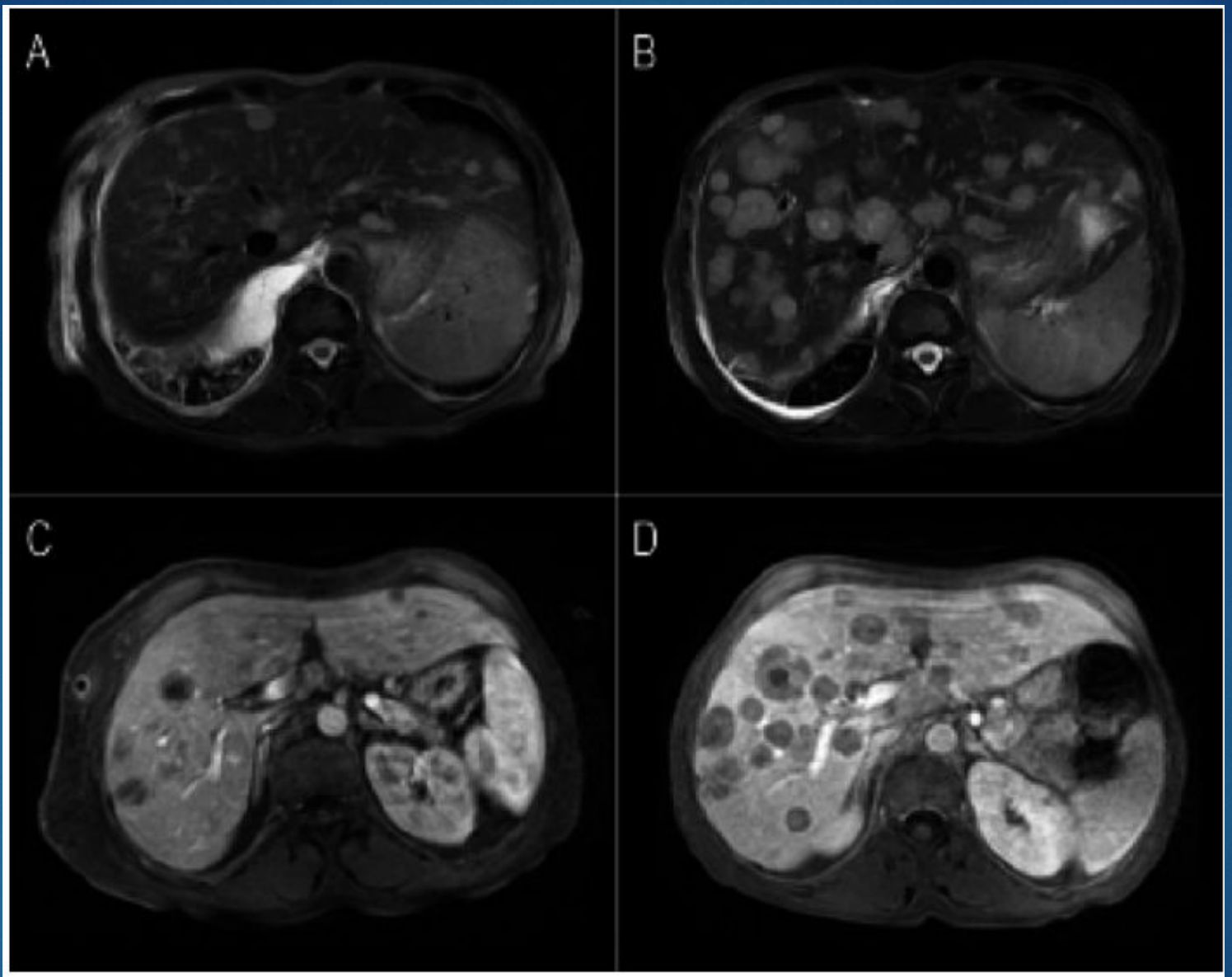
Production of Bile:
- Needed for digestion
- GI anti-microbial

Protein Synthesis:
- Blood clotting (prothrombin)
- Cholesterol transport (lipoproteins)
- Immune Function (globulins)
- Oncotic pressure (albumin)
- Copper bioavailability (ceruloplasmin)


LIVER FUNCTION TESTS
Classification
Tests based on excretory function
Tests based on synthetic function
Enzymes
Tests based on detoxification function
Serum bilirubin: Total, conjugated, unconjugated
Serum total protein, albumin, globulin, A/G ratio
ALT
AST
Blood ammonia
Urine: Bilirubin, bile salts, urobilinogen
Prothrombin time
PT
ALP
GGT
USG
CT
MRI
Biopsy


Dist 10.8 cm
Dist 10.2 cm
RT LIVER Long
20


R
100 mm



Conventional MRI images of liver metastases from small lung cell carcinoma . A, B. Fat-suppressed T2-weighted fast spin-echo images. C, D. Gadolinium-enhanced hepatic arterial domi- nant-phase 3-dimensional gradient-echo. Multiple areas of distinctly hyperintensity suggesting the possibility of metastases are seen on T2- weighted image (A-B) and on gadolinium-enhanced images (C-D). Notice the increase in number and size for most l e sions in the 2-months follow-up (B-D).

The gold standard or identifying liver lesions by imaging is

A. Intraoperative ultrasound
B. Computed tomography (C) with triple-phase contrast
C. Magnetic resonance imaging (MRI) with contrast
D. Positron emission tomography (PE) scan

	Advantages	Disadvantages	Additional Notes
Ultrasound	Inexpensive Widely available Highly sensitive for differentiating cystic and solid lesions No ionizing radiation	Low sensitivity for detecting focal, solid liver lesions, particularly in the setting of diffuse disease Often unable to detect lesions <1 cm in size Low specificity High operator dependency	Use of contrast agents may improve characterization of hepatic tumors Useful for guiding liver parenchymal and some focal mass biopsies Elastography may overestimate degree of fibrosis and may not be useful for screening in CHD
CT	Best spatial resolution (submillimeter resolution)	Exposure to ionizing radiation dose Low sensitivity for detecting and characterizing lesions <1 cm in size Contrast contraindicated in renal failure Diffuse liver disease and fatty infiltration limit sensitivity for lesion detection	CT-guided liver mass biopsy useful in cases when ultrasound visualization is poor
MRI	High lesion-to-liver contrast High spatial resolution Better lesion detection and characterization than CT No ionizing radiation Unenhanced MRI superior to unenhanced CT	Contrast relatively contraindicated in renal failure (eGFR <30 $mL \cdot min^{-1} \cdot 1.73\ m^{-2}$) High cost Long scan time Need for longer breath-holds Less widely available	Hepatobiliary contrast media useful in characterizing specific liver tumors

Advantages and Disadvantages of Imaging Modalities for Detection of Liver Disease and Screening for HCC in Patients With CHD

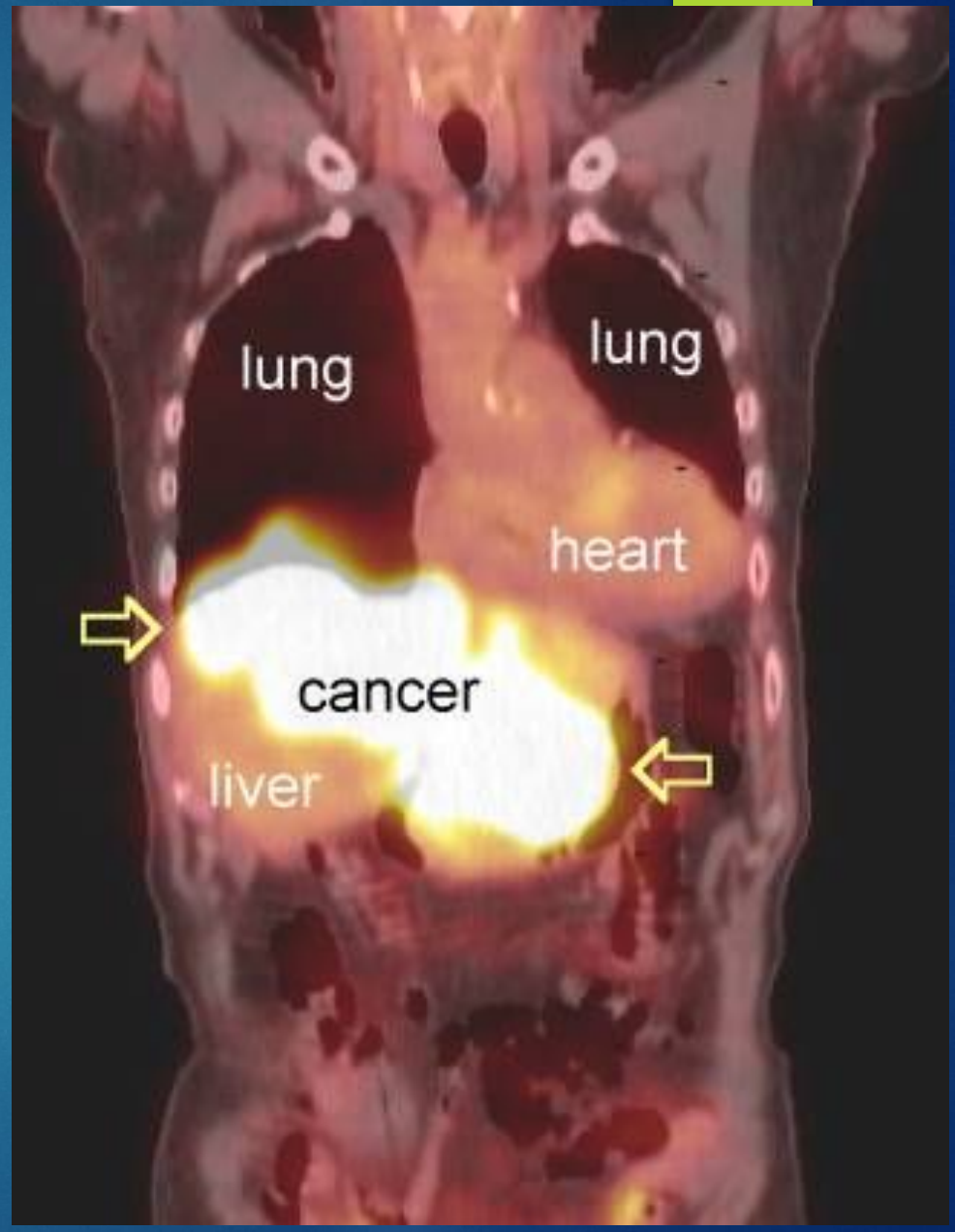
PET SCAN

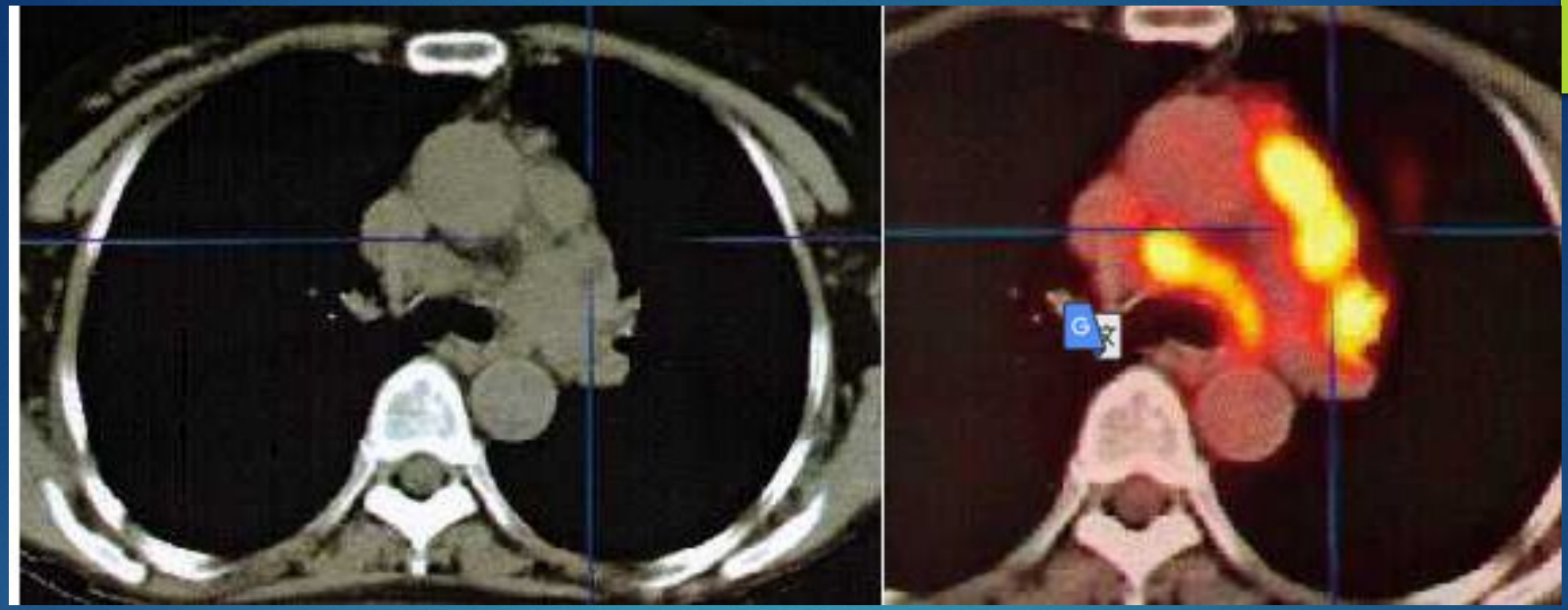
- • In principle, whole - body PET can identity a tumour and indicate the presence of spread anywhere in the body at an early stage (micrometastases).
- • It can differentiate between benign and malignant tumours (metabolic activity of the lesion).
- • It differentiates viable from non-viable tumour, which may be increasingly important for *in situ* ablation of tumours, e.g. liver,prostate.

PET Scans (Positron Emission Tomography)

PET scans (which tag radioactive glucose metabolism) to evaluate the spread and activity of cancer. PET scans are more sensitive than other tests in evaluating cancer patients for many forms of cancer.

Picture at the right is a PET scan showing colon cancer that has spread from the pelvis region to the liver. PET scans are much more sensitive than CT scans

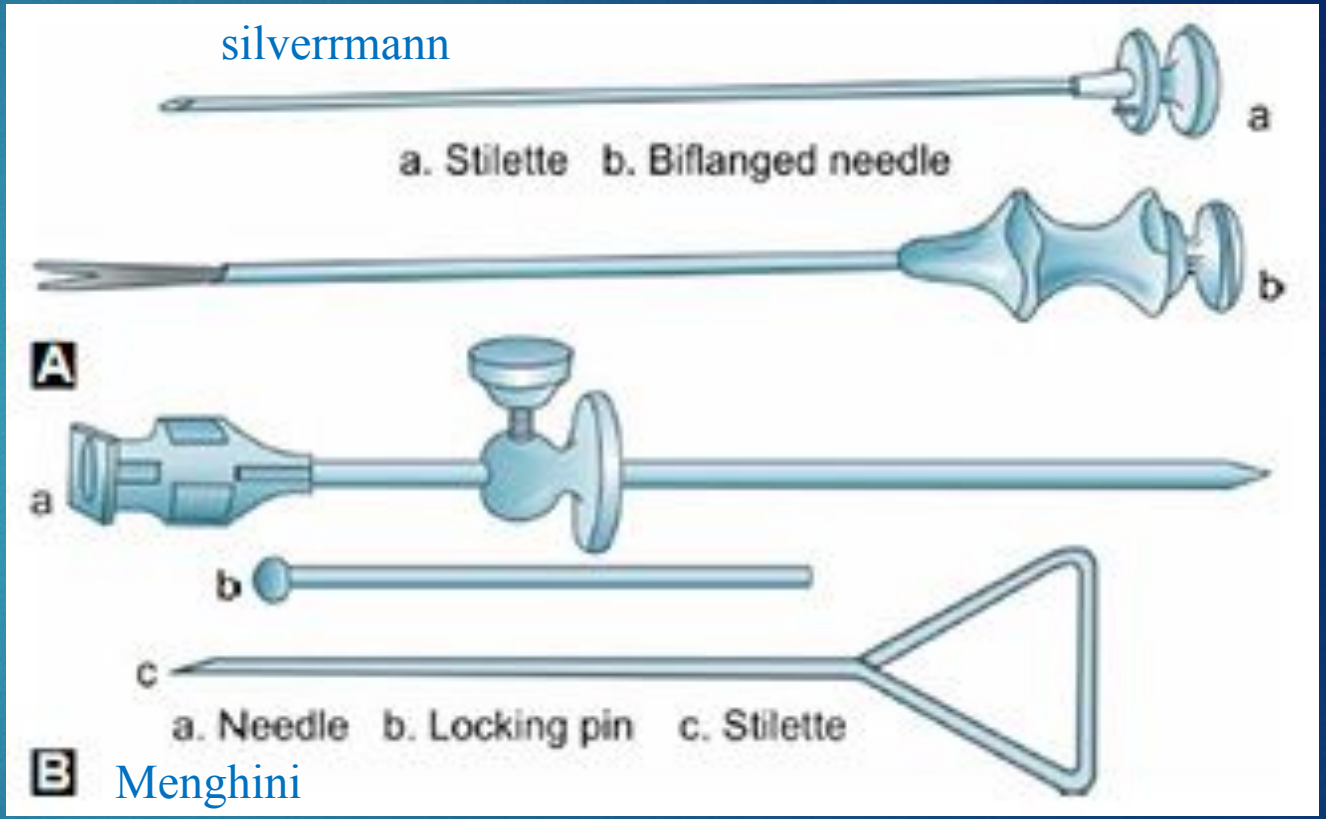




the PET helps identify the malignant lymph nodes and avoids confusing these structures with normal blood vessels

Needle Biopsy

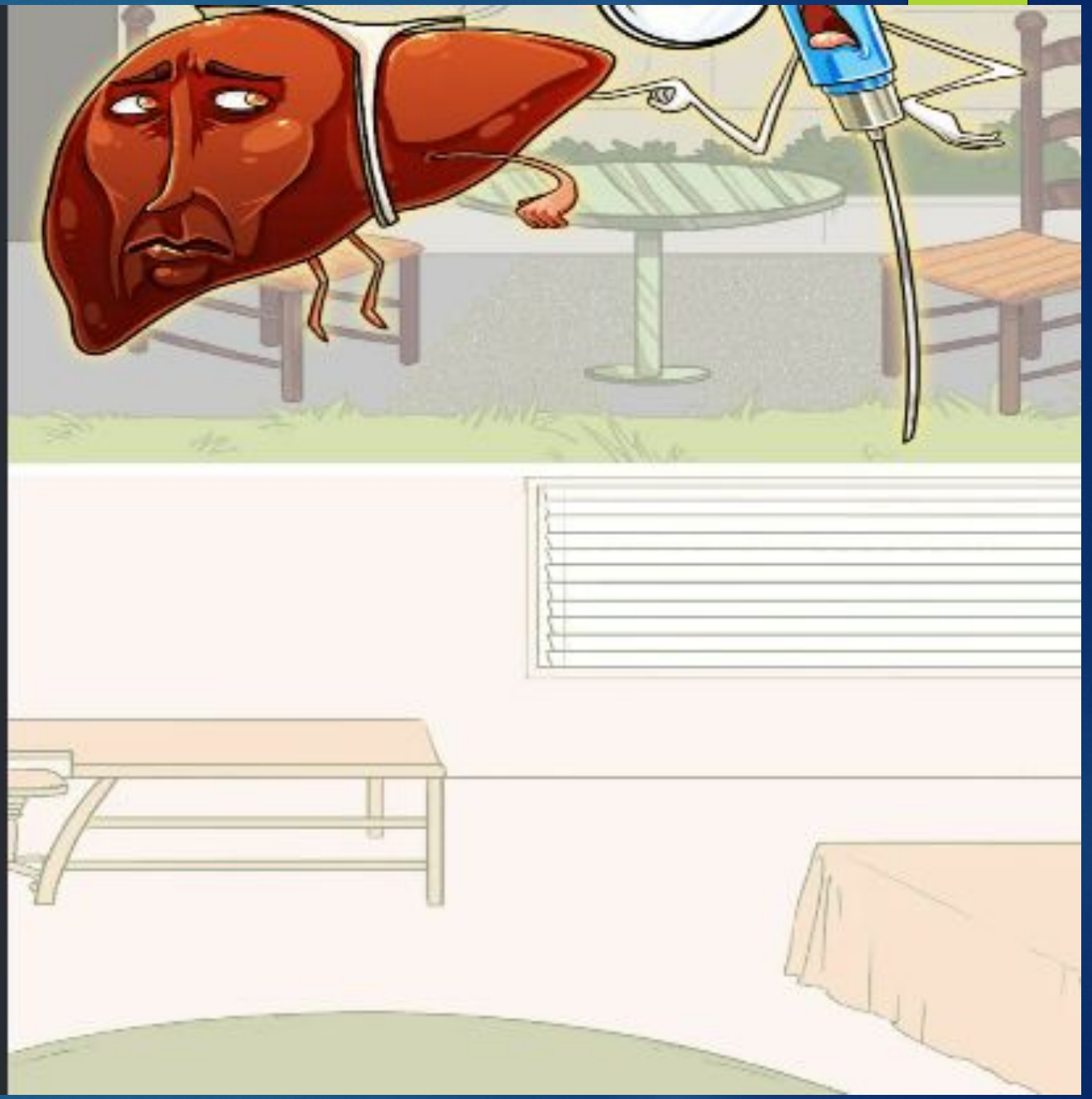
- **Diffuse Liver diseases**
- **Focal liver lesions**



Question 5 / 7

Which of the following should most likely be assessed prior to undergoing a liver biopsy procedure?

- BUN (Blood Urea Nitrogen) Lab Values
- Bilirubin Lab Value
- Creatinine Lab Values
- Hydration Status
- Coagulation Status



Complication of liver needle Biopsy

The most common complications of liver needle biopsy are:

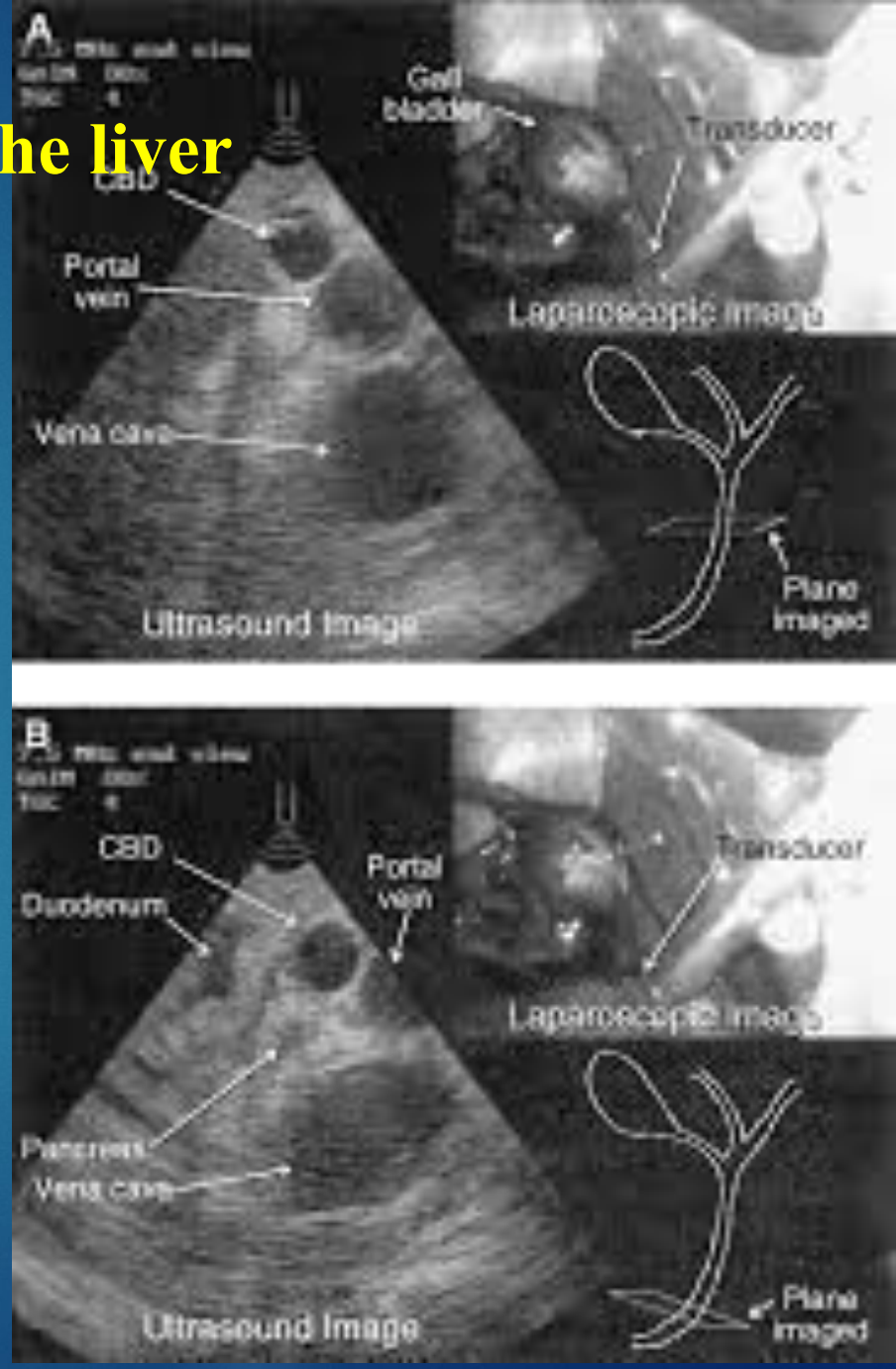
- pleural effusion
- haemorrhage from the liver and thoracic wall
- intrahepatic haematoma
- hepatic arteriovenous fistulas
- haemobilia
- accidental puncture of the gallbladder and large bile ducts leading to bile peritonitis
- tumour cell implantation.

Contraindications

- **Hydatid disease, where it will precipitate anaphylaxis**
- **Haemangioma, bleeding disorders**
- **Ascites**

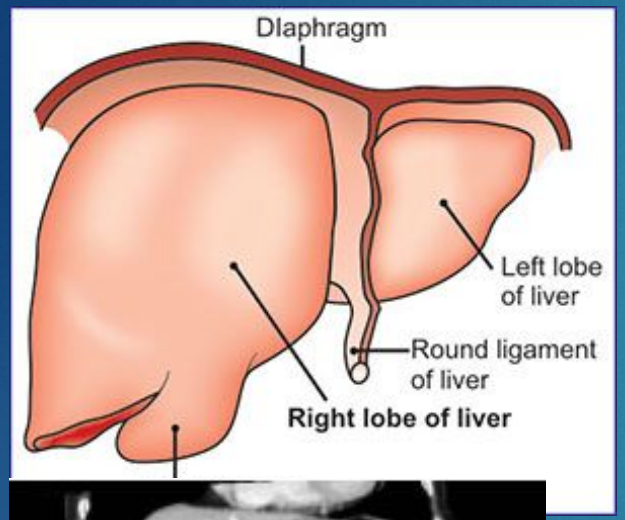
Laparoscopy with contact ultrasonography of the liver

- provides direct information on the state of the live
- peritoneal cavity.
- investigation of patients with jaundice, chronic liver disease, ascites of unknown origin
- and in the diagnosis and staging of both primary and secondary hepatic tumors



Congenital abnormalities

- **Riedel's lobe**



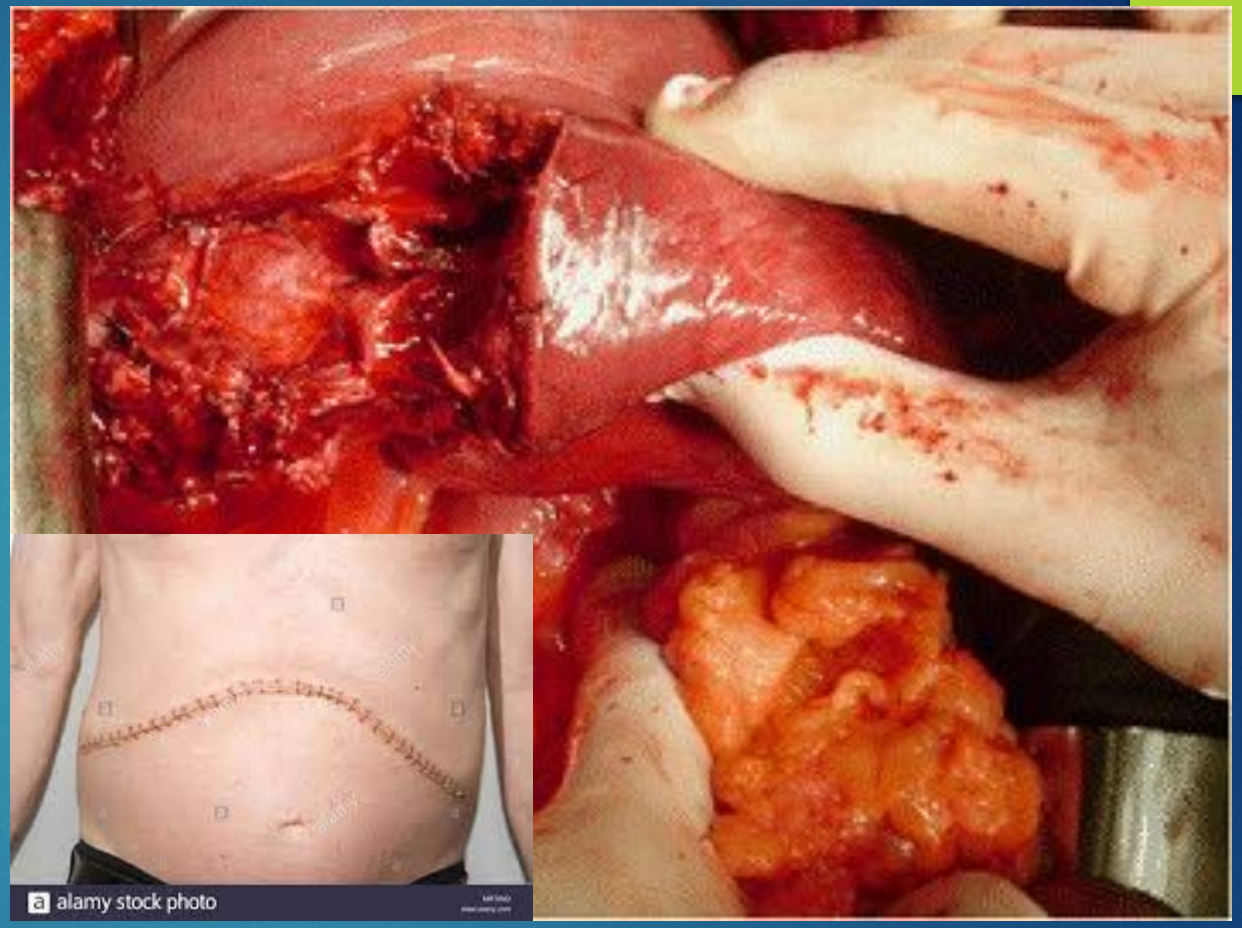
Polycystic liver

Malformation of bile ducts

LIVER INJURY

- **Penetrating:**

- **Blunt trauma**



Blunt Trauma

Indications for surgical intervention

progressive deterioration and bleeding, grade 5 liver injury on CT scan, associated bowel injury.

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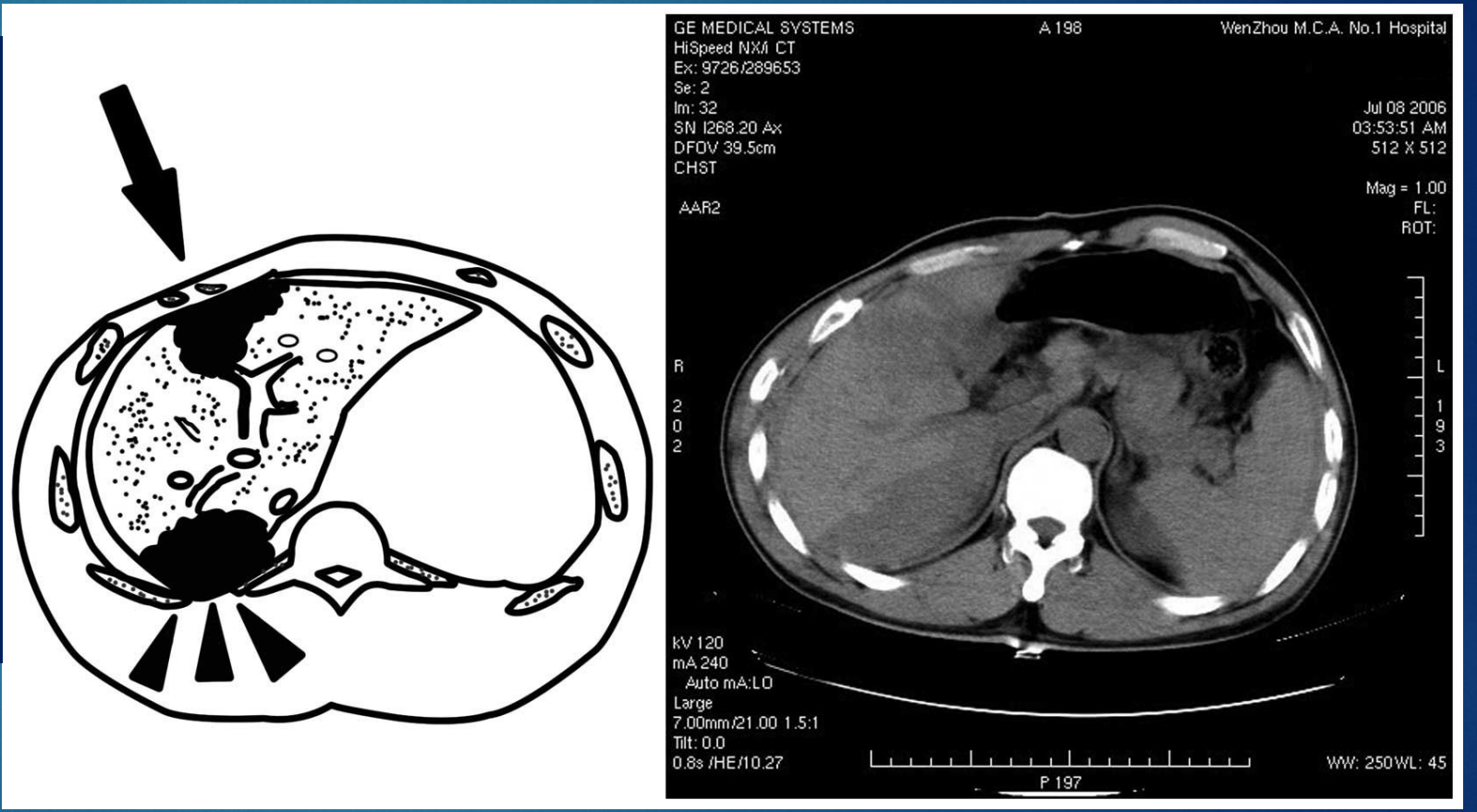
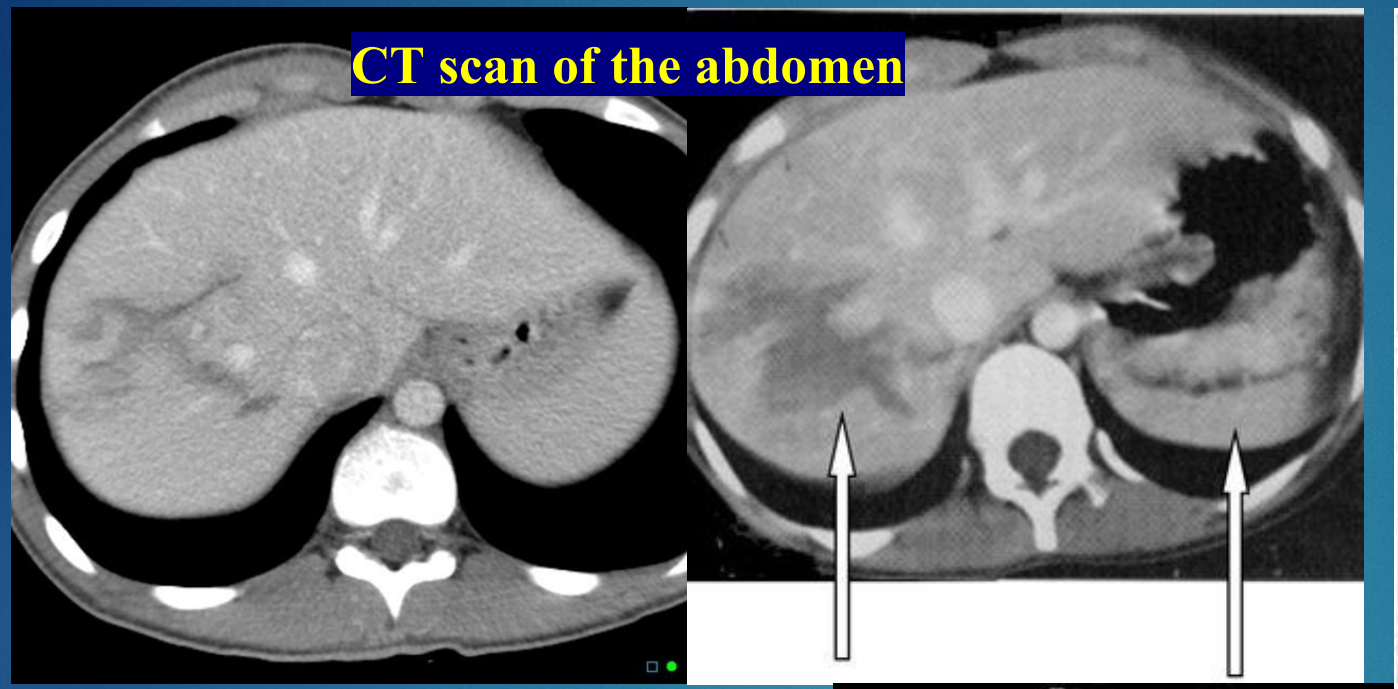
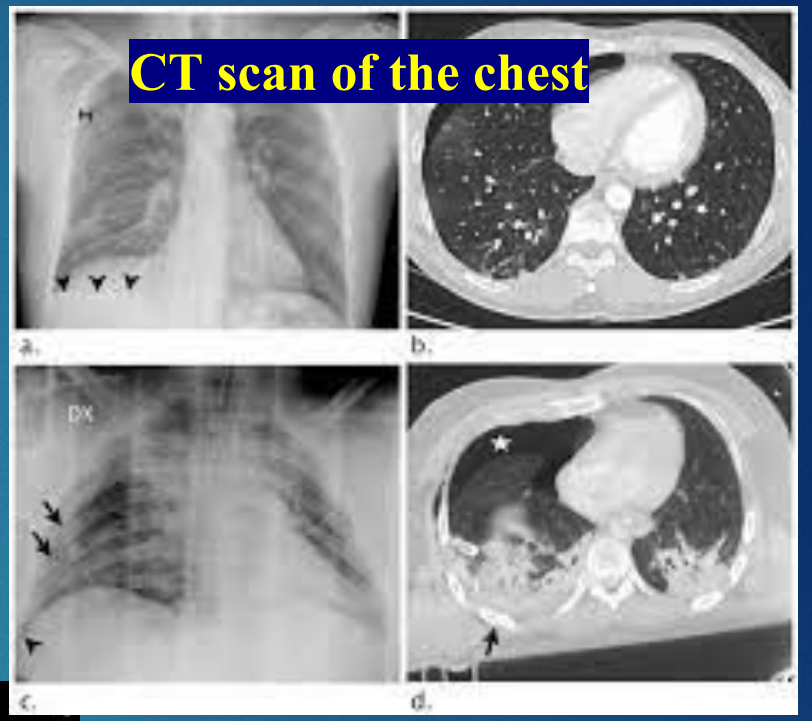


Clinical Features



CT scan of the abdomen



CT scan of the chest

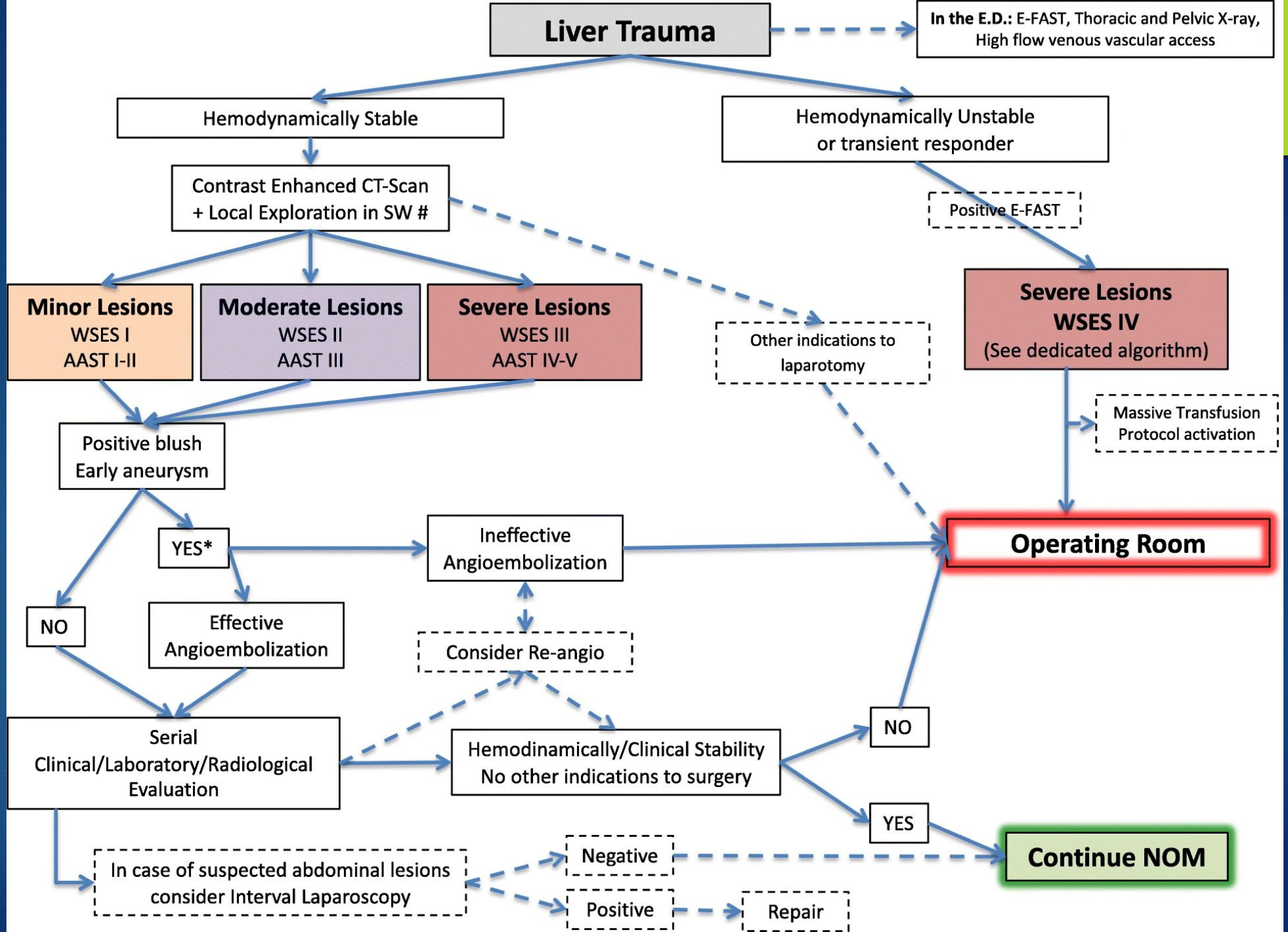
Focused assessment sonography in trauma (FAST)

	WSES grade	AAST	Hemodynamic
Minor	WSES grade I	I–II	Stable
Moderate	WSES grade II	III	Stable
Severe	WSES grade III	IV–V	Stable
	WSES grade IV	I–VI	Unstabl

AAST American Association for the Surgery of Trauma
WSES World Society of Emergency Surgery

Investigations

- **x Diagnostic peritoneal lavage.**
- **10 ml gross blood on initial aspiration, > 1,00,000 cu mm**
- **RBCs, > 500 WBCs, and presence of enteric contents suggest positive DPL. Diagnostic**
- **peritoneal aspiration only can also be done.**


Liver Trauma
In the E.D.: E-FAST, Thoracic and Pelvic X-ray, High flow venous vascular access
Hemodynamically Stable
Hemodynamically Unstable or transient responder
Contrast Enhanced CT-Scan + Local Exploration in SW #
Positive E-FAST
Minor Lesions
WSES I
AAST I-II
Moderate Lesions
WSES II
AAST III
Severe Lesions
WSES III
AAST IV-V
Other indications to laparotomy
Severe Lesions
WSES IV
(See dedicated algorithm)
Massive Transfusion Protocol activation
Positive blush
Early aneurysm
YES*
Ineffective Angioembolization
Operating Room
NO
Effective Angioembolization
Consider Re-angio
Serial
Clinical/Laboratory/Radiological Evaluation
Hemodinamically/Clinical Stability
No other indications to surgery
NO
YES
Continue NOM
In case of suspected abdominal lesions consider Interval Laparoscopy
Negative
Positive
Repair

Diagnostic Peritoneal Lavage

A sensitive way to evaluate for intra-abdominal injury in the trauma patient

In Blunt Trauma

Unexplained hypotension

Concern for injury but no obvious indication for laparotomy and serial abdominal examinations are not practical (i.e., unconscious or under anesthesia)

Equivocal focused abdominal sonography for trauma (FAST) examination and concern for an intra-abdominal injury

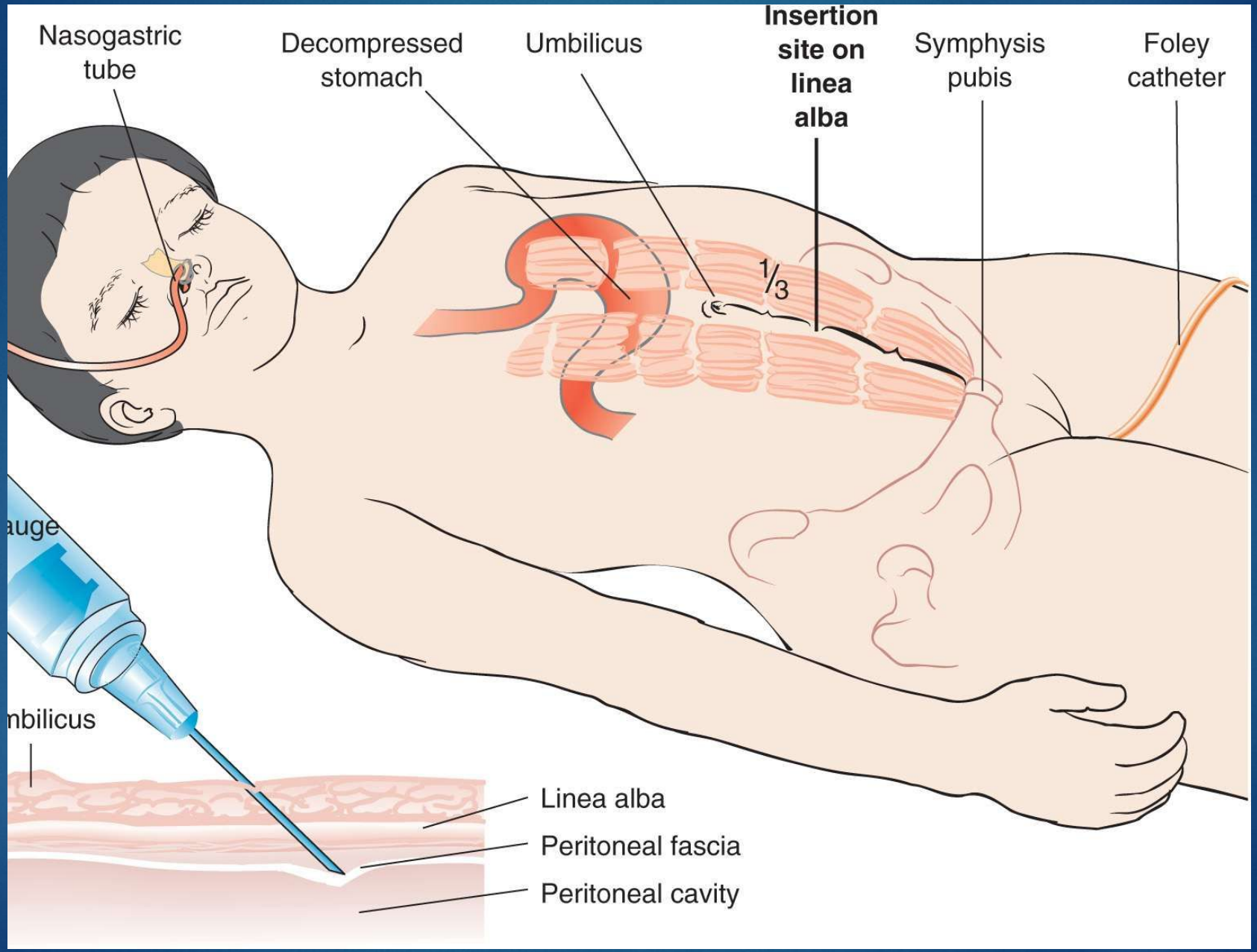
Patient unsuitable for computed tomography (CT) in whom there is concern for intra-abdominal injury

Concern for mesenteric or hollow viscous injury not seen on CT

In Penetrating Trauma

Anterior abdominal stab wound and evidence of fascial penetration in the stable patient with no obvious indication for laparotomy

To evaluate for hollow organ or diaphragmatic injury in the stable patient


Nasogastric tube
Decompressed stomach
Umbilicus
Insertion site on linea alba
Symphysis pubis
Foley catheter
1/3
auge
mbilicus
Linea alba
Peritoneal fascia
Peritoneal cavity

Treatment

- airway patency, breathing and circulation
- Peripheral venous
  access is gained with two large-bore cannulae and
  blood sent for cross-match of 10 units
  of blood, full blood count, urea and electrolytes,
  liver function tests, clotting screen,
  glucose and amylase.

Initial conservative nonoperative management

	Extent of damage	Description
I	Hematoma	Subcapsular, non-expansive, < 10% of surface
	Laceration	Non-bleeding, < 1 cm deep
II	Hematoma	Subcapsular, non-expansive, 10 - 50% of surface
	Laceration	1 - 3 cm deep, < 10 cm in size
III	Hematoma	Subcapsular, expansive,> 50% of surface or intraparenchymal > 2 cm
	Laceration	> 3 cm deep
IV	Hematoma	Bleeding intraparenchymal rupture
	Laceration	Involving 25 - 50% of lobe
V	Laceration	Parenchymal, involving more than 50% of lobe
	Vascular	Juxtahepatic veins, main hepatic veins or retrohepatic cava
VI	Vascular	Hepatic avulsion

FIGURE 1 – Surgical and anatomopathological classification of liver damage (AAST)

Initial conservative nonoperative management

- nonprogressive liver injuries in patients who are haemodynamically stable,
- low grade (I-III) liver injury, need of less than 2 units of transfusion, without peritoneal signs, normal mental status.
- Repeat CT or regular ultrasound follow-up is a must
- Replacement of lost blood; prevention of sepsis;
- regular monitoring by haematocrit, liver function tests, prothrombin time are needed.

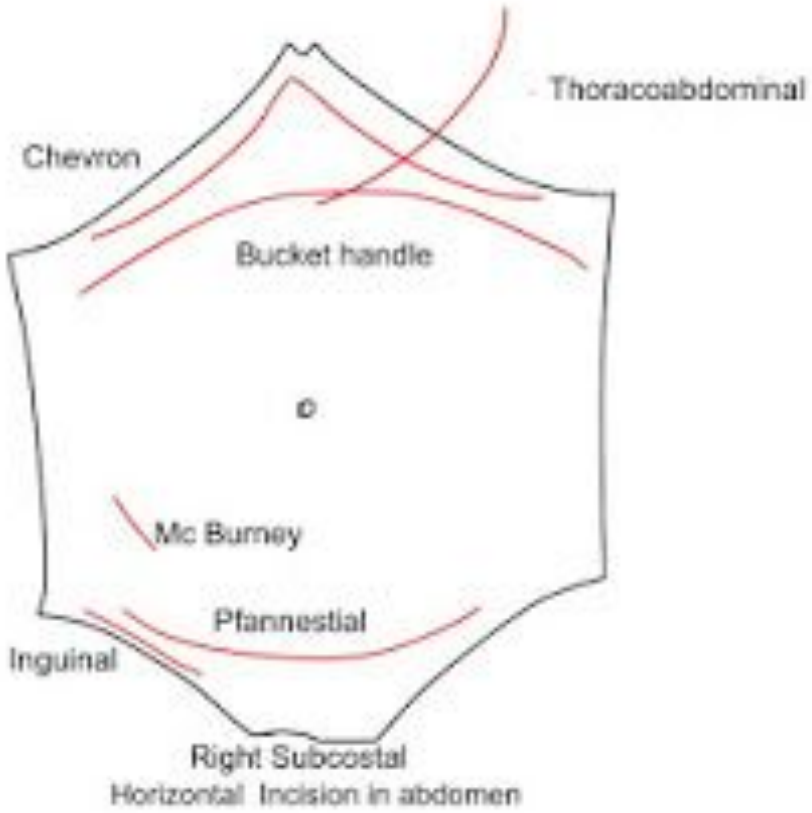
- Angiographic embolisation increases the success rate of nonoperative therapy.
- Intensive care unit (ICU) management for 2–5 days; repeat CT scan after 5 days;
- bedrest to be continued; patient can have normal activity only after 3 months.
- When at any time patient's condition worsens, he should be taken up for laparotomy.
- Success rate of nonoperative treatment is 85% in grade I-III injuries; 40% in grade IV–VI
- injuries. It is the associated injuries which decides the success.


C

Indications Surgery

- Hemodynamic Unstable patient
- Extravasation of intravenous contrast on abdominal Imaging
- Expanding hematoma
- Grade IV and V liver injury

Specific treatment



- **Hemostasis**
- **Bilestasis**
- **Infection control**

- Good access is vital. A ‘rooftop’ incision with midline extension to the xiphisternum and retraction of the costal margins gives excellent access to the liver and spleen. If the laparotomy has been started through a midline incision, a transverse lateral extension to the right can be added to improve access to the liver

In deep severe injuries, following methods are used:

Hepatic artery ligation, not usual.

Segmental resection.

Hemi-hepatectomy, not commonly used.

Packing the liver temporarily with mops and closing the abdomen