

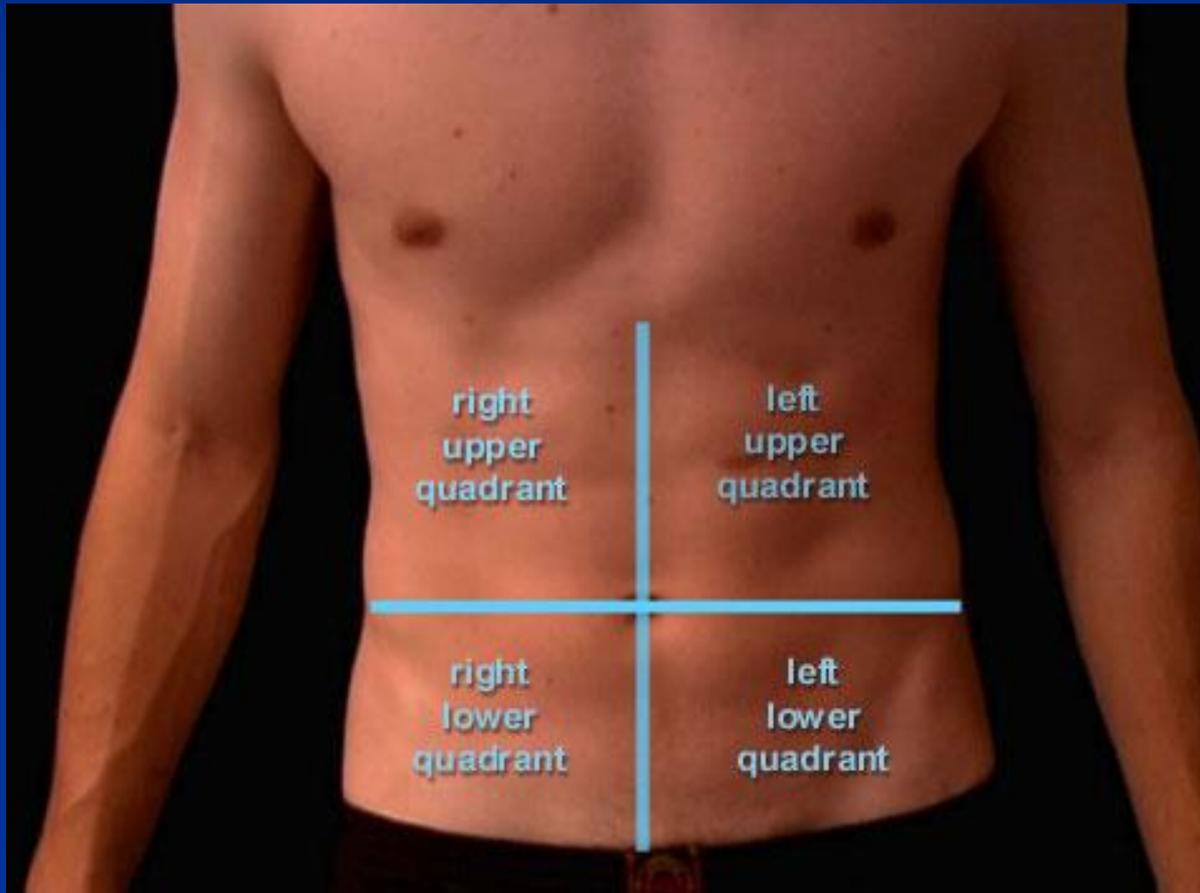
Spleen and hepatic injury :



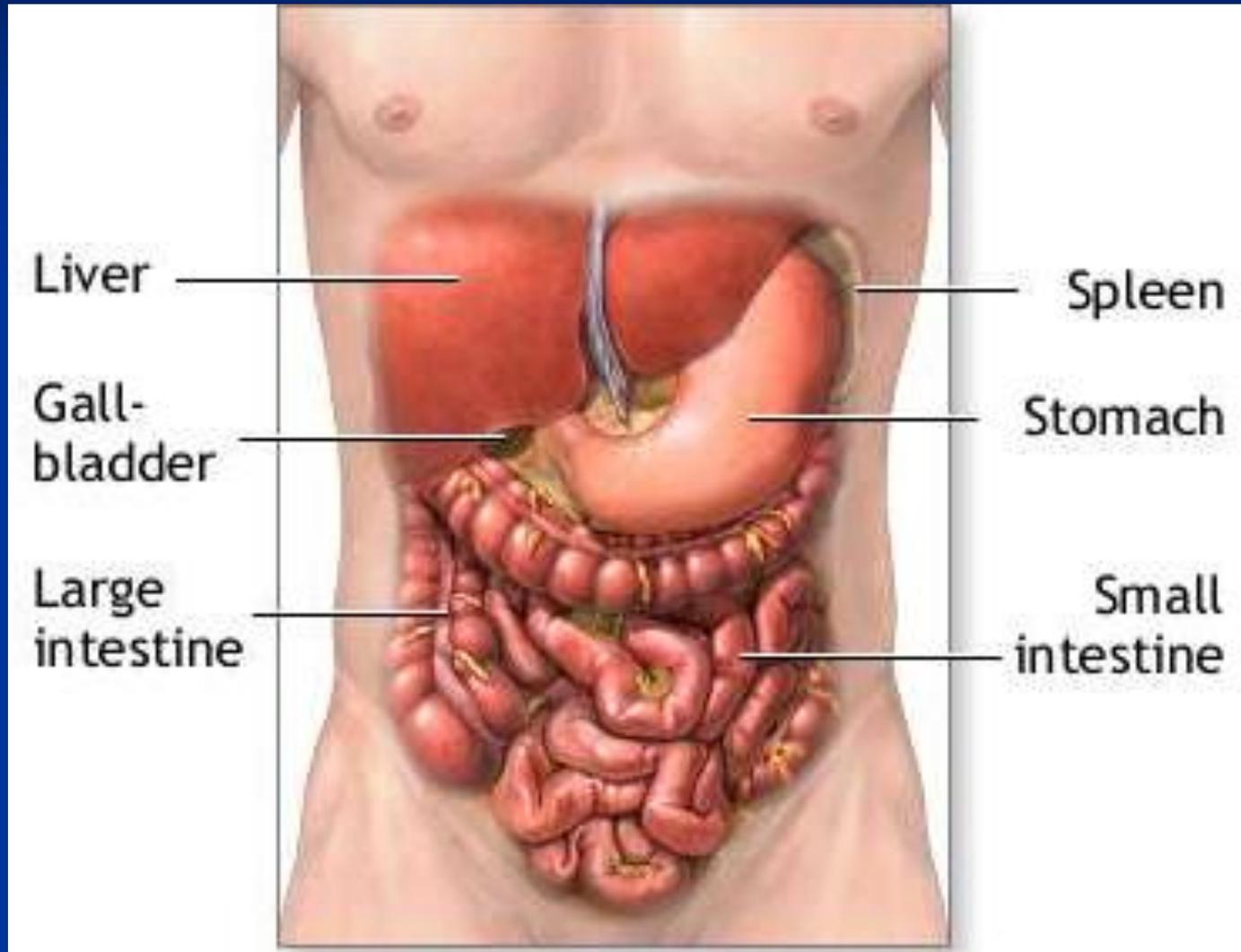
Golden Clock :



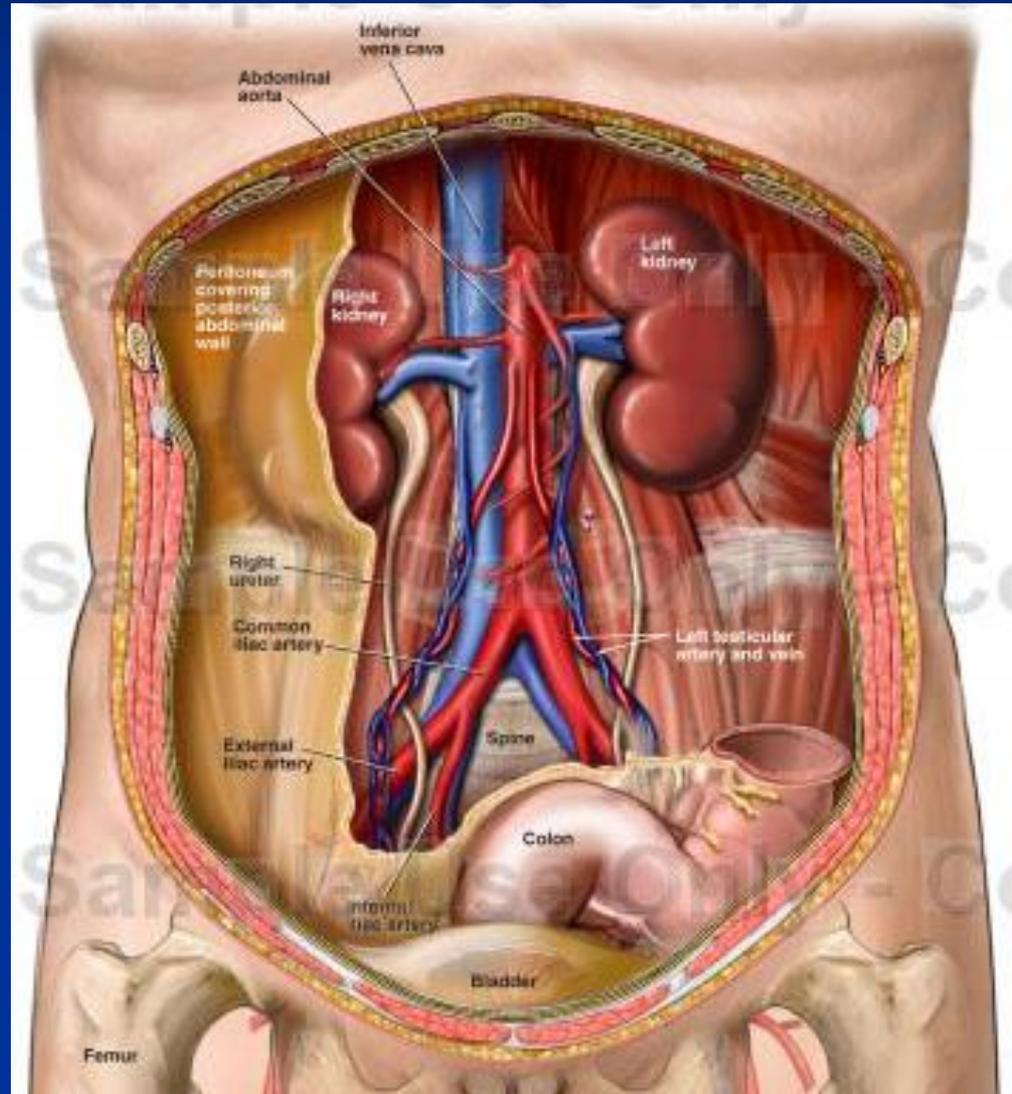
Abdominal Anatomy: Four Quadrants



Intraperitoneal Structures :



Retro / Extra peritoneal Structures :



External Anatomy of Abdomen



INTRODUCTION :

- Leading cause of about 20% of all trauma operations
- Trauma is the leading cause of death in patients ages 1 to 44 years.
- About 80% of all significant traumas involve the abdomen.
- Death usually result from hemorrhage and sepsis



Trauma severity Types :

- A- kills in minutes Exanguinating hemorrhage
- B- kills in hours (Less Severe)
- C- kills in days (Occult) due to sepsis and other Trauma complications



Common Causes of Trauma Mortality :

- 1= Major Bleeding
- 2- Major CNS injury
- 3- Major Respiratory tract injury



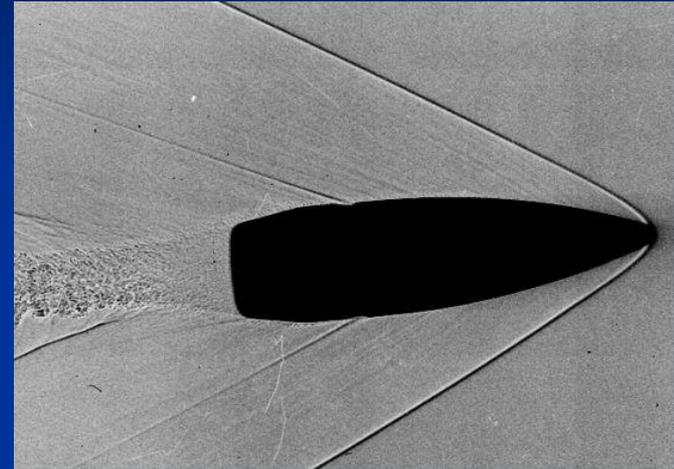
Mechanism of Abdominal Injuries :

- Blunt / Penetrating / Both
- Blunt is the most common



Mechanisms of Penetrating Trauma :

- **Stab**
 - Low energy, lacerations



- **Gunshot**
 - Kinetic energy transfer
 - Cavitation, tumble
 - Fragments



Mechanisms of Blunt injury :

- Compression, crush, or sheer injury to abdominal viscera → deformation of solid / hollow organs rupture (small bowel , gravid uterus)
- Deceleration injuries : Falling down
Differential movements of fixed and nonfixed structures (liver and spleen)



Blunt Abdominal Trauma :



Penetrating Ballistic wounds :



High Velocity Shot to Abdomen



Penetrating Trauma :



ATLS :

- ATLS (Advanced Trauma Life Support) :
 - 1) Primary survey
 - 2) Concurrent resuscitation
 - 3) Secondary survey
 - 4) Diagnostic Evaluation
 - 5) Definitive Care



Primary Survey

- Patients are assessed and treatment priorities established based on their injuries, vital signs, and injury mechanisms
- ABCDEs of trauma care
 - A : Airway and c-spine protection
 - B : Breathing and ventilation
 - C : Circulation with hemorrhage control + IV + Blood
 - D : Disability / Neurologic status / Drug / D.C shock
 - E : Exposure / Extremities / Environmental control



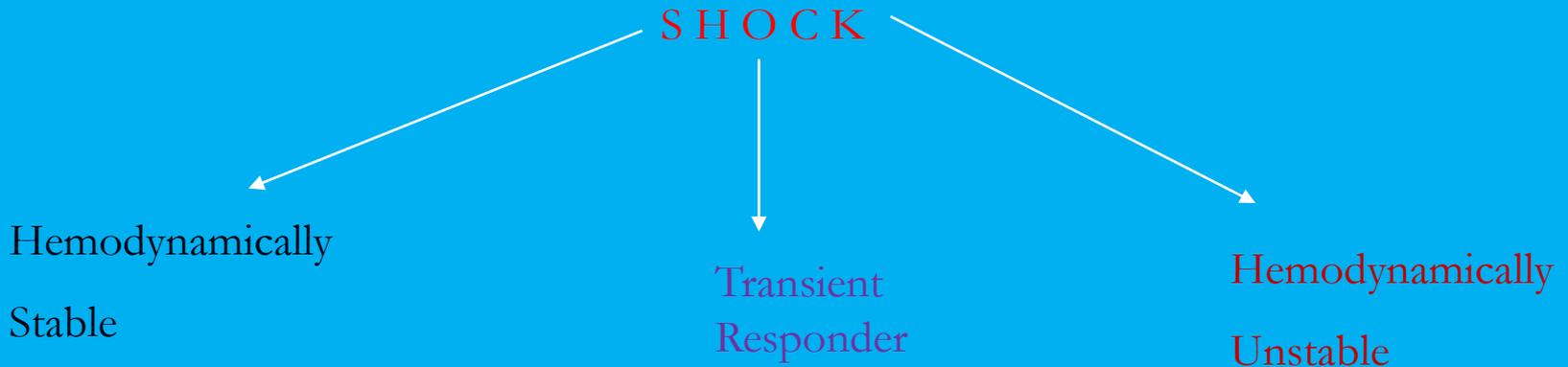
Secondary Survey

- ┌ **AMPLE HX :**
 - Allergies, Medications, PMH, Last meal, Events
- ┌ **Physical exam from head to toe, including rectal exam**
- ┌ **Frequent reassessment of vital signs Q5min / Continuous monitoring**
- ┌ **Diagnostic studies at this time simultaneously**
 - X-rays, lab work, CT orders if indicated
 - FAST exam



ABCDE :

- Airway
- Breathing
- Circulation
- Disability
- Exposure/ Environment / Extremities



Shock common sources :

- Scalp Laceration
- Chest Hemothorax CXR / CT
- Abdomen Intra-abdominal Hemorrhage
 - FAST
 - DPL
 - Pelvic X-ray
- Extremities – Femur 1500 ml/ Pelvis 2000-2500 ml
- Other causes of shock – cardiogenic, obstructive, anaphylactic, septic



Assessment: Physical Exam

- Inspection, auscultation, percussion, palpation
 - **Inspection:** abrasions, contusions, lacerations, deformity
 - Grey-Turner, Kehr, Balance, Cullen
 - **Auscultation:** careful exam advised by ATLS. (Controversial utility in trauma setting.)
 - **Percussion:** subtle signs of peritonitis; tympany in gastric dilatation or free air; dullness with hemoperitoneum
 - **Palpation:** elicit superficial, deep, or rebound tenderness; involuntary muscle guarding



Abdominal Injury Inaccurate P/E :

Factors that Compromise the Exam

- Alcohol /Antipsychotic /
Anticonvulsant / Narcotics /
Tranquilizers
- Injury to CNS (brain, spinal cord)
- Injury to ribs, spine, pelvis



**A missed abdominal
injury can cause a
preventable death.**



Physical Exam : Eponyms

- **Grey-Turner sign :**
 - Bluish discoloration of lower flanks, lower back; associated with retroperitoneal bleeding of pancreas, kidney, or pelvic fracture.
- **Cullen sign :**
 - Bluish discoloration around umbilicus, indicates peritoneal bleeding, often pancreatic hemorrhage.
- **Kehr sign :**
 - Lt shoulder pain with LUQ palpation while supine; caused by diaphragmatic irritation (splenic injury, free air, intra-abd bleeding)
- **Balance sign :**
 - Fix Dull percussion in LUQ. Sign of splenic injury; blood accumulating in subcapsular or extracapsular spleen.



Seat Belt Sign :



Diagnostic adjuncts :

- Labs: BMP, CBC, coags, b-HCG, amy/lip, U/A, tox screen, T&C
- Plain films: CXR, pelvis; abd films generally lower priority
- DPL
- FAST
- CT



How do you investigate the Abdomen?

- Hemodynamically stable:
 - ABCDE, secondary survey
 - FAST
 - CT Scan
 - Lab work



Decision Making :

- Stable patient
- CT Scan
- Operative :
 - Solid organ injury, hypotensive
 - Hollow viscus organ injury
 - Intraperitoneal bladder injury
 - Diaphragmatic injury
- Non-operative management :
 - Observation
 - Interventional Radiology SAE



FAST

└ Focused assessment with sonography for trauma (FAST)

- To diagnose free intraperitoneal blood after blunt trauma
- 4 areas:
 - » Perihepatic & hepato-renal space (Morrison's pouch)
 - » Perisplenic
 - » Pelvis (Pouch of Douglas/rectovesical pouch)
 - » Pericardium (subxiphoid)
- sensitivity 60 to 95% for detecting 100 mL - 500 mL of fluid

└ Extended FAST (E-FAST):

- Add thoracic windows to look for pneumothorax.
- Sensitivity 59%, specificity up to 99% for PTX (c/w CXR 20%)

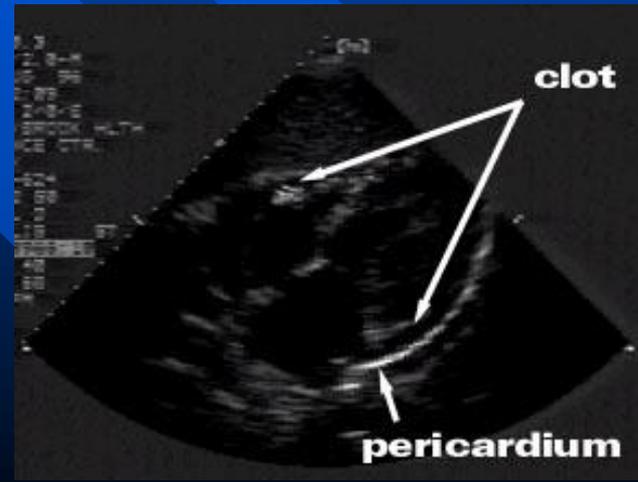


FAST

■ Retrovesicle (Pouch of Douglas)

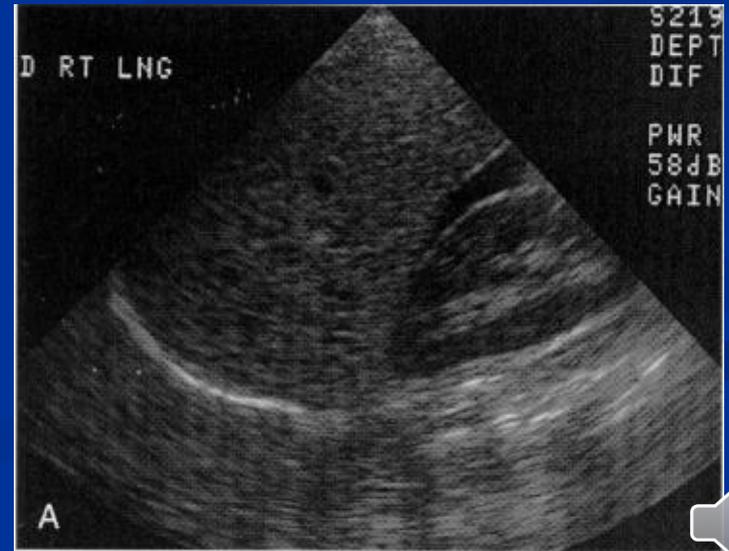
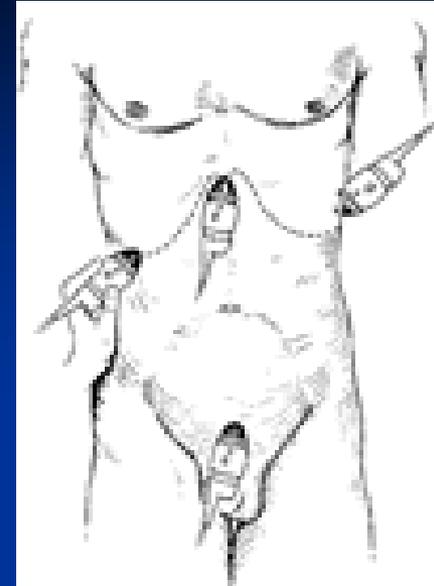


■ Pericardium (subxiphoid)



FAST :

- Four View Technique:
 - Morrison's pouch (hepatorenal)
 - Douglas pouch (retropelvic)
 - Left upper quadrant (splenic view)
 - Epigastric (View pericardium)



FAST: Strengths and Limitations

Strengths

- Rapid (~2 mins)
- Portable
- Inexpensive
- Technically simple, easy to train (studies show competence can be achieved after ~30 studies)
- Can be performed serially
- Useful for guiding triage decisions in trauma patients

Limitations

- Does not typically identify source of bleeding, or detect injuries that do not cause hemoperitoneum
- Requires extensive training to assess parenchyma reliably
- Limited in detecting <250 cc intraperitoneal fluid
- Particularly poor at detecting bowel and mesentery damage (44% sensitivity)
- Difficult to assess retroperitoneum
- Limited by habitus in obese patients



FAST: Accuracy

For identifying hemoperitoneum in blunt abdominal trauma:

- Sensitivity 76 - 90%
- Specificity 95 - 100%

The larger the hemoperitoneum, the higher the sensitivity. So sensitivity increases for *clinically significant* hemoperitoneum.

How much fluid can FAST detect?

- 250 cc total
- 100 cc in Morison's pouch



Diagnostic Peritoneal Lavage :

- 98% sensitive for intraperitoneal bleeding (ATLS)
- Open or closed (Seldinger), usually infraumbilical, but supraumbilical in pelvic FX or advanced pregnancy.
- Free aspiration of blood, GI contents, or bile indication for laparotomy
- If gross blood (> 10 mL) or GI contents not aspirated, perform lavage with 1000 mL warmed LR.
- + test: $>100,000$ RBC/mm³, >500 WBC/mm³, Gram stain with bacteria.
- Injected R/L Alters subsequent examination of patient
- Unstable & intermediate FAST , R/O small bowel injury.



DPL Indications :

└ Indications for DPL in blunt trauma:

1. Hypotension with evidence of abdominal injury
2. Multiple injuries and unexplained shock
3. Potential abdominal injury in patients who are unconscious, intoxicated, or paraplegic
4. Equivocal physical findings in patients who have sustained high-energy forces to the torso
5. Potential abdominal injury in patients who will undergo prolonged general anesthesia for another injury, making continued reevaluation of the abdomen impractical or impossible



Contraindications of DPL

■ Absolute :

- Peritonitis
- Injured diaphragm
- Extraluminal air by x-ray
- Significant intraabdominal injury by CT scan
- Intraperitoneal perforation of the bladder by cystography

■ Relative :

- Previous abdominal operations (because of adhesions)
- Morbid obesity
- Gravid Uterus
- Advanced cirrhosis (because of portal hypertension and the risk of bleeding)
- Preexisting coagulopathy



Evaluation of DPL :

- Fluid is sent for: cell count, amylase, alk phos, presence of bile

	Index	Positive value
Aspirate	Blood	>10 mL
	Fluid	Enteric content
Lavage	RBC	> 100,000/mL
	WBC	> 500/mL
	Amylase	>175 U/dL
	Alk Phos	> 3 IU
	Bile	Confirmed
Negative	RBC	< 50,000/mL
	WBC	< 100/mL
	Amylase	< 75 U/dL



Diagnostic Peritoneal Lavage :

RBC Count	Incidence of visceral damage
>100,000	95%
20,000-100,000	15-25% Warrant further investigation
<20,000	< 5%

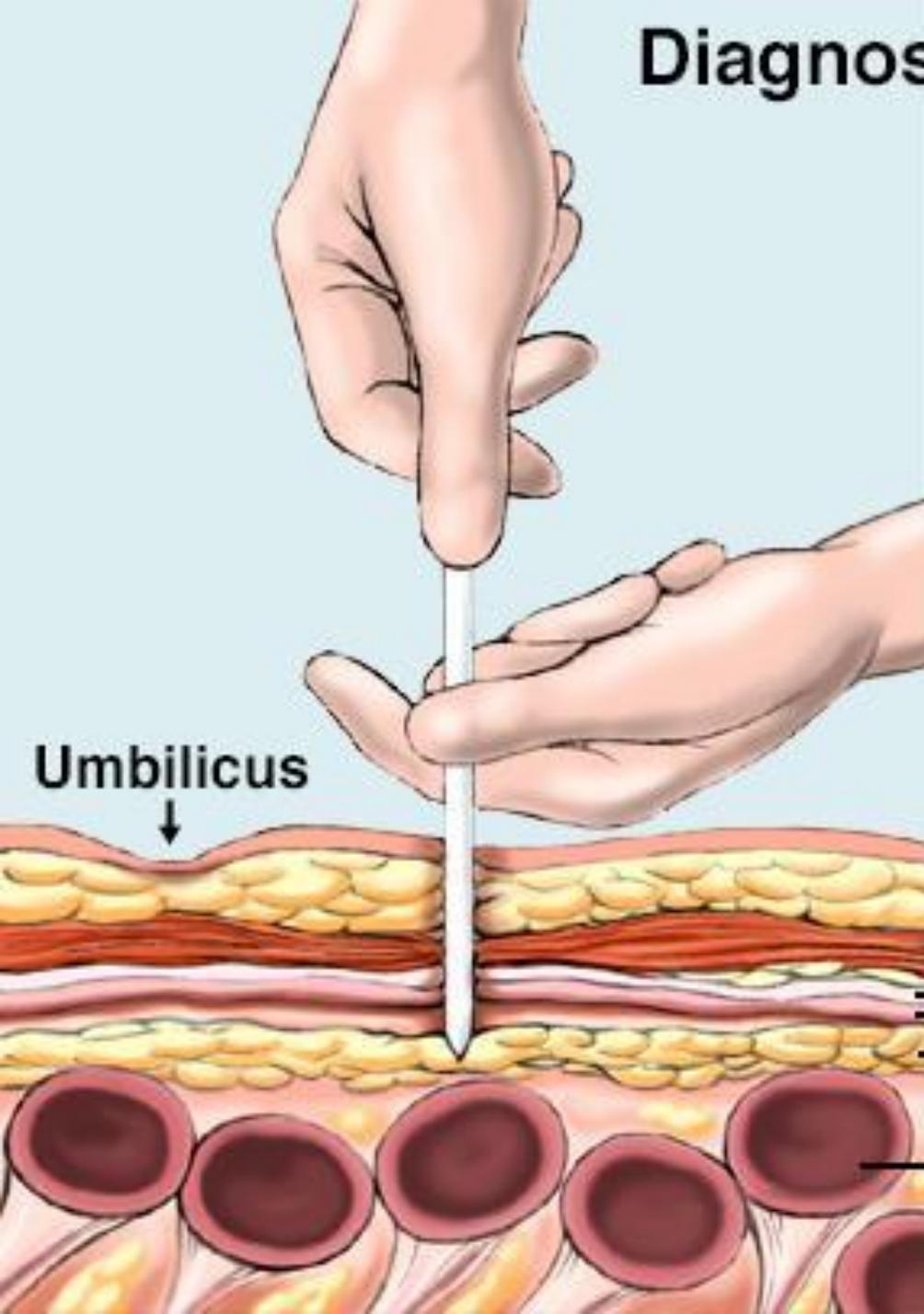
- Complications of DPL: Perforation of small bowel, mesentery, bladder and retroperitoneal vascular structures.
- Limitation: Retroperitoneal organs / Which organ ???



Diagnostic Peritoneal Lavage

Closed Percutaneous Technique

Using controlled pressure, insert the catheter and stylet perpendicular to the skin along the anesthetized track using a twisting motion.



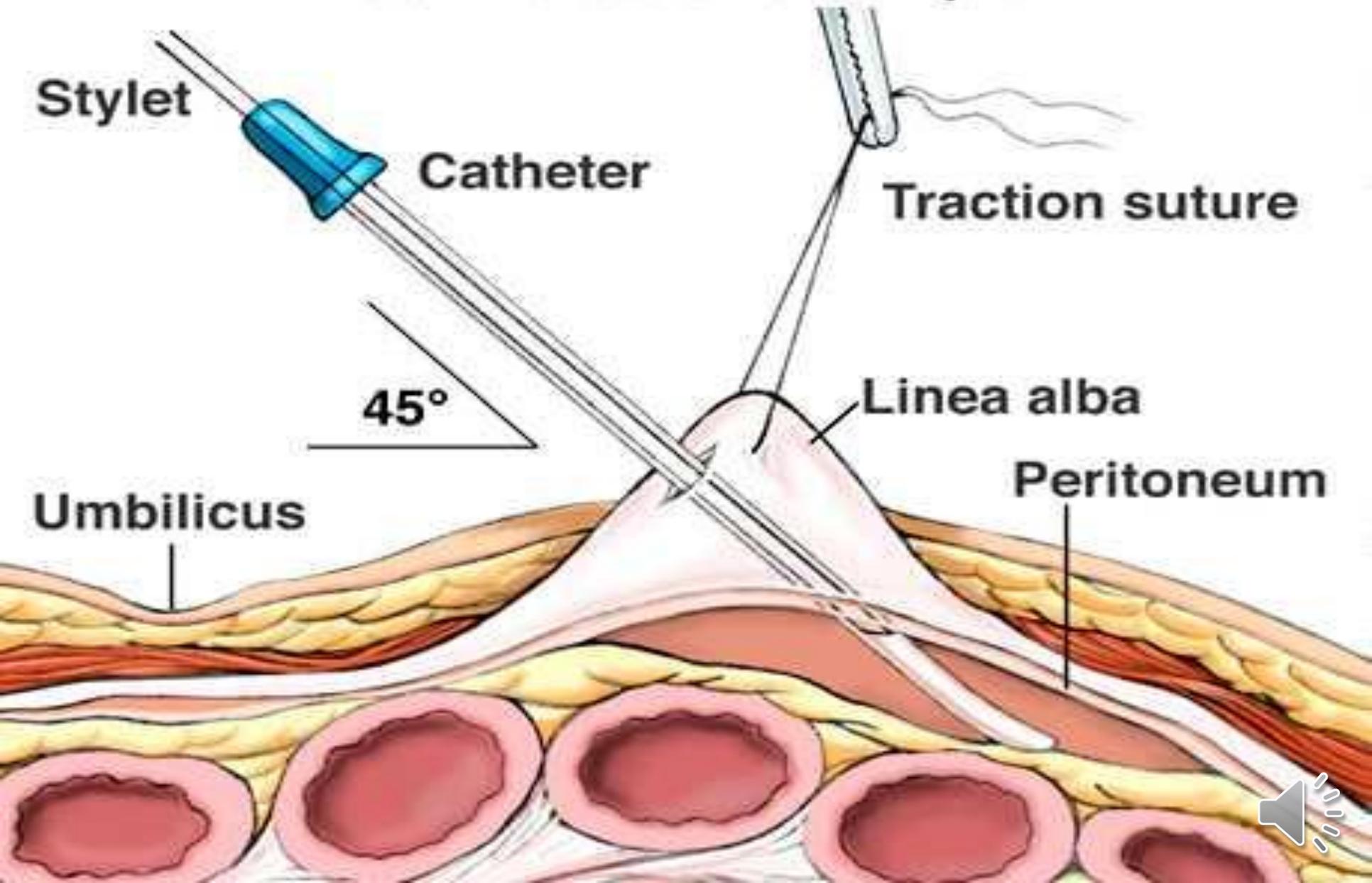
Umbilicus

Linea alba
Peritoneum
Omentum
Intestines



Diagnostic Peritoneal Lavage

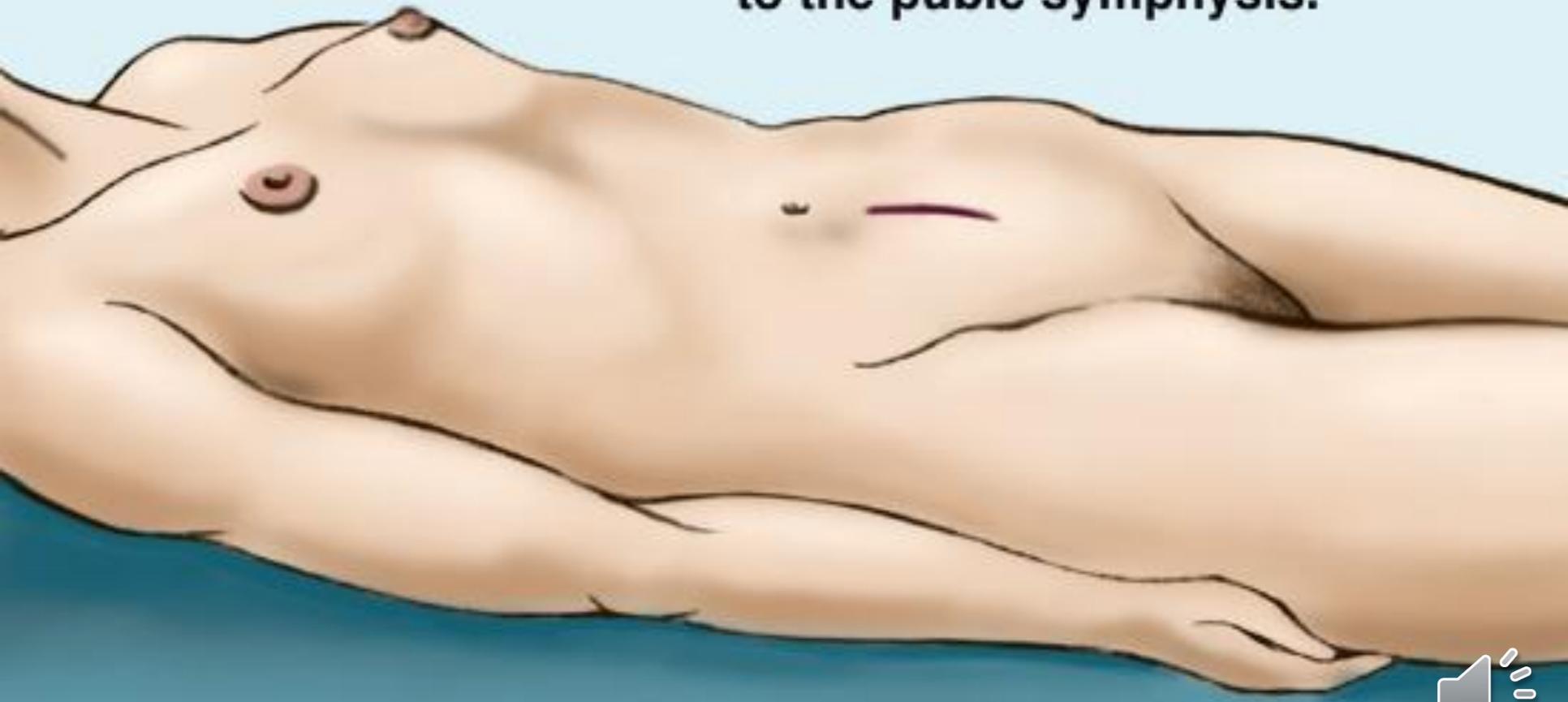
Semi-Closed Technique



Diagnostic Peritoneal Lavage

Incision Site

Incision site is one-third of the way down from the umbilicus to the pubic symphysis.



Angiography :

└ Angiography

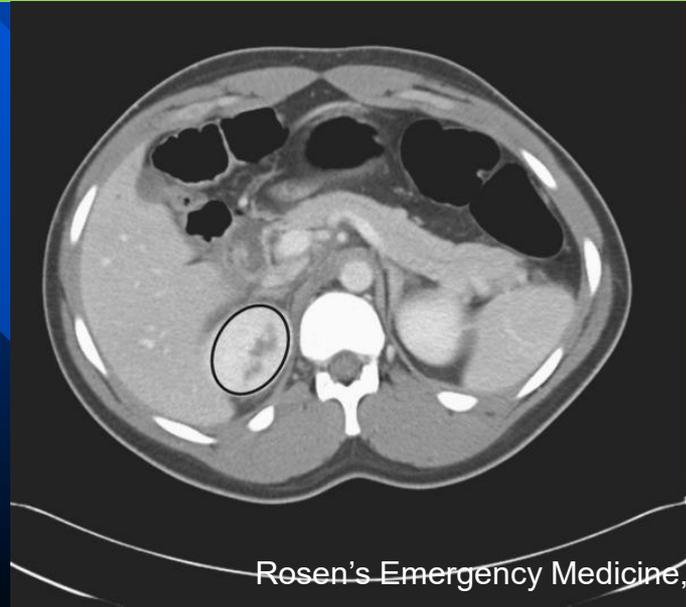
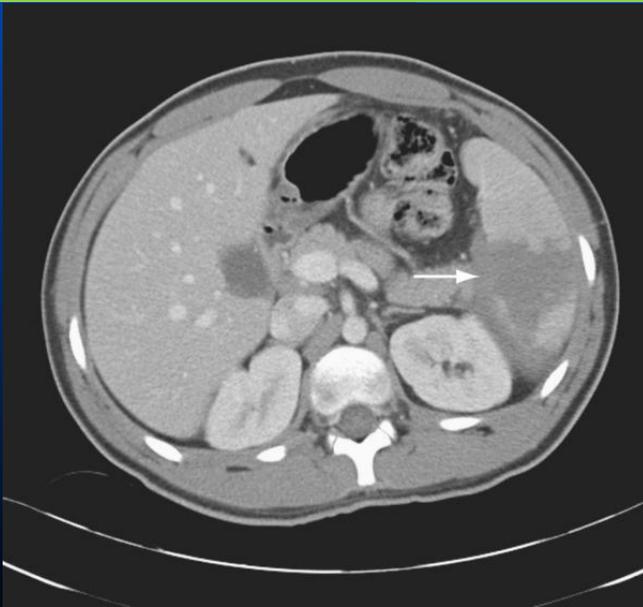
- To embolize bleeding vessels or solid visceral hemorrhage in an unstable pt



CT scan :

■ CT

- Accurate for solid visceral lesions and intraperitoneal hemorrhage
- guide nonoperative management of solid organ damage
- IV not oral contrast
- Disadvantages : insensitive for injury of the pancreas, diaphragm, small bowel, and mesentery



Imaging in Blunt Abdominal Trauma – CT Scan :

- Sensitivity:
 - Solid organ injury: 97% [II,III]
 - Identify Contrast extravasation
 - Guide Operative vs. Non-operative management
 - Enteric injury: 64 – 94% [III]
 - Diaphragmatic injury: 61% [III]
 - Pancreatic injury: 30% [III]



CT :

CT is recommended for evaluation of hemodynamically stable patients with equivocal findings on physical examination, associated neurologic injury, or multiple extra-abdominal injuries.

- CT is the diagnostic modality of choice for nonoperative management of solid visceral injuries.



Computerised tomography (CT) :

- Gold standard
- Stable
- Iv / oral contrast : sensitivity / diagnosing retroperitoneal injury



Diagnostic laparoscopy :

- Used as a screening investigation in penetrating trauma to exclude peritoneal penetration and/or diaphragmatic injury in stable pt.
- Difficult to exclude all abdominal injury laparoscopically.
- Reduces the rate of non therapeutic laparotomies but its not a substitute



Indications for Laparotomy – Blunt Trauma

- Hemodynamically abnormal with suspected abdominal injury (DPL / FAST)
- Free air
- Diaphragmatic rupture
- Peritonitis
- Positive CT



Common injury patterns :

- Solid organ injury
 - Laceration to liver, spleen, or kidney
 - Injury to one of these three + hemodynamic instability: considered indication for urgent laparotomy
 - Isolated solid organ injury in hemodynamically stable patient: can often be managed nonoperatively.



Pattern of Injury in Blunt Abdominal Trauma

Spleen	40.6%	Colorectal	3.5%
Liver	18.9%	Diaphragm	3.1%
Retroperitoneum	9.3%	Pancreas	1.6%
Small Bowel	7.2%	Duodenum	1.4%
Kidneys	6.3%	Stomach	1.3%
Bladder	5.7%	Biliary Tract	1.1%



Common injury patterns :

■ Blunt :

spleen (40-55%), liver (35-45%), and small bowel (5-10%).



Spleen :

- Most common organ to be affected in Blunt Injury.
 - Children are treated conservatively.
 - In the past, surgery was advocated to all adults, nowadays, 50-80% are treated without surgery.
 - Predictive factors for non-op success:
 - 1- localized trauma to the left flank
 - 2-age < 60
 - 3- Transfusion < 4 u PRBCs
 - 4- Grade I-III
 - Splenectomy VS splenorrhaphy
 - Don't be misled by blood changes following splenectomy
- Note: always watch for delayed hemorrhage.

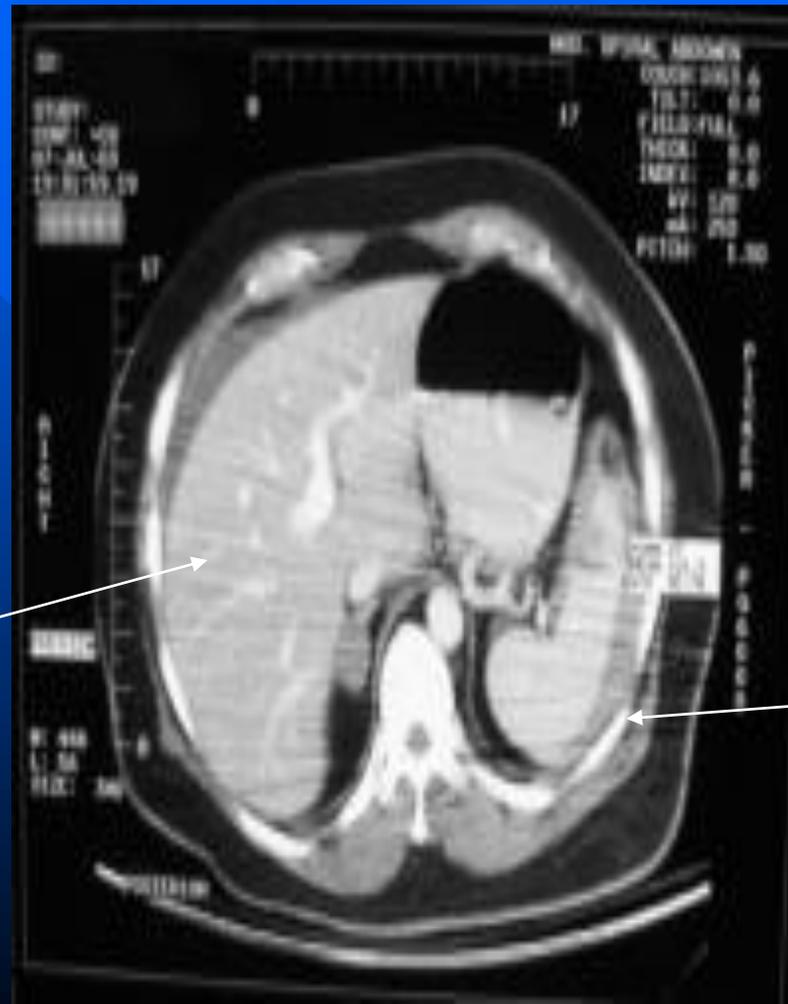


Splenic Lacerations :

- I. Subcapsular Hematoma <10% Surface Area
- II. Subcapsular Hematoma 10-50%
- III. Subcapsular Hematoma >50%
- IV. Laceration producing devascularization of
>25% of the spleen
- V. Shattered Spleen



Splenic



Blood from spleen
Tracking around
liver

Spleen with surrounding
blood



Laceration of Spleen :



CT (Splenic rupture) :

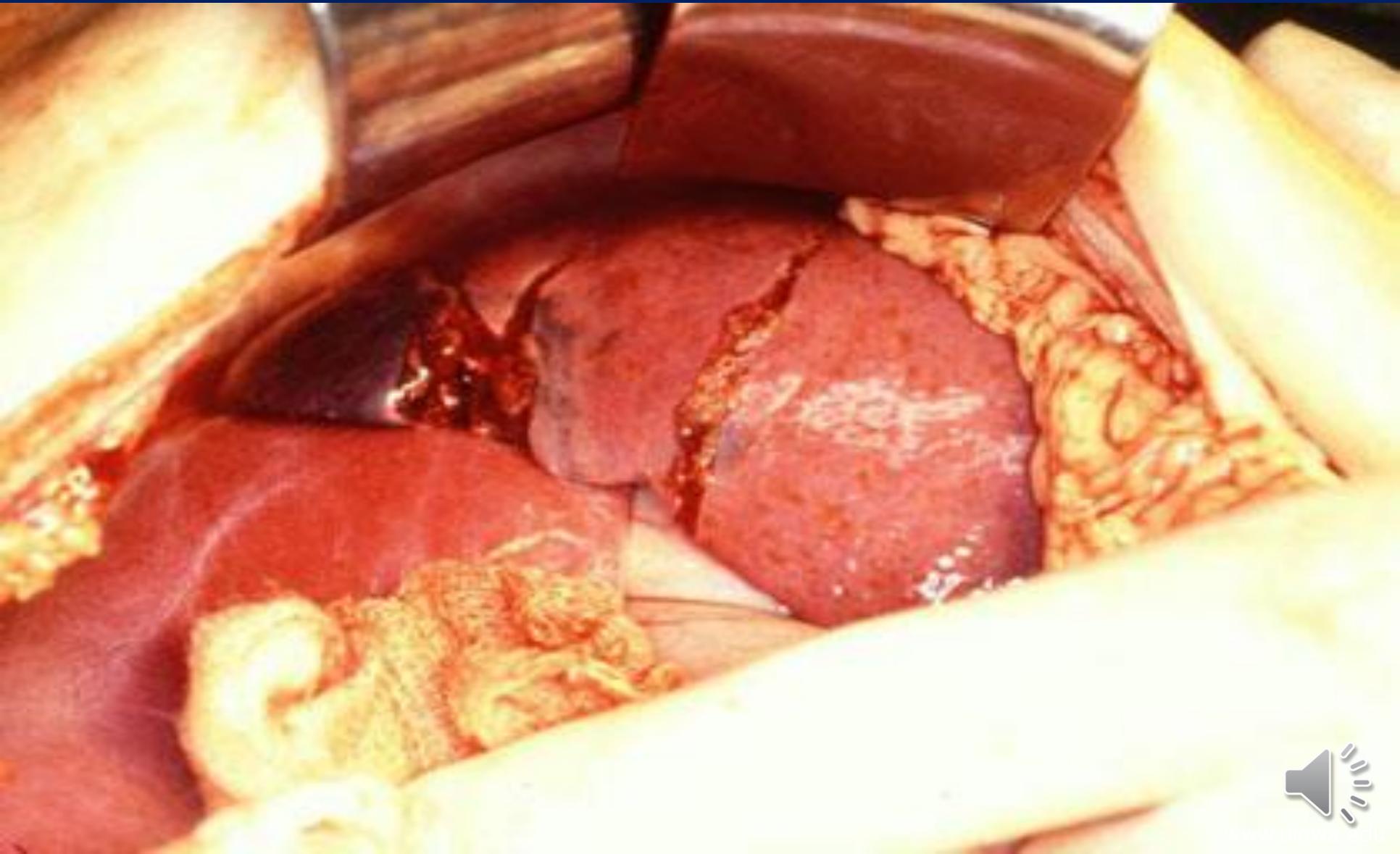


Blood

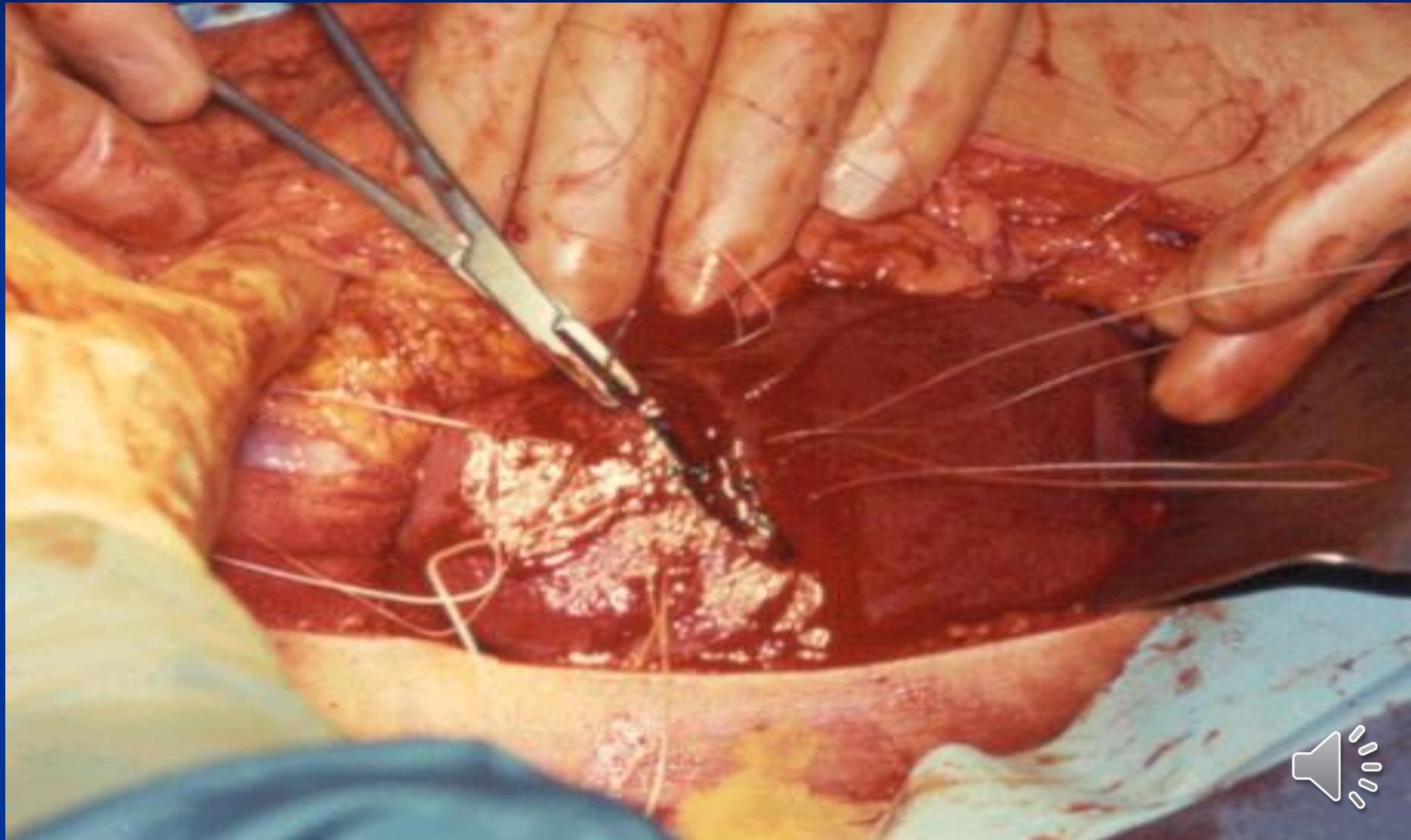
Normal
Tissue



Splenic Laceration :



Splenorrhaphy :



Treatment Spleen :

- Conservative
- SAE (Angioembolization)
- OP :
Total Splenectomy +/- Implant / Partial Splenectomy
Splenorraphy



Management Spleen :

- Spleen Salvage to prevent OPSI (all ages)
- High grade injuries with contrast blush => SAE
- Early Splenectomy : 15-20 % :
 - A- Blood transfusion need in 1st 12 hrs
 - B- Hemodynamic instability
 - C- Rebleeding Wks



Management : Total Splenectomy

- Intraop Total Splenectomy +/- Autotransplantation for Immunity (in young without associated bowel perforation) :

Without Drains

A- Significant Hilar injury

B- Devitalized paranchyma

C- >Grade II with coagulopathy / Multiple
life threatening injuries



Management Partial Splenectomy:

Superior / Inferior pole injury



Post Op Complications :

- 1- Bleeding

- 2- Septicemia

Post OP : NI (Leukocytosis/ thrombocytosis)

WBC > 15000 + platelet / WBC ratio < 20 if > 5th post op day
= Sepsis

A- subphrenic Abscess → PC Drainage

B- Pancreatic Tail injury (Ascites / Fistula / Abscess)

- C- Gastric Fistula (Free perforation/ Collection)

- 3- OPSI

(Resistant Pneumococci, Haemophilus. Influenzae, Neisseria Meningitidis) Vaccine : > 14 days post injury

- 4- LT lung lower lobe atelectasis



Management :

1- Operative :

A- Total Splenectomy

B- Partial Splenectomy

C- Splenorrhaphy

D- Splenic Implant

2- Non Operative

A- Conservative

B- Selective Angioembolization (SAE)



Spleen SAE :



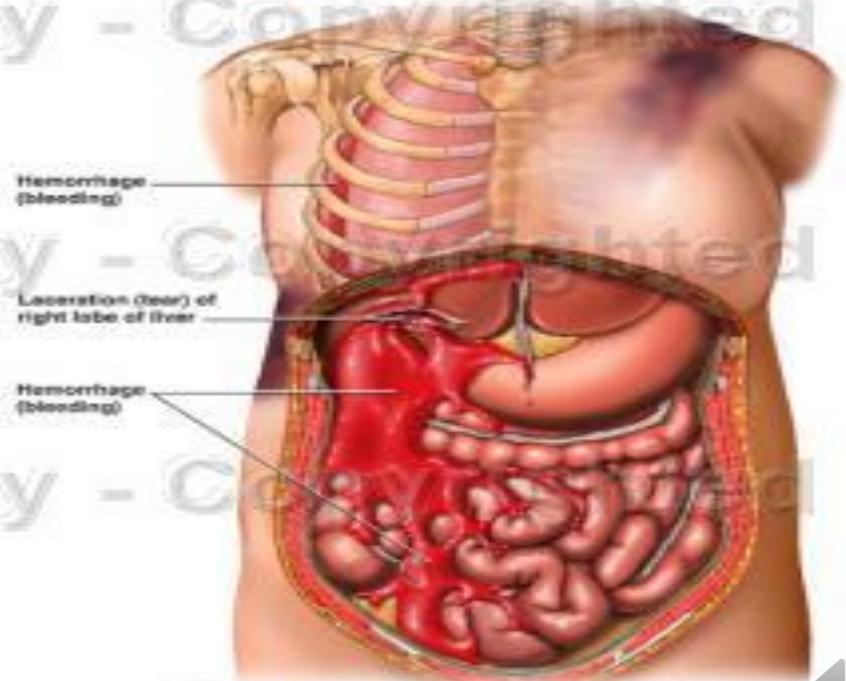
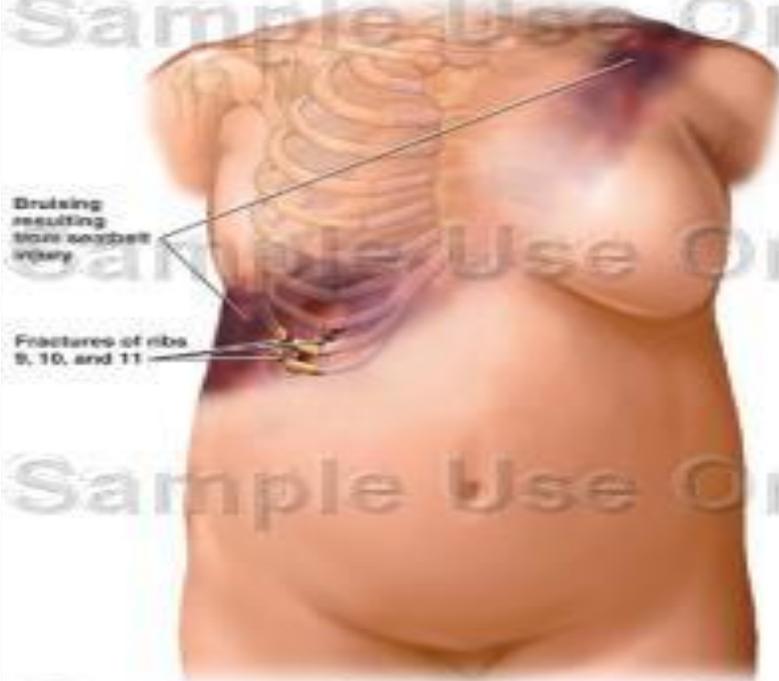
Blunt Force Trauma with Massive Liver Injury

JANE DOE

Blunt Force Trauma with Massive Liver Injury

External Injuries

Internal Injuries



Liver :

- Majority due to blunt injury
- Most are relatively minor
- AAST-OIS
- Most important thing is to control the hemorrhage.
- Remember the 4”Ps (Manual compression(Push), Perihepatic Packing, Plug, Pringle Maneuver)
- Electrocautery for bleeding from liver surface.
- Suture ligation or clips for bleeding vessels.
- If the injury has already resulted in massive blood loss, pack the abdomen with laparotomy pads and reexplore later.
- Drains should always be used.
- Biliary tract decompression is contraindicated.
- Hepatic vein inj bleeds massively, suspect if Pringles’ fail.



Liver :

- 85% of blunt liver inj are stable following resuscitation, and here nonsurgical management is superior. (if continued hemodynamic stability).
- If more than 2 PRBCs are required, arteriography with embolization is considered.
- Extrahepatic bile collection → Percutaneous drainage.
- Intrahepatic collections → Resolve spontaneously over months.



Liver Lacerations :

- I. Subcapsular Hematoma <10% Surface Area
- II. Subcapsular Hematoma 10-50%
- III. Subcapsular Hematoma >50%
- IV. Parenchymal Disruption of 25-75%
- V. Parenchymal Disruption of >75%
- VI. Liver Avulsion



Liver Laceration :

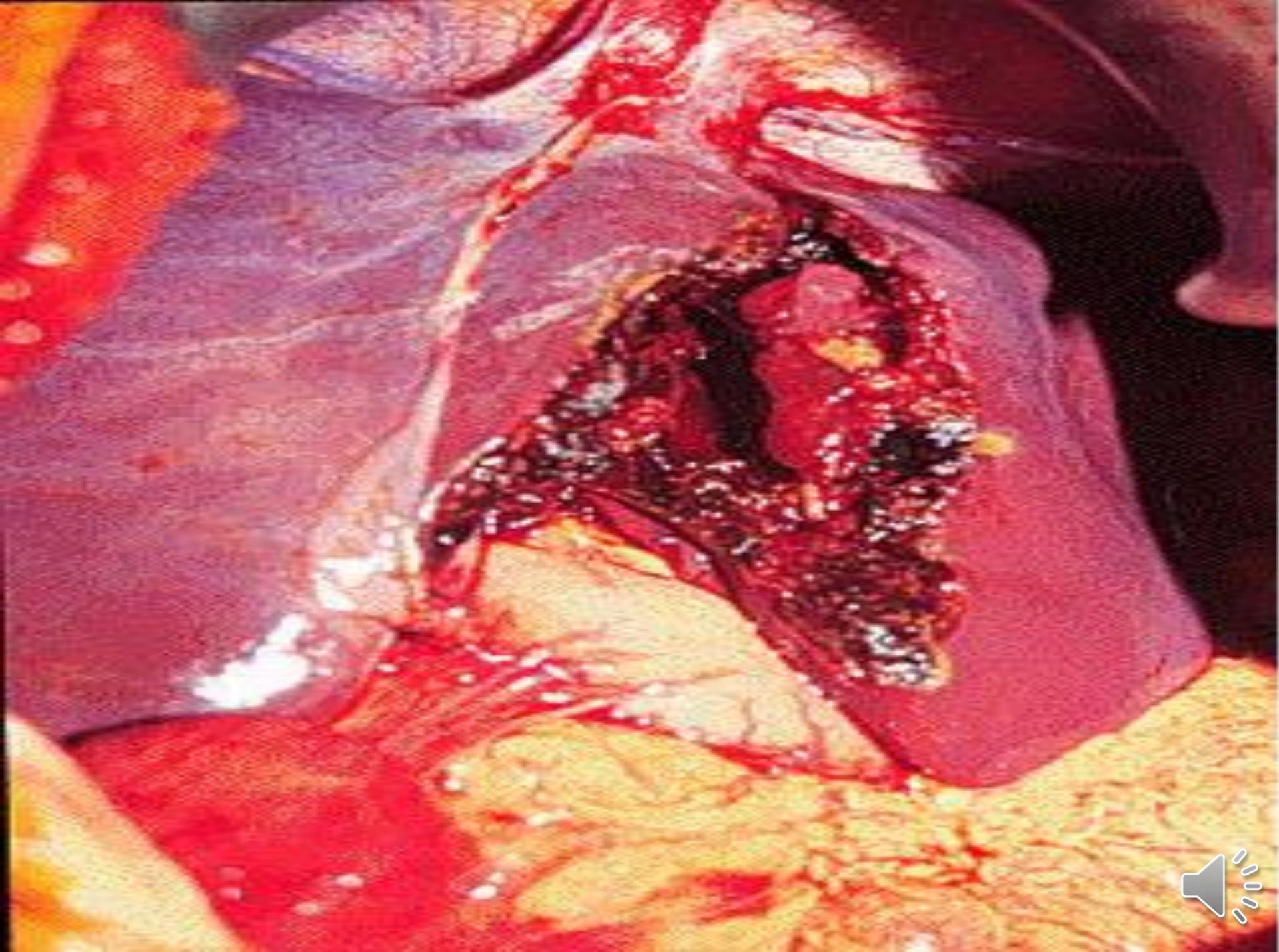


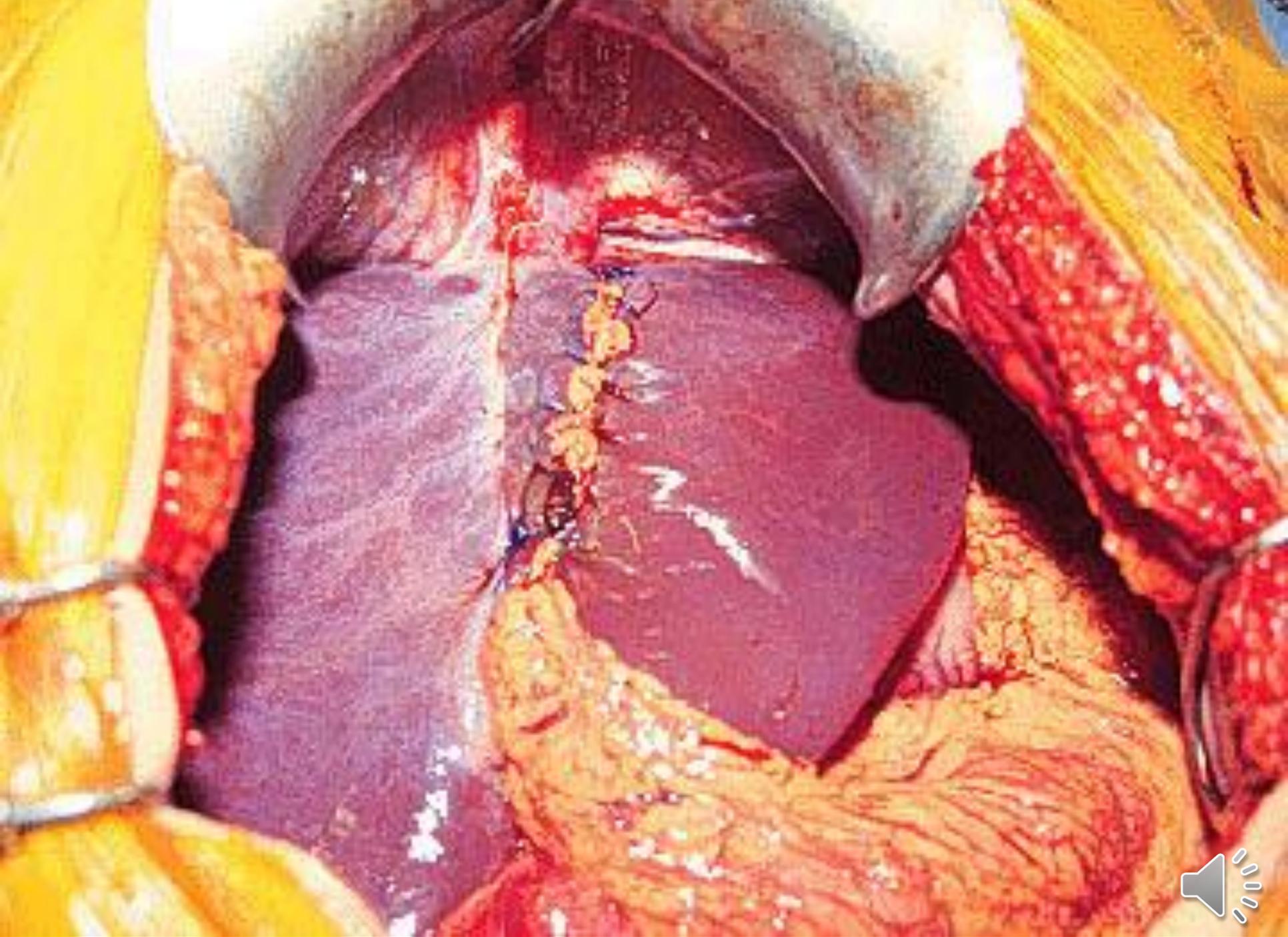
Liver Laceration :



CT Scan Liver laceration :







Hepatic injury :

- 2% body wt prone to Blunt & Penetrating injury
- Conservative Rx if no overt peritonitis or other injury with laparotomy indication
- >Grade II SICU under frequent Monitoring
- Only absolute contraindication of nonop Rx = Hemodynamic instability
- Fail nonop Rx :
 - 1- Large hemoperitoneum
 - 2- high grade injury
 - 3- contrast extravasation
 - 4- Pseudoaneurysms



Management :

- Nonoperative +/- ERCP +/- Early Angioembolization
(IF TRANSFUSE 4 PC in 6hrs /6 PC 24hrs)
- Laparotomy 15% :
 - 1-most with perihepatic/ manual packing (10-15 Pads) 2nd look pack removal 24 hrs later
 - 2-Pringle Maneuver
 - 3- Repair (Liver & Proper HA & Rt HA if clean stab or RSVG)
 - 4- Ligation (Coeliac Axis , PV , RT & LT HA)
 - 5- Delayed anatomic resection following lobar Necrosis
 - 6- Cholecystectomy if Rt HA ligation
 - 7- Pancreatic Transection to Repair
 - 8- Hepatic Vein radiologic Stenting
 - 9- Direct HV repair & Temporary Veno- venous Shunting of Retrohepatic venocava & Resection
 - 10- Hepatotomy Bleeder Ligation
 - 11- Transplantation
 - 12- Bile duct repair +/- T. tube +/- Roux en Y Choledochojejunostomy +/- ERCP Stent



Post op Complications :

- Rebleeding 1st 48 hrs
- Hepatic necrosis
- Sepsis and intermittent Hepatic Fever 1st 5 days
- Biloma PC Drainage (if infected / Large Sterile)
- Arterial Pseudoaneurysm
- Biliary Fistula
- Bile Ascites =
Relaparotomy + Drain + Resectional debridement



Post op Complications cont.

■ Pseudoaneurysm

1- Rupture into bile duct → Hemobilia Triade :
Intermittent UGIB + RUQ Pain + Jaundice

2- Rupture into PV → PHTN + Esophophageal
Varices

3- Biliovenous Fistula

(Rx= ERCP + Sphincterotomy)

4- Broncho / Pleuro Biliary fistula If associated
Diaphragmatic injury

(RX= ERCP + Sphincterotomy → Spontaneous
closure

