

Liver Trauma

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• • Over View

- Anatomy
- Frequency / Mortality / Morbidity
- Age / Sex
- Pathophysiology
- Presentation
- Work Up
- Management

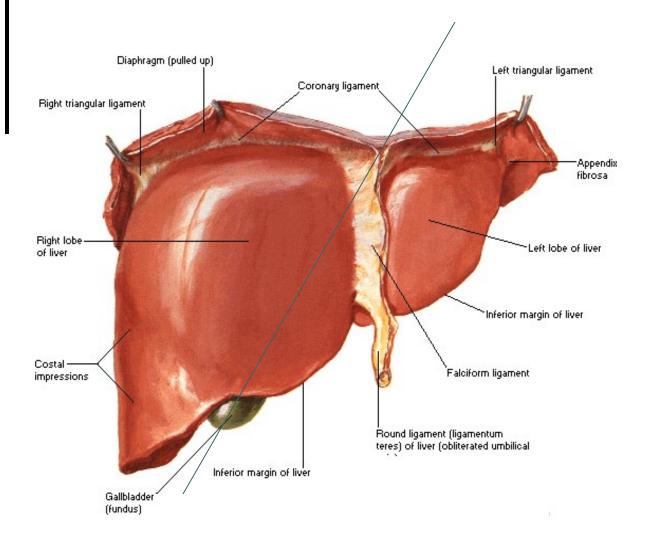
• • Anatomy

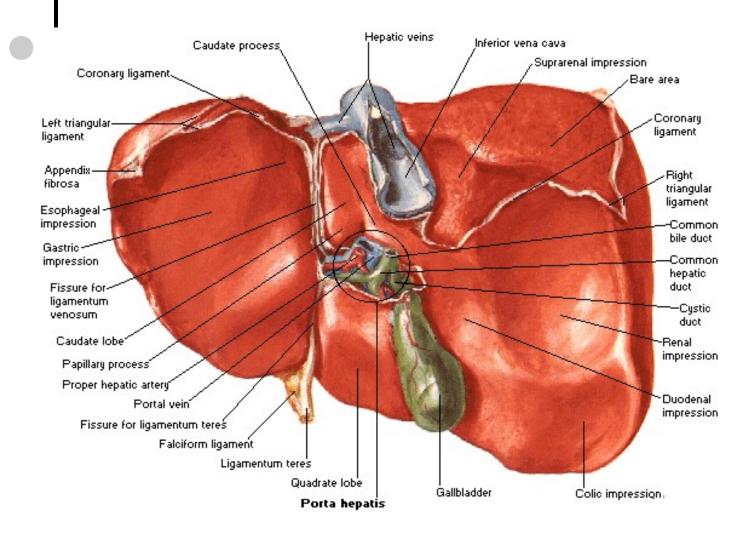
Largest Solid Organ

• 1.2-1.6 Kg in adult

2 Lobes , 2 Accesory lobes , 4
 Sectors , 8 Segments

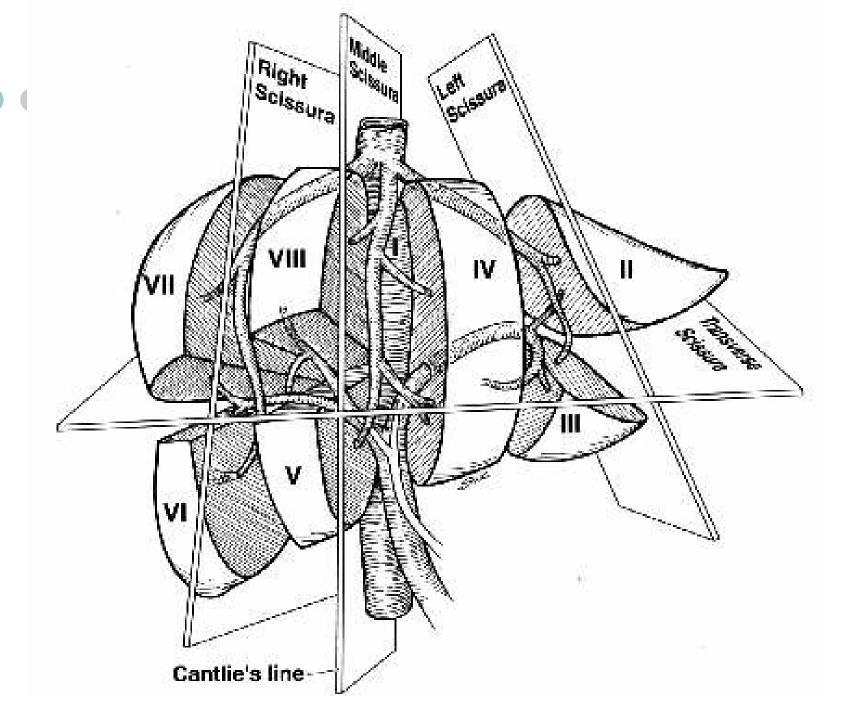
4 Ligaments





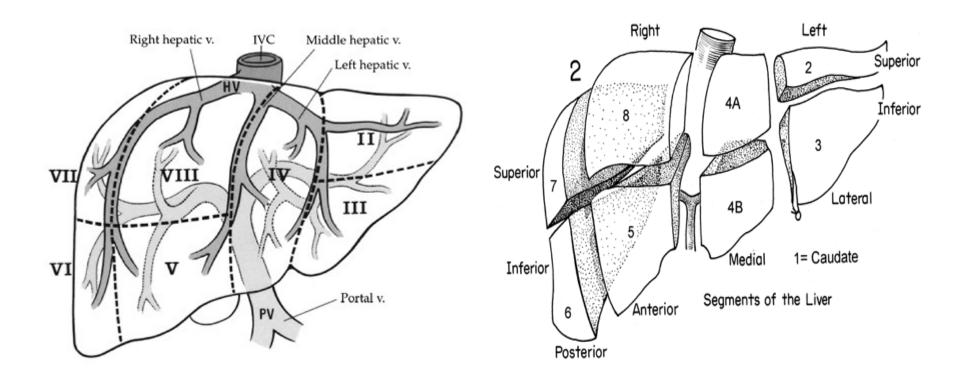
 Hepatic viens divide the liver into 4 sectors and form 3 portal scissura

 Transverse scissura is the plane of division of leftand right portal vien



 This forms 8 segments of the liver, namely I to VIII in a clock wise direction when viewed from the front.

 Each segment has its own independent portal vein , hepatic artery and bile duct .



Distribution of Vessels and Ducts of Liver 1 Right lobar 8 Medial inferior area 9 Anterior superior area 2 Left lobar 3 Anterior segmental 10 Medial superior area 4 Medial segmental 11 Posterior inferior area 5 Posterior segmental 12 Lateral inferior area 6 Lateral segmental 13 Posterior superior area 7 Anterior inferior area 14 Lateral superior area 15 Caudate lobar (right and left) 16 Caudate process Common hepatic duct, portal vein and proper hepatic artery Phantom division between anterior and posterior superior areas

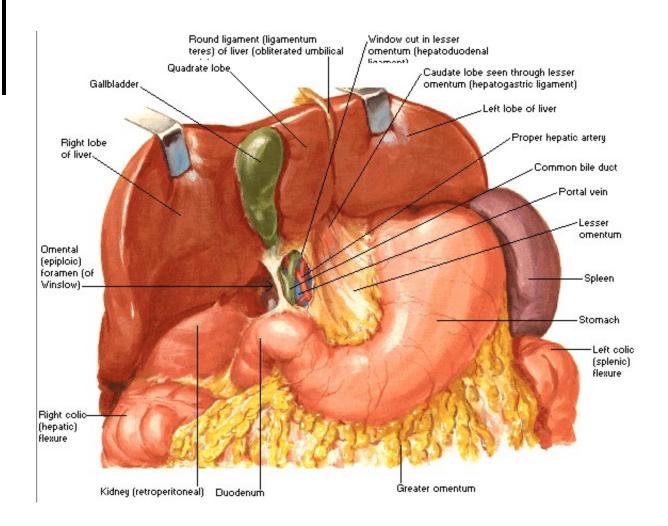
Each segment is getting its own duct, artery and vein.

Inferior vena cava

- Caudate lobe is segment I, also called separate liver.
- It drains directly to IVC.
- 35% RHA, 12% LHA in remaining both arteries
- Rt portal vien branch supply this lobe

 Vital structures enter the liver through its hilum, hepatic artery, bile duct and portal vien.

 Liver is its self related to right kidney, colon, stomach, IVC and stomach.

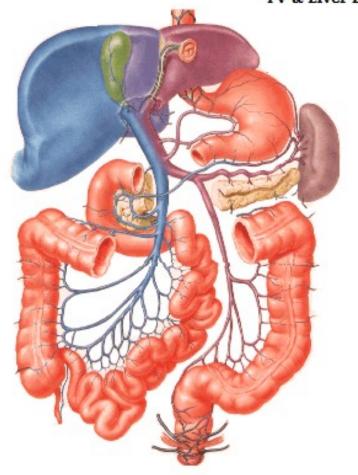


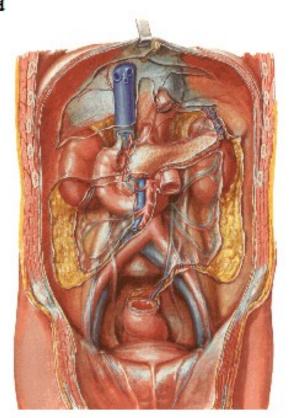
• • Portal Vien

 Formed behind neck of pancrease by union of SMA and splenic vien.

 Delivers 50% O₂ and 75% blood flow to the liver.

PV & Liver Bed



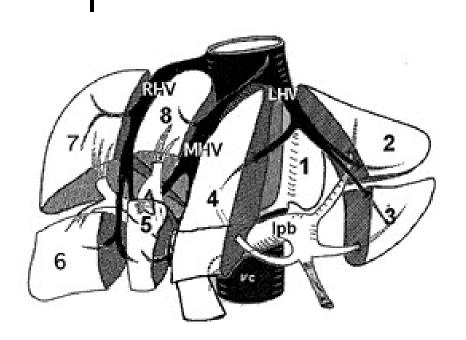


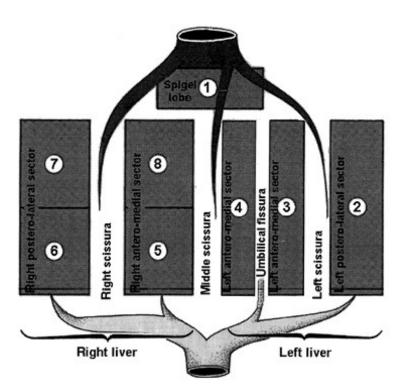
• • Hepatic Vien

Drains blood to IVC

Portal Scissura

LHV 2,3,4 , MHV 5 , RHV 6,7,8

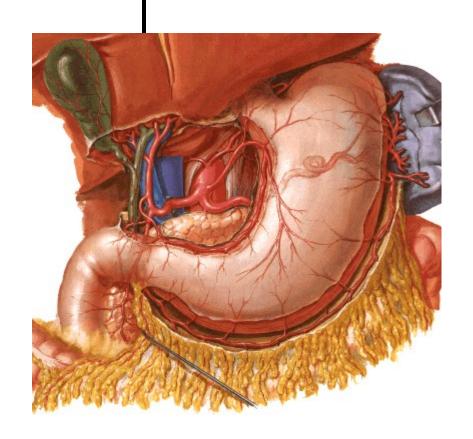


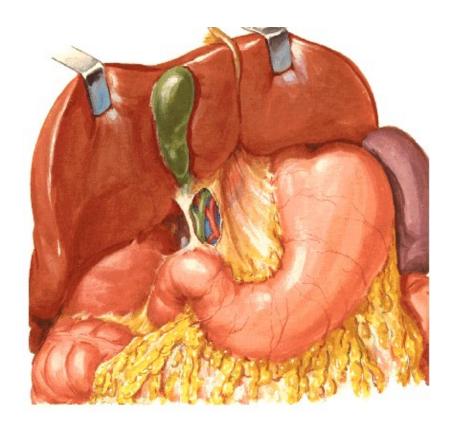


• • Hepatic Artery

Branch of celiac trunk

• 25% blood, 50% O₂





• • Cuadate lobe

Separate liver

 Multiple small veins directly drains into IVC

Comprises segment I of liver

- Frequency15-20% of blunt trauma pts in USA

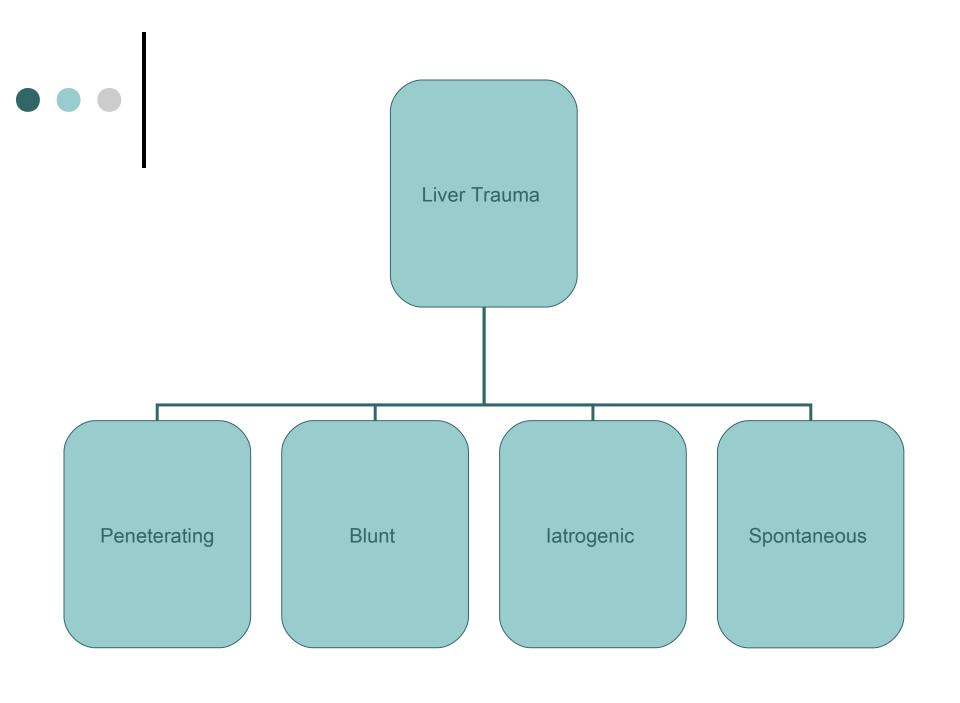
- Mortality
 - 50% of all blunt trauma deaths

- Age/Sex
 - Adults involved in RTAs or fighting

• • Pathogenesis

Predisposition to injury due to

- Large size
- Fixed position relative to ribcage and spine
- Thin capsule
- Friable parenchyma



• • Peneterating

Gun shot, shot guns, knives, daggers

 Fire arm injury corresponds with the KE of the missle at entry and exit wound

 20% of such injuries cause heamobilia , biloma , AV fistula or even abcess.

• • Blunt Injuries

Compressive injuries

Acceleration / deceleration injuries

- Compressive Injuries
 High elastin content in artys > viens, biliary channels > hepatic parenchyma
 - Hepatic parenchyma thus is more prone to blunt trauma
 - Parenchymal injuries cause deep lacerations also called fractures mostly running along vascular channels

 Horizontal # running parallel to each other Bear Claw Injury

Transverse # can cause trasection of the liver Three point restraints in the car causes classical bear claw injury

 Head on RTAs causes injury to rt lobe with fractures of right lower ribs

• • Acceleration / Deceleration Injuries

- Falls from height
- Hepatic viens can get avulsed from its attachment causing severe He
- Laceration can extend deep into parenchyma due to accompanying compression secondary to fall.

 >85% injuries involve right lobe, segment 6,7,8 due to less protected location

 Incidence is high in children due to elastic rib cage and more friable parenchyma Blunt abdominal injury

Isolated liver injury 50%

Liver with splenic injury 45%

• Liver with rib # 33%

• • latrogenic

Percuteneous Biopsy

• ERCP

• TIPS

• • Spontaneous / High Risk

- Liver tumors , HCC
- Scikle Cell Disease
- Collagen Vascular Disease
- Coagulopathy
- CRF
- Third trimester eclampsia and pre eclampsia

Nature Of Hepatic Injuries Hematomas (subcapsular, parenchymal)

Lacerations

Contusions

Vascular Disruption

Biliary Tract Injuries

• • Grades

- Mild
 - Less then 25%, one lobe, 3 Months

- Moderate
 - 25-50 % , one lobe , 6 months

- Severe
 - >50%, one lobe, 9-15 months

PresentationsWith or without shock

- Pain right upper quadrant, Lower chest (broken ribs)
- Peritonism due to heamoperitoneum takes time to develop. In 50% cases, abdominal examination is normal in the presence of heamoperitoneum.*

 However, bilary tract injuries cause rapid and severe peritonitis due to bile in the peritoneal cavity.

• • Management

ABCDE

Base line / Grouping and cross match.

- CXR,AXR
 - Associated skeletal injuries , R/P air , gas under diaphragm

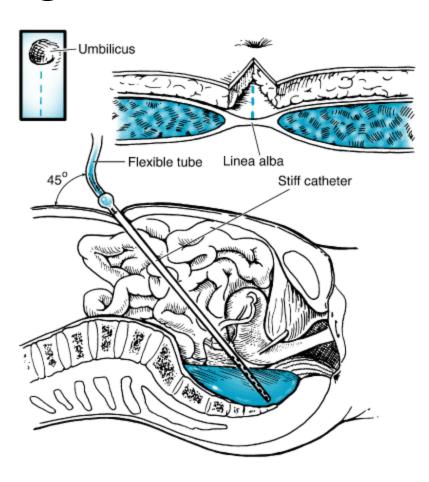
Diagnostic Peritoneal Lavage

- 95% sensitivity, 1-2 % complications, no role in retroperitoneal injuries.
- >10 ml frank blood is considered positive
- If nothing comes on insertion of the catheter, N/S can be instilled and the fluid thus aspirated can be send for Lab analysis

• • Positive if,

- Red blood cell > 100,000/ L
- Bile, vegetable or fecal material
- Observation of effluent draining through a chest tube, a nasogastric tube, or a Foley catheter
- In equivocal cases, measurement of amylase and alkaline phosphatase levels can be helpful

Diagnostic PeritonealLavage

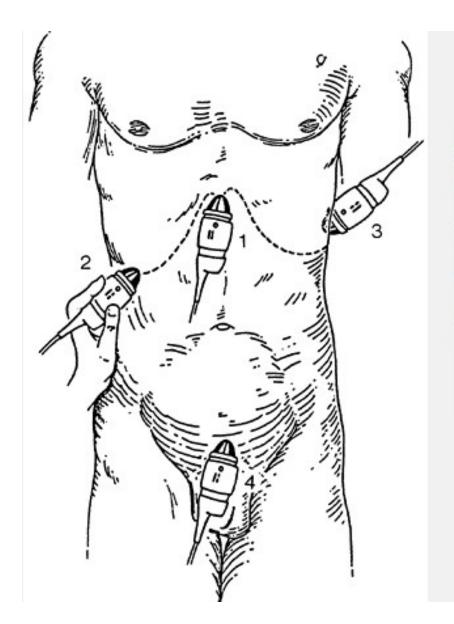


• • USG (FAST)

Easily avaliable and quick results

 46% sensitive, 94% specific in peneterating abdominal injuries

72% sensitive in blunt abdominal injuries



Focused assessment by sonography in trauma (FAST

- 1.Morrison's pouch
- 2.Splenorenal recess
- 3.Pelvis

CT scan

- Can only be done in stable patients
- Investigation of choice in abdominal trauma

Angiography

- Diagnostic and therupatic
- Use only in stable patients
- Transcatheter embolization / stenting

For Bile LeakRadiolabelled Tc 99m scan

 RBCs labelled for active bleed, non labelled for bile duct injuries

Can be used for follow up as non invasive investigations or where CT scan is contraindicated

MRCP

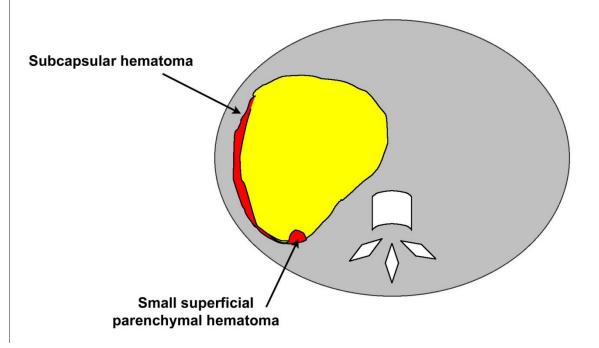
 For diagnosis and follow up of bile duct injuries

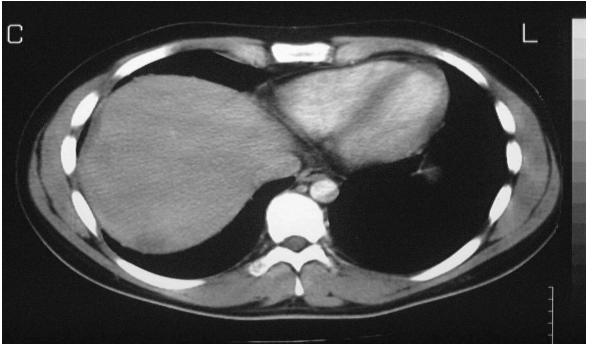
MRI

- No advantage over CT scan
- Only useful in young pregnant females

Grades As Per CT Scan

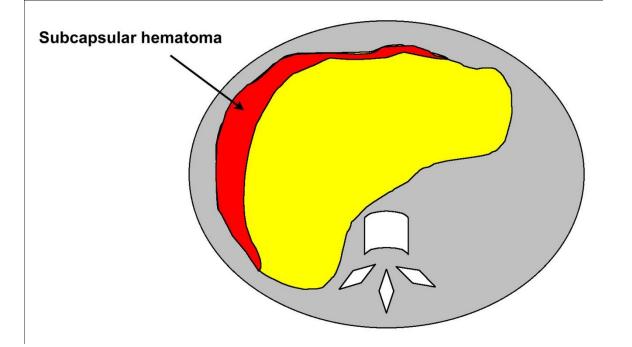
Grade	Injury Description
ı	
Hematoma	Subcapsular, nonexpanding, <10% surface area
Laceration	Capsular tear, nonbleeding, <1 cm deep parenchymal disruption

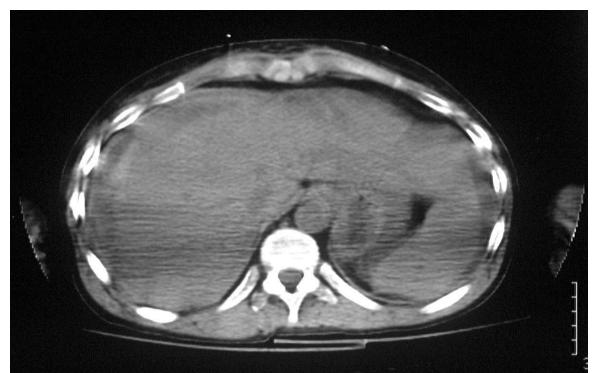




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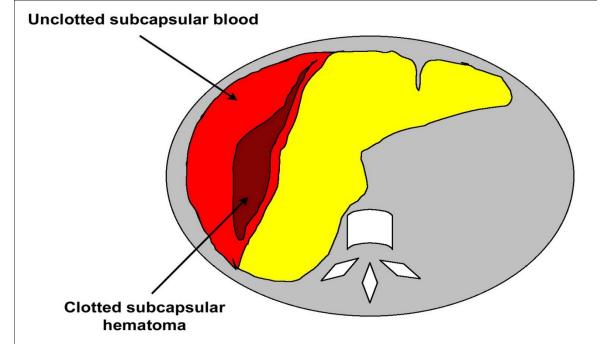
Hematoma	Subcapsular, nonexpanding, hematoma 10% - 50%; intraparenchymal, nonexpanding, <2 cm in diameter
Laceration	<3 cm parenchymal depth, <10 cm in length





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Hematoma	Subcapsular, >50% of surface area or expanding; ruptured subcapsular hematoma with active bleeding; intraparenchymal hematoma >2 cm
Laceration	>3 cm parenchymal depth

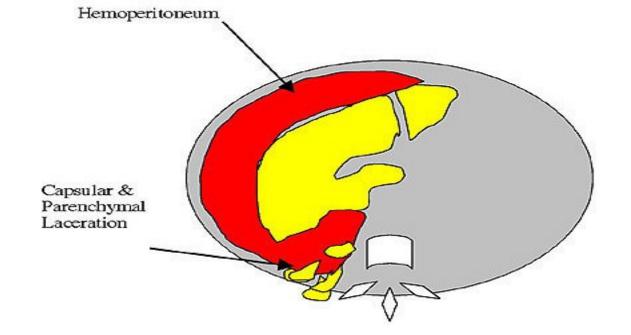




IV

Hematoma Ruptured central hematoma

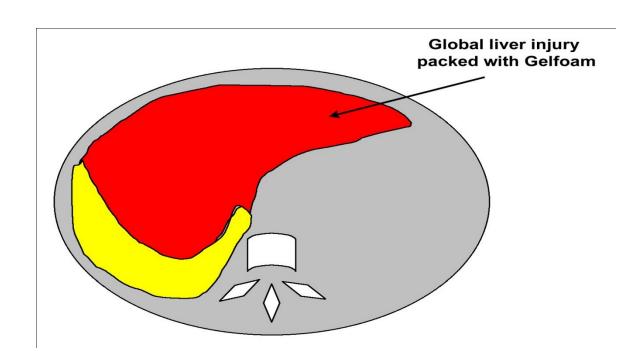
Laceration Parenchymal destruction involving 25%–75% of hepatic lobe

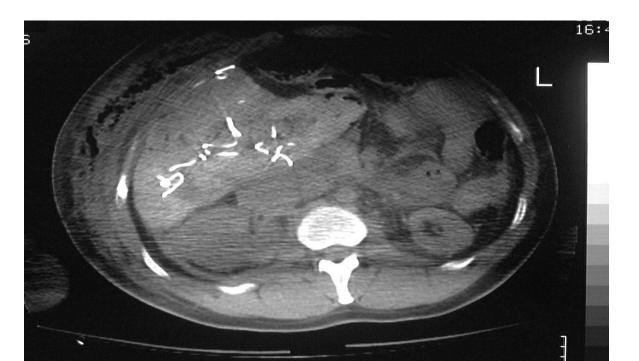




V

Laceration	Parenchymal destruction of >75% of hepatic lobe
Vascular	Juxtahepatic venous injuries (retrohepatic cava/major hepatic veins)





VI

Vascular Hepatic avulsion

 In trauma, always advice contrast enhance CT scan

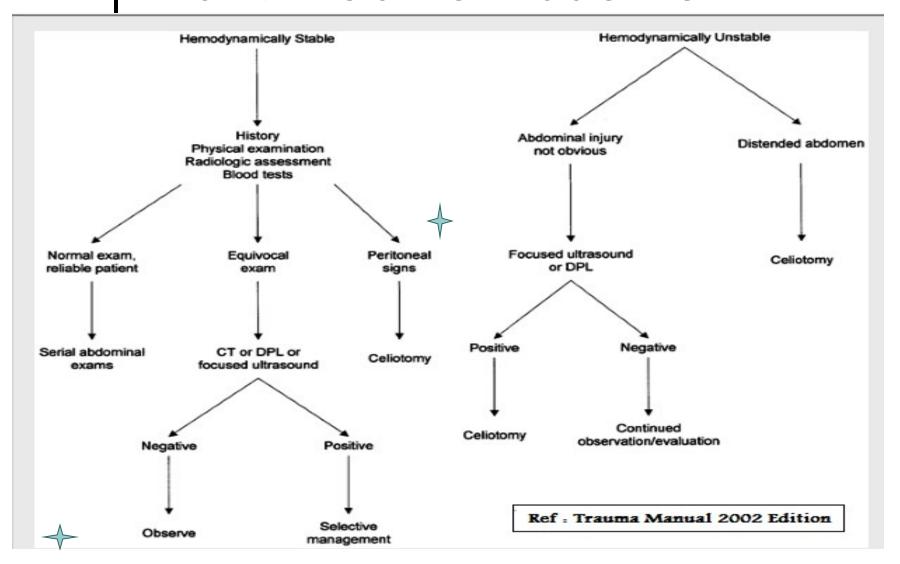
 In active Hge, extravasation of the contrast is seen

 Active Hge, attenuation value 85-350HU, in clotted heamatoma 40-70HU. Remmember, anatomical grading does not correspond with heamodynamic stability of the patient

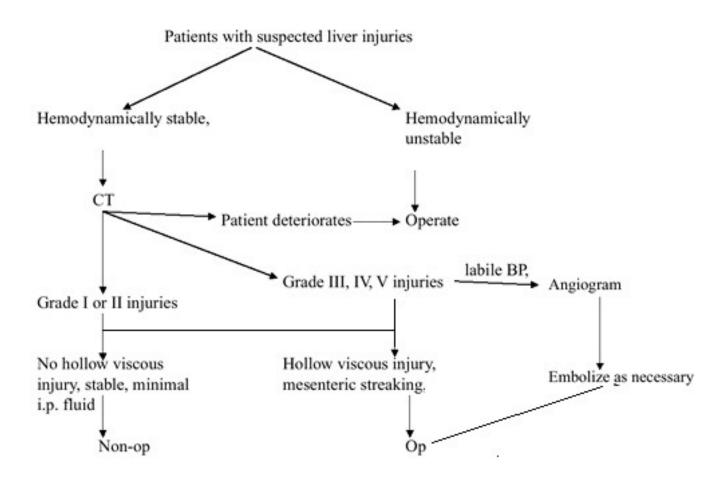
- Generally
 - Grade III, IV & V have mortality of 25,46 & 80%

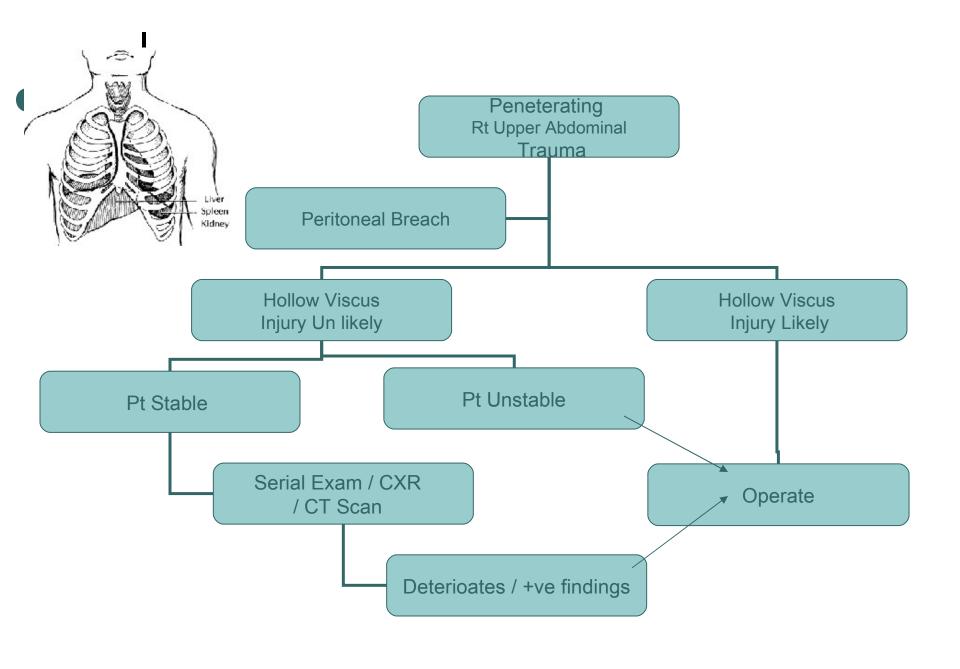
Approach

Blunt Trauma Abdomen



Hollow viscus injury can not be ruled out on investigations

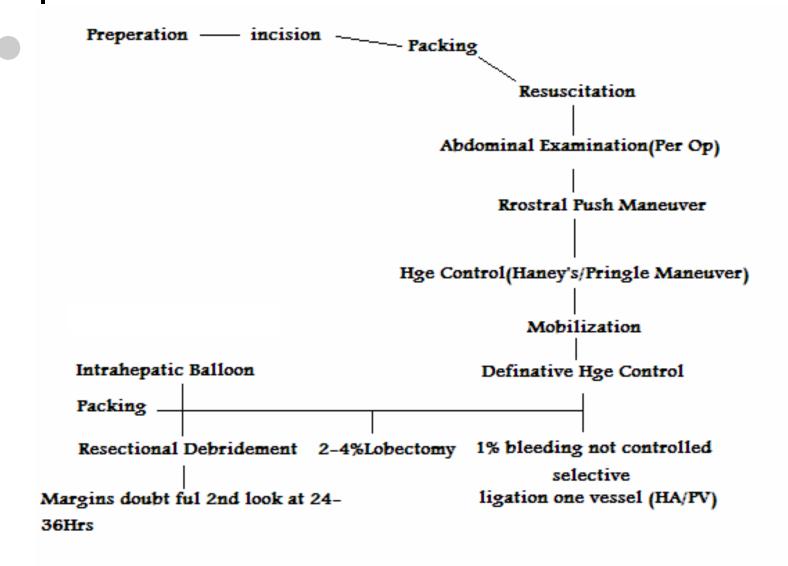




- Stable patient
 - Management is with serial examination and monitoring

- Unstable patient
 - Intervention is done in a methodical way

Major cause of death in child and adult is rapid intraoperative bleed related to torn intrahepatic / juxtahepatic vasculature and FAILURE to control blood loss in antacipation to early surgical repair



• • Preperation

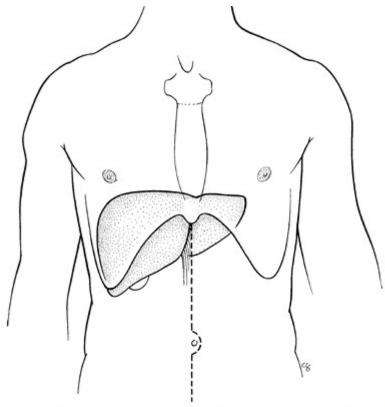
 Midneck to mid thigh, table top to table top laterally

 Draping should be done before induction of anasthesia because it can cause profound drop in blood pressure

• • Incision

Xiphoid to below umblicus

 Blood in peritoneal cavity, extend incision to suprapubic area



An extensive midline incision (dashed line) is preferred for all major hepatic injuries, with an option of extending the incision up the sternum.

• • Evacuate & Pack

 Evacuate immediately as much blood/clots as possible to temporarily control He

Pack all four quadrants

 Allow anasthetist to replace lost volumes

• • Resuscitation

Wait for heamodynamic stability

Operation Theter thermostat 85 F

Vent humidifier 105F

Transfuse fluids

• • Reassess abdomen

 Remove packs from lower abdomen, look for associated bleed, fecal contamination and Gut injury

 If no fecal contamination , autotransfusion can be considered

• • Contd

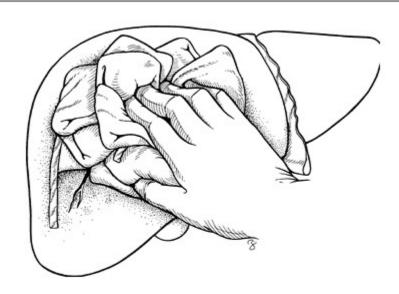
- Autotransfusion involves collection of blood from body cavities and drains and adding anticoagulant
- Its reinfused after washing/filtering
- Dilutional coagulopathy / DIC can occour

• • Contd

 Remove pack in left upper quadrant, if spleenic injury present deal with it.

If required proceed with splenectomy

• • Direct Pressure



Hemostasis of liver fracture. Direct pressure with packs is usually sufficient to control the majority of liver parenchymal bleeding.

• • Approach Liver

Remove packs in RHC

Assess liver

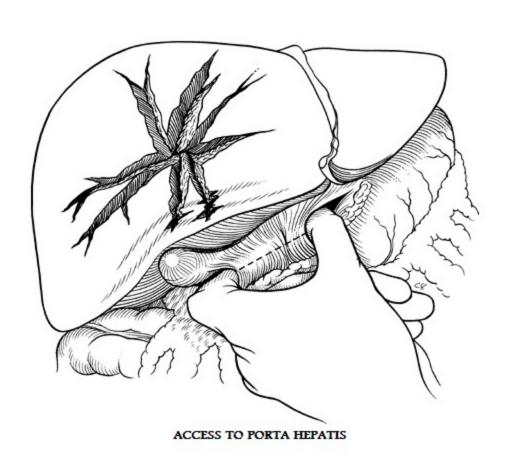
 Gentelly retract dome of liver rostrally, gush of blood from central area means hepatic vien injury

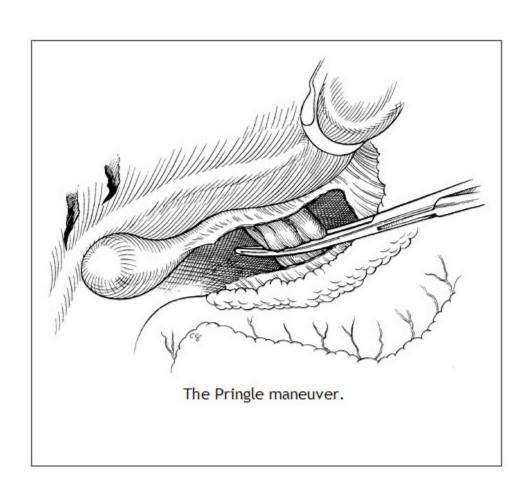
• • Vascular Isolation

 Apply vascular clamp across porta hepatis (pringle), if this control Hge, bleed is from hepatic arty / portal vien

 If pringle maneuver is positive, dissect porta hepatis, take control of left and right portal vien / hepatic artery for selective control

• • Porta Hepatis



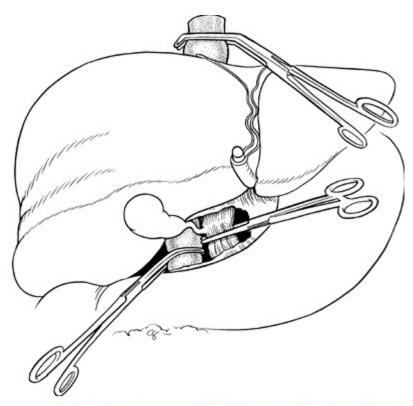


• • Contd

 If pringle maneuver fails to control Hge, the blood is coming from retrohepatic IVC or hepatic viens

 Heaney's maneuver can be done to control Hge.

• • Heaney Maneuver



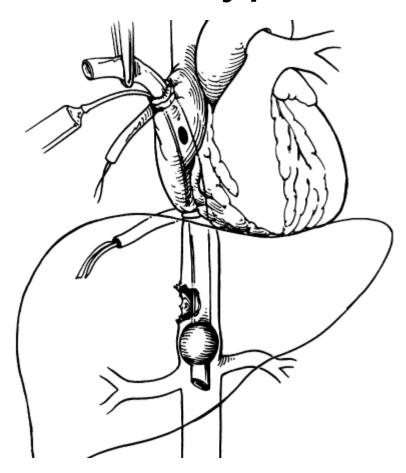
The Heaney maneuver for vascular isolation of the liver.

Clamping Suprahepatic & Infrahepatic IVC with Pringle maneuver

 By passing the venous blood from kidneys nad lower extrimities can be done now to reduce morbidity.

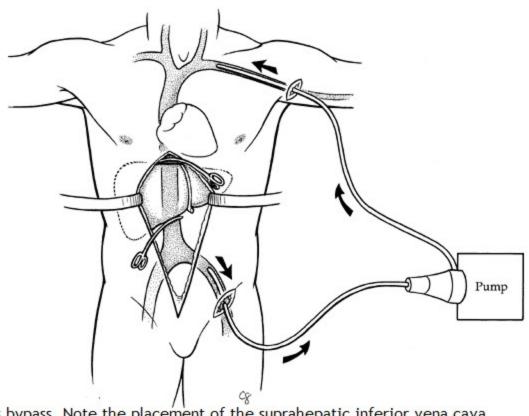
- Two methods
 - Atrio caval bypass
 - Venoveneous bypass

• • • Atrio Caval Bypass



This method involves opening thorax so most surgeons have abondaned it

• • Veno venous bypass



Venovenous bypass. Note the placement of the suprahepatic inferior vena cava clamp and the intrahepatic suprarenal venous clamp.

Axillary and femoral vien catherization can decrease morbidity of vascular isolation and renal injury

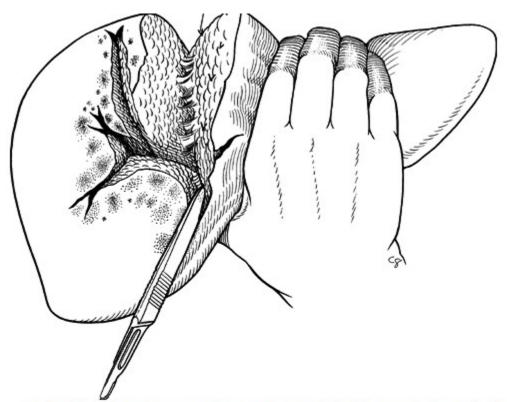
• • Mobilize Liver

 Sharply divide falciform, both leaves of coronary ligament and left triangular ligament.

 Lesser sac should be entered by dividing gastrohepatic ligament

- Definative Control
 >86% of liver injuries involve rt lobe , segment 6,7,8.
 - Assistant stands on left, extend left hand underneath the right lobe, compress the dome or the uninjured part with the right hand
 - Surgeon deepens laceration with finger fracture technique

Finger Fracture / Scalpel Handle



Scalpel handle resection. After incision of the liver capsule with the electrocautery unit, the finger fracture technique or the scalpel handle can be used to dissect through the parenchyma to expose the hepatic vessels and biliary radicals, which are individually suture ligated with 2-0 or 4-0 silk.

- Deep liver sutures and matress sutures are rarely indicated for control of Hge (heamobilia,hepatic necrosis, abcess)
 - Ooze is controlled with cautery
 - Once Hge has been control margins are checked for viablity
 - Finally omentum is plugged into the defect

 Pringle maneuver can be done in elective surgery for 1 hr

• In compromised pt in trauma, no studies have been done. However, it should be restricted to 15 mins and at the most to ½ hr.

• • Next

- Resectional Debridement
 - All non viable liver tissue shuld be resected using scalpel or finger fracture technique
 - When resistence is encountered, its vessel or biliary tract which should be ligated

 Oozing should be controlled with cautery

 In case of viablity of the tissue is doubtful, 2nd look lap should be done after 24-36 Hrs

• • Still Bleeding

Less then 1%

 Ligate one vessel, right or left hepatic artery or portal vien by dissectin through porta hepatis

• • Hepatic Lobectomy

2-4% of all Liver trauma

 Uncontrollable bleed or deep laceration with wide spread destruction of liver parenchyma

 Finger fracture technique with ligation of vessels or bile duct is done across specific anatomical planes In trauma, there are 3 options

Left lateral segmentectomy

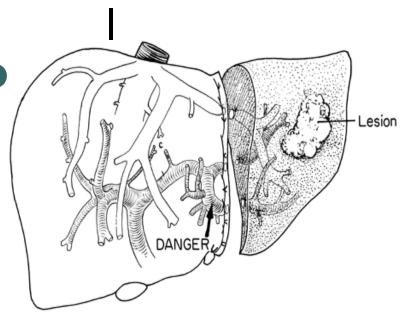
Left lobectomy

Right lobectomy

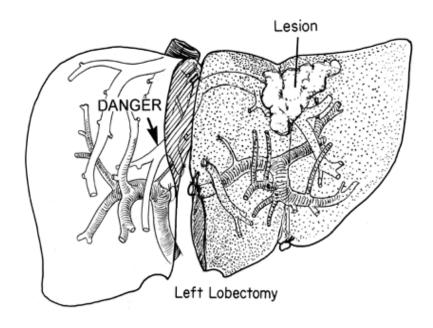
Left lateral segmentectomy Segment II & III are taken out.

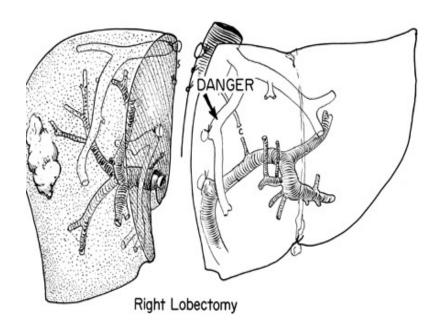
- Resection is carried out to the left of falciform ligament
- Care is taken not to divide vessels supplying segment IV
- On reaching proximal part of left hepatic vien, be careful not to ligate middle hepatic vien

- • • Left lobectomy
 - Carried out to the left of GB fossa
 - Right Lobectomy
 - Carried out to the right of GB fossa
 - After left or right lobectomies, large area should be cauterized and omentum should be placed on it.



Left Lateral Segmentectomy



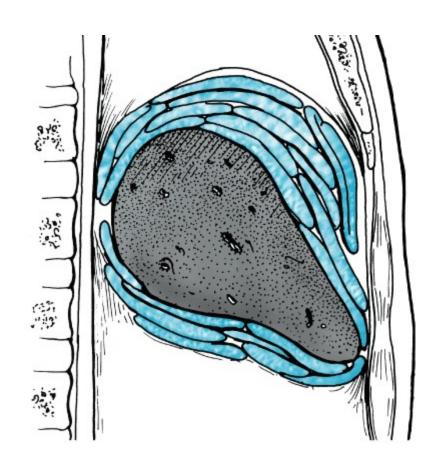


• • Packing

 It was famous in WWII but results are poor

Buys time in very compromised patient

 Only indicated in patient who is coagulopathic or hypothermic, bleeds from large surface and bleed is veneous.



Pack & Re Look after 48 hrs , I/A pressure should be less then $40 mmHg\,$

• • Contd

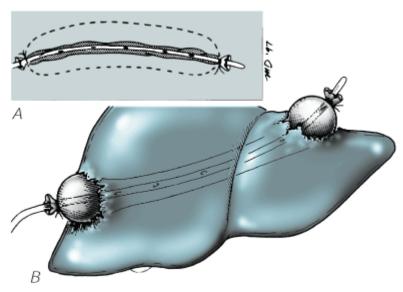
 Placement of pack should not puch diaphram upwards to compromise breathing or compress IVC to compromise veneous return

 BP & CVP monitoring is done to aviod these complications If either of these values fall, compression of IVC is likely.

 Once done successfully, pt is resussicitated in icu. Mean while venoveneous bypass or transport to hepatiobiliary surgical unit is planned

- Intrahepatic balloon
 Done in unstable pt , to gain time in which peneterating injuries form a tract through liver parenchyma
 - A catheter is placed with a balloon inside, to control bleed via temponade effect
 - Temporary measure, re Lap is indicated after stabilizing patient.

• • Intrahepatic balloon



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A. Intrahepatic balloon used to tamponade hemorrhage form transhepatic penetrating injuries. B. Intrahepatic balloon in situ

• • Hepatic transplant

 If there is severe hepatic injury, causing hepatic avulsion, severe nonreconstructable injury to porta hepatis or both lobes, hepatic transplantation can be considered

• • Porta Hepatis Injuries

Vascular injuries

Bliary tract injuries

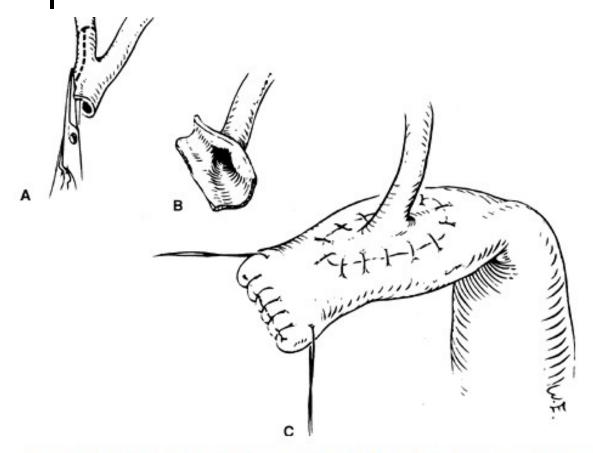
 Vascular Injuries
 Extended Kocker's maneuver to mobilize hepatic flexture and duodenum

- Expose IVC , Aorta , Duodenum & PV
- Proper hepatic arty repair with reverse sapheneous graft
- Portal vien Repair with IJV / Splenic vien* *Only if splenectomy has been done

Biliary InjuriesUnstable patient

- - Exteriorize biliary drainage using catheter
- Stable patient
 - No segmental loss end to side anastamosis
 - Segmental loss Modified Carrel Patch

Modified Carrel Patch (choledocojejunostostomy)



A 1-cm length of cystic duct is preserved after cholecystectomy, and the side wall is opened into the common bile duct remnant. This patch of bile duct is then used to anastomose in an end-to-side fashion to the Roux limb

Post Operative Complications

- Coagulopathy
- Pulmunary Failure
- Juaindice
- Bile Leaks
- Heamatobilia
- Sepsis (7-12%pneumonia , acalcolous cholecystitis)

Thank you

Contemporary Operative Management

Temporary compression

Tractotomy/suture ligation

Gelfoam, Surgicel, thrombin, Fibroseal

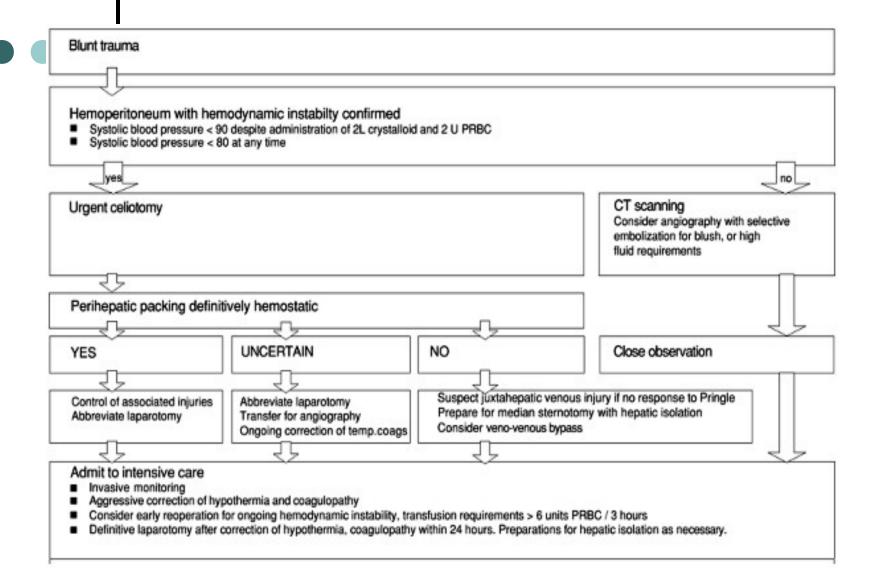
Omentum

Resectional di@bridement

Lobectomy

Temporary packs

Embolization



Blood Loss	Heart rate	Blood Pressure	Capill Return	Resp Rate	Mental State
<750	<100	Normal	Normal	Normal	Normal
750-1500	>100	Systolic Normal	Prolonged	20-30	Mildly Anxious
>1500- 2000	>120	Decreased	Prolonged	30-40	Anxious Confused