الله
بسم الله الرحمن الرحيم

ناصر

الله
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 Accessory lobes, 4 Sectors, 8 Segments
- 4 Ligaments
Hepatic veins divide the liver into 4 sectors and form 3 portal scissura.

Transverse scissura is the plane of division of left and right portal veins.
This forms 8 segments of the liver, namely I to VIII in a clockwise direction when viewed from the front.

Each segment has its own independent portal vein, hepatic artery and bile duct.
Each segment is getting its own duct, artery and vein.
Caudate lobe is segment I, also called separate liver.

- It drains directly to IVC.
- 35% RHA, 12% LHA in remaining both arteries
- Rt portal vein branch supply this lobe
- Vital structures enter the liver through its hilum, hepatic artery, bile duct and portal vein.

- Liver is itself related to right kidney, colon, stomach, IVC and stomach.
Portal Vien

- Formed behind neck of pancreas by union of SMA and splenic vein.
- 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% $O_2$
Cuadate lobe

- Separate liver
- Multiple small veins directly drains into IVC
- Comprises segment I of liver
- **Frequency**
  - 15-20% 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 arteries > veins, 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 transection 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 veins 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%
Iatrogenic

- Percutaneous 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 than 25%, one lobe, 3 Months

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

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

- With 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.*

*Mastery Of Surgery
However, biliary 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 Peritoneal Lavage
USG (FAST)

- Easily available and quick results
- 46% sensitive, 94% specific in penetrating 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 therapeutic
  - Use only in stable patients
  - Transcatheter embolization / stenting
For Bile Leak
- Radiolabelled 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
<table>
<thead>
<tr>
<th>Grade</th>
<th>Injury Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

<p>| Hematoma | Subcapsular, nonexpanding, &lt;10% surface area |
| Laceration | Capsular tear, nonbleeding, &lt;1 cm deep parenchymal disruption |
| II |<br />
|---|---|
| Hematoma | Subcapsular, nonexpanding, hematoma 10% – 50%; intraparenchymal, nonexpanding, &lt;2 cm in diameter |
| Laceration | &lt;3 cm parenchymal depth, &lt;10 cm in length |</p>
<table>
<thead>
<tr>
<th>III</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematoma</td>
<td>Subcapsular, &gt;50% of surface area or expanding; ruptured subcapsular hematoma with active bleeding; intraparenchymal hematoma &gt;2 cm</td>
</tr>
<tr>
<td>Laceration</td>
<td>&gt;3 cm parenchymal depth</td>
</tr>
</tbody>
</table>
Unclotted subcapsular blood

Clotted subcapsular hematoma
<table>
<thead>
<tr>
<th>IV</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Hematoma</td>
<td>Ruptured central hematoma</td>
</tr>
<tr>
<td>Laceration</td>
<td>Parenchymal destruction involving 25%–75% of hepatic lobe</td>
</tr>
<tr>
<td></td>
<td>Description</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Laceration</td>
<td>Parenchymal destruction of &gt;75% of hepatic lobe</td>
</tr>
<tr>
<td>Vascular</td>
<td>Juxtahepatic venous injuries (retrohepatic cava/major hepatic veins)</td>
</tr>
</tbody>
</table>
Global liver injury packed with Gelfoam
<table>
<thead>
<tr>
<th>Vascular</th>
<th>Hepatic avulsion</th>
</tr>
</thead>
</table>

VI
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.
Remember, anatomical grading does not correspond with hemodynamic 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
Patients with suspected liver injuries

Hemodynamically stable, → Hemodynamically unstable

CT

Grade I or II injuries

No hollow viscous injury, stable, minimal i.p. fluid → Non-op

Hollow viscous injury, mesenteric streaking. → Op

Patient deteriorates → Operate

Labile BP, → Angiogram

Embolize as necessary
Penetrating Rt Upper Abdominal Trauma

Peritoneal Breach

Hollow Viscus Injury Unlikely
- Pt Stable
  - Serial Exam / CXR / CT Scan
- Pt Unstable
  - Deterioates / +ve findings

Hollow Viscus Injury Likely
- Operate
- 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 anticipation to early surgical repair
Preperation — incision — Packing
Resuscitation

Abdominal Examination (Per Op)

Krostral Push Maneuver

Hge Control (Haney's/Pringle Maneuver)

Mobilization

Intrahepatic Balloon — Packing

Resectional Debridement — 2–4% Lobectomy — 1% bleeding not controlled

Selective ligation one vessel (HA/PV)

Margins doubt ful 2nd look at 24–36 Hrs
Preperation

- Midneck to mid thigh, table top to table top laterally

- Draping should be done before induction of anaesthesia 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 anesthetist to replace lost volumes
Resuscitation

- Wait for hemodynamic stability
- Operation Theter thermostat 85 F
- Vent humidifier 105 F
- 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
Autotransfusion involves collection of blood from body cavities and drains and adding anticoagulant.

- It's reinfused after washing/filtering.

- Dilutional coagulopathy / DIC can occur.
Contd

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

- If required proceed with splenectomy
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
- Gently retract dome of liver rostrally, gush of blood from central area means hepatic vein injury
Vascular Isolation

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

- If pringle maneuver is positive, dissect porta hepatis, take control of left and right portal vlein / hepatic artery for selective control
Porta Hepatis
The Pringle maneuver.
If pringle maneuver fails to control Hge, the blood is coming from retrohepatic IVC or hepatic veins.

Heaney’s maneuver can be done to control Hge.
Heaney Maneuver

The Heaney maneuver for vascular isolation of the liver.

Clamping Suprahepatic & Intrahepatic IVC with Pringle maneuver
By passing the venous blood from kidneys and lower extremities can be done now to reduce morbidity.

Two methods
- Atrio caval bypass
- Venovenous bypass
Atrio Caval Bypass

This method involves opening thorax so most surgeons have abandoned it
Veno venous bypass

Axillary and femoral vein catheterization 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.
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 viability
- 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.
Resectional Debridement

- All non viable liver tissue should be resected using scalpel or finger fracture technique.

- When resistance is encountered, its vessel or biliary tract which should be ligated.
- Oozing should be controlled with cautery

- In case of viability of the tissue is doubtful, the 2nd look lap should be conducted after 24-36 Hrs.
Still Bleeding

- Less then 1%

- Ligate one vessel, right or left hepatic artery or portal vein by dissecting 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 vein, be careful not to ligate middle hepatic vein
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

Left Lobectomy

Lesion

Right Lobectomy

Lesion

DANGER
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 venous.
Pack & Re Look after 48 hrs, I/A pressure should be less than 40mmHg
Placement of pack should not push diaphragm upwards to compromise breathing or compress IVC to compromise venous return

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

- Once done successfully, pt is resuscitated in icu. Meanwhile venovenous bypass or transport to hepatobiliary surgical unit is planned.
Intrahepatic balloon

- Done in unstable pt, to gain time in which penetrating injuries form a tract through liver parenchyma

- A catheter is placed with a balloon inside, to control bleed via tamponade effect

- Temporary measure, re Lap is indicated after stabilizing patient.
A. Intrahepatic balloon used to tamponade hemorrhage from 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
- Biliary tract injuries
Vascular Injuries

- Extended Kocker’s maneuver to mobilize hepatic flexure and duodenum

- Expose IVC, Aorta, Duodenum & PV

- Proper hepatic artery repair with reverse saphenous graft

- Portal vein Repair with IJV / Splenic vein*

*Only if splenectomy has been done
Biliary Injuries

- Unstable patient
  - Exteriorize biliary drainage using catheter

- Stable patient
  - No segmental loss end to side anastomosis
  - Segmental loss Modified Carrel Patch
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
- Pulmonary Failure
- Jaundice
- Bile Leaks
- Hematobilia
- Sepsis (7-12% pneumonia, acalcolous cholecystitis)
Thank you
Contemporary Operative Management

- Temporary compression
- Tractotomy/suture ligation
- Gelfoam, Surgicel, thrombin, Fibroseal
- Omentum
- Resectional débridement
- Lobectomy
- Temporary packs
- Embolization
Blunt trauma

Hemoperitoneum with hemodynamic instability confirmed
- Systolic blood pressure < 90 despite administration of 2L crystalloid and 2 U PRBC
- Systolic blood pressure < 80 at any time

YES → Urgent celiotomy

NO → CT scanning
Consider angiography with selective embolization for blush, or high fluid requirements

Perihepatic packing definitively hemostatic

YES
Control of associated injuries
Abbreviate laparotomy

UNCERTAIN
Abbreviate laparotomy
Transfer for angiography
Ongoing correction of temp.coags

NO
Suspect juxtahepatic venous injury if no response to Pringle
Prepare for median sternotomy with hepatic isolation
Consider vено-venous bypass

Close observation

Admit to intensive care
- Invasive monitoring
- Aggressive correction of hypothermia and coagulopathy
- Consider early reoperation for ongoing hemodynamic instability, transfusion requirements > 6 units PRBC / 3 hours
- Definitive laparotomy after correction of hypothermia, coagulopathy within 24 hours. Preparations for hepatic isolation as necessary.
<table>
<thead>
<tr>
<th>Blood Loss</th>
<th>Heart rate</th>
<th>Blood Pressure</th>
<th>Capill Return</th>
<th>Resp Rate</th>
<th>Mental State</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;750</td>
<td>&lt;100</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>750-1500</td>
<td>&gt;100</td>
<td>Systolic Normal</td>
<td>Prolonged</td>
<td>20-30</td>
<td>Mildly Anxious</td>
</tr>
<tr>
<td>&gt;1500-2000</td>
<td>&gt;120</td>
<td>Decreased</td>
<td>Prolonged</td>
<td>30-40</td>
<td>Anxious Confused</td>
</tr>
</tbody>
</table>