Hepatobiliary Trauma: Current Approach to Management

William Schecter, MD
Professor of Clinical Surgery
University of California, San Francisco
Chief of Surgery
San Francisco General Hospital
FIGURE 2.4. Ligaments of the liver viewed anteriorly. On the right is the upper layer of the right coronary ligament. On the left is the left coronary ligament, which ends as the left triangular ligament. In the midline lies the falciform ligament, the free margin of which contains the ligamentum teres. Most of convex superior surface is illustrated ending in a sharp inferior margin.
FIGURE 2.5. Diaphragmatic surface after removal of the liver. The ligamentous attachment, bare-area, and adjacent structures (inferior vena cava, aorta, stomach, duodenum, hepatic flexure of colon, and right adrenal and kidney) can be seen.
## OIS Liver Injury Grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type</th>
<th>Description</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Haematoma</td>
<td>Subcapsular, &lt;10% surface area</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Capsular tear, &lt;1 cm parenchymal depth</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>Haematoma</td>
<td>Subcapsular, 10-50% surface area</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intraparenchymal, &lt;10 cm diameter</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>1-3 cm parenchymal depth, &lt;10 cm length</td>
<td>2</td>
</tr>
<tr>
<td>III</td>
<td>Haematoma</td>
<td>Subcapsular, &gt;50% surface area or expanding. Ruptured subcapsular or parenchymal haematoma</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intraparenchymal haematoma &gt;10 cm or expanding</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>&gt;3 cm parenchymal depth</td>
<td>3</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>Parenchymal disruption involving 25-75% of hepatic lobe or 1-3 Coinaud's segments in a single lobe</td>
<td>4</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Parenchymal disruption involving &gt;75% of hepatic lobe or &gt;3 Coinaud's segments within a single lobe</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Vascular</td>
<td>Juxtahepatic venous injuries ie. retrohepatic vena cava/central major hepatic veins</td>
<td>5</td>
</tr>
<tr>
<td>VI</td>
<td>Vascular</td>
<td>Hepatic Avulsion</td>
<td>6</td>
</tr>
</tbody>
</table>

Advance one grade for multiple injuries to same organ up to Grade III.
BACKGROUND

- 1990: nonoperative “therapy” for liver tx
- 2000: nonoperative approach = standard
- 85% blunt liver trauma: no surgery
- Most have Grade I-III injuries
- Hemodynamics uncompromised

Knudson/Lim: 1990 Pachter/Knudson:1996
Malholtra/Fabian: 2000
GRADE IV-V LIVER INJURIES

• Operative mortality: $>50\%$
• Hemodynamically *compromised*
ADJUNCTIVE MEASURES FOR LIVER INJURIES

- Angiography
- ERCP with stenting/sphincterotomy
- Percutaneous drainage: IAH
CASE PRESENTATION

• 20 year old man: **restrained** driver in MVA
• seat-belt mark; **tense, tender** abdomen
• BP-80 systolic: **responsive** to fluids
• **FAST exam positive** - transfusion initiated
• Abdominal **CT scan** performed
INITIAL CT SCAN: ACTIVE EXTRAVASATION
ANGIOGRAM – ACTIVE EXTRAVASATION
POST-EMBOLIZATION ANGIOGRAM
ICU COURSE

• Bleeding controlled with embolization
• **9 unit transfusions**: first 24 hours
• Progressive respiratory failure
• PT Day #4: \( \text{FiO2-100\%}, \text{PEEP of 14 cm} \)
• PIP: 42
• IAP: 50
• **OR for Decompression???
PELVIC COLLECTION - PRE DECOMPRESSION
PELVIC DRAINS: POST US - GUIDED DECOMPRESSION
HOSPITAL COURSE: CONTINUING THE SAGA

• Abdominal decompression: 4Liters!
• IAP: 12
• Dramatic improvement in PIP/FiO2
• Continuous high-output bilious drainage
ERCP PRIOR TO STENT
### SUMMARY: 3 PATIENTS GRADE V LIVER INJURIES

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th>POST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BLOOD</strong></td>
<td>6-9 UNITS/first 24 hours</td>
<td></td>
</tr>
<tr>
<td><strong>IAP</strong></td>
<td>35-50</td>
<td>12</td>
</tr>
<tr>
<td><strong>FIO2</strong></td>
<td>50-100%</td>
<td>40-50%</td>
</tr>
<tr>
<td><strong>CREAT</strong></td>
<td>0.9-1.5</td>
<td>0.6-0.8</td>
</tr>
<tr>
<td><strong>FLUID</strong></td>
<td>drained</td>
<td>3-5L</td>
</tr>
</tbody>
</table>

2/3 patients with bile leaks
REDUCTION IN LIVER MORTALITY

- Grade IV-V injuries
- Mortality reduced from 40-80% to 8-22%

Multi-modality therapy:
  - early packing
  - angioembolization
  - ERCP/stents/drainage abscesses

Asensio et al J Trauma, 2000
APPLICATION TO PENETRATING TRAUMA

- Adjunctive techniques - complications of penetrating liver trauma*
- Nonoperative management - selected cases

*Knudson/Lim:1994
PROPOSED ALGORITHM:

MAJOR LIVER TRAUMA

UNSTABLE

OR

PACK

STABLE / RESPONDS TO RESUS.

SPIRAL CT: EXTRAV.?

YES

ANGIO & CONTINUE RESUSCITATION

Bile leak – ERCP
IAH – U/S guided decompression

ICU

NO

NON-OP
SPIRAL CT CLASSIFICATION

- **Type I:** active extravasation-peritoneum
  - unstable/required laparotomy
- **Type II:** intraparenchymal contrast + hemoperitoneum: 4/6 to OR
- **Type III:** only intraparenchymal contrast
  - none required laparotomy

*Feng et al, J Trauma, 2000*
Autotransfusion
Perihepatic Packing

- Damage control procedure
- Laparotomy pads compress areas of injury
- Avoid mobilization of the liver
  - falciform and triangular ligaments
  - diaphragmatic and retroperitoneal attachments
- Temporary abdominal wall closure
  - Skin or “Bogota” bag silo
- Return to OR for removal of lap pads in 24-48 hr
Fibrin Glue

Fibrinogen $\xrightarrow{\text{Ca}^{++}}$ Fibrin

$\uparrow$

Thrombin
Absorbable Mesh Packing
Pringle Maneuver

• First described in 1908*

• Can be tolerated for up to 60 minutes
  – Causes ischemia reperfusion injury to liver
  – Associated with massive bowel edema

• Controls hepatic parenchymal hemorrhage in 60-80% of cases
  – Helps diagnose hepatic vein/caval injuries

Hepatic Artery Ligation

- Collateral flow through translobar and subcapsular vessels
- Well tolerated if portal flow is preserved
  - Portal vein supplies 80% of hepatic oxygen requirement
  - Hepatic artery clamping increases portal vein oxygen extraction
Hepatic Artery Extravasation

Successfully controlled by embolization
<table>
<thead>
<tr>
<th>Blood Flow Location</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior Vena Cava</td>
<td>25</td>
</tr>
<tr>
<td>Inferior Vena Cava</td>
<td>75</td>
</tr>
<tr>
<td>Renal Veins</td>
<td>25</td>
</tr>
<tr>
<td>Portal Vein</td>
<td>40</td>
</tr>
<tr>
<td>Infrarenal IVC</td>
<td>10</td>
</tr>
</tbody>
</table>

J Malo, et.al., *J Appl Physiol* 56:1403, ‘84
Atrial-Caval Shunt

chest tube

suprahepatic & subhepatic snares

Pringle maneuver
Problems with Atrial Caval Shunts

• Generally requires additional thoracotomy or sternotomy
• Snaring the vena cava is technically challenging
• Insertion is associated with additional blood loss
• Potential for air embolism in a hypotensive patient
Total Vascular Occlusion

suprahepatic & subhepatic caval control

Pringle maneuver

aortic control
Indications for Total Vascular Occlusion (TVO)

• Penetrating injuries
  – Major GSW with blast injury to parenchyma requiring hepatotomy for control of hemorrhage
  – Penetrating retrohepatic caval and hepatic vein injuries

• Blunt injuries
  – Second-stage hepatic resections
  – Liver avulsion

• Consider TVO when the Pringle maneuver and packing together are insufficient
CVP After Total Vascular Occlusion
22 noncirrhotic patients

D Eyraud et.al. Anesth Analg 95:1173, ‘02
Hemodynamics of TVO
22 non-cirrhotic patients

D Eyraud et.al. Anesth Analg 95:1173, ‘02
Humoral Agents in TVO
22 non-cirrhotic patients

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Baseline</th>
<th>5 minutes after clamping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arg vasopressin</td>
<td>8 ± 10</td>
<td>31 ± 26</td>
</tr>
<tr>
<td>(pg/ml)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epinephrine</td>
<td>175 ± 128</td>
<td>347 ± 292</td>
</tr>
<tr>
<td>(pg/ml)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norepinephrine</td>
<td>595 ± 366</td>
<td>1226 ± 1045</td>
</tr>
<tr>
<td>(pg/ml)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D Eyraud et.al. *Anesth Analg* 95:1173, ‘02
Extracorporeal Inferior Vena Caval Bypass: study in 5 mongrel dogs

• Bypass all blood to suprahepatic vena cava
  – Percutaneous femoral vein to internal jugular vein
  – Inferior mesenteric vein to internal jugular vein
  – Heparin bonded shunts with extracorporeal pump

• Less drop in MAP and CO
  – Compared to Pringle maneuver + complete caval interruption (TVO) or atrial-caval shunt

Vascular Occlusion

- 10 patients with penetrating juxtahepatic IVC injuries
- Pringle maneuver & clamping of the vena cava above and below the liver
- Aortic clamping used only if systolic BP < 60 mmHg
- 9 left OR and 7 discharged alive

Selective Vascular Occlusion

• Pringle maneuver
• Dissection of the R side of the vena cava with isolation of the R hepatic vein trunk and middle/left hepatic vein confluence
  – Be careful of an inferior R hepatic vein
• Application of bulldog clamps to the hepatic veins parallel to the vena cava

• Maintains flow in the IVC
Extrahepatic Biliary Injuries
33-year-old Man with Multiple Gun Shot Wounds

- Portal vein
- Hepatic artery
- Blast injury to CBD
- Diaphragm
- Spleen
- Blast injury to the pancreas
- Duodenum
- Stomach
Initial Therapy

• Splenectomy
• Closure of stomach wounds
• Repair of hepatic artery
Treatment of Blast Injury and Hole in the Common Duct

- Cholecystectomy
- Repair of small hole in the distal duct
- T-tube drainage of the duct
Post Operative Course

- Liver Failure
  - Coma
  - Hypoprothrombinemia
  - Hyperbilirubinemia
11-23-94 - Opening eyes to command
11-26-94 - Extubated
12-1-94 - 510 cc of bile drainage from RUQ drains

T-tube cholangiogram 12-1-94
* distal CBD intact with flow of contrast into duodenum
* extravasation of contrast in region of proximal CBD
February 1995 - Transhepatic stent
Extrahepatic Biliary Injury

• Gallbladder most common site—treatment cholecystectomy
• Injury to the Extrahepatic bile ducts is uncommon. Treatment depends upon the location and nature of the injury and the physiologic status of the patient
Treatment Options for Extrahepatic Bile Duct Injuries

- Small injuries due to stab wounds--lateral choledochochory
- Duct transections--Roux-en-y choledochojejunostomy
- Complex injuries in unstable patients--cholecystectomy and tube drainage of the duct

Burgess P, Fulton RL. Gallbladder and extrahepatic biliary duct injury following Abdominal trauma. Injury 1992;23:413-4
Technical Tips for Hepaticojejunostomy

- Single layer absorbable suture
- Spatulate the duct
- Extend choledochotomy to left hepatic duct
- Place interrupted sutures in the anterior wall of the duct prior to beginning the posterior row of the anastomosis
Liver

Access loop

Hepaticojejunostomy
ERCP in Patients with Pancreatic Trauma

• 20 patients (ages 17-54)
• 6 patients (30%) normal ERCP
• 13 patients with partial or complete PDD
• 1 patient with biliary injury (Rx biliary stent)
• 15 patients Rxed expectantly after ERCP
• 2 patients-distal pancreatectomy
• 7 patients sphincterotomy and/or pancreatic stent—none required surgery
Sphincterotomy  
Pancreatic stent
Normal ERCP
Blunt trauma

Pancreatic and peripancreatic edema

Extravasation of contrast
From pancreatic duct
Rx- pancreatic sphincterotomy
Mildly edematous pancreatic tail
Fluid in lesser sac

Extravasation of contrast at
Tail of pancreas
Rx- Observation
2 cases of Blunt Trauma

Extravasation from Pancreatic tail
Rx - Sphincterotomy

Extravasation from head of Pancreas
Rx-IR peripancreatic drains
Blunt Trauma

Mild edema of body of pancreas

Extensive extravasation
Rx- distal pancreatectomy
Distal Pancreatectomy

Distal Pancreatectomy with Preservation of the Spleen
Lessons Learned

- Use ERCP to diagnose PDD after both blunt and penetrating trauma
- Treat PDD in selected cases by pancreatic sphincterotomy and/or pancreatic duct stent
- Early diagnosis of PDD can lead to prompt minimally invasive or resection therapy and minimize morbidity and mortality
Summary

- Non operative treatment of all hepatic injuries if possible
- Pack liver and close if bleeding is controlled
- Pringle maneuver for proximal control
- Supra and infrahepatic caval occlusion for distal control
- Temporary aortic crossclamp to prevent cardiac arrest in selected patients
Summary

- Cholecystectomy for gunshot wounds of the gallbladder in stable patients
- Cholecystorrhaphy vs cholecystectomy for small stab wounds of the gallbladder
- Tube cholecystostomy in unstable patients
- Choledochorrhaphy for small stab wounds of the common bile duct
- Hepatojejunostomy for Common Duct Transections
- Drain the bile duct in the unstable patient