Managemen of Liver Injuries

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Shock Trauma Center
University of Maryland

Nonoperative management for blunt hepatic trauma: Do We Still Operate??

Nonoperative Management of Blunt Hepatic ≠ Splenic Injuries
Bleeding from hepatic injuries can be exacerbated by operation

Hepatic related transfusions ≤ 4 units
Transfusion limit has not been verified

Richardson JACS 2005(201)
Initial assessment of BLT abdominal exam

*Signs of instability*

- Hemodynamically unstable
- Responsiveness to resuscitation

**Patient becomes unstable**

- Consider other causes of instability

**Operative intervention**

**Hemodynamically unstable**

- CT scan

Liver injury: blush?

- Observation

**Continued transfusion requirement or unstable**

**Stable**

- FAST DPA

**Consider other causes of instability**

**SIRS**

- Abdominal pain
- Jaundice
- Fever

**Bile ascites/hemoperitoneum**

- Laparoscopy with drainage

**Successful Management**

**Continued bilious drainage**

**ERCP + Sphincterotomy**

**Liver Abscess**

- IR

**Angioembolization**

**Repeat CT scan**

**Operative Intervention**

**Patient becomes unstable**

**Jaundice**

**Variable significant in Multivariate Analysis**

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR</th>
<th>95% CI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Gender</td>
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<tr>
<td>ISS</td>
<td></td>
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<tr>
<td>ED SBP &lt; 90</td>
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<tr>
<td>ED Base Deficit</td>
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<td></td>
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<tr>
<td>Grade 3 Liver Injury</td>
<td>5</td>
<td>2 - 10</td>
<td>0.0004</td>
</tr>
<tr>
<td>Grade 4 Liver Injury</td>
<td>12</td>
<td>4 - 36</td>
<td>&lt; 0.0001</td>
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<tr>
<td>Grade 5 Liver Injury</td>
<td></td>
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<tr>
<td>Extend of hemoperitoneum</td>
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<tr>
<td>Positive FAST</td>
<td></td>
<td></td>
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<tr>
<td>1st 24 hr Crystalloids</td>
<td>7</td>
<td>3 - 13</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>1st 24 hr PRBCs</td>
<td>10</td>
<td>4 - 24</td>
<td></td>
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<tr>
<td>1st 24 hr FFP</td>
<td>3</td>
<td>1 - 5</td>
<td></td>
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<tr>
<td>Total FFP</td>
<td>4</td>
<td>2 - 8</td>
<td></td>
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<tr>
<td>1st 24 hr Platelets</td>
<td>6</td>
<td>3 - 14</td>
<td></td>
</tr>
<tr>
<td>Total Platelets</td>
<td>6</td>
<td>3 - 13</td>
<td></td>
</tr>
<tr>
<td>1st 24 hr Cryoprecipitate</td>
<td>7</td>
<td>3 - 23</td>
<td></td>
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<tr>
<td>Total Cryoprecipitate</td>
<td>7</td>
<td>2 - 19</td>
<td></td>
</tr>
<tr>
<td>SIRS</td>
<td></td>
<td></td>
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<tr>
<td>Hyperbiliurinemia</td>
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</table>

ROC = 0.79

Risk Factors for Hepatic Morbidity Following Nonoperative Management

Multicenter Study

Arch Surg 2006:141
COMPLICATION
BLEEDING
Bleeding that required intervention by either angioembolization or laparotomy

COMPLICATION
ABDOMINAL COMPARTMENT SYNDROME
Development of ACS requiring decompressive laparotomy
Complication: Biliary

COMPLICATION
LIVER-RELATED INFECTION

TIMING OF COMPLICATIONS

Bleeding & ACS occur early
Infectious Biliary

**TIMING OF COMPLICATIONS**

- **Bleeding & ACS**: occur early while infectious and biliary occur late.
- **Biloma**: Continued bilious drainage.
- **Liver Abscess**: IR (Successful Management).
- **Bile Peritonitis**: Laparoscopy with drains. ERCP/sphincterotomy.

**Complications of Nonop Management**

- **Operation**: (-) ERCP/sphincterotomy (+)

**Liver Abscess** → IR (+) continued bilious drainage → (+) ERCP/sphincterotomy
Majority pts have grade IV or V injuries
- Associated with SIRS
- OR 3-5 days post injury
- Drain bile and blood laparoscopically
- Place peri-hepatic drains
- Dramatic improvement is symptoms

Biliary leaks complicate 0.5-21% of liver trauma
- Retrospective review of 1548 liver traumas, 2% (31 pts) had ERCP for suspected leak
- Occurred in all high grade (3-5) injuries
- Half blunt, half penetrating
- 92% pts were post op
- Very rare to develop a significant bile leak after NOM

All leaks stopped, average 47 days
- Patients underwent ERCP, sphincterotomy and biliary stenting (10F)
- Noted that 8 of these patients had previously undergone angioembolization and 6/8 subsequent liver resection for hepatic necrosis which then lead to the bile leak
Successful Nonoperative Management of the Most Severe Blunt Liver Injuries

A Multicenter Study of the Research Consortium of New England Centers for Trauma

Archives Surg May 2012;147

- Retrospective study of 393 patients from 11 trauma centers in New England looking at Grade 4 and 5 blunt liver injuries
- Overall 39.2% needed operative intervention
  - 131 immediate for HD instability and 23 delayed
- Outcome: failure of NOM defined as the need for delayed operation

Failure of NOM

8.8% (23 pts) failure rate:
- 17 liver related: 6.5%
  - 7 bleeding and 10 biliary peritonitis
- 5 other: missed injuries, GB necrosis

Risk factors for failure: BP<100
  - other abdominal injuries

No increase in mortality in failures

The swinging pendulum: A national perspective of nonoperative management in severe blunt liver injury

Patrick M. Peluso, MB; Joshua B. Rovin, MD; David Corroto Payano, MB; Timothee K. Bihora, MB;

- NTDB 2002-2008
- 3627 blunt liver injury patients with AIS≥ 4 and no other solid organ injury

Looked at recent trends in NOM
Have we swung too far??
Non-operative management in hypotensive patients

![Graph showing non-operative management (NOM) success and failure rates over time with an initial NOM rate of 6.5% and failed NOM rate increasing over time.]

NOM of the hypotensive patient

| TABLE 2. Characteristics by Outcome of NOM | | |
| --- | --- | --- | --- |
| | Sucessful | Failed | p |
| Age, median (IQR), y | 24 (18-37) | 29 (22-42) | -0.01 |
| Sex, male, % | 63 | 55.3 | 0.05 |
| ISS, median (IQR) | 26 (17-34) | 32 (25-38) | -0.01 |
| AIS score, % | 4.2 | 4.5 | 0.70 |
| Hypotension, % | 54 | 16.1 | -0.01 |
| LOS, median (IQR) | 6 (4-10) | 21 (10-32) | -0.01 |
| ICU LOS, median (IQR) | 2 (1-5) | 12 (5-21) | -0.01 |
| Survival, % | 92.9 | 78.8 | -0.01 |

Kaplan-Meier survival curve for NOM

![Survival curve showing significant difference (p<0.01) between successful and failed NOM patients in hospital days.]

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Damage-control resuscitation increases successful nonoperative management rates and survival after severe blunt hepatic injury

George H. Tyson III, MD, Philip R. Adams, MB, Salem Khan, MB, and Charles E. Wade, PhD, Houston, Texas
J Trauma 2015;78(2)

- Retrospective study
- 206 pts Grade IV and V blunt hepatic injuries

<table>
<thead>
<tr>
<th>Liver injury grade</th>
<th>Pre-DCR</th>
<th>DCR</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade IV (%)</td>
<td>79 (73%)</td>
<td>79 (81%)</td>
<td>0.27</td>
</tr>
<tr>
<td>Grade V (%)</td>
<td>29 (27%)</td>
<td>18 (18%)</td>
<td></td>
</tr>
<tr>
<td>Grade VI (%)</td>
<td>0</td>
<td>1</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Pre-DCR (n=108)</th>
<th>DCR (n=98)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Survival</td>
<td>79 (73 %)</td>
<td>92 (94 %)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Grade IV (%)</td>
<td>66 (84 %)</td>
<td>75 (95 %)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Grade V (%)</td>
<td>13 (45 %)</td>
<td>17 (94 %)</td>
<td></td>
</tr>
<tr>
<td>Patients who received blood, n</td>
<td>66</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>Survival (%)</td>
<td>38 (58 %)</td>
<td>48 (89 %)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Patients who did not receive blood, n</td>
<td>42</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Survival (%)</td>
<td>41 (98 %)</td>
<td>44 (100%)</td>
<td>0.49</td>
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</table>
Patients who received blood products (n)

<table>
<thead>
<tr>
<th></th>
<th>Pre-DCR (n=108)</th>
<th>DCR (n=98)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>24hr RBC (units)</td>
<td>13 (6, 26)</td>
<td>6 (2, 13)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>24hr plasma (units)</td>
<td>13 (7, 24)</td>
<td>8 (2, 16)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>24hr platelets (u)</td>
<td>3 (2, 6)</td>
<td>2 (1, 3)</td>
<td>0.02</td>
</tr>
<tr>
<td>24hr crystalloid (ml)</td>
<td>8000 (5000, 11225)</td>
<td>5050 (3525, 6450)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Infectious:

- Pneumonia: 25 (23%) vs 30 (31%) p=0.23
- IAA: 11 (10%) vs 3 (3%) p=0.05
- Sepsis: 34 (32%) vs 31 (32%) p=0.98

Other complications:

- Other site rebleed: 3 (3%) vs 3 (3%) p=1.0
- ACS: 7 (7%) vs 4 (4%) p=0.54
- PE: 2 (2%) vs 4 (4%) p=0.43
- DVT: 4 (4%) vs 8 (8%) p=0.24

What if Nonoperative Management is not possible?: operating on the bleeding liver
The Academic Challenge of Teaching Psychomotor Skills for Hemostasis of Solid Organ Injury

Charles Lucas and Anna Ledgerwood

J Trauma 2009;66.

“...a fully trained surgical resident would perform some type of hemostatic technique to control liver bleeding only 1.2 times by completion of their residency.”

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REBOA: Gets you to the OR

Operative management of blunt hepatic trauma

Minor bleeding

Electrocautery or argon beam, topical hemostatic agents
Operative management of blunt hepatic trauma

Major bleeding

Pack and resuscitate

STEPS:
1. Manual compression
2. Intraop resuscitation
3. Perihepatic packing
4. Rapid abdominal exploration

Operative management of blunt hepatic trauma

Major bleeding

Pack and resuscitate

Bleeding controlled

Damage control laparotomy
Consider angiography

Mike Rotondo
University of PA

J Trauma 1993

1. Control of bleeding with packs
2. Temporary abdominal closure
3. ICU for resuscitation
4. Delayed definitive repair

Decision early
Damage control has ↓ liver mortality
Operative management of blunt hepatic trauma

- Major bleeding
  - Pack and resuscitate
  - Damage control laparotomy
  - Consider angiography

Delayed laparotomy:
- Remove packing
- Definitive debridement or resection if indicated
- Assess for associated injuries and liver complications
- Consider omental pack
- Consider drainage if evidence of biliary leak

Angioembolization After Damage Control Laparotomy

- High success rate
- Lowers mortality
- High rate of complications: parenchymal necrosis, bile leak, abscess, and liver failure

The specific subset of patients that would benefit most from hepatic angiography is not well defined.

<table>
<thead>
<tr>
<th></th>
<th>Blunt</th>
<th>Penetrating</th>
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</thead>
<tbody>
<tr>
<td>n</td>
<td>195</td>
<td>333</td>
</tr>
<tr>
<td>36.9%</td>
<td>63.1%</td>
<td></td>
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<tr>
<td>Operative time, min</td>
<td>135 (95-177)</td>
<td>155 (112-206)</td>
</tr>
<tr>
<td>Damage control</td>
<td>66.2%</td>
<td>39.6%</td>
</tr>
<tr>
<td>Packing</td>
<td>71.8%</td>
<td>55.9%</td>
</tr>
<tr>
<td>Bowel/Argon</td>
<td>35.6%</td>
<td>36.0%</td>
</tr>
<tr>
<td>Deep liver suture</td>
<td>32.0%</td>
<td>35.4%</td>
</tr>
<tr>
<td>Formal resection</td>
<td>6.2%</td>
<td>9.9%</td>
</tr>
<tr>
<td>Pringle maneuver</td>
<td>11.3%</td>
<td>8.7%</td>
</tr>
<tr>
<td>Omental packing</td>
<td>3.6%</td>
<td>3.3%</td>
</tr>
<tr>
<td>Closed suction drainage</td>
<td>3.0%</td>
<td>15.9%</td>
</tr>
</tbody>
</table>

The role of computed tomographic scan in ongoing triage of operative hepatic trauma: A Western Trauma Association multicenter retrospective study.
455 patients undergoing immediate exploration for abdominal injury
CT was performed within 24 hours of index operation in 27% of patients
Positive findings on CT were 83.3% sensitive for positive angiography
Absence of hepatic bleeding on CT had a specificity of 83.3% for later negative (or not performed) angiography.

<table>
<thead>
<tr>
<th>TABLE 4. Multivariate Predictors of Mortality</th>
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</thead>
<tbody>
<tr>
<td>Odds Ratio</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>ISS</td>
</tr>
<tr>
<td>Base deficit</td>
</tr>
<tr>
<td>Blunt injury</td>
</tr>
<tr>
<td>ED systolic blood pressure</td>
</tr>
<tr>
<td>Early postoperative contrast CT</td>
</tr>
</tbody>
</table>

CT Blush Hepatic

<table>
<thead>
<tr>
<th>Angiography</th>
<th>Laparotomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>68</td>
<td>4</td>
</tr>
</tbody>
</table>

Angio Blush | Angio No Blush | Embo | No Embo | Rebleed | 11% | 32% | p < 0.05 |
| 46         | 22          | 46   | 22      | 5       | 7   | p < 0.05 |
Retrospective study
- 538 pts with high-grade liver injuries
- 22% (116) underwent angiography
- 71/116 angioembolization
- 30 pts (42%) developed hepatic necrosis

Risk Factors for hepatic necrosis
- Higher grade injury, more blood, longer LOS
- Higher incidence of other liver complications
- More likely to:
  - operation 96.7% vs 41.3%
  - damage control surgery
- ?? Role of perihepatic packing and length of time packs remained

Looked at the 30 pts from last study with HN
- TX: 14 multiple IR/OR procedures
  - 16 hepatic lobectomy
- Outcomes similar but serial debridement group had higher complication rate and increased # procedures
- Concluded: early lobectomy may be better
Retrospective observations study high grade liver injuries, 56/216 underwent resection as either initially or delayed.
- Nonanatomic resections, segmentectomy, lobectomy
- Morbidity 62.5%, 30% secondary liver resection
- Mortality 17.8%, 9% liver related
- Liver resection should be considered as an option for complex liver injuries

Operative management of blunt hepatic trauma

- Pack and resuscitate
- Bleeding uncontrolled
- Pringle Maneuver

OCCLUSION OF THE PORTA HEPATIS
NOTES ON THE ARREST OF HEPATIC HEMORRHAGE DUE TO TRAUMA.

“The hepatic and portal vessels were grasped between fingers and thumb as soon as the abdomen was opened......
.....the method acted admirably, perfect control of the bleeding areas of the liver was obtained.”
Operative management of blunt hepatic trauma

Pack and resuscitate

Bleeding uncontrolled

Pringle Maneuver

Bleeding controlled

Selective vessel ligation

Omental pack

OMENTAL PACK

Pack and resuscitate

Bleeding uncontrolled

Pringle Maneuver

bleeding uncontrolled

Juxtahepatic venous injury
Pack and resuscitate

Bleeding uncontrolled

Juxtahepatic venous injury

Pringle Maneuver

bleeding uncontrolled

Pack and resuscitate

Call for help
Notify blood bank
Discuss with anesthesia

Options for repair of juxtahepatic injuries:

- Direct repair
- Shunt then repair

Both have a high mortality
Best when done at the time of delayed laparotomy
or in a stable patient

Juxtahepatic Venous Injuries: A Critical Review of Reported Management Strategies

Robert F. Buckman, Jr., MD, Reza Miraliakbari, MD, and Michael M. Badellino, MD

J Trauma. 2000 May;48(5):978-84
ATRIOCAVAL SHUNT

Inferior vena cava endograft to control surgically inaccessible hemorrhage

Victor Z. Erzurum, Margo Shoup, Marc Borge, Peter G. Kalman, Heron Rodriguez, Geoffrey M. Silver, Maywood


Reports limited to case reports
Traditional stents grafts cannot be removed
When is it safe to anticoagulate?

Majority of pts managed nonop
Nonop pts develop complications and still need operations
Nonop complications: bleeding and ACS occur early while biliary and infections late
Damage control techniques should be employed when possible for op livers
Call for help with severe bleeding not controlled with packs

Summary of Blunt Liver Trauma