Pancreatic Trauma: Lessons Learned

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• I have no disclosures
Acute grade III pancreatic injury
• Which management strategy do you prefer for this injury?
  - Operative (distal pancreatectomy)
  - Non-operative (observation)
  - ERCP and stent placement
  - Undecided
Serum Lipase Level

Post-injury Day 1: 121

Post-injury Day 2: 5,800
Post-Injury Day 3
Background

• Pancreatic injury in children is relatively rare
• Blunt epigastric force causes the pancreas to fracture, most commonly in the body overlying the spine
# AAST CT Grading Scale for Pancreatic Trauma

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type of Injury</th>
<th>Description of Injury</th>
<th>Treatment Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hematoma</td>
<td>Minor contusion without duct injury</td>
<td>Observation</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Superficial laceration without duct injury</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Hematoma</td>
<td>Major contusion without duct injury or tissue loss</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Major laceration without duct injury or tissue loss</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Laceration</td>
<td>Distal transection or parenchymal injury with duct injury</td>
<td>Observation? Distal Pancreatectomy?</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>Proximal transection or parenchymal injury involving ampulla</td>
<td>Observation vs. Complex Operative Management</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Massive disruption of pancreatic head</td>
<td></td>
</tr>
</tbody>
</table>
Controversy Regarding Management

• Adult recommendations*:
  • Grade III/IV injuries should be managed with resection and drainage as non-operative management leads to morbidity

• Pediatric recommendations: UNCLEAR
  • Lack of high-quality evidence
    • Retrospective
    • Lack of standardization

<table>
<thead>
<tr>
<th>First author, publication year</th>
<th>Number of centers</th>
<th>Number of patients treated with OM</th>
<th>Number of patients treated with NOM</th>
<th>AAST injury grades included</th>
<th>% Pseudocyst</th>
<th>% Fistula</th>
<th>Other complications</th>
<th>Mean/Median hospital length of stay (days)</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mattix et al. 2007</td>
<td>7</td>
<td>23 (13-II)</td>
<td>30 (13-II)</td>
<td>III-IV</td>
<td>OM: 23% (III) NOM: 23% (III)</td>
<td>OM: 23% (III) NOM: 23% (III)</td>
<td>Pancreatitis OM 15%, NOM 23% (III)</td>
<td>OM: 9.7 ± 8.4 NOM: 13.8 ± 10 (III-IV)</td>
<td>No significant differences, failure rate of NOM reported at 26%, but this included early operation cases</td>
</tr>
<tr>
<td>Paul and Mooney 2011</td>
<td>9</td>
<td>20</td>
<td>23</td>
<td>II/III</td>
<td>OM: 15% NOM: 35%</td>
<td>OM: 10% NOM: 0%</td>
<td>Not reported</td>
<td>OM: 16 ± 13.4 NOM: 14.2 ± 12.8</td>
<td>NOM has higher pseudocyst rate (NS), more TPN use, similar LOS (unclear which is better)</td>
</tr>
<tr>
<td>Cuenca and Islam 2012</td>
<td>3</td>
<td>32</td>
<td>47</td>
<td>All grades</td>
<td>OM: 0% NOM: 6.4%</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Not reported</td>
<td>NOM appears to be safe. No analysis of superior strategy</td>
</tr>
</tbody>
</table>
| Beres et al. 2013             | 2                | 15                                | 24                                | III/IV                      | OM: 0% NOM: 54.2%          | OM: 6.7% NOM: 10.8%          | -CVC complication OM 20%, NOM 30%  
-Abcess OM 0%, NOM 9%  
-Leak OM 7%, NOM 0%           | OM: 15.1 ± 8.4 NOM: 27.5 ± 19.8 | NOM has longer hospital stay, TPN use and more complications, only significant one pseudocyst formation (OM is better) |
| Iqbal et al. 2014             | 14               | 57                                | 95                                | II/III                      | OM: 0% NOM: 28.7%          | Not reported                     | Need for repeat intervention OM 2%, NOM 46% | OM: 11.9 ± 7.5 NOM: 13.4 ± 12.7 | NOM has higher pseudocyst formation and interventions and OM has shorter time to initial and goal feeds (OM is better) |
| Mora MC et al. 2015           | Multiple (NTDB review including 76% level I/II trauma centers) | 202 | 194 | AIS score 3 or greater | OM: 1.9% NOM: 8.1% | Not reported                     | -Infection OM 6% vs NOM 2%,  
-Death OM 3% vs NOM 3%  
-1+ complication OM 17% vs NOM 22% | OM: 12.6 (CI 11.4-13.9) NOM: 11.8 (CI 10.6-13.1) | NOM is equal to or better than OM and delayed OM (NOM is better) |
| Englum et al. 2016            | Multiple (NTDB review) | 160 | 514 | All grades | Not reported | Not reported                     | Wound infection OM 10%, NOM 2% | OM: 11 NOM: 7 | Unclear which strategy is better as high-grade injuries were not separately analyzed |
Most Common Reported Outcomes

- % Pseudocyst
- % Fistula
- % Other complications

**VARIABILITY**
- When to feed?
- How to feed?
- How long to observe in hospital?
- Pseudocyst management?
- Role of ERCP?

- Hospital Length of Stay
- ICU Length of Stay
- Use of TPN
- Time to oral feeds
- Number of additional interventions
Practice variability exists in the management of high-grade pediatric pancreatic trauma

Bindi Naik-Mathuria

On behalf of the PTS (Pediatric Trauma Society) Pancreatic Trauma Study Group.

- 19 pediatric trauma centers
- 12/19 (63%) used both approaches
- Lack of standardization in NOM clinical management

21% were laparoscopic

51% OM

49% NOM

Apple

Orange
#GOALS

1. We need to **standardize** NOM management

2. We need a **prospective** trial to compare outcomes of OM vs NOM
Creating a Standard NOM Clinical Pathway

- 20 Pediatric Trauma Centers
- Retrospective study of children ≤ 18
- AAST Grade III-V managed with NOM
- 86 patients
- Median age 9
- 73% grade III, 27% grade IV/V

Pancreatic Enzymes

![Graphs of Amylase and Lipase levels over days](image)
## Are Serial Pancreatic Enzymes Useful?

<table>
<thead>
<tr>
<th></th>
<th>Grade III</th>
<th>Grade IV/V</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amylase at Presentation</td>
<td>399 (n=55)</td>
<td>392 (n=20)</td>
<td>0.95</td>
</tr>
<tr>
<td>(median)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lipase at Presentation</td>
<td>1050 (n=55)</td>
<td>713.5 (n=22)</td>
<td>0.70</td>
</tr>
<tr>
<td>(median)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Amylase (median)</td>
<td>538 (n=23)</td>
<td>1325 (n=7)</td>
<td>0.29</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Lipase (median)</td>
<td>2130 (n=55)</td>
<td>1755 (n=21)</td>
<td>0.65</td>
</tr>
</tbody>
</table>
Feeding Practices

• Diet advancement
  • 46 (66%) advanced diet based on symptom improvement
  • 24 (34%) advanced diet based on symptom improvement + down-trending labs
• Jejunal feeds 31%
• TPN 68%
Feeding Practices

Feeding Management for Grade III (Pancreatic Body Inj)

Feeding Management for Grade IV/V (Pancreatic Head Inj)
Hospital LOS

Hospital LOS for Grades III & IV/V

- Grade III
- Grade IV/V

[Box plot showing distribution of hospital LOS for Grades III & IV/V]
Development of a Standard Clinical Pathway

Peri-Pancreatic Fluid Collection Management

- 42/100 (42%) patients
  - APFC (1-4 wk): 27%
  - Pseudocyst (4 wk): 15%
- 11/42 (27%) needed CG/resection
- Cysts > 7cm had longer recovery

ERCP Use

- ERCP was used at 14/22 (64%) centers
- 20 patients with NOM, 6 with OM

Days from Injury to ERCP

Did ERCP Alter Management or Improve Outcome?

- Evaluation of duct integrity (diagnostic only)
- Stricture
- Fistula control
- Early attempt at duct leak control
- Symptomatic pseudocyst
- Delayed attempt at duct leak control

<table>
<thead>
<tr>
<th></th>
<th>Observation</th>
<th>Interventional ERCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to regular diet</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Days on TPN*</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Length of stay</td>
<td>12</td>
<td>14</td>
</tr>
</tbody>
</table>

- 4/4 (100%) YES
- 3/3 (100%) YES
- 2/3 (67%) YES
- 3/11 (37%) YES
- 0/3 (0%) NO
- 2/2 UNCLEAR if outcome altered
Is MRCP Superior to CT?

Fig. 4 a CT of a child with blunt pancreatic injury. Arrow points to linear hypodensity at site of laceration. b MRCP demonstrating slightly more clear laceration (arrow) and a loculated fluid collection and site of suspected duct injury. c MRCP reconstruction view with more clear demonstration of pancreatic duct with haziness at point of discontinuity (arrow)


MRCP vs CT scan

* p<0.05
Clinical Pathway for NOM of Blunt Pancreatic Injury in Pediatric Patients

1. Radiographic diagnosis of AAST grade III-IV blunt pancreatic injury
2. Obtain baseline amylase/lipase
3. Admission for pain control
   (Avoid routine serial imaging or labs)
4. Initiate oral diet when some improvement in tenderness
   (Not based on labs)
5. Progression/persistence of symptoms or inability to tolerate diet one week after injury?
6. Organized peri-pancreatic fluid collection or amylase/lipase higher than baseline?
   - No
     - Hold diet until symptoms improve (initiate TPN)
   - Yes
     - Hold diet until symptoms improve (initiate TPN) and observe fluid collection
7. Discharge based on resolution of fluid collection or normalization of labs
   (Not based on labs)
8. Consider intervention OR continue observation

“LESS IS MORE”

*Operation may be considered for significant clinical deterioration at any time*

Avoid serial labs
Early oral feeding
Avoid re-imaging until at least one week
Discharge based on symptoms, not labs
Initial observation of pseudocyst

Prospective, Multicenter Trial OM vs NOM

- Observational longitudinal cohort study
- 25 PTS pediatric trauma centers
- Acute grade III injuries
- Surgeon chooses OM vs NOM
- Standard clinical pathways
- Outcomes:
  - Early and delayed complications
  - Return to school
  - Quality of life
  - Readmissions
  - Hospital costs
PRELIMINARY DATA

• 18 patients: 7 OM, 11 NOM

• Avg Time to Oral diet 2.4 days
  • 1 day OM vs 3 days NOM

• Avg Length of Stay 8.8 days
  • 7 days OM vs 10 days NOM
Peripancreatic fluid collection > 7 days after injury

- 2 OM (28%)
- 2 NOM (18%)

1 PT WITH NOM HAD PANCREATIC INSUFFICIENCY 10 MONTHS AFTER INJURY
Guideline for Non-Operative Management of Blunt Pediatric Pancreatic Injuries

**GUIDE DEVELOPMENT**

- Retrospective review of 86 children with grade III/IV pancreatic injury managed non-operatively
- Pancreatic enzymes peaked 2 days after injury then fell. No correlation with outcomes
- Addition of MRCP to CT did not add much value
- ERCP/stent did not lead to faster recovery
- Practice variability in feeding strategy
- Most common complication was organized fluid collection (42%). Observation worked well for most. >7cm longer recovery

**GUIDE**

- Baseline pancreatic enzymes then avoid serial labs
- Initiate early oral diet when tenderness improves
- Avoid re-imaging for symptoms sooner than 1 week if clinically stable
- Observe organized fluid collection (NPO, TPN); drain only if does not resolve or very large
- Discharge based on symptoms, not labs or imaging
- Follow-up imaging only if symptomatic

Naik-Mathuria B et al. J Trauma Acute Care Surg 2017; 83(4):589-596
Rosenfeld EH et al. Pediatr Surg Int 2018; 34(9): 961-966

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