Pediatric Blunt Abdominal Trauma

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Outline

- Epidemiology
- Mechanisms
- Initial Management
- Imaging
- Specific organ injuries:
  - Liver and Spleen
  - Renal
  - Bowel
  - Pancreas
- Follow up
- Role of minimally invasive surgery
Epidemiology:

- 1.5 million children/year involved in trauma
- 500,000 hospitalizations/year
- 20,000 deaths/year
- Blunt abdominal trauma 30% more common than thoracic trauma but 40% less fatal
- 8-12% of children with blunt abdominal trauma will have intra-abdominal injuries
- Only 5-10% of these require surgery
- Mortality 10%
Mechanism:

- MVC without proper restraints: commonest
- Seat belt injuries:
  - Lap belt
  - Triad of abdominal wall contusion, Chance fracture & intestinal injuries
- Automobile versus pedestrian
- Falls
- ATV
- Handlebar injuries: bowel & pancreatic injuries
- Sports related (1%) 
- Run over
Initial Evaluation

- LR or NS bolus at 20 cc/kg x2 if HD unstable
- Packed RBCS at 10 cc/kg if HD unstable
- Relevant History (if possible):
  - Mononucleosis
  - Bleeding tendency
  - Developmental delay (CP, autism, etc...)
- Physical Examination:
  - ABCDE
  - Broselow tape
  - Commonest cause of abdominal distension & tenderness is gastric distension with air
  - Second most common cause is a full bladder
Initial Evaluation

- **Physical Examination:**
  - Localized tenderness most predictive of IAI
  - Abdominal wall bruises/echymosis highly suggestive
  - Additional findings that help predict IAI:
    - Femur fracture (OR 1.3)
    - Low systolic BP (OR 4.8)
    - GCS < 13 (OR 1.7)
- **Challenges:**
  - The preverbal child
  - The mentally challenged child
  - Children with head injury
Lab studies:

- Type & cross
- Hemogram, LFTs and UA most useful
- Should not alter management but guide further studies
- CBC:
  - Useful for f/u of solid organ injury
  - Do not use to guide further imaging
- ALT & AST:
  - Elevation is highly suggestive of liver injury
  - If elevated & exam equivocal get a CT
- UA: (>5-50 RBCs/hpf)
  - Controversial
  - If +ve with an equivocal exam get a CT
- Coags: Only in those with head injury
Imaging:

- **Plain films:**
  - Lateral C spine, CXR & pelvis
- **CT abd/pelvis:**
  - Most accurate, noninvasive
  - IV contrast a must
  - Obtain CT head 1st before contrast injection
  - Not indicated if HD unstable
  - Grades injury severity but does not correlate with outcome
- **Contraversies:**
  - Contrast blush with solid organ injury
  - Free fluid with no evidence of solid organ injury
- **US: (FAST)**
  - Not well studied in the pediatric population
  - May have a role in HD unstable patients
Adjuncts:

- **DPL:**
  - May be useful to exclude bowel injury
  - Largely replaced by CT & diagnostic laparoscopy

- **Laparoscopy:**
  - Diagnostic & therapeutic
  - Results in 53% reduction in Ex Laps (University of TN)
  - Exclude serious head injury before OR
Liver & Spleen injury:

- Liver is the most common followed by spleen
- Hepatic injuries cause greatest number of fatalities (25% mortality)
- Associated abdominal injuries in 30-40%
- Liver injuries commonly involve right lobe (60-80%) and 10% of patients will arrive in shock
- Splenic injury often HD stable with less transfusion requirements
- Overwhelming postsplenectomy sepsis (OPSS):
  - Lifetime risk 0.026%
  - Mortality 50%
  - Pneumococcal, meningococcal & H influenza vaccination + Penicillin for at least 2 years
Liver & Spleen injury:

<table>
<thead>
<tr>
<th>Grade*</th>
<th>Description</th>
<th>AIS-90</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hematoma Subcapsular, &lt;10% surface area</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Laceration Capsular tear, &lt;1 cm parenchymal depth</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma Subcapsular, 10-50% surface area</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Intraparenchymal, &lt;10 cm in diameter</td>
<td>2</td>
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<tr>
<td></td>
<td>Laceration Capsular tear, 1-3 cm parenchymal depth, &lt;10 cm length</td>
<td>2</td>
</tr>
<tr>
<td>III</td>
<td>Hematoma Subcapsular, &gt;50% surface area or expanding</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Ruptured subcapsular or parenchymal hematoma</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Intraparenchymal hematoma &gt;10 cm or expanding</td>
<td>3</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration &gt;3 cm parenchymal depth</td>
<td>3</td>
</tr>
<tr>
<td>V</td>
<td>Laceration Parenchymal disruption involving &gt;75% of hepatic lobe or 1-3 Couinaud’s segments within a single lobe</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Vascular Juxtahepatic venous injuries; i.e., retrohepatic vena cava/central major hepatic veins</td>
<td>5</td>
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<tr>
<td></td>
<td>Vascular Hepatic avulsion</td>
<td>6</td>
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</tbody>
</table>

* Advance one grade for multiple injuries up to grade III
Liver & Spleen injury:

### Spleen Injury Scale

<table>
<thead>
<tr>
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<td>Capsular tear, &lt;1 cm parenchymal depth</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma</td>
<td>Subcapsular, 10-50% surface area</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intraparenchymal, &lt;5 cm in diameter</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Capsular tear, 1-3 cm parenchymal depth which does not involve a trabecular vessel</td>
<td>2</td>
</tr>
<tr>
<td>III</td>
<td>Hematoma</td>
<td>Subcapsular, &gt;50% surface area or expanding</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ruptured subcapsular or parenchymal hematoma</td>
<td>3</td>
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<td>Intraparenchymal hematoma &gt;5 cm or expanding</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>&gt;3 cm parenchymal depth or involving trabecular vessels</td>
<td>3</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>Laceration involving segmental or hilar vessels producing major devascularization (&gt;25% of spleen)</td>
<td>4</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Completely shattered spleen</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Vascular</td>
<td>Hilar vascular injury which devascularizes spleen</td>
<td>5</td>
</tr>
</tbody>
</table>

* Advance one grade for multiple injuries up to grade III
Liver & Spleen Management:

- Paradigm shift to non-operative management
- First reported by Simpson et al from Toronto in 1968. Twelve patients with clinical diagnosis of solid organ injury (NO CT or US)
- Hemodynamic stability is the sole determinant of management:
  - No role for age
  - No role for CT grading
  - No role for contrast blush
  - Even if intestinal injury suspected
Prospective Results of a Standardized Algorithm Based on Hemodynamic Status for Managing Pediatric Solid Organ Injury

John R Mehall, MD, Jared S Ennis, BS, Daniel A Saltzman, MD, PhD, John C Chandler, MD, Harsh Grewal, MD, Charles W Wagner, MD, Richard J Jackson, MD, Samuel D Smith, MD, FACS

**BACKGROUND:** Controversy surrounds the need for ICU admission, prolonged bed rest, and the duration of activity restrictions for children sustaining blunt trauma. Adult literature supports management based on hemodynamic status, not CT grade.

**STUDY DESIGN:** A 3-year prospective study of a standardized management algorithm for hemodynamically normal pediatric patients with blunt liver or spleen injury was performed. Patient selection was based on vital signs, irrespective of injury grade on CT. Patients requiring ICU admission for nonliver or nonspleen injury were excluded. Patients were admitted to a surgical ward with serial hematocrit levels. Discharge occurred 48 hours postinjury if patients had no abdominal tenderness, tolerated a regular diet, and had a stable hematocrit. Patients were allowed noncontact activity, including school, after discharge. Patients were followed up at 1 month with ultrasonographic imaging.

**RESULTS:** Eighty-nine patients sustained blunt liver or spleen injury. Forty-five patients were excluded for other injuries (Glasgow Coma Scale < 13, 32 of 45); the remaining 44 patients had a mean age of 8.9 years (range 2 to 17 years), Injury Severity Score 10.6 (range 4 to 33), liver grade 2.1, and splenic injury grade 2.3. Mechanisms of injury were predominately motor vehicle collisions (59%). All patients were managed nonoperatively without transfusion; 43 of 44 patients completed the algorithm. Mean observation was 55.2 ± 12.3 hours. One-month followup occurred in 33 of 44 patients, with one complication detected and no delayed bleeding.

**CONCLUSIONS:** Management of pediatric solid organ injury should be guided by hemodynamic status and not injury grade on CT. Hemodynamically normal children can be safely managed without intensive care monitoring, do not need prolonged hospitalization, and can resume school on discharge. (J Am Coll Surg 2001;193:347–353. © 2001 by the American College of Surgeons)
Outcomes from pediatric solid organ injury: role of standardized care guidelines
Steven Stylianos

Purpose of review
Recent advances in the delivery of trauma and critical care in children have resulted in improved outcome following major injuries. It is imperative that physicians who treat injured children familiarize themselves with current treatment algorithms for abdominal trauma. Important contributions have been made in the diagnosis and treatment of children with abdominal injury by radiologists and endoscopists.

Recent findings
This report examines the impact of consensus guidelines in the treatment of blunt abdominal solid organ injuries. Consensus guidelines for treatment of children with isolated spleen and liver injury are reviewed demonstrating conformity of care and significant reduction of resource utilization without adverse sequelae. Review of large datasets indicate contrasting rates of splenectomy depending on the expertise of the institution, emphasizing the need for wide dissemination of guidelines.

Summary
Clinical experience and published reports addressing specific concerns about the nonoperative treatment of children with solid organ injuries and recent radiologic and endoscopic contributions have made pediatric trauma care increasingly nonoperative. Although the trend is in this direction, the pediatric surgeon should remain the physician-of-record in the multidisciplinary care of critically injured children.
Liver & Spleen Management:

- **Success 90-95%**
- **Major concern is delayed Dx of intestinal injury:**
  - Occurs in only 2-3.6% of cases with solid organ injury
  - No added morbidity or mortality with delayed diagnosis
  - No justification for laparotomy to exclude it
- **Other concerns:**
  - Postraumatic pseudoaneurysms: very low incidence
  - Postraumatic biloma: Can be percutaneously drained
  - Contrast blush on CT: may be associated with increased transfusion requirements but does not alter management
- **Angiographic embolization not well studied and not recommended in pediatric patients**
- **Nonoperative management more likely used in pediatric trauma centers**
Pediatric Splenic Injuries With a Contrast Blush: Successful Nonoperative Management Without Angiography and Embolization

By David R. Cloutier, Todd B. Baird, Paula Gormley, Kathleen M. McCarten, J. Gibson Bussey, and Francois I. Luks
Providence, Rhode Island

Background: The presence of a contrast blush on computed tomography (CT) in adult splenic trauma is a risk factor for failure of nonoperative management. Arterial embolization is believed to reduce this failure rate. The significance of a blush in pediatric trauma is unknown. The authors evaluated the outcome of children with blunt splenic trauma and contrast extravasation.

Methods: The trauma registry was queried for all pediatric patients with blunt splenic injuries. Admission CT was reviewed for injury grade and presence of an arterial blush by a radiologist blinded to patient outcome. Hospital and office charts were reviewed for success of nonoperative management, late splenic rupture, and other complications.

Results: One hundred seven children with blunt splenic trauma were identified over a 6-year period. Mean injury grade was 2.9. Six patients required emergency splenectomy. An additional 7 patients met hemodynamic criteria for surgical intervention (3 splenectomies, 4 splenorrhaphies). Admission CT was available in 63 patients. An arterial blush was identified in 5 (9.7%). Four remained stable and were treated conservatively. One underwent splenectomy for hemodynamic instability. There were no cases of delayed splenic rupture, failed nonoperative treatment, or long-term complications.

Conclusions: Contrast blush in children with blunt splenic trauma is rare, and its presence alone does not appear to predict delayed rupture or failure of nonoperative treatment. Based on this limited series, splenic artery embolization does not have a place in the management of splenic injuries in children.

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Significance of ‘Blush’ on Computed Tomography Scan in Children With Liver Injury

By James W. Eubanks III, Donald E. Meier, Barry A. Hicks, Jeanne Joglar, and Philip C. Guzzetta
Dallas, Texas

Background/Purpose: The aim of this study was to determine if the presence of “blush” (an indication of active bleeding) on abdominal CT in children with blunt liver injury adversely affected their clinical outcome as has been reported in adults.

Methods: The authors reviewed the records of 165 children ages 1 to 16 years with blunt liver injury seen on admission IV contrast CT seen over a 6-year period. Demographic characteristics measured were age, mechanism of injury, and injury severity score (ISS). Clinical outcomes included ICU stay, hospital length of stay (LOS), transfusion requirement (milliliters per kilogram), operations performed, and mortality rate. CT scans were evaluated retrospectively by a radiologist blinded to prior reports, for a “blush” and grade of liver injury. No patient underwent arterial embolization. The authors eliminated children with grade I-II injuries (30 patients), because only one had a blush, and analyzed the 75 patients with severe liver injuries (grades III-VI). Those patients without a blush (n = 53) seen on CT were the control group, whereas patients with a blush (n = 22) were the study group. Data were analyzed using the Fisher’s Exact and Mann-Whitney U test. The level of significance was set at .05.

Results: Patients with a blush had a significantly larger transfusion requirement (17.3 ± 30.5 mL/kg vs 5.0 ± 10.9 mL/kg; P = .02) and mortality rate (23% vs 4%; P = .02), but the ISS also was significantly greater (25.8 ± 14.6 vs 17.5 ± 12.2; P = .019). All other data were similar between the 2 groups.

Conclusions: Children with a blush seen on abdominal CT after blunt liver injury have higher transfusion requirements and greater risk of mortality than those without blush. Mortality is primarily related to the severity of their other injuries.

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INDEX WORDS: Blunt liver injury, computed tomography, contrast extravasation, embolization, arteriogram.
Liver & Spleen Management:

• In case of HD instability despite fluids & blood:
  • Splenic injury: Attempt splenic preservation unless spleen massively injured, associated abdominal injuries & HD instability
  • Hepatic injury:
    • Use compression, suture & topical hemostatics
    • For exanguinating injuries (mortality 60-80%):
      • Total hepatic vascular exclusion x 30 min
      • Avoid lethal triad: pH<7.2, PT > 16 sec & temp < 35 c
      • Early application of damage control: Control Hge & soiling, pack and temporary closure. Survival 60% for Grade 4 & 5-25% in Grade 5
- IH, 12 yo, slightly obese
- Fell face down in playground. Rt wrist and left shoulder pain
- Presented to PCP, X ray right wrist shows non-displaced distal radial frx
- Abdominal exam benign in office, patient sent home
- Abdominal pain and left shoulder pain just outside the office urged mom to ask for a CT of the abdomen
- Patient sent to ED for CT
- HD stable
- Hct 42----35----35----36.8----35.8
JW, 10 yo
- Riding bike, lost control with handlebar injury to Lt UQ
- Walked home, one episode of vomiting & some abdominal pain
- Presented to Urgent care. Exam benign & sent home
- More pain in AM. Family took him to ED
- CT obtained
- HD stable
- Hct 40.8----34.5----31----33.5----32.6----30.9----37.9
Renal injury:

- Commonest injured genitourinary organ
- In 10% of patients with blunt abdominal trauma
- Children more susceptible, particularly in the presence of underlying congenital renal anomalies

### Kidney Injury Scale

<table>
<thead>
<tr>
<th>Grade*</th>
<th>Description</th>
<th>AIS-90</th>
</tr>
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<tbody>
<tr>
<td>I</td>
<td>Contusion Microscopic or gross hematuria</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Hematoma Subcapsular, nonexpanding without parenchymal laceration</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma Nonexpanding perirenal hematoma confined to renal retroperitoneum</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Laceration &lt;1 cm parenchymal depth of renal cortex without urinary extravasation</td>
<td>2</td>
</tr>
<tr>
<td>III</td>
<td>Laceration &lt;1 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravasation</td>
<td>3</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration Parenchymal laceration extending through the renal cortex, medulla, and collecting system</td>
<td>4</td>
</tr>
<tr>
<td>V</td>
<td>Vascular Main renal artery or vein injury with contained hemorrhage</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Laceration Completely shattered kidney</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Vascular Avulsion of renal hilum which devascularizes kidney</td>
<td>5</td>
</tr>
</tbody>
</table>

* Advance one grade for multiple injuries up to grade III
Renal injury:

- Hematuria is the most reliable indicator of injury
  - Can be absent in complete avulsion or thrombosis
  - Microscopic hematuria < 50/HPF usually not associated with serious injury
  - Microscopic hematuria > 50/HPF associated with serious renal injury 8%
  - Gross hematuria associated with serious injury 32% of the time
- CT scan with IV contrast most useful
Renal injury:

- Only 5% will need surgery
- Management of Grade I-III mostly conservative:
  - Bed rest, abx & serial Hct till gross hematuria resolves
  - Limited activity for 2-4 w till no hematuria
  - Urinary extravasation treated by perc drainage & stenting
- Management of Grade IV-V (10-15%) controversial:
  - Angio with embolization for persistent hematuria
  - Extravasation treated by perc drainage & stenting
  - Incidence of hypertension very low
Blunt Renal Injuries in Children Can Be Managed Nonoperatively: Outcome in a Consecutive Series of Patients

Michael L. Nance, MD, Nicolas Lutz, MD, Michael C. Carr, MD, PhD, Douglas A. Canning, MD, and Perry W. Stafford, MD

Background: Nonoperative management of radiographically defined solid organ injuries has proven highly successful in children with blunt splenic and hepatic injuries. The role of nonoperative management protocols is less well defined for blunt renal injuries. The purpose of this study was to review the management and outcome of a consecutive series of children with blunt renal injury.

Methods: The trauma registry from a Level I pediatric trauma center was reviewed to identify all children (age < 19 years) who were treated for a blunt renal injury for the period January 1995 through December 2002. Demographic, anatomic, physiologic, management, and outcome data were analyzed.

Results: For the 8 years of review, 101 children with a blunt renal injury were identified, including 95 with accessible and complete data. The renal injury population had a mean age of 10.4 years (range, 0.5–18 years) and was 72.6% male. The renal injuries were distributed as follows: grade 1, n = 22; grade 2, n = 40; grade 3, n = 20; grade 4, n = 11; and grade 5, n = 2. Hematuria was present in 88.1% of children (in whom urinalysis results were available). Four children had underlying congenital renal anomalies. The mean hospital length of stay and intensive care unit stay were 6.0 and 2.6 days, respectively. Overall, 5 children (5.3%) required laparotomy, including 1 nephrectomy (isolated grade 4 injury) and 1 renorrhaphy, for an overall renal salvage rate of 98.9%. In children with isolated renal injuries (n = 48), one child (2.1%) required laparotomy. Seven children required adjunctive urologic procedures (ureteral stenting, n = 5; cystoscopy/cystogram, n = 2). There were seven deaths (7.4% overall; five because of head injury and two because of severe abdominal bleeding at presentation).

Conclusion: A nonoperative management strategy was advantageous and successful in pediatric blunt renal injuries (94.7% successful nonoperative rate, 98.9% renal salvage rate). Adjunctive urologic procedures (e.g., ureteral stenting) were beneficial in selected cases.

Key Words: Nonoperative management, Blunt renal injuries, Pediatric.
Pancreatic injury:

- Rare (3-10%)
- Suspect in cases of handle bar injuries
- Elevated Amylase highly suggestive but cannot exclude if normal
- Early spiral CT with IV contrast essential

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<tbody>
<tr>
<td>I</td>
<td>Hematoma Minor contusion without duct injury</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Laceration Superficial laceration without duct injury</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma Major contusion without duct injury or tissue loss</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Laceration Major laceration without duct injury or tissue loss</td>
<td>3</td>
</tr>
<tr>
<td>III</td>
<td>Laceration Distal transection or parenchymal / duct injury</td>
<td>3</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration Proximal transection or parenchymal injury involving ampulla</td>
<td>4</td>
</tr>
<tr>
<td>V</td>
<td>Laceration Massive disruption of pancreatic head</td>
<td>5</td>
</tr>
</tbody>
</table>

* Advance one grade for multiple injuries up to grade III
Pancreatic injury:

- Management controversial:
  - Aggressive intervention with early ERCP & surgery (San Diego)
  - Non-operative management even with complete duct disruption & percutaneous drainage of pseudocyst if develops (Toronto)
  - Conservative management is warranted in most cases
  - Pseudocyst may develop in up to 60% but can be managed conservatively
  - Ductal disruption to the left of the spine best managed by early splenic preserving distal pancreatectomy
CM, 9 yo

Vomiting and diffuse abd pain x 1 day. No fevers

Presented to ED. WBCs 20.7K and Abd US shows slightly enlarged appendix and free fluid around

Diagnosis of appendicitis possibly ruptured made & child admitted to hospital for surgery

Exam shows tenderness in epigastrium and none in RT LQ

CT obtained
- Amylase 2083 and Lipase 1365
- NPO, one dose of Zosyn (for appendicitis) & PICC for TPN
- Amylase 1259 in 24 h
- Amylase 237 on day 3, started PO
- Discharged day 5 tolerating low fat diet with Amylase 201
Intestinal injury:

- 2-3% of patients with blunt abdominal trauma
- Common with the “seat belt complex”:
  - 10-15% have intestinal injuries
  - CT scan mandatory
  - Admission for at least 24 hours observation
- Perforation, hematoma or mesenteric tear with bleeding
- CT not sensitive unless shows pneumoperitoneum
Intestinal injury:

- More common with seat belt injuries, pancreatic injuries & multiple solid organ injuries
- Suspect if:
  - Free fluid with no solid organ injury
  - Localized bowel wall thickening
- Delayed diagnosis common but does not increase morbidity
- Maintain a high index of suspicion and if in doubt perform diagnostic laparoscopy
Predicting Hollow Visceral Injury in the Pediatric Blunt Trauma Patient With Solid Visceral Injury

By Michael L. Nance, Martin S. Keller, and Perry W. Stafford
Philadelphia, Pennsylvania

Background: Nonoperative management of a solid organ injury (SVI) is accepted in the stable pediatric trauma patient. A concern with nonoperative management is missing a hollow visceral injury (HVI). Factors that may help predict HVI have not been well documented.

Methods: The National Pediatric Trauma Registry was reviewed for the period October 1988 through September 1998 for all blunt injured, hemodynamically stable pediatric patients (age ≤ 12 years) with an SVI (kidney, liver, pancreas, spleen) of Abbreviated Injury Scale (AIS) score ≥ 2. HVIs included AIS ≥ 2 gastrointestinal tract injuries.

Results: For the decade of review, 2,977 pediatric patients sustained an SVI, including 96 with an HVI (3.2%). The mean age was 6.6 years, with a mean Injury Severity Score of 12.4. An occupant in a motor vehicle accident was the most common injury mechanism (30.4%), but assault was the most likely to result in an HVI (11.5%). The liver was the most common SVI (n = 1,400), the spleen the least likely to have an associated HVI (2.5%). Pancreatic injuries had a higher rate of HVI (P < .001). The majority of patients had a single SVI (n = 2,507) with 71 associated HVIs (2.8%). The risk of associated HVI increased as the number of solid organs injured increased: 4.7% with 2 organs, 13.5% if 3 organs were injured (P < .001). In patients with a single SVI, the rate of HVI did not differ as AIS increased (range, 2.7% to 6.5%, P value not significant).

Conclusions: The overall rate of HVI was low (3.2%). Higher rates of HVI were found in assaulted patients and patients with multiple SVIs or pancreatic injuries. The risk of associated HVI was dependent more on number of SVIs than severity of the individual organ injury. This data suggest that nonoperative management is justified in the patient with a single SVI but should be used cautiously in the patient with multiple SVI or a pancreatic injury.


INDEX WORDS: Blunt trauma, abdominal injury, small bowel injury.
Thank You