



Hide & Seek: Occult Injuries In Children



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The Hiding Places of Pediatric Injury



Occult injuries in children occur in all body regions – making early detection very difficult:

- Head & Neck
- Thoracic Cavity
- Abdominal Cavity
- Upper & Lower Extremities



Tools to Master the Search



- Consider Age/Weight of Child
- Identify Restraint Used
- Identify Direction of Impact
- *Predict Injury Pattern to Identify Most Probable Hiding Place*

Occult Injury Prevention



Case Example A

- ◆ 9-Year Female, 66 pounds
- ◆ 3-Point Seatbelt - Shoulder Belt Under Arm
- ◆ Front Passenger of 1994 Pontiac Sunbird
- ◆ Frontal Impact - Moderate Speed



Think Seatbelt Syndrome !



Case A. Crash Information



- ◆ V1: 94 Pontiac Sunbird
- ◆ V2: 94 Pontiac Sunbird
- ◆ Frontal Impact
- ◆ Delta V - 21 MPH
- ◆ Max Crush - 18.5 in

* Both vehicles were the exact same make/model.



Case A. ED Presentation



- ◆ Transported to local hospital
- ◆ Abdominal Tenderness / “Coffee-Ground” Emesis
- ◆ Abdominal CT Negative / Admitted for Observation
- ◆ Worsening Abdominal Pain on **Day 2**
- ◆ Repeat CT - Free Fluid in Abdomen
- ◆ Exploratory Laparotomy Performed Day 2 - Jejunal Perforation
- ◆ Transferred to CNMC on Day 3 for complications



Case A. Radiology



Bowel thickening should be a red flag and should make any radiologist **VERY** suspicious of internal bowel injury. Recommend laparotomy to the surgeon. Insist on additional scans to better confirm possible occult injury.

Case A. Important Clues

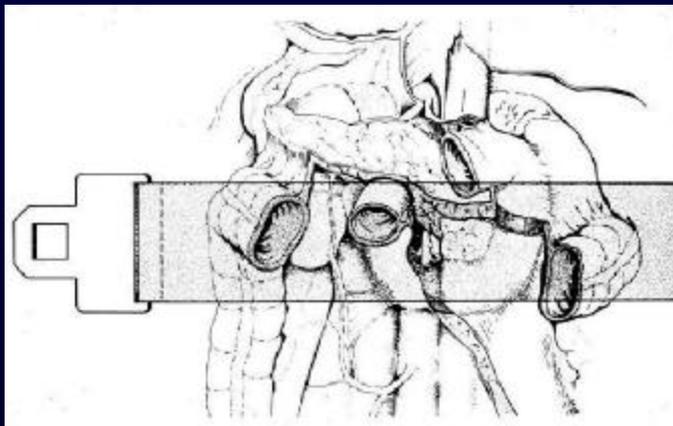


Abdominal Contusion

- ◆ Clue #1: Abdominal Ecchymosis!
- ◆ Clue #2: Child in Seatbelt
- ◆ Clue #3: Frontal Impact
- ◆ Clue #4: Clinical Symptoms



**Intensive Search for Intra-abdominal
Injuries / Early Exploratory
Laparotomy**





Case Example B



- ◆ 5-Year Male, 44 pounds, 41 inches
- ◆ 3-Point Seatbelt
- ◆ Right Rear Passenger Third Row
- ◆ 1992 Chevrolet Lumina Minivan
- ◆ Right Side Impact Collision



Think Side Impact Syndrome !



Case B. Crash Information



- ◆ V1: 92 Lumina Minivan
- ◆ V2: 91 Isuzu Rodeo
- ◆ Right Side Impact
- ◆ Delta V - 13.5 MPH
- ◆ Max Crush - 13.1 in
- ◆ PDOF - 85 degrees



Case B. ED Presentation



- ◆ Flown to CNMC. GCS 15.
- ◆ Clavicle deformity (AC separation).
- ◆ Minor facial abrasions.
- ◆ All other initial radiological images normal.
- ◆ Admitted to ICU w/ c-spine collar in place.



Case B. Radiology

- ◆ Normal Initial C-Spine Radiograph
- ◆ Horner's / Brown Sequard Syndrome on Day 2:
 - Pain sensation on right
 - Sensation w/ left hemiparesis



Case B. Complications



- ◆ Persistent Neck Pain
- ◆ Additional Radiology Revealed C2-C3 Subluxation
- ◆ Placed in Halo Traction
- ◆ Halo Removed 6-Months Post-Crash
- ◆ Outcome: Brown-Sequard, Horner's Syndrome

Case B. Important Clues



- ◆ Clue #1 - Small Child in Seatbelt
- ◆ Clue #2 - Side Impact Collision
- ◆ Clue #3 - C-Spine Tenderness



Detailed Search for C-Spine Injury
Obtain Additional Radiological
Images



Side Impact Syndrome



This table illustrates the increased odds of sustaining injury to the head, chest, and cervical spine for children in side impact crashes compared to frontal crashes

	Odds Ratio	95% CI	P-value
AIS2+	2.5	1.1, 5.5	.020
AIS3+	2.3	1.3, 4.0	.006
AIS4+	2.8	1.4, 5.2	.002
AIS5+	2.7	1.1, 6.2	.020
AIS2+ Head	2.5	1.4, 4.4	.003
AIS3+ Head	2.8	1.5, 5.3	.001
AIS4+ Head	3.4	1.6, 7.0	.001
AIS2+ Chest	4.0	2.0, 8.0	.000
AIS3+ Chest	4.8	2.3, 9.9	.000
AIS4+ Chest	4.3	1.5, 12.6	.008
AIS2+ Cervical	3.7	1.2, 11.3	.018
GCS <9	4.9	2.2, 10.6	.000
ISS > 15	3.1	1.7, 5.8	.000

Case Example C



- ◆ 1-Year Male, 22 pounds, 27 inches
- ◆ Forward-Facing Car Seat
- ◆ Anchored with 3-Point Seatbelt
- ◆ No Locking Clip Used as Required.
- ◆ Right Rear Passenger 1992 Ford Escort
- ◆ Frontal Collision
- ◆ Child Fatality in Front Seat



Think Trauma Criteria!



Case C. Mechanism of Injury



Crash demonstration of
car seat with multiple
misuses (foreground)
including:

- Loose safety belt
- Loose & incorrectly
routed harness straps
- Low harness clip

compared to car seat
used correctly (background).



Case C. Crash Information



- ◆ V1: 92 Ford Escort Wagon
- ◆ V2: 89 Honda Civic
- ◆ Frontal Impact
- ◆ Delta V - 39 MPH
- ◆ Max Crush - 31.1 in
- ◆ PDOF - 40 degrees



Case C. ED Presentation



- ◆ Transported as Priority 3 Patient to Local Hospital
- ◆ Blood in Nares. Contusion of Mid-Occiput
- ◆ Head CT Negative
- ◆ *No C-Spine Films Obtained*
- ◆ Discharged from ER
- ◆ Day 4 - Persistent Neck Pain/Refusal to Ambulate. Referred to CNMC by Pediatrician
- ◆ Radiology revealed ***Cervical Spine Injury***
- ◆ Admitted to CNMC. Placed in Minerva Jacket
- ◆ 3-months post-crash cervical spine was stable



Case C. Important Clues



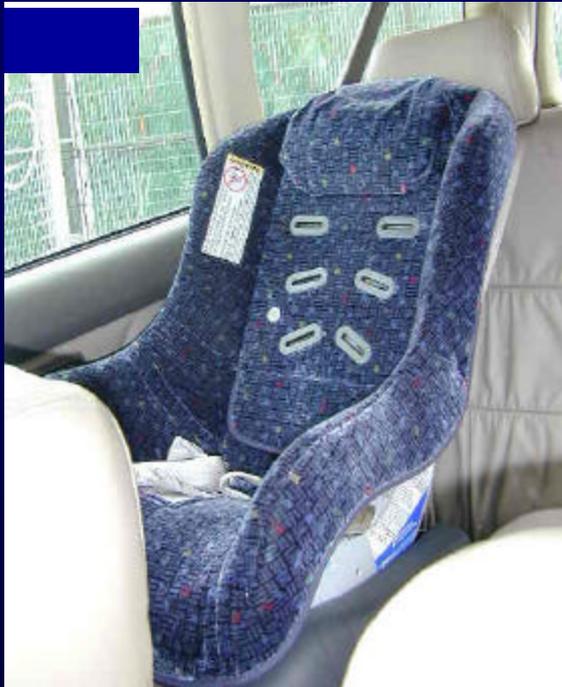
- ◆ Clue #1: Small Child in FFCSS
- ◆ Clue #2: Severe Frontal Collision
- ◆ Clue #3: Forehead Contusion**
- ◆ Clue #4 - Fatality in Case Vehicle

**Indicative of Head Contact w/ Interior Vehicle



Recognition of Trauma Patient -Transport to Appropriate Facility (Detailed Focus on Head/C-Spine)

Case Example D



- ◆ 2-Year Female, 30 pounds
- ◆ Forward-Facing Car Seat (5-pt harness)
- ◆ Anchored w/ 3-Point Belt in ALR mode
- ◆ Top Tether Used Correctly
- ◆ Right Rear Passenger 2000 Subaru Outback
- ◆ Frontal Collision - High Speed



Think Persistent Clinical Symptoms =
Possible Occult Injury



Case D. Crash Information



- ◆ V1: 2000 Subaru Outback
- ◆ Frontal Impact
- ◆ Delta V - 32 MPH
- ◆ Max Crush - 33 in
- ◆ PDOF - 10 degrees



Case D. ED Presentation



- ◆ Transported to Trauma Center
- ◆ Bilateral Shoulder Abrasions
- ◆ Discharged Day 2 w/ Persistent Neck Pain & Refusal to Keep Neck Straight
- ◆ Returned to ER Post-Crash Day 9
- ◆ Flexion-Extension Films



Shoulder contusions



- ◆ Clue #1: Small Child in FFCSS.
- ◆ Clue #2: High Speed Frontal Crash.
- ◆ Clue #3: Cervical Pain/Head Tilting
- ◆ Clue #4: Initial Films = Possible Injury



Perform More Detailed Radiological C-Spine Imaging Studies

Case Example E



- ◆ 2-Year Male, 26 pounds, 34 inches
- ◆ Forward-Facing Car Seat
- ◆ Harness in Lower Slots - Incorrect
- ◆ Anchored w/ 3-Point Belt
- ◆ Belt Not in ALR / No Locking Clip
- ◆ Left Rear Passenger 1992 Nissan Sentra
- ◆ Frontal Collision



Think Persistence of Clinical Symptoms =
Possible Occult Injury



Case E. Crash Information



- ◆ V1: 92 Nissan Sentra
- ◆ Frontal Impact
- ◆ Delta V - 23 MPH
- ◆ Max Crush - 14.6 in
- ◆ PDOF - 340 degrees



Case E. ED Presentation



- ◆ Transported to CNMC
- ◆ Forehead Contusion
- ◆ Drowsiness
- ◆ Admitted for Observation
- ◆ Refusal to Bear Weight Left Leg
- ◆ Negative Radiological Images
- ◆ Discharged Home Day 3



Case E. Radiology



- ◆ Outpatient Visit Day 8
- ◆ Favored Right Leg
- ◆ Repeat X-Ray
- ◆ Leg Casted
- ◆ Discharged Home



Case E. Important Clues



- ◆ Clue #1: Young Child in FFCSS.
- ◆ Clue #2: High Speed Frontal Crash.
- ◆ Clue #3: Persistence of Clinical Symptoms of Lower Extremity Injury



Perform More Detailed Radiological Imaging Studies



Case Example F



- ◆ 14-Year Female, 134 pounds
- ◆ 2-Point Automatic Shoulder Belt Only
- ◆ No Lap Belt Used
- ◆ Front Passenger 1992 Saturn 4-Door
- ◆ High Speed Frontal Collision



Think Injury Pattern - Automatic Shoulder
Belt Only

Case F. Crash Information



- ◆ V1: 92 Saturn 4-Door
- ◆ V2: 93 Ford Ranger
- ◆ Frontal Impact
- ◆ Delta V - 49 MPH
- ◆ Max Crush - 35.8 in
- ◆ PDOF - 20 degrees



Case F. ED Presentation



- ◆ Arrived at CNMC GCS 15
- ◆ Rigid abdomen
- ◆ Leg Pain w/ Absent Distal Pulses
- ◆ Vitals Stable
- ◆ Radiology Revealed:
 - Rib Fractures
 - Femur Fracture
 - Tibia Fracture
 - **Hangman's Fracture**



Case F. Radiology



C2 Hangman's Fracture
C2-C3 Instability

C2-C3 Anterior Fusion &
Instrumentation (Day 11)

C1-C3 Posterior Fusion &
Instrumentation (Day 15)



Case F. Complications



- ◆ Hospital Day 20:
 - Decreased Pulse Oxygen to 82%
 - Coughing Up Green Mucus. GCS decrease to 12
 - Aphasic with Hemiparesis
- ◆ Sent to MRI
 - Left Carotid Artery Dissection / MCA Infarction
- ◆ Sent Back to Intensive Care
- ◆ Discharged to Rehabilitation Facility



Case F. Radiology



- Left Internal Carotid Artery Dissection
- Resultant Left Cerebral Middle Artery Infarction

- Outcome - Hemi paresis, Aphasia



Case F. Important Clues



- ◆ Clue #1: Automatic Shoulder Belt Only
- ◆ Clue #2: Severe Frontal Crash
- ◆ Clue #3: Throat Laceration /Confirmed Cervical Spine Injury



Confirmation of “Hanging Mechanism” &
Confirmed C-Spine Injury = Automatic Search for
CA Dissection

Case Example G



- ◆ 14-Month Female, 33 pounds
- ◆ FFCSS Anchored w/ Lap Belt
- ◆ Center Rear Passenger
- ◆ 1998 Dodge Neon
- ◆ High Speed Right Side Impact with 1986 Mazda RX7. Neon rotated counterclockwise 180 degrees before coming to rest



Think Side Impact Syndrome

Case G. Crash Information



- ◆ 1998 Dodge Neon
- ◆ Right Side Impact
- ◆ Max Crush: 14.6 in
- ◆ Delta V: 18 MPH
- ◆ PDOF: +030



Case G. ED Presentation



- ◆ CPR Initiated On Scene
- ◆ Transported to Closest Hospital
- ◆ Temporarily Resuscitated & Flown to CNMC
- ◆ Placed on Mechanical Ventilation
- ◆ Day 4 - Declared Brain Dead / Organs Donated
- ◆ Radiology:
 - Severe Intracranial Injury
 - Complete Cranial-Cervical Dislocation

Case G. Important Information



- ◆ Harness Straps Loose / CSS Loosely Installed
- ◆ May Have Caused Increased Head Excursion
- ◆ Diagnosis & Treatment of this Injury - Very Challenging



Summary:

- ◆ Occult Injuries Can Have Many Hiding Places
- ◆ Hiding Places Are Often Repetitive & Predictable
- ◆ If Trauma Criteria Met, Patient Must Be Transported Appropriately
- ◆ Appropriate Transport to Trauma Center Ensures Proper Implementation of Trauma Protocols to Detect Occult Injury
- ◆ Key Pieces of Information Can Help Isolate the Hiding Place EARLY
- ◆ Early Detection = Saved Lives & Improved Outcomes