Abdominal Trauma

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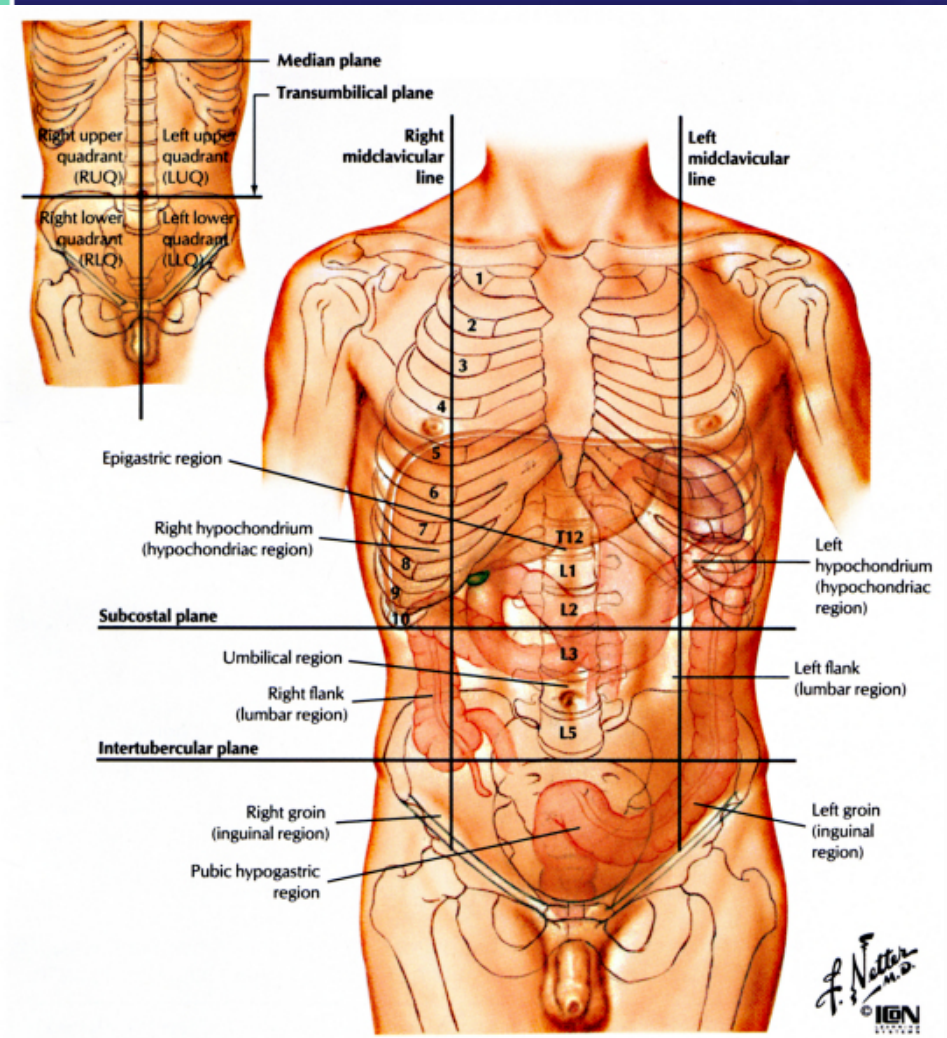
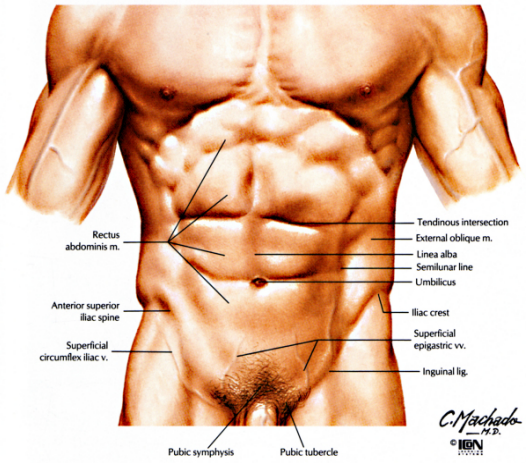
Abdominal Trauma

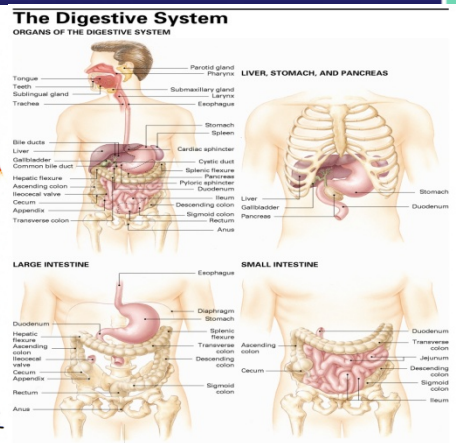
- **"Abdomen"**
  - Derived from Latin word "abdere" which means "to hide"
  - Often referred to as "the black box."

"Follow the clues"

Abdominal Anatomy and Physiology

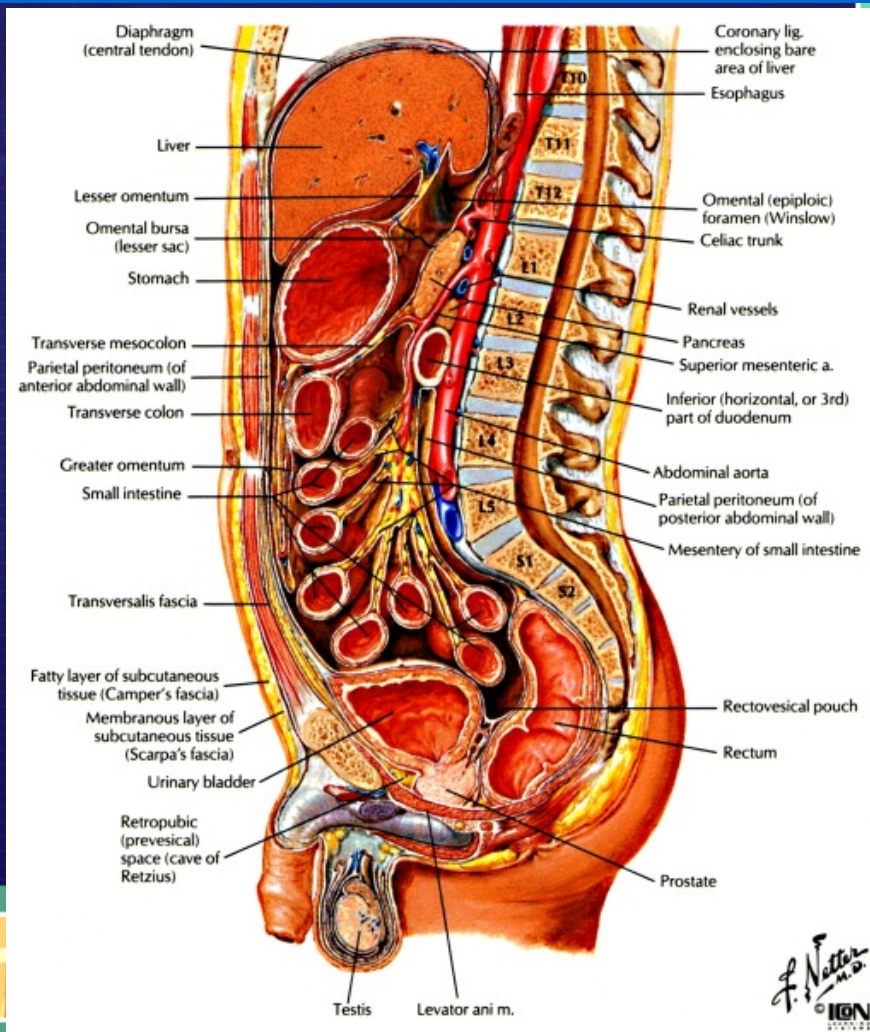






Abdominal Anatomy and Physiology

- **Boundaries**
  - Superior: Diaphragm
  - Inferior: Pelvis
  - Posterior: Vertebral column and posterior and inferior ribs
  - Lateral: muscles of the flank
  - Anterior: Abdominal muscles



Abdominal Anatomy and Physiology

- **Three Specific Spaces**
  - Peritoneal Space
    - Organs covered by abdominal (peritoneal) lining
  - Retroperitoneal Space
    - Organs posterior to the peritoneal lining
  - Pelvic Space
    - Organs contained within pelvis

Hollow & Solid Abdominal Organs

- **Solid**
  - Liver
  - Spleen
  - Pancreas
  - Kidneys
  - Ovaries
- **Hollow**
  - Stomach
  - Small Intestine
  - Large Intestine
  - Gall Bladder
  - Bladder
  - Uterus

Abdominal Anatomy and Physiology

- **Digestive Tract**
  - Alimentary canal
  - Structures
    - Stomach
    - Small Intestine
    - Large Intestine
    - Rectum
- **Accessory Organs**
  - Liver
  - Gallbladder
  - Pancreas

Urinary System

- Kidneys
- Ureters
- Urinary Bladder
- Urethra

Immune System

- Spleen

Genitals

- Ovaries
- Fallopian Tubes
- Uterus
- Vagina

Mechanism of Abdominal Trauma

- **Categorized according to Mechanism**
  - **Penetrating**
    - Gunshot
    - Stabbings
  - **Blunt**
    - Motor vehicle / Motorcycle accidents
    - Assault
    - Falls
    - Pedestrians struck
  - Blast

Mechanism of Abdominal Trauma

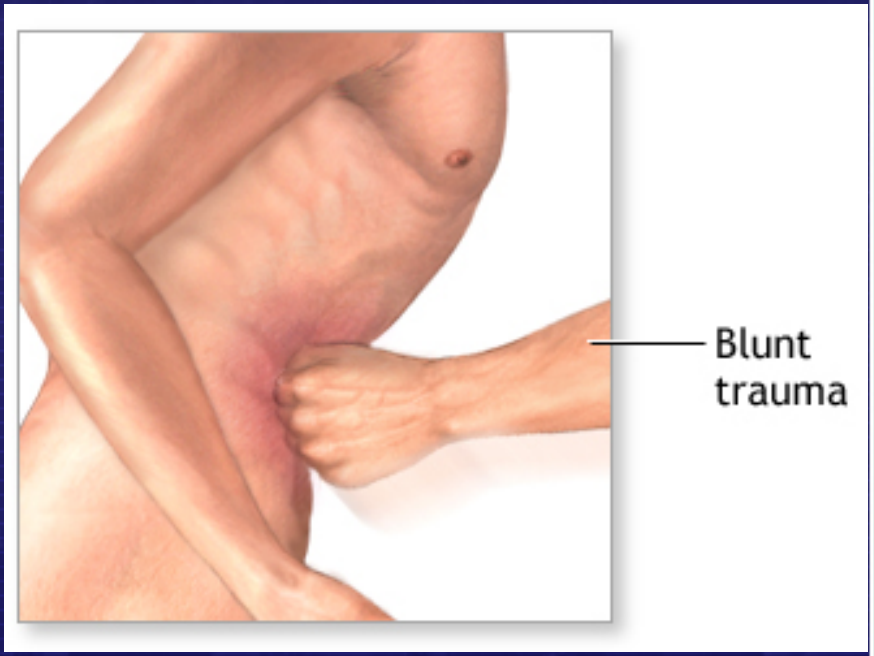
TABLE 28–2. ADMISSIONS, MECHANISMS OF INJURY, AND LAPAROTOMY RATES FOR THE PRESLEY REGIONAL TRAUMA CENTER, 1992–1996

Penetrating	1992	1993	1994	1995	1996
Gunshot	846	737	742	724	615
Stab	397	340	315	333	316
Shotgun	75	84	75	68	60
Total	1,318	1,161	1,132	1,125	991
Laparotomies	400 (30%)	285 (25%)	338 (30%)	328 (29%)	359 (36%)
Blunt	**1992**	**1993**	**1994**	**1995**	**1996**
Motor vehicles	937	1,122	1,347	1,431	1,698
Assault	380	392	420	430	433
Falls	347	315	270	233	281
Pedestrian	169	162	174	164	163
Other	308	313	430	222	94
Total	2,141	2,304	2,641	2,480	2,642
Laparotomies	138 (6.4%)	109 (7.6%)	153 (5.8%)	134 (5.4%)	202 (7.6%)

Trauma. Fourth ed. Mattox

Mechanism of Blunt Abdominal Trauma (BAT)

- **Compression**
  - Direct blow or compression against a fixed object
    - Commonly cause tears and subcapsular hematomas to solid viscera
    - Less commonly, transiently increase intraluminal pressure and lead to rupture



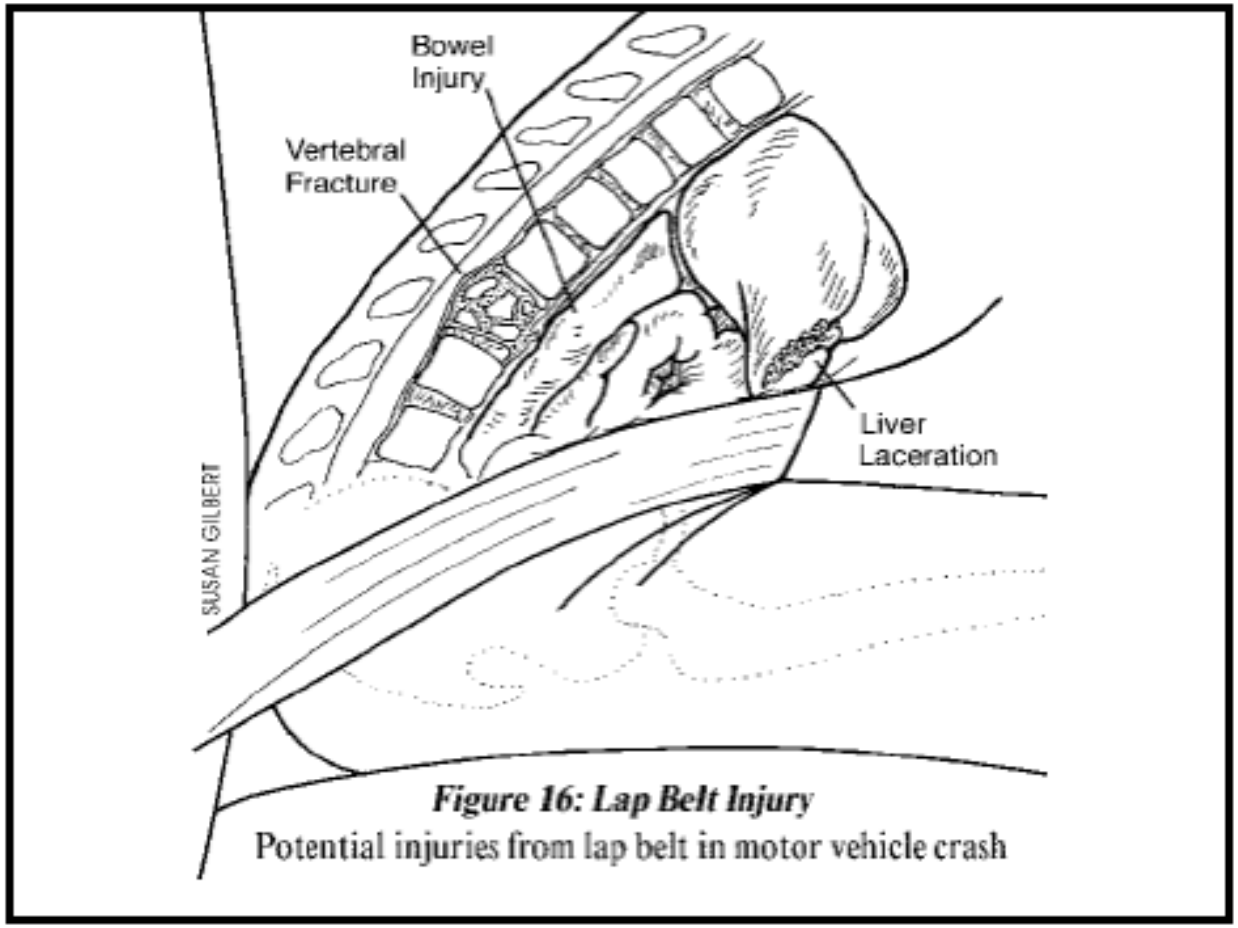
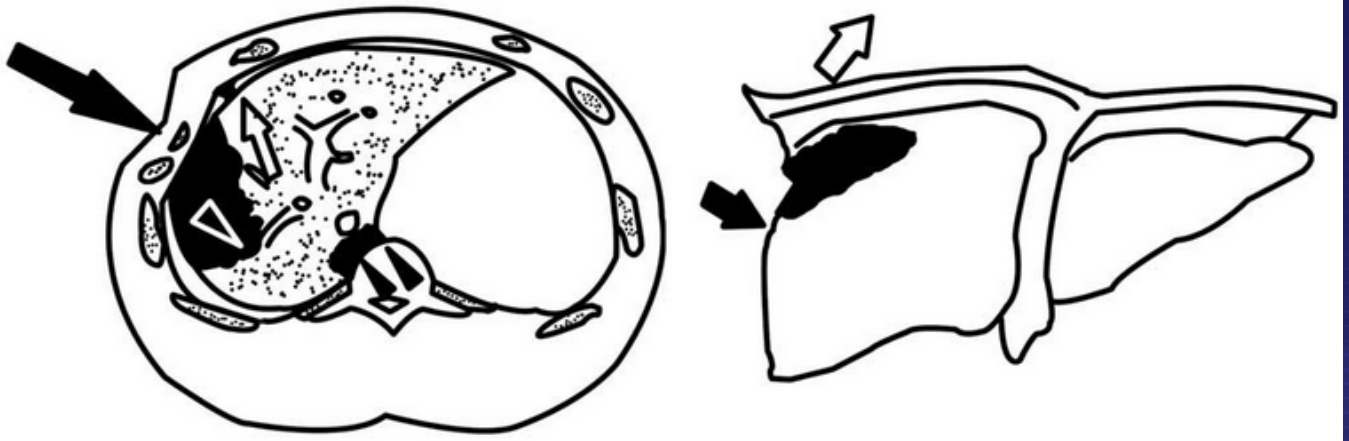


Figure 16: Lap Belt Injury

Potential injuries from lap belt in motor vehicle crash




29.0cm
Mag = 1.2
ROT:
m/27.50 1.375:1
E+.06.63
WW: 260WL:

Mechanism of Blunt Abdominal Trauma (BAT)

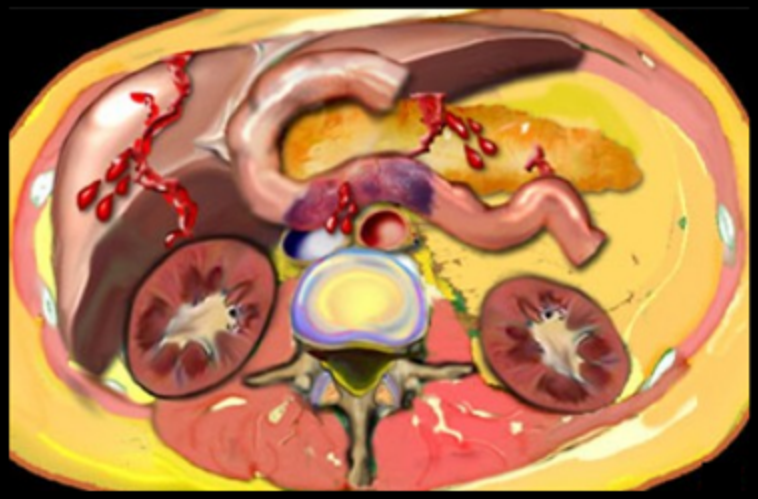
- **Acceleration and Deceleration**
  - Stretching and linear shearing between a fixed and free object
    - Hepatic tears along the ligamentum teres, intimal injuries, mesenteric tears

Mechanism of Blunt Abdominal Trauma (BAT)

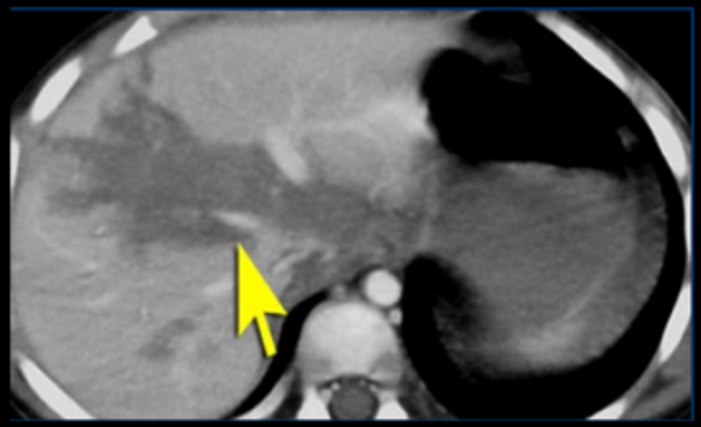
- Pattern of Injury in Blunt Abdominal Trauma

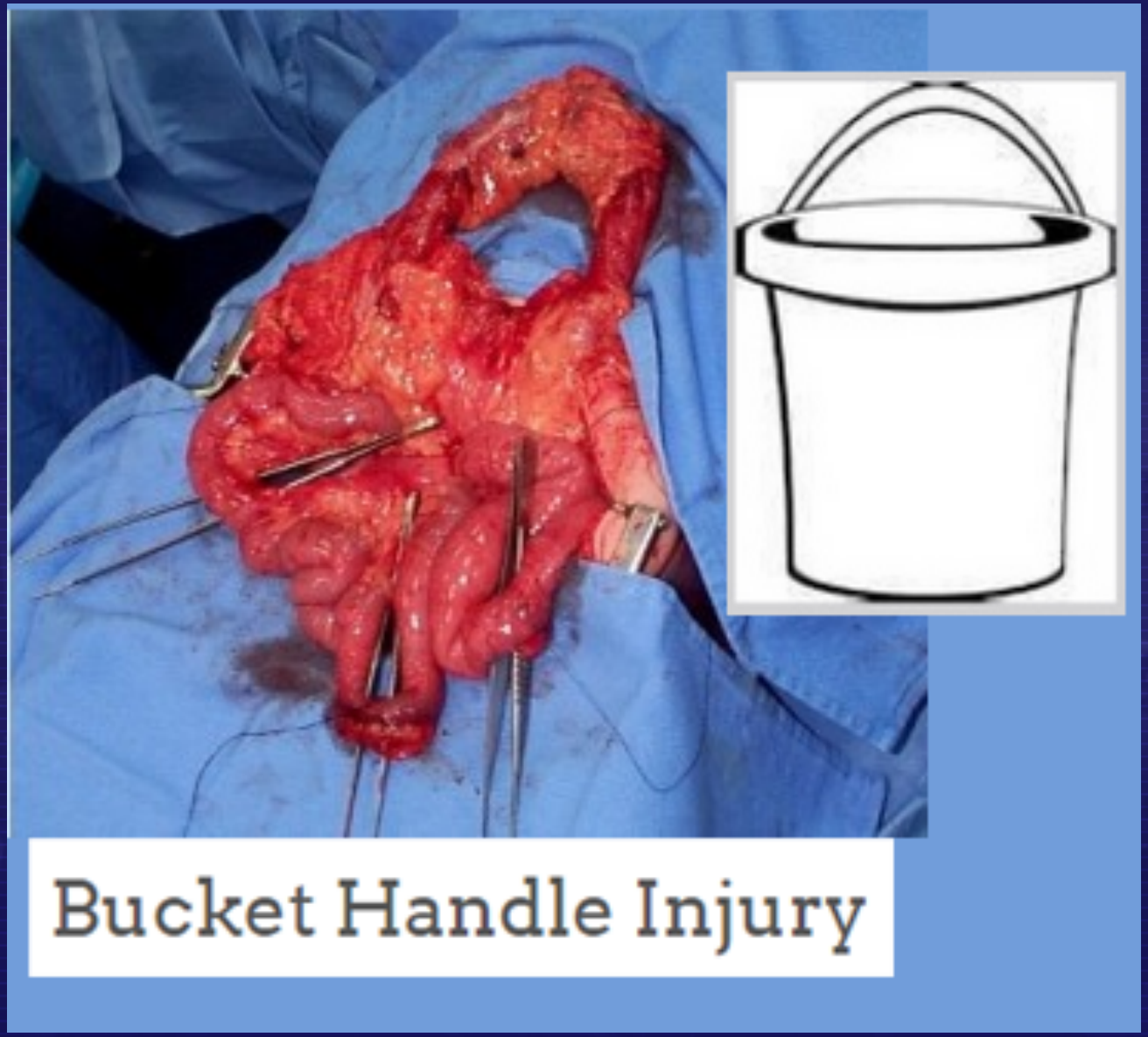
Spleen	40.6%	Colorectal	3.5%
Liver	18.9%	Diaphragm	3.1%
Retroperitoneum	9.3%	Pancreas	1.6%
Small Bowel	7.2%	Duodenum	1.4%
Kidneys	6.3%	Stomach	1.3%
Bladder	5.7%	Biliary Tract	1.1%

* Rosen: Emergency Medicine (1998)




25/1992
Nr.64925
Abdomen 1.0 SI
CT ABDOMEM WITH CON





Bucket Handle Injury

Mechanism of Penetrating Abdominal Trauma (PAT)

- **Stab**
  - Low energy, lacerations
- **Gunshot**
  - Kinetic energy transfer
    - Cavitation, tumble
    - Fragments

Initial Assessment: Physical Examination

- **RESCUSITATION** continues as PE is completed
  - Airway, with cervical spine precautions
  - Breathing
  - Circulation
  - Disability
  - Exposure

Initial Assessment

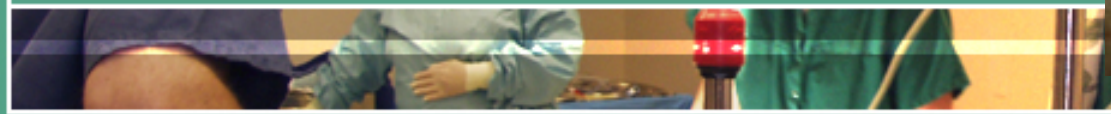
- Initially, Evaluation and Resuscitation occur simultaneously
- Detailed History may be impossible
  - AMPLE
    - Allergies
    - Medications
    - Past medical history
    - Last intake
    - Events leading to presentation

Initial Assessment: Description of mechanism

- **Predicts injury patterns and helps avoid pitfalls**
  - Type of collision (frontal, lateral, sideswipe, rear, rollover)
  - Speed
  - Damage to vehicle and whether prolonged extrication was required
  - Ejection from vehicle and/or co occupant death
  - Types of restraints
  - The presence of alcohol or drug use

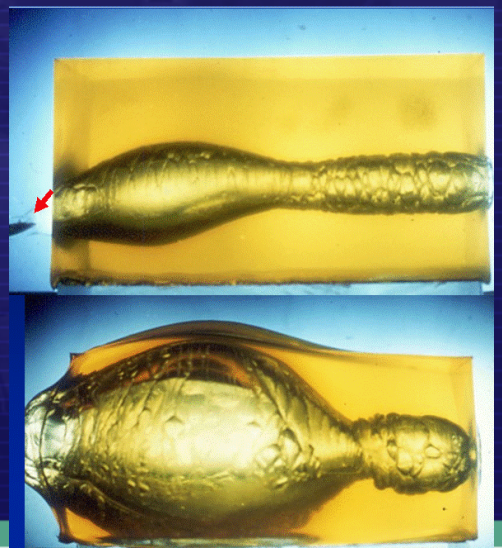
Initial Assessment: Physical Examination

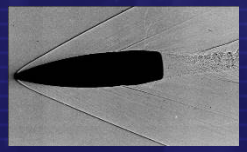
- **Inspection, auscultation, percussion, palpation**
  - **Inspection:** abrasions, contusions, lacerations, deformity
    - Grey-Turner, Kehr, Balance, Cullen
  - **Auscultation:** careful exam advised by ATLS. (Controversial utility in trauma setting.)
  - **Percussion:** subtle signs of peritonitis; tympany in gastric dilatation or free air; dullness with hemoperitoneum
  - **Palpation:** elicit superficial, deep, or rebound tenderness; involuntary muscle guarding

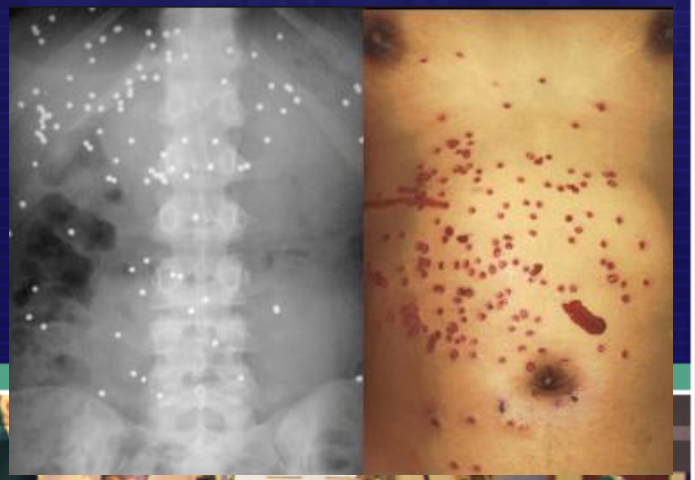


Initial Assessment: Physical Examination

- **Penetrating – Gunshot wounds (high energy injury)**
  - Determining the trajectory can give an idea of what is injured
  - Need even number of holes and/or bullets on X-ray
  - Must be careful since bullets can “settle” to dependent areas







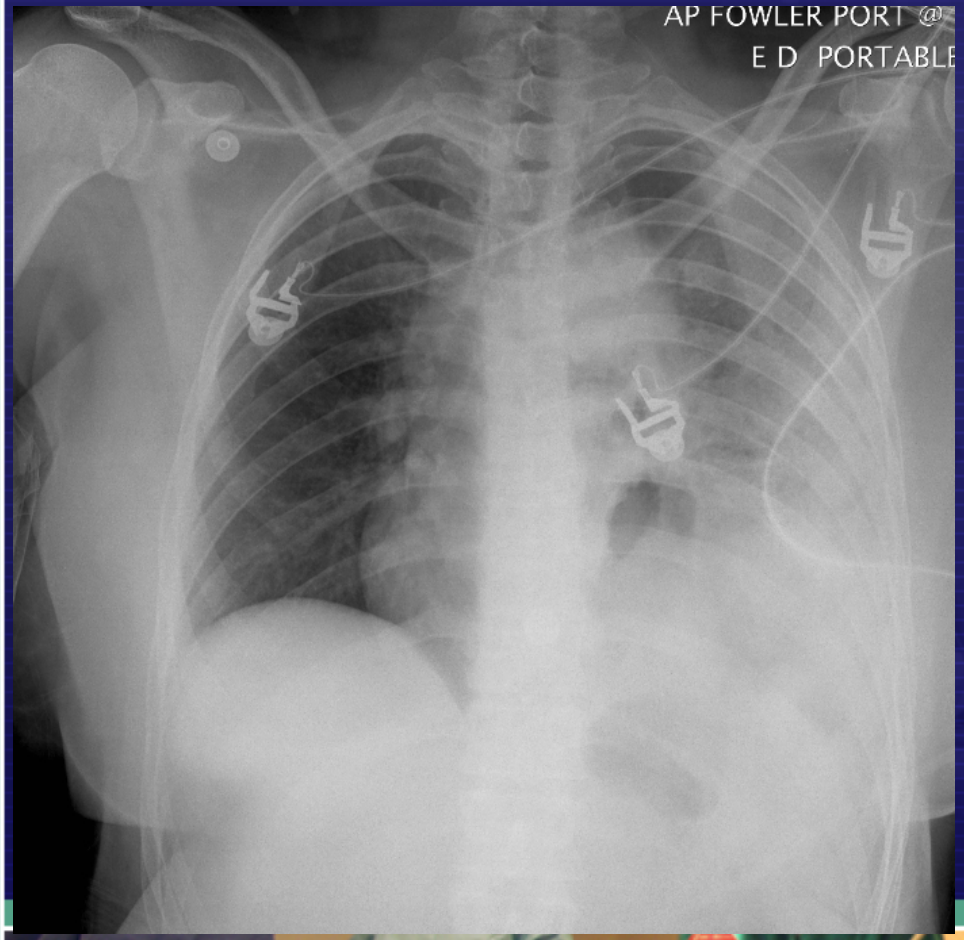
Initial Assessment: Physical Examination

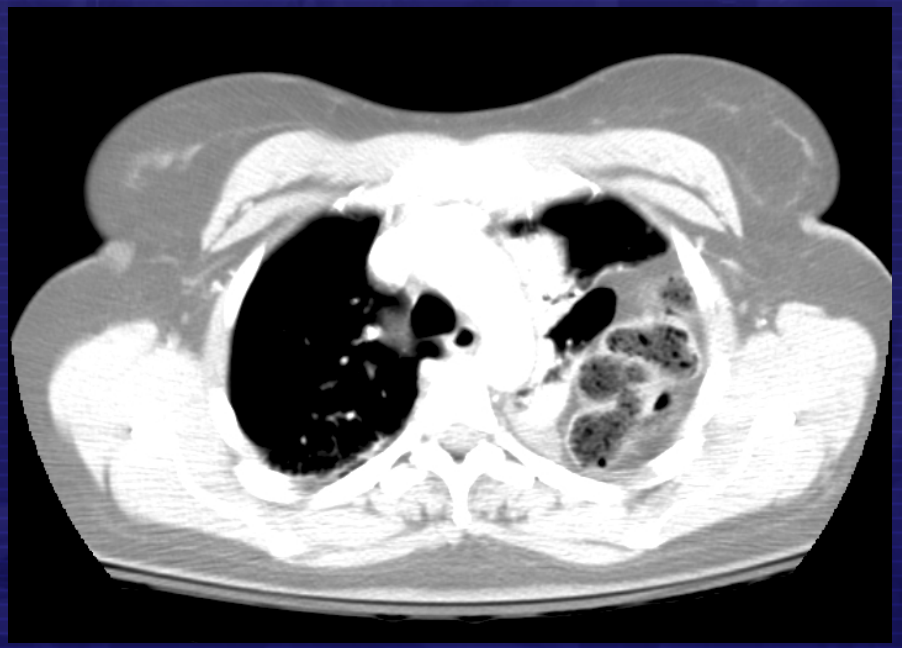
- **Penetrating – Stabbing(Low energy injury)**
  - More difficult since there is only an entrance and no “trajectory”
  - Injury can be far from the injury
  - May be all that is needed in hemodynamically stable patients (observation).

Plain film X-Rays

- Can show evidence of free air (hollow viscus injury)
- Can help determine the trajectory of the missile

Plain film X-Rays



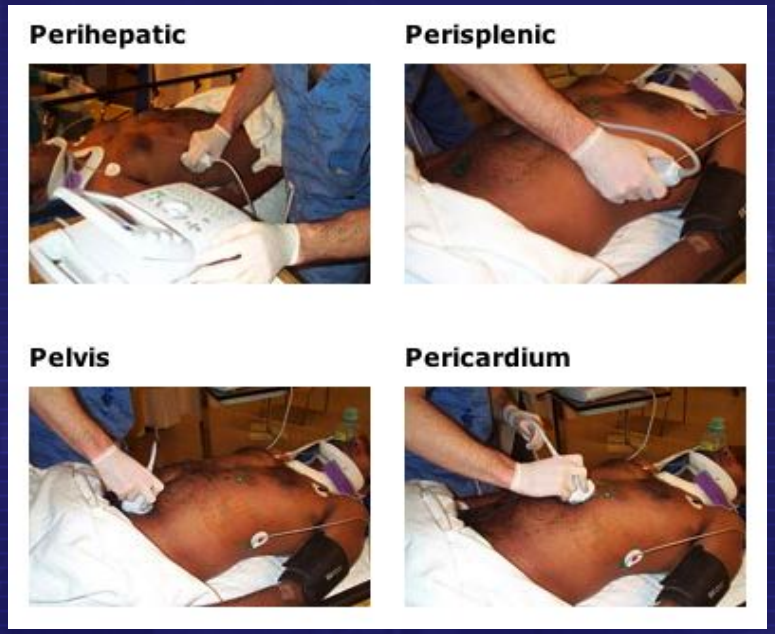


Focused Assessment Sonography for Trauma (FAST)

- Demonstrate presence of free intraperitoneal fluid
- Evaluate solid organ hematomas
- **Advantages**
  - No risk from contrast media or radiation
  - Rapid results, portability, non-invasive, ability to repeat exams.
- **Disadvantages**
  - Cannot assess hollow visceral perforation
  - Operator dependent
  - Retroperitoneal structures are not visualized

Focused Assessment Sonography for Trauma (FAST)

- **Four View Technique:**
  - Morrison's pouch (hepatorenal)
  - Douglas pouch (retropelvic)
  - Left upper quadrant (splenic view)
  - Epigastric (View pericardium)



Diagnostic Peritoneal Lavage (DPL)

- **Indications for DPL in blunt trauma:**

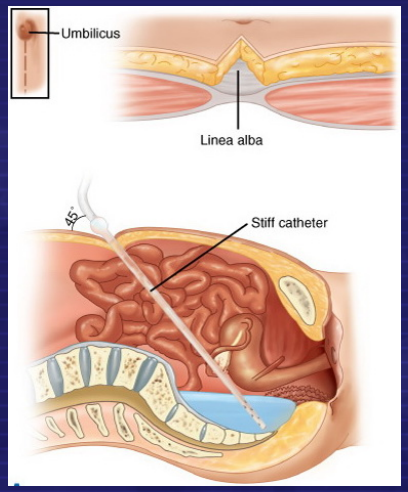
1. Hypotension with evidence of abdominal injury
2. Multiple injuries and unexplained shock
3. Potential abdominal injury in patients who are unconscious, intoxicated, or paraplegic
4. Equivocal physical findings in patients who have sustained high-energy forces to the torso
5. Potential abdominal injury in patients who will undergo prolonged general anesthesia for another injury, so re-evaluated the abdomen impractical or impossible

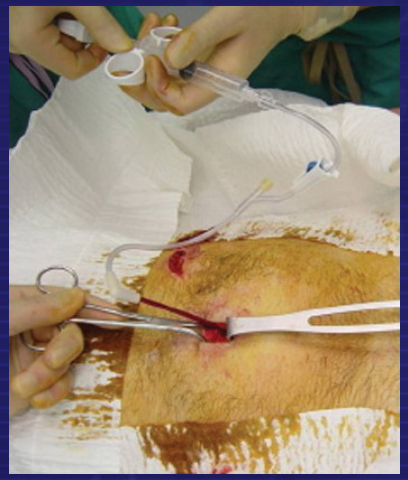
Diagnostic Peritoneal Lavage (DPL)

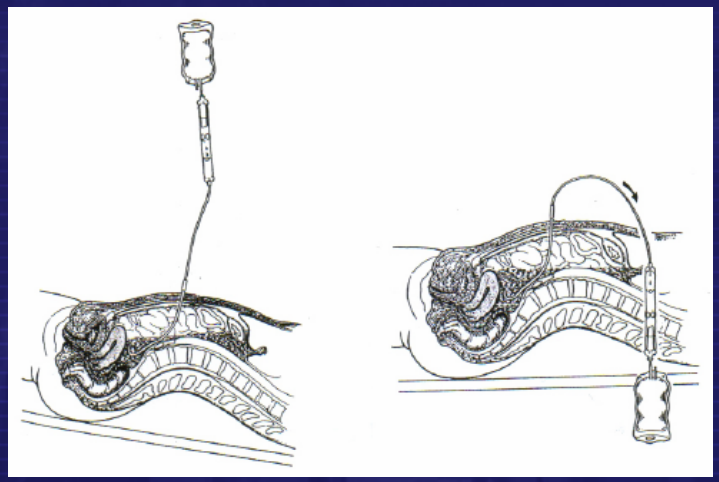
- **Absolute contraindication** :
  - Peritonitis
  - Injured diaphragm
  - Extraluminal air by x-ray
  - Significant intraabdominal injury by CT scan
  - Intraperitoneal perforation of the bladder by cystography

- **Relative contraindication** :
  - Previous abdominal operations (because of adhesions)
  - Morbid obesity
  - Gravid Uterus
  - Advanced cirrhosis (because of portal hypertension and the risk of bleeding)
  - Preexisting coagulopathy

Diagnostic Peritoneal Lavage (DPL)







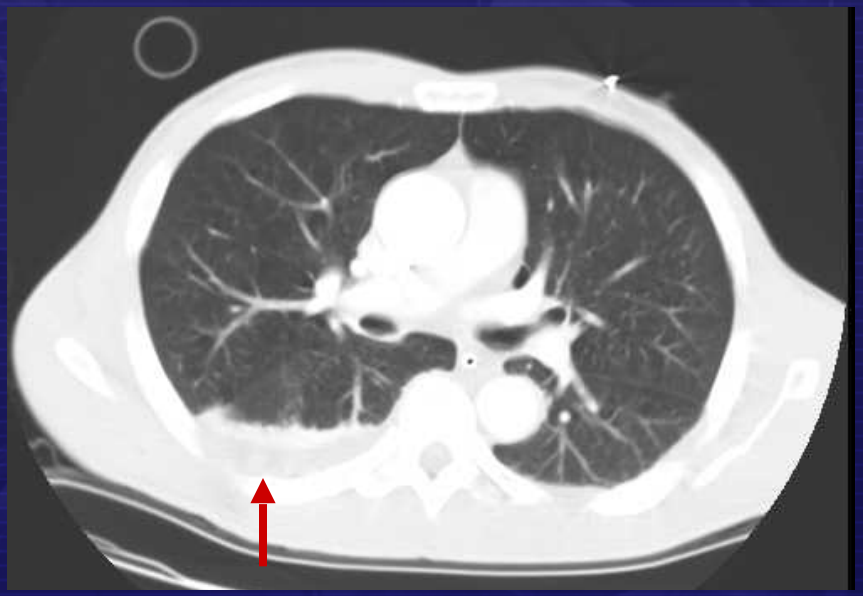
Positive findings if >10 mL of blood is aspirated or bowel content

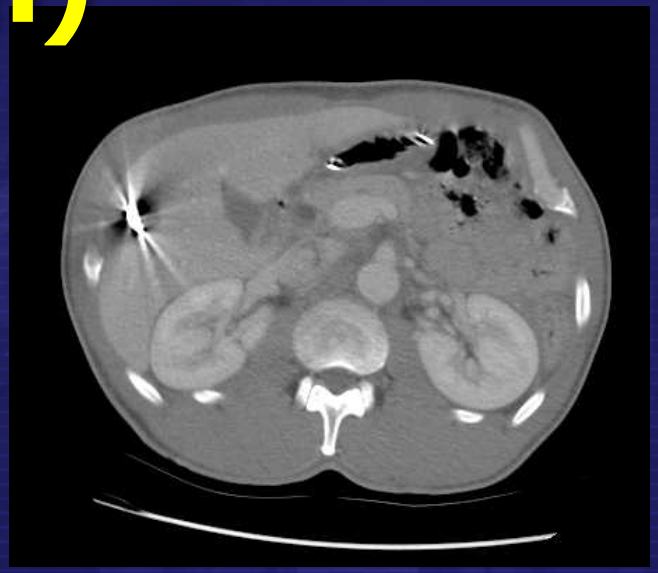
Table 7-6 Criteria for "Positive" Finding on Diagnostic Peritoneal Lavage		
	Anterior Abdominal Stab Wounds	**Thoracoabdominal Stab Wounds**
Red blood cell count	>100,000/mL	>10,000/mL
White blood cell count	>500/mL	>500/mL
Amylase level	>19 IU/L	>19 IU/L
Alkaline phosphatase level	>2 IU/L	>2 IU/L
Bilirubin level	>0.01 mg/dL	>0.01 mg/dL

Diagnostic Peritoneal Lavage (DPL)

- **Disadvantages**
  - Invasive
  - Difficult to perform in some populations (relative contraindications)
  - Time consuming
  - Lavage fluid may interfere with subsequent imaging
  - May lead to high non-therapeutic laparotomy rate (Bain et al; suggests numbers as high as 36%)
- **Advantages**
  - Answers question quickly if there is > 10 mL of blood or GI contents
  - Reported to be more sensitive than either CT or US for detection of hollow viscus injuries (Hoff et al)

Computed Tomography (CT Scan)





Computed Tomography (CT Scan)

- **Strengths**
  - Gold standard for solid organ injury
  - Can determine source of bleeding
  - Detects retroperitoneal injuries that may not be identified by FAST or DPL
  - Reveals associated injuries
- **Limitations**
  - Time consuming and typically involve leaving the department
    - In the unstable patient “Death begins with a CT”
  - Marginal sensitivity for diagnosing diaphragmatic injuries, pancreatic and hollow viscus injuries
  - Relatively expensive
  - Require IV contrast, which may cause an adverse reaction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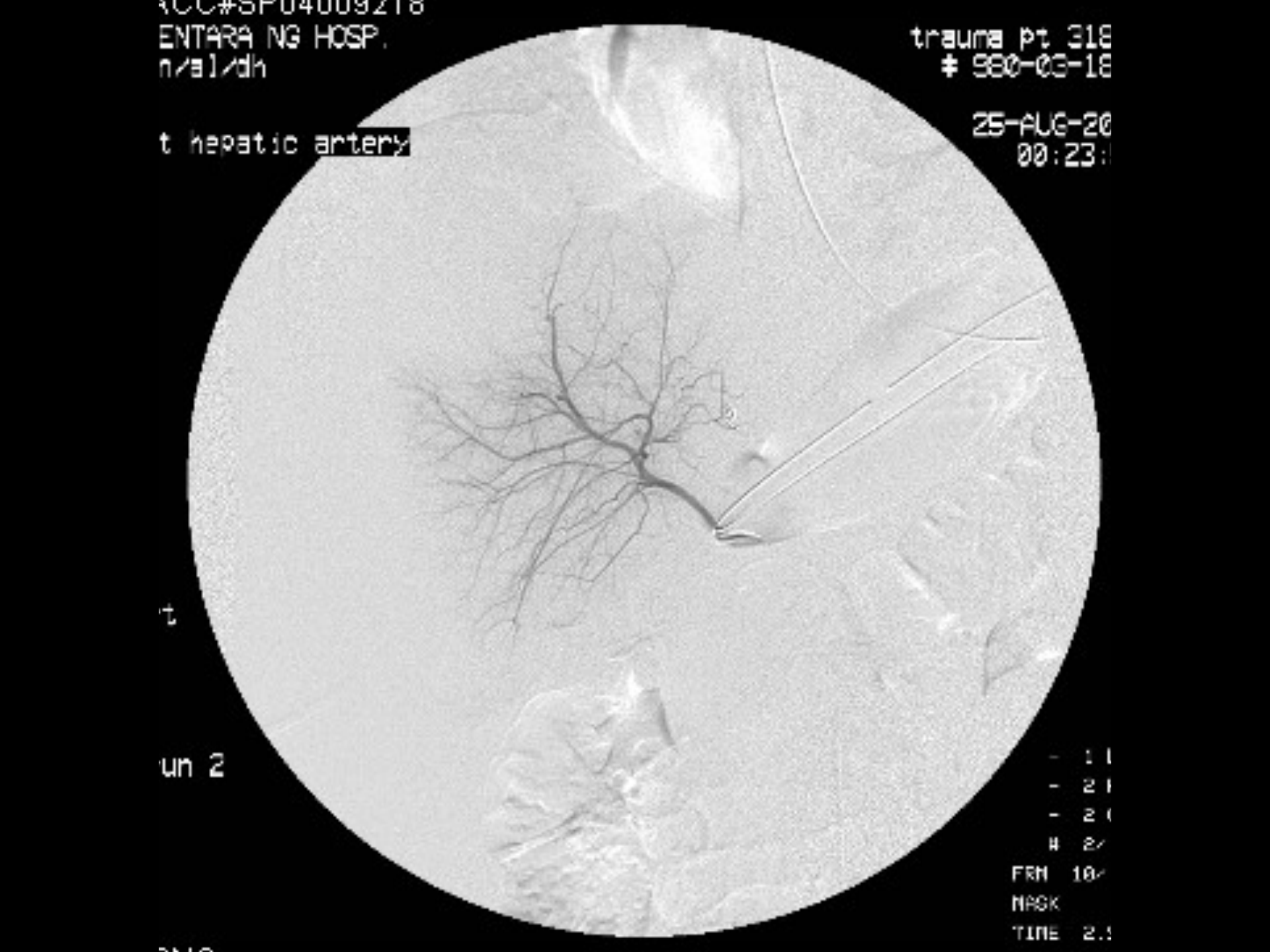
American Association for the Surgery of Trauma grading scales for solid organ injuries		
	SUBCAPSULAR HEMATOMA	LACERATION
Liver Injury Grade		
Grade I	<10% of surface area	<1 cm in depth
Grade II	10%–50% of surface area	1–3 cm
Grade III	>50% of surface area or >10 cm in depth	>3 cm
Grade IV	25%–75% of a hepatic lobe	
Grade V	>75% of a hepatic lobe	
Grade VI	Hepatic avulsion	
Splenic Injury Grade		
Grade I	<10% of surface area	<1 cm in depth
Grade II	10%–50% of surface area	1–3 cm
Grade III	>50% of surface area or >10 cm in depth	>3 cm
Grade IV	>25% devascularization	Hilum
Grade V	Shattered spleen Complete devascularization	

Angiography

- Using catheters via a femoral / brachial approach to occlude arteries
- Used increasingly for solid organ injury
  - Liver – Embolize either Right/Left hepatic arteries (Liver has both arterial and portal blood supplies)
  - Spleen – Can be selective or embolize the entire organ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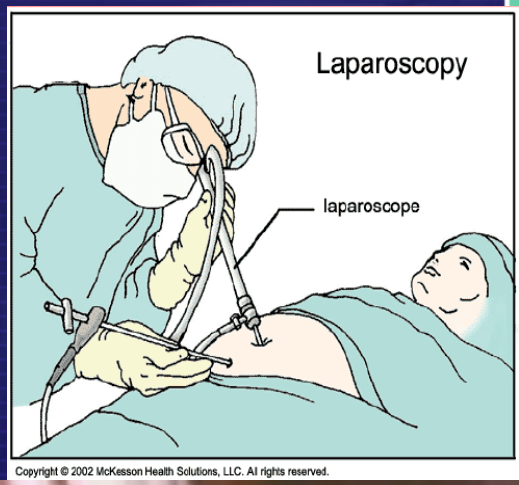
Angiography

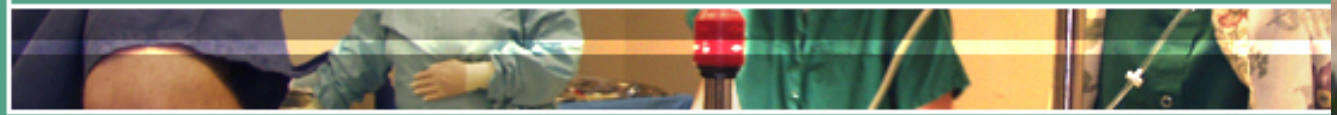
- Can convert what would be a large and bloody case into a easily managed situation
- Doesn't always work
  - Now operating later on a sicker patient
  - Can embolize too much and infarct other vascular beds
- All fluid isn't blood – Can miss small bowel injuries

Diagnostic Laparoscopy

- Excellent for stable stab wounds (peritoneal penetration/ diaphragm injury)
- Hard to see everything
  - Can “run the bowel”
  - Hard to see retroperitoneum, lesser sac

  and assess liver /splenic injuries
- Invasive, expensive
- May need to open

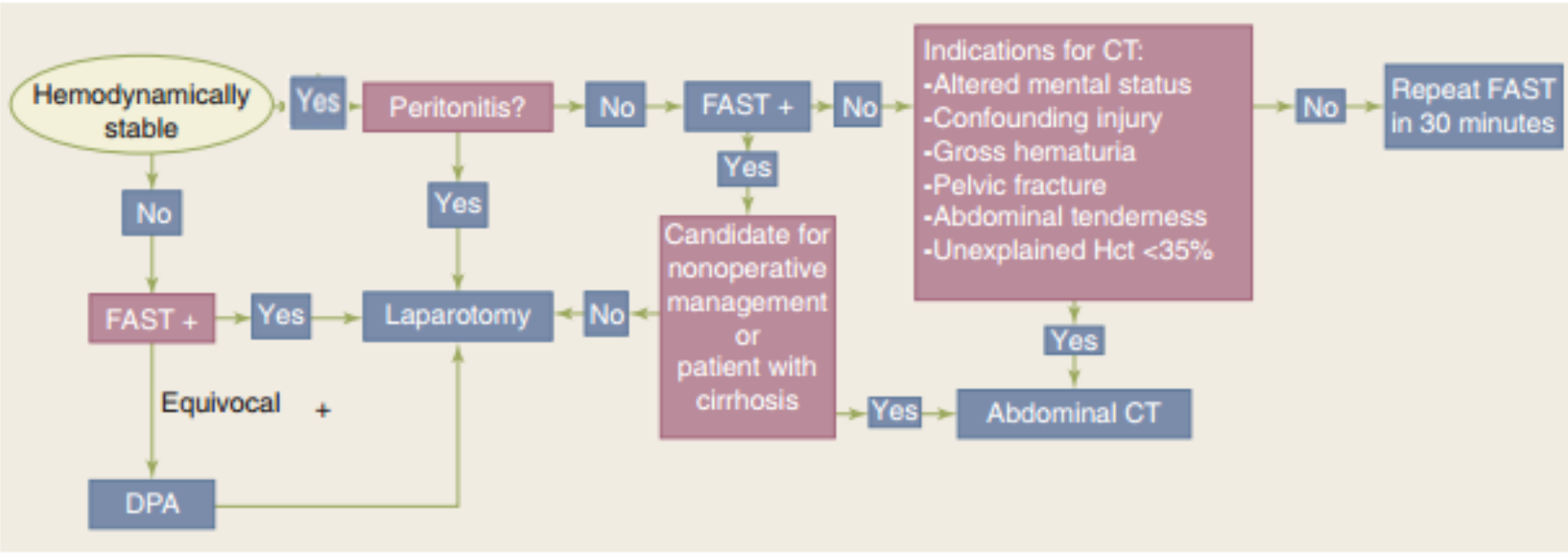




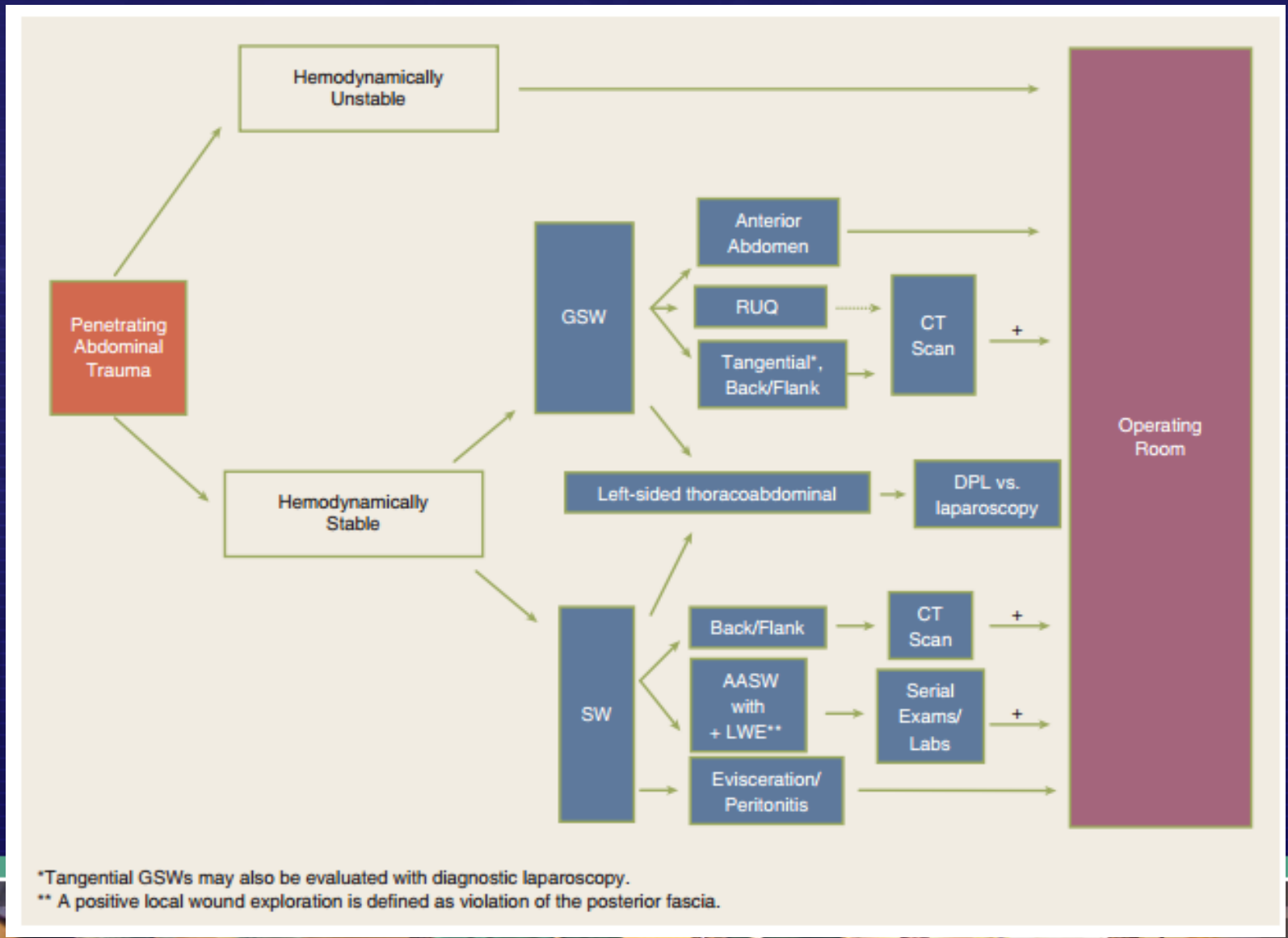
Non-operative management (NOM)

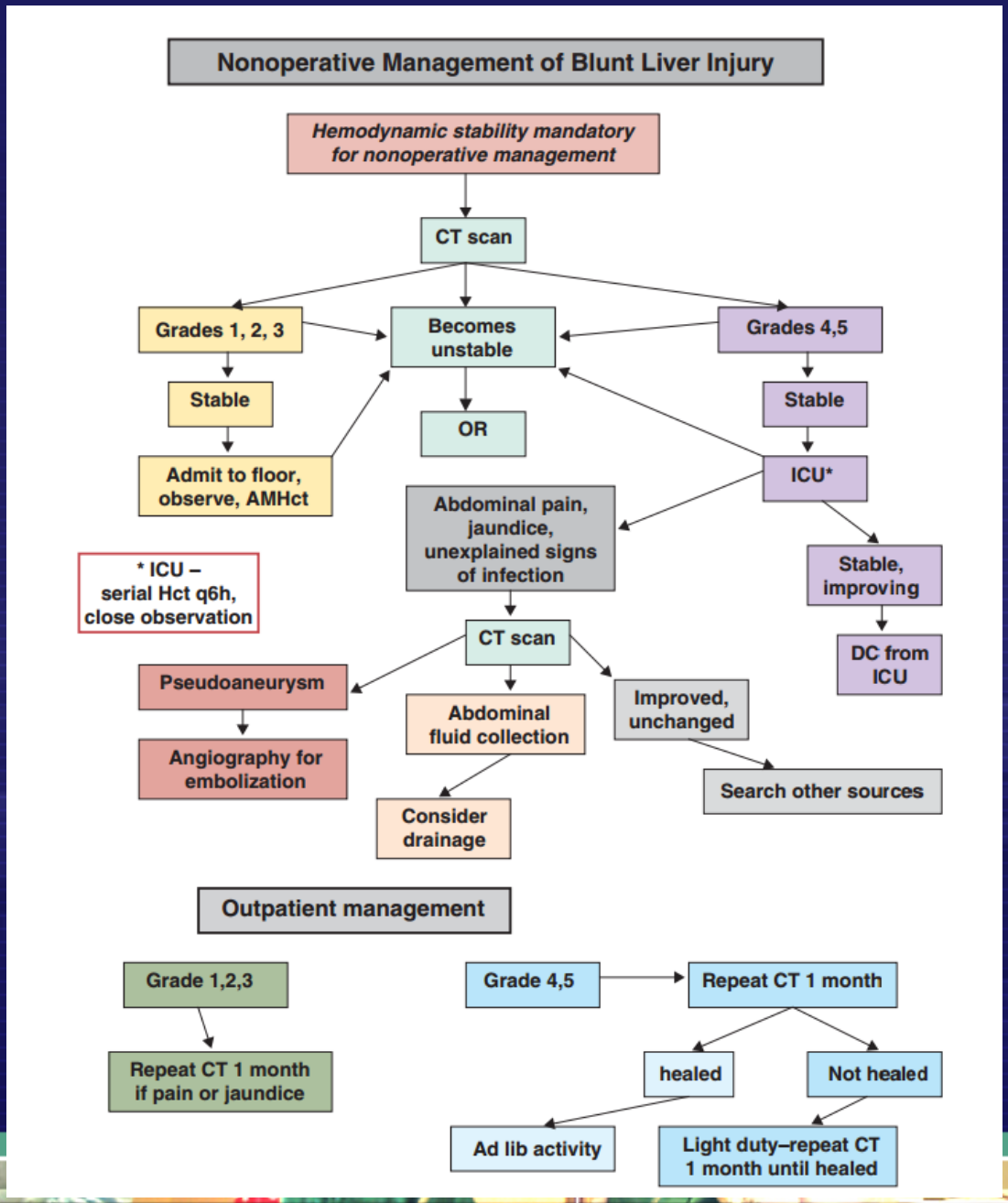
- **Solid organs injuries can be observed**
  - *Hemodynamic stable*
  - *No associated intra-abdominal injury need surgery*
  - Have to observe VERY closely
    - Repeated abdominal exams
    - Vital signs, dropping hematocrits
  - Have to be ready to operate if needed quickly

Management in Blunt abdominal injury

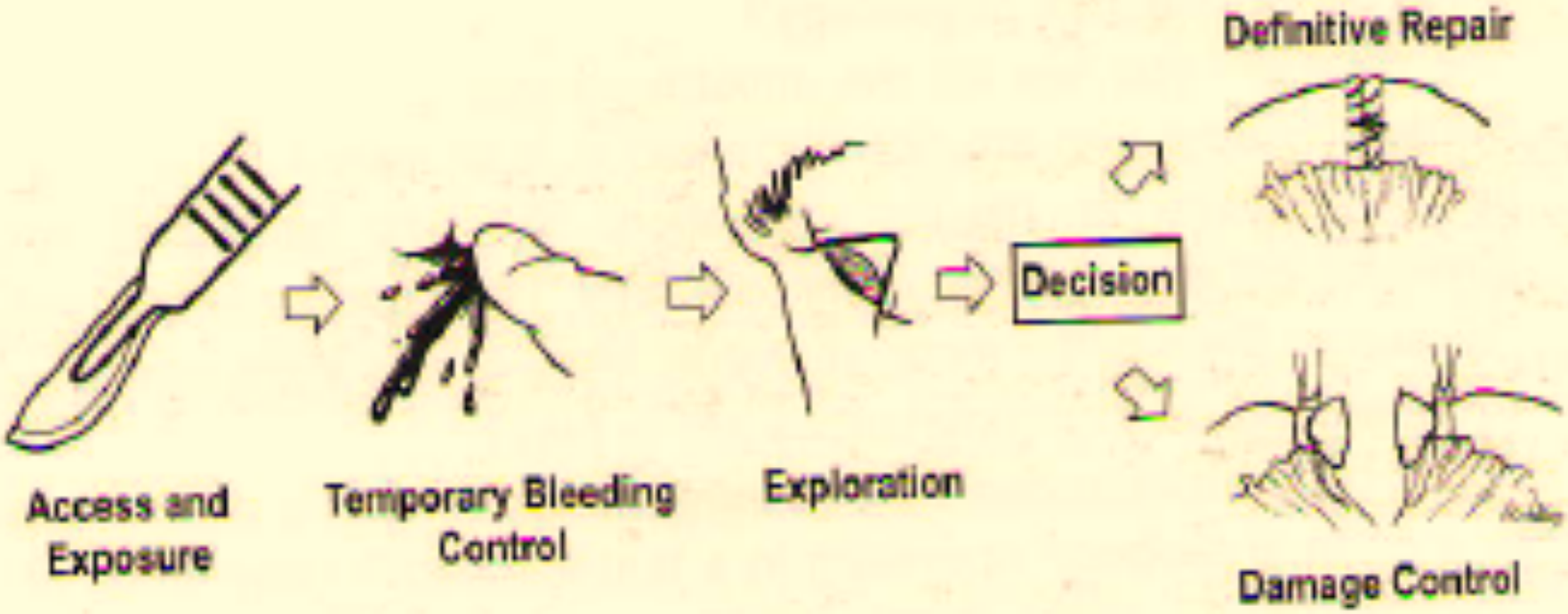


Management in Penetrating abdominal injury




Nonoperative Management of Blunt Liver Injury
Hemodynamic stability mandatory for nonoperative management
CT scan
Grades 1, 2, 3
Becomes unstable
Grades 4,5
Stable
OR
Stable
Admit to floor, observe, AMHct
ICU*
Abdominal pain, jaundice, unexplained signs of infection
* ICU – serial Hct q6h, close observation
Stable, improving
DC from ICU
CT scan
Pseudoaneurysm
Abdominal fluid collection
Improved, unchanged
Angiography for embolization
Search other sources
Consider drainage
Outpatient management
Grade 1,2,3
Grade 4,5
Repeat CT 1 month
Repeat CT 1 month if pain or jaundice
healed
Not healed
Ad lib activity
Light duty–repeat CT 1 month until healed

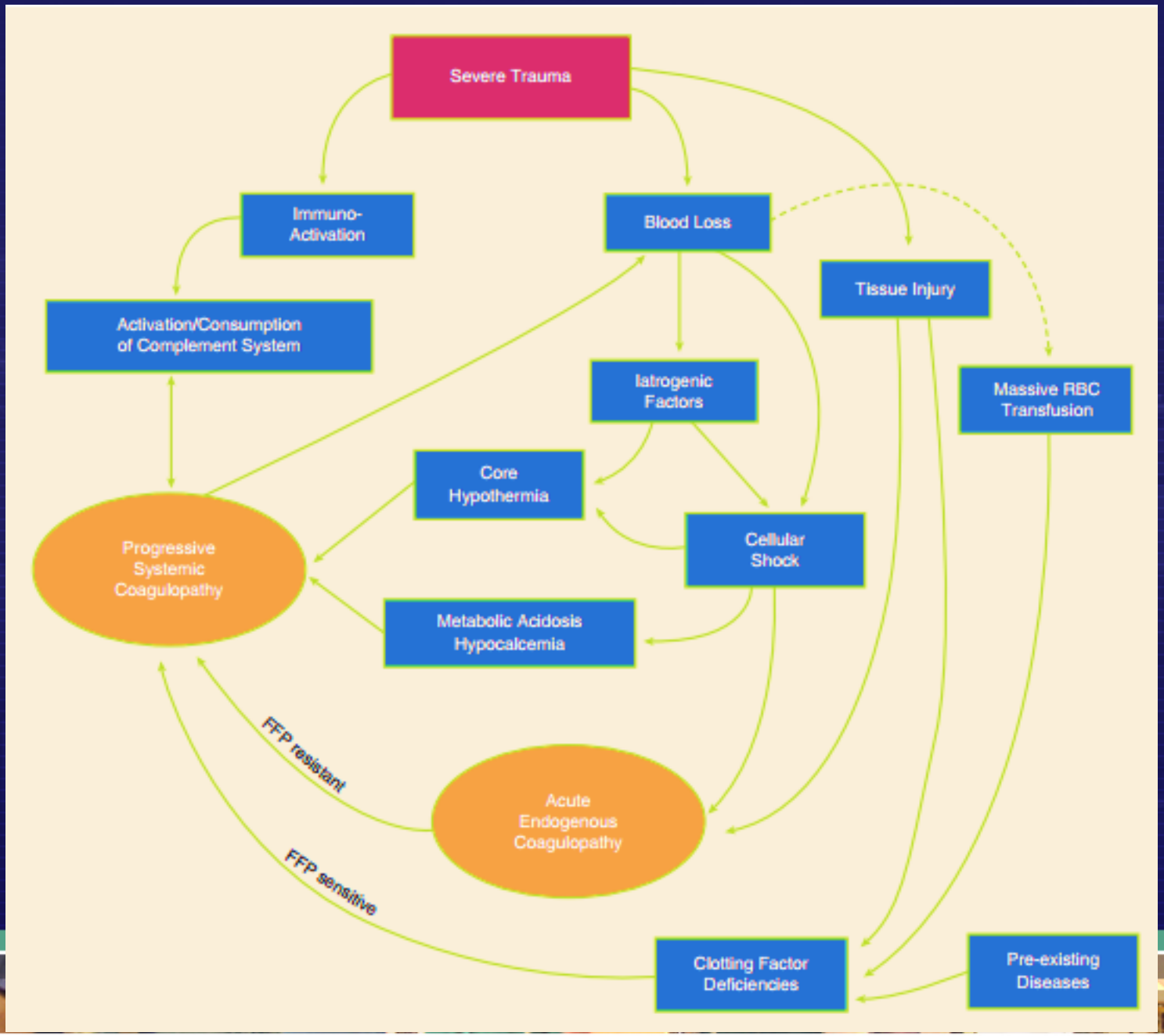
Intra-operative room



Damage Control Surgery

- **Stop the bleeding and contamination and then get out.**
  - Pack the liver
  - Staple out injured small bowel/colon (no anastamosis needed)
  - Vascular shunts
- Leave abdomen open or just close skin
- Get to ICU for resuscitation/warming

”The bloody vicious cycle”



Damage Control Surgery

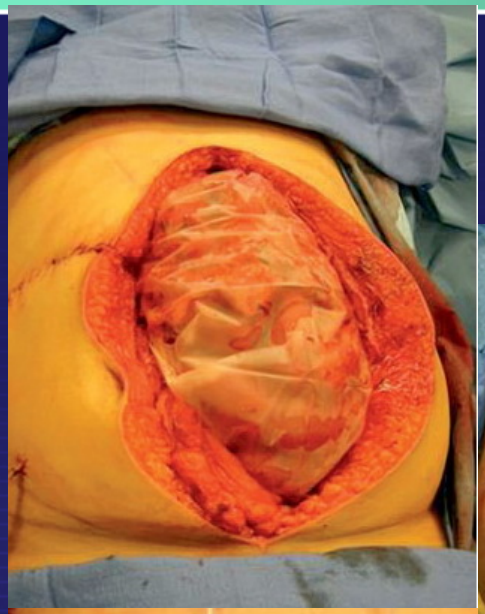
- **Critical factors**
  - Severe metabolic acidosis : pH < 7.2
  - Hypothermia : T° < 34°
  - Lactate > 5 mmol/l
  - Coagulopathy
  - Operating time > 90 minutes

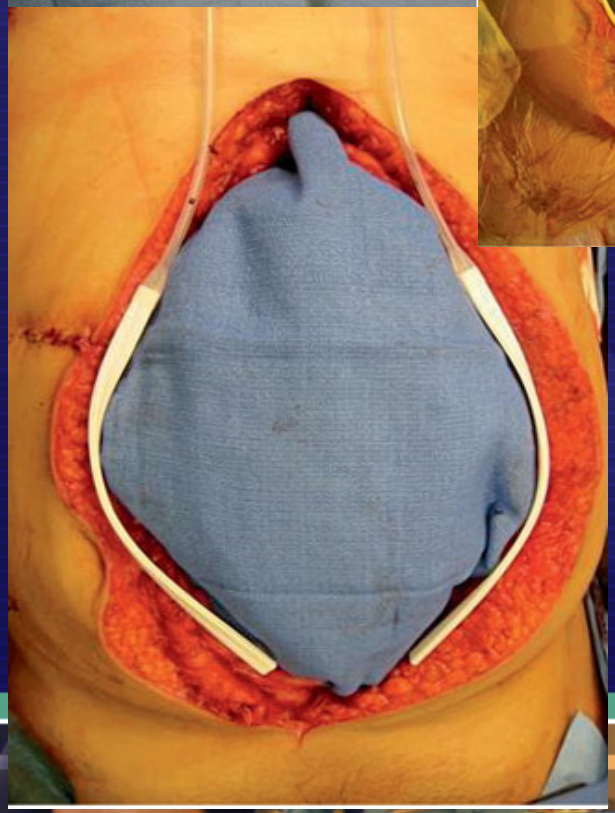
Damage Control Surgery

- **After 24 to 48 hours go back to the OR**
  - Patient is resuscitated, warm, stable
- **Definitive Surgery**
  - Establish GI continuity
  - Wash out areas of contamination
  - Vascular repairs
- ***Patients live***

Temporary Abdominal Closure

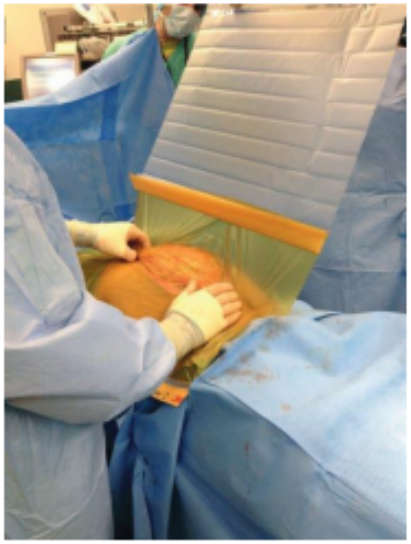
- **The Open Abdomen**
  - A clear, fenestrated plastic layer over the bowel and viscera (Vi-drape)
  - OR towel or sponge in the dead space
  - Large drains in the gutters
  - Cover entire opening with occlusive dressing (Ioban)
  - Place drains to suction





A

B



C

D

Temporary Abdominal Closure

- Open Abdomen (VacPack, Blue Towel)
  - Can be done fast in the OR
  - Controls abdominal fluids (can measure)
  - Prevents abdominal compartment syndrome (more to follow)
  - Can be taken down in ICU to allow inspection of the abdomen

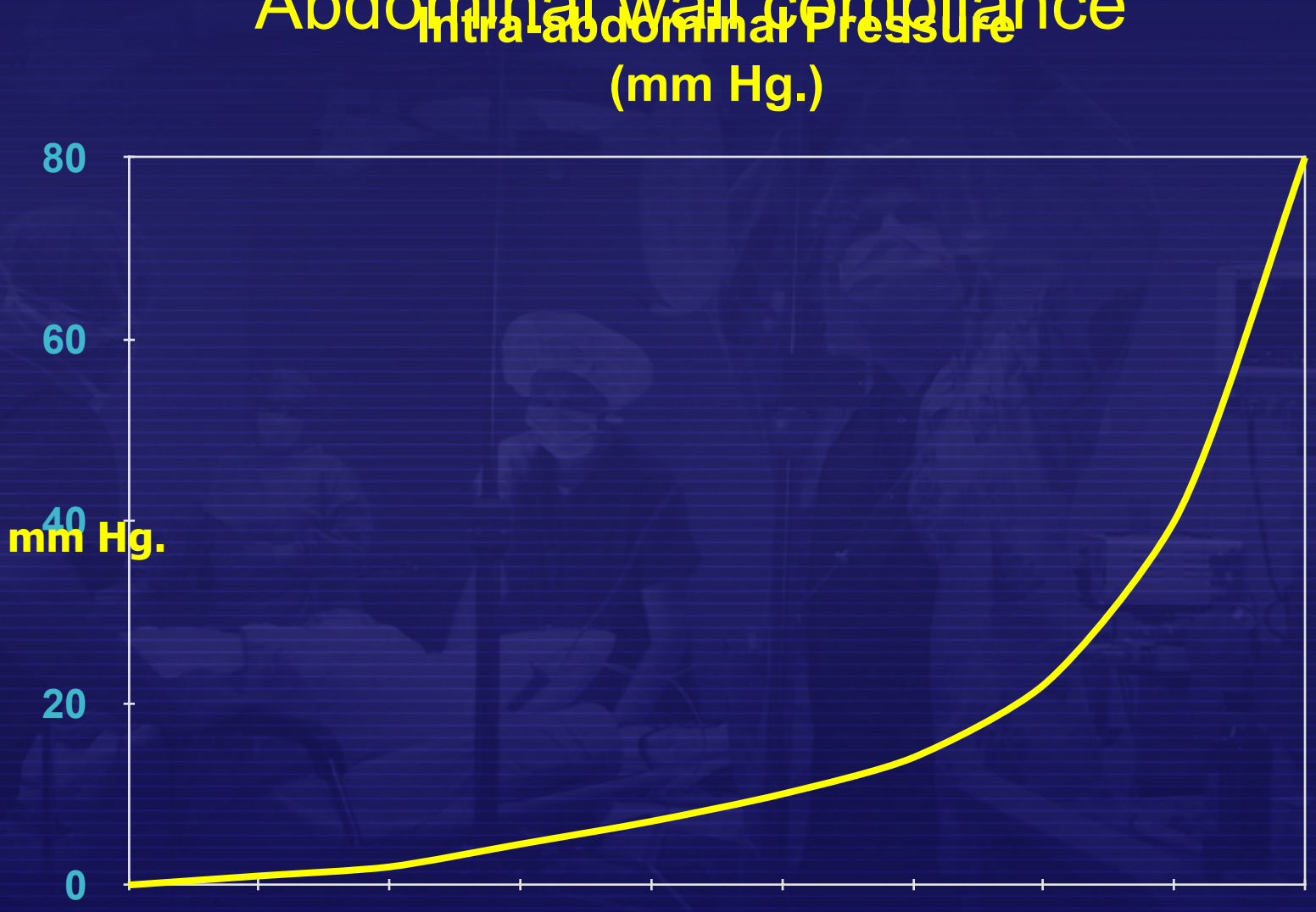
Abdominal Compartment Syndrome (ACS)

An acute condition in which
increased intra-abdominal pressure
causes organ dysfunction as a result of
Intra-abdominal hypertension (IAH)

ACS =

Sustained or repeated
IAP of > 20 mm Hg. (27 cm H_2O)
With or without APP < 60 mm Hg.
associated with new onset organ system failure

Abdominal wall compliance



Intra-abdominal Hypertension (IAH)

Grade	mm Hg.	(cm H_2O)	Severity
I	12 – 15	16 - 19	Mild
II	16 – 20	20 – 29	Moderate
III	21 – 25	30 - 34	Severe
IV	>25	>35	Critical

Abdominal Compartment Syndrome (ACS)

Causes

- Intra-abdominal
  - Bowel obstruction / Ileus
  - Ruptured AAA
  - Mesenteric venous obstruction
  - Abscess
  - Pneumoperitoneum
  - Intraperitoneal bleed / trauma
  - Visceral edema
- Retroperitoneal
  - Pancreatitis
  - Pelvic Fracture/bleeds
  - Ruptured AAA
- Abdominal Wall
  - Burn Eschar
  - Massive hernia repair
  - Closing the tight abdomen

Abdominal Compartment Syndrome (ACS)

Symptoms

- Renal failure
  - Decreased urine output
- Respiratory failure
  - Decreased compliance, increase pulmonary edema / airway pressure
- Cardiac failure
  - Decreased cardiac output (decrease preload / increase afterload)
- Visceral failure
  - Decrease blood flow to liver, bowel (bacterial translocation)
- Neurologic complications
  - Increased intracranial pressure
- Abdominal wall “failure”
  - Dehiscence, hernia formation

Abdominal Compartment Syndrome (ACS)

Treatment

- **Grade I:**
  - Maintenance of adequate intravascular volume and continued observation
- **Grade II:**
  - Volume expansion, continued observation
  - Decompression depending on clinical state
- **Grade III:**
  - Decompression and further resuscitation
- **Grade IV:**
  - Emergency decompression and resuscitation

Stassen et al. 2002

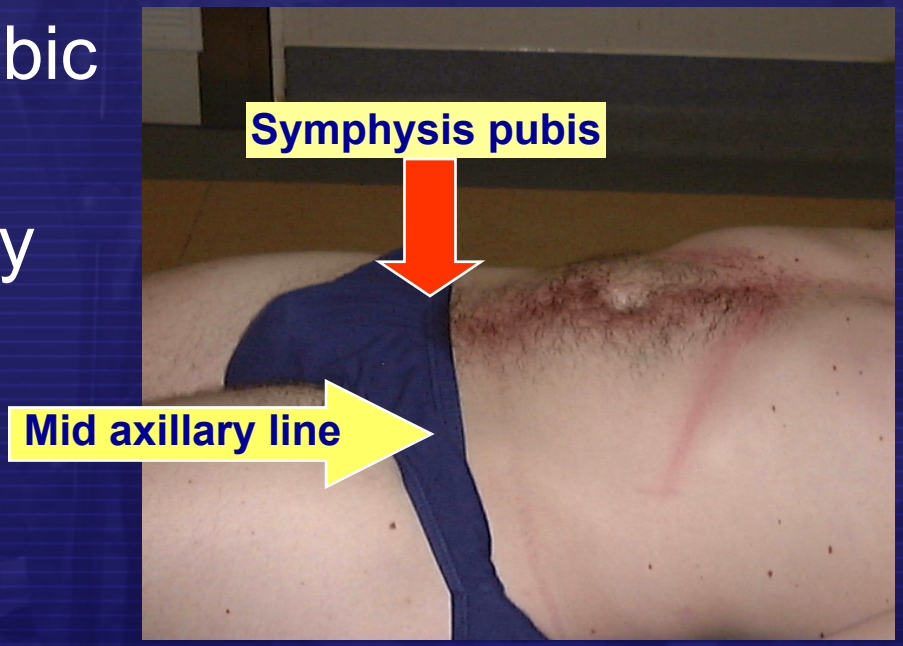
Measurement of IAP

Measurement of pressure:

- Direct
  - Intraperitoneal
- Indirect
  - Intragastric pressure
  - Intravesical pressure

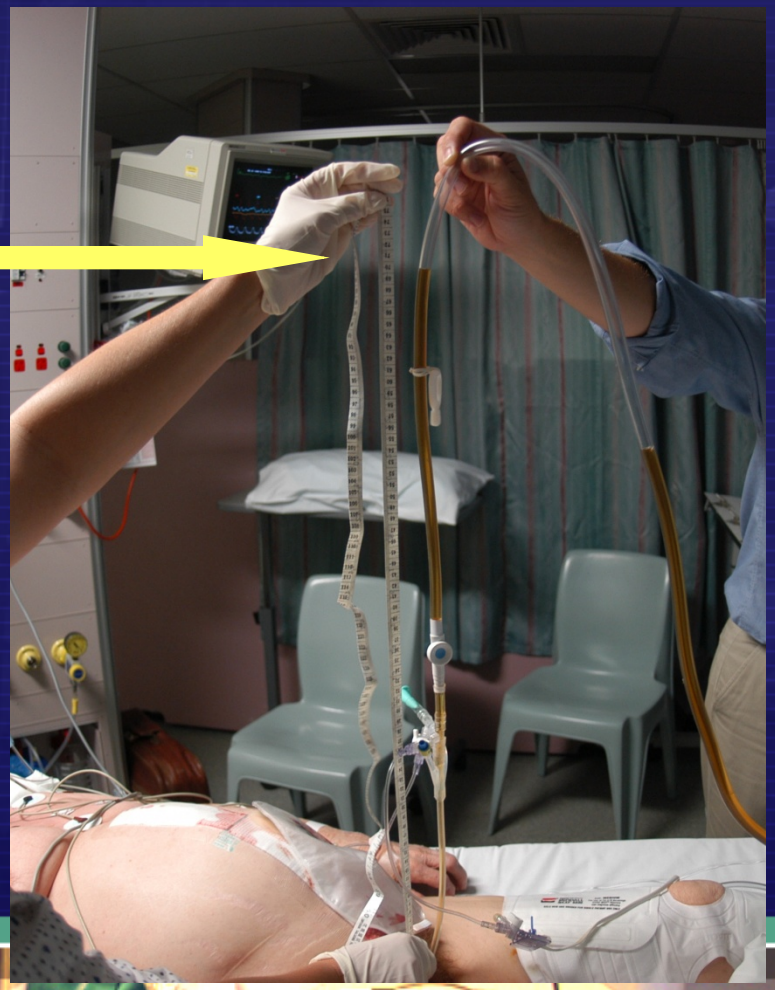
Measuring the IAP - manual

- T - piece to catheter
- Measured at level of pubic symphysis
- Zero point is mid-axillary line
- 50 ml saline into bladder

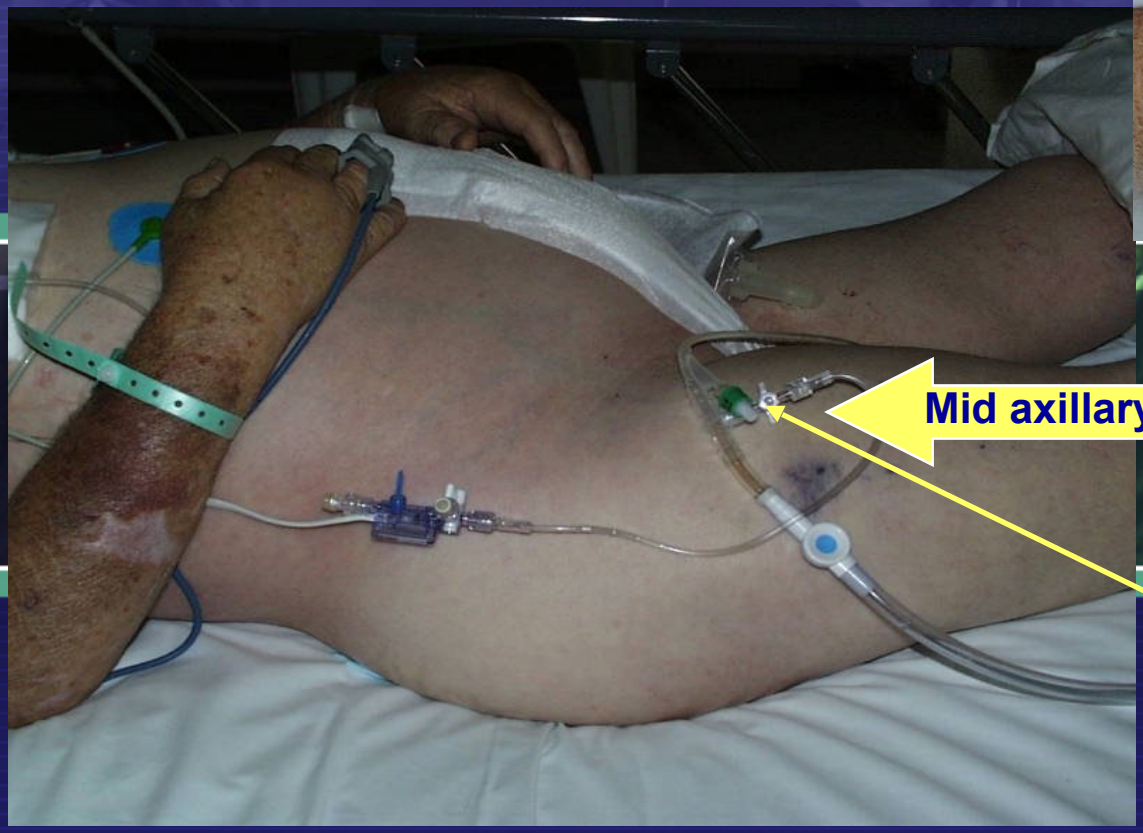


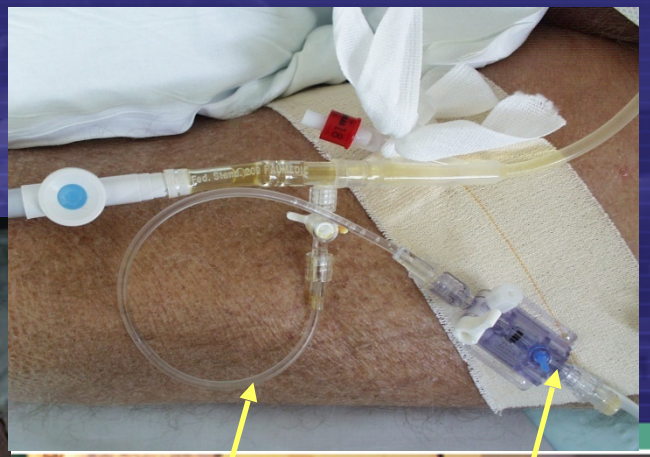
Measuring the IAP - indirect

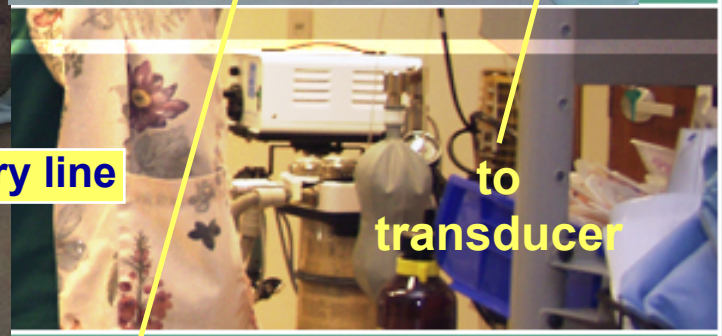
- Urine catheter held vertically
- Measure height of urine column



Measuring the IAP - transducer





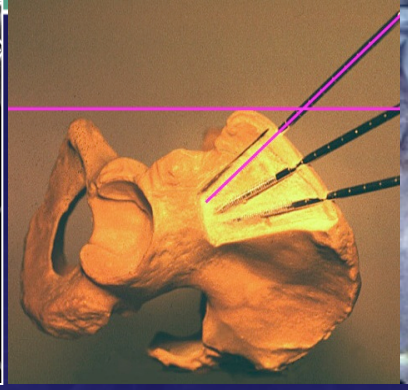


T piece

Summary

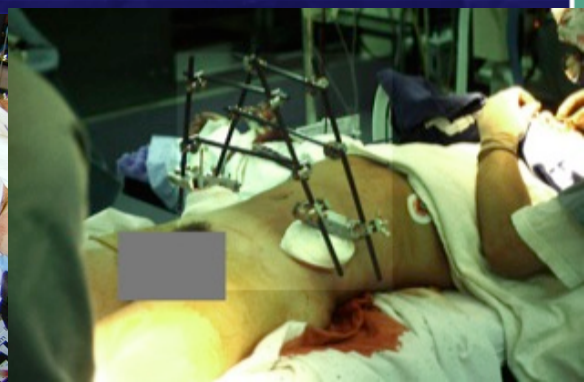
- Mechanism of injury – Blunt vs. Penetrating
- ABCDE → Stability of trauma patients
- Select appropriate diagnostic imaging
- Think about associated injuries
- Multi-modality
  - Clinical
  - FAST
  - CT Scan
  - Interventional Radiology
  - Surgical exploration





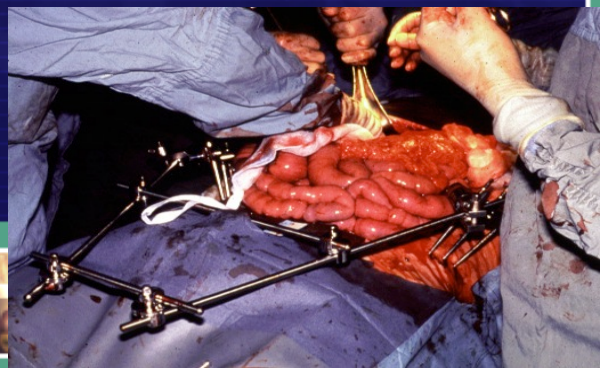

Pelvic Injury



Pelvic Injury

- **Introduction**
  - Significant blood loss if bilateral
  - may settle in retroperitoneal space
  - 3% of all fractures
  - Mortality 8 - 50%
  - 2nd most common cause of traumatic death



Pelvic Fractures & Hemorrhage: Young and Burgess Classification

Lateral Compression (LC)

Anteroposterior Compression (APC)

Vertical Shear (VS)

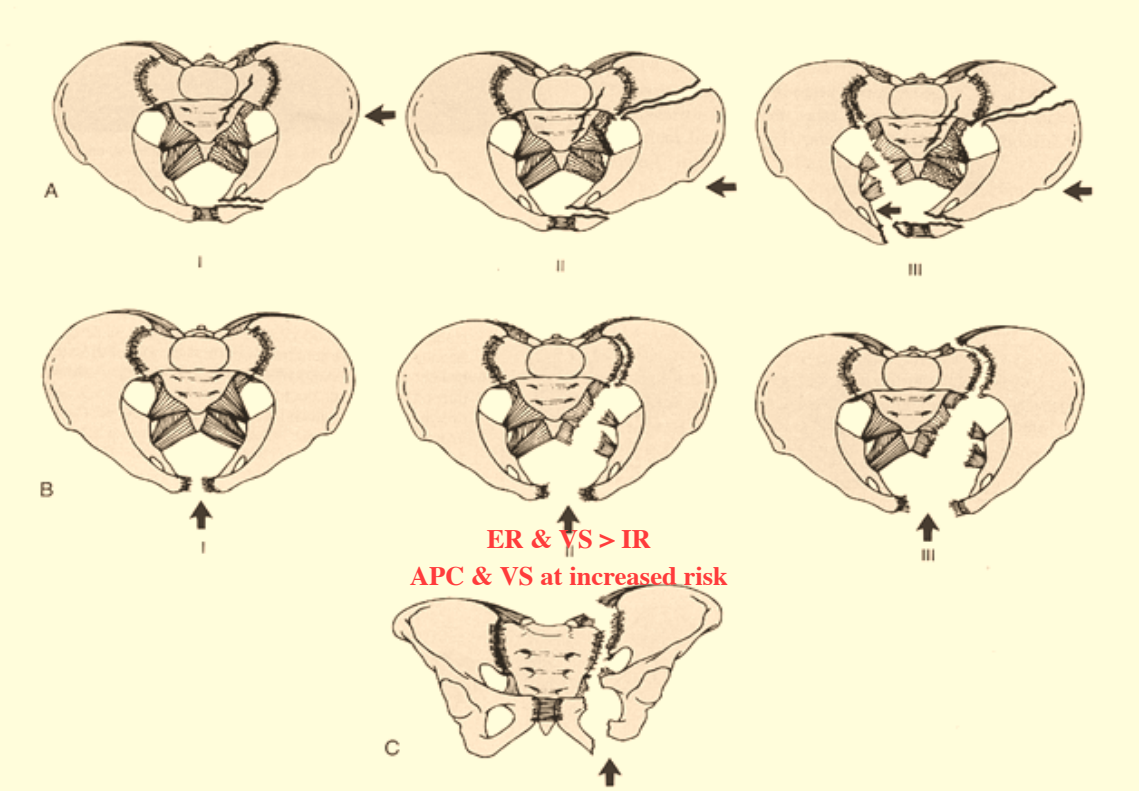
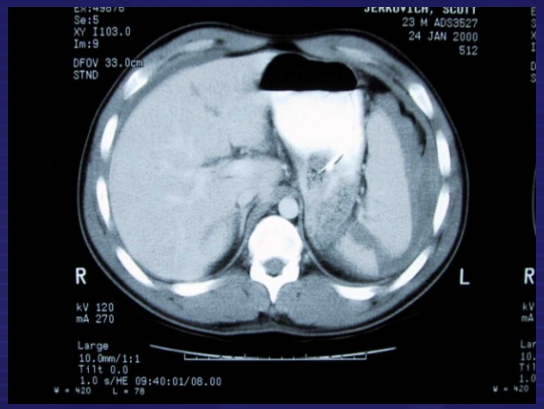
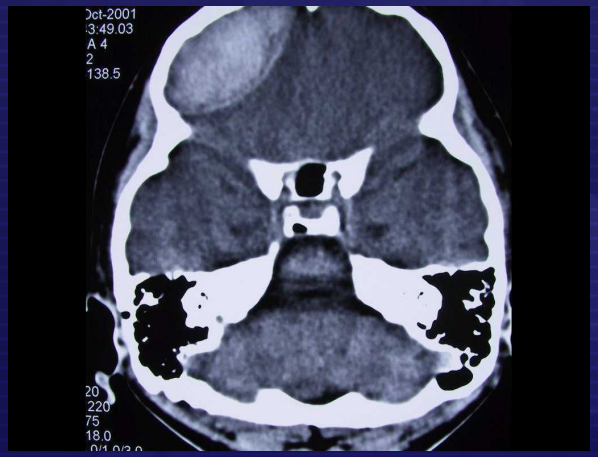


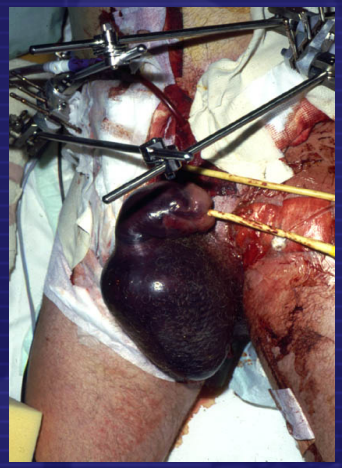
TABLE IV.2 PELVIC FRACTURES

CONDITION	IMAGE FINDINGS	SIGNIFICANCE	INTERVENTION
Pelvic fracture	**Pelvic x-ray** • Pubic ramus fracture	• Less blood loss than other types • Lateral compression mechanism	• Volume replacement • Probable transfusion • Decreased pelvic volume • Pelvic binder • External fixator • Angiography • Skeletal traction • Orthopedic consultation
	• Open book	• Pelvic volume increased • Major source of blood loss	
	• Vertical shear	• Major source of blood loss	
Visceral organ injury	**CT scan** • Intraabdominal hemorrhage	• Potential for continuing blood loss • Performed only in hemodynamically normal patients	• Volume replacement • Possible transfusion • Surgical consultation

Associated injuries







- Chest / abdomen 23%
- Genitourinary 17%
- Head injury 31%

Associated injuries

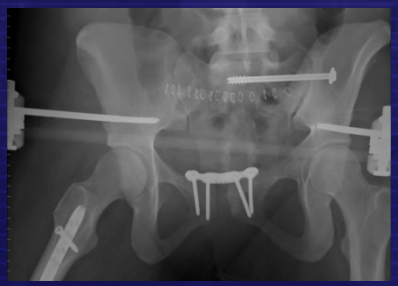
- Sacral nerve injuries
- Rectal perforation
- Vaginal perforation
- Bladder and vesical injuries
- Spinal injuries
- Femoral fractures
- Long-term disability

Mortality

- Uncontrolled haemorrhage
  - Chest
  - Abdomen
  - Retroperitoneal
- Other unsurvivable injuries
  - i.e. neurological injury
- Multiple organ failure
- Sepsis

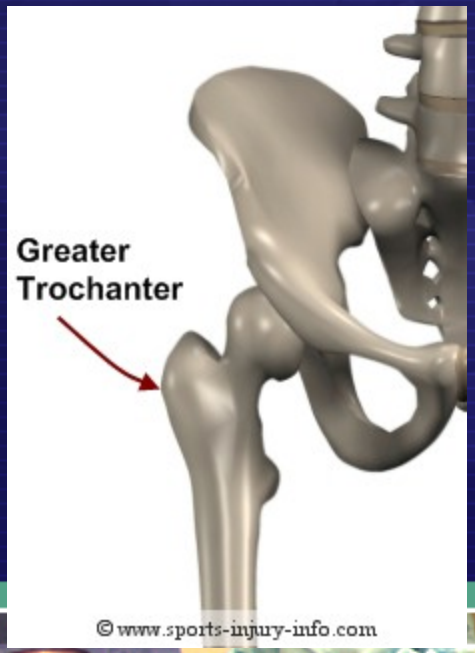
Procedures-pelvic

- Sheet wrap
- External fixation
- Internal fixation
- Pelvic packing
- Angiography



Draw Sheet Method cont.

Locate the great trochanter



Wrap and twist the running ends around the pelvis

This method can also be used while patients are in the car

Sheet wrap

Advantages

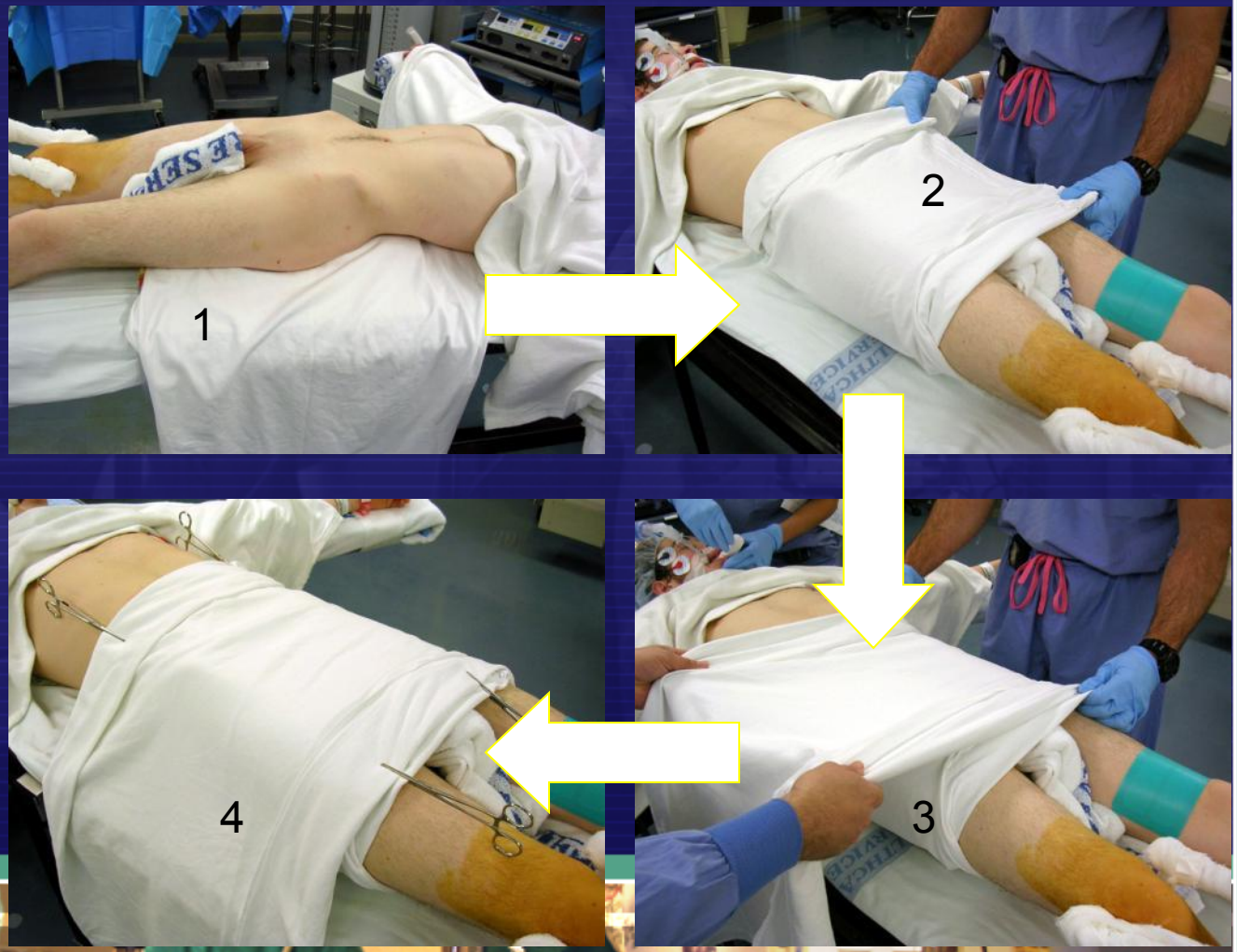
- Quick and easy
- Inexpensive
- Can do in ED
- Good tamponade of expanding haematoma

Disadvantages

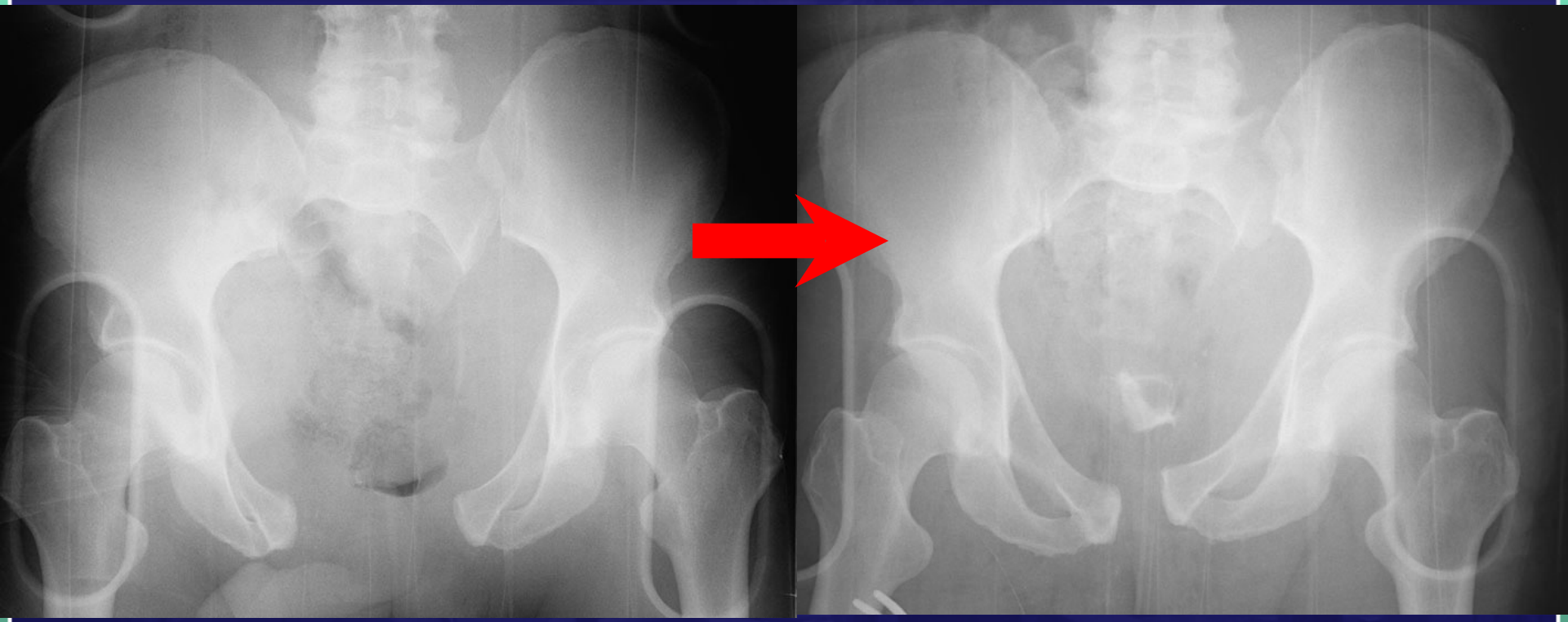
- Not definitive stabilisation
- May impact on exposure

Circumferential Sheeting

- Supine
- 2 “Wrappers”
- Placement
- Apply
- “Clamper”
- 30 Seconds



Routt et al, JOT, 2002



Before

After

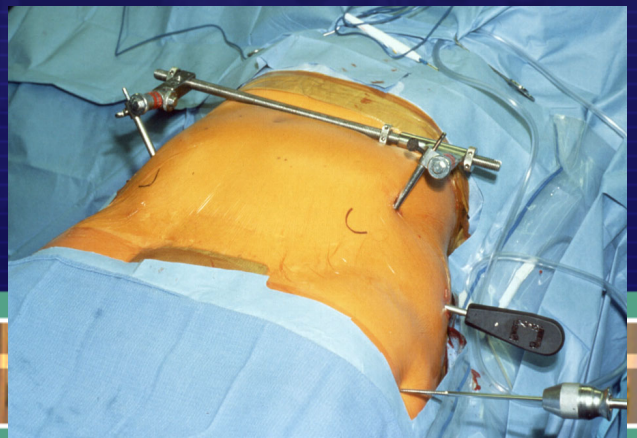
External fixation

Advantages

- Good control of anterior instability
- Exposure not a problem
- Low complication rate
- Biomechanically ideal

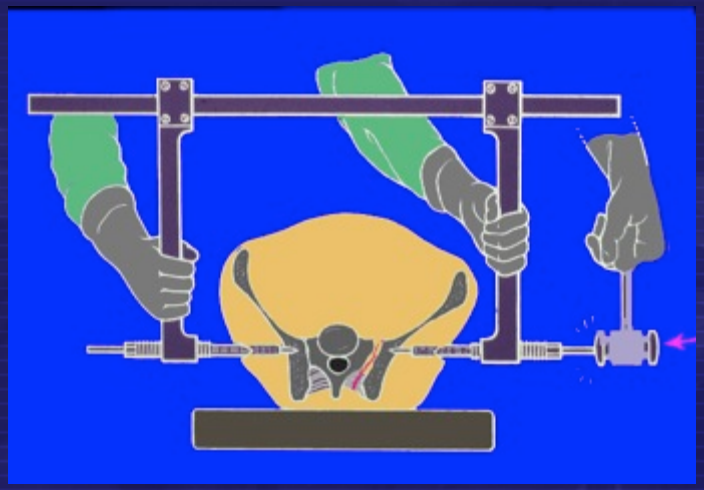
Disadvantages

- Detailed anatomical knowledge required
- Technically demanding
- Not definitive



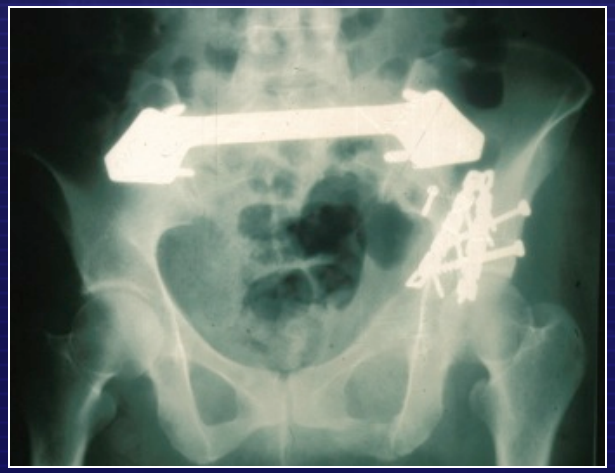
Immediate External Fixation

Pelvic “clamps”

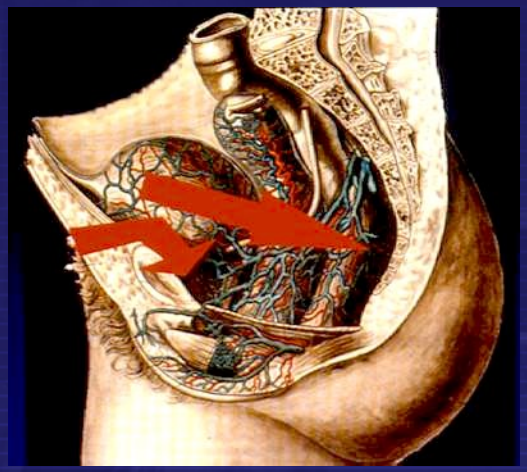


Open internal fixation

- Big exposures
- Unavoidable complication rate
- Timing problematic in multiple trauma



Pelvic Packing



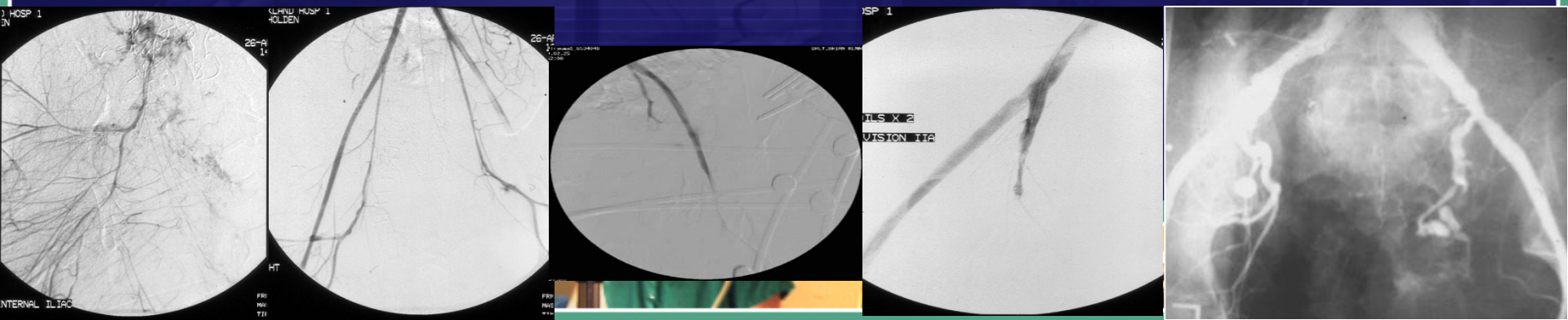
- Ertel, W et al, JOT, 2001
- Pohlemann et al, Giannoudis et al,

Extraperitoneal Packing: Internal Fixation

- Success at Hannover/Denver
- Pack only, don’t ligate
- Fix fractures easily exposed

Interventional Angiography

- Much hemorrhage is venous
- Timeliness & availability of intervention
- Angiography suite not optimal for resuscitation
- Useful adjunct to other methods

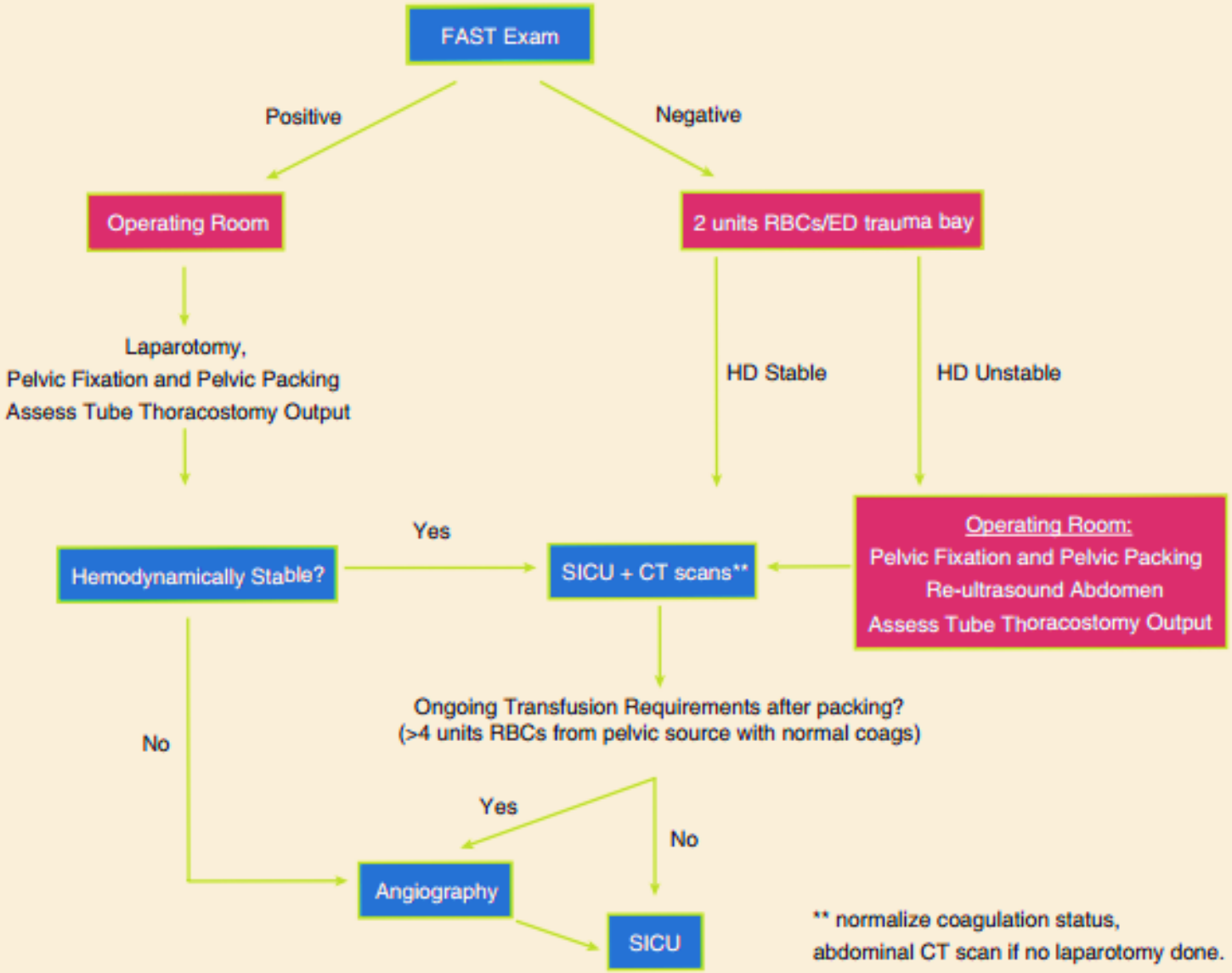


Resuscitate with 2 L crystalloid – measure base deficit – rule out thoracic source (portable chest radiograph) – sheet the pelvis.

If immediate red blood cell (RBC) transfusion, discuss the role pelvic packing (alert the operating room).

Transfuse fresh frozen plasma (FFP) and RBC 1:2; 1 apheresis unit of platelets for each 5 units RBCs; perform thromboelastography.

Immediate notification: Attending Trauma Surgeon, Attending Orthopaedic Surgeon, blood bank resident, IR fellow



Prioritization

- ABC's
- Binder/Sheet
- Exclude other injury
- Depending on needs;
  - Access to angiogram
  - Laparotomy
  - Perineal debridement
- Temporizing external fixation
- Percutaneous methods
- Definitive Fixation


Thank You