One in a Million…

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Disclosures

- I have NO financial disclosures or conflicts of interest with the presented material in this presentation

What Makes Trauma Exciting/Challenging?

- ***In the trauma bay*** - Making critical treatment decisions in a very short period of time with very limited information

- ***In the OR*** - Being prepared to manage injuries that are extremely rare or injuries that you may not have seen before (ie “one in a million” injuries)

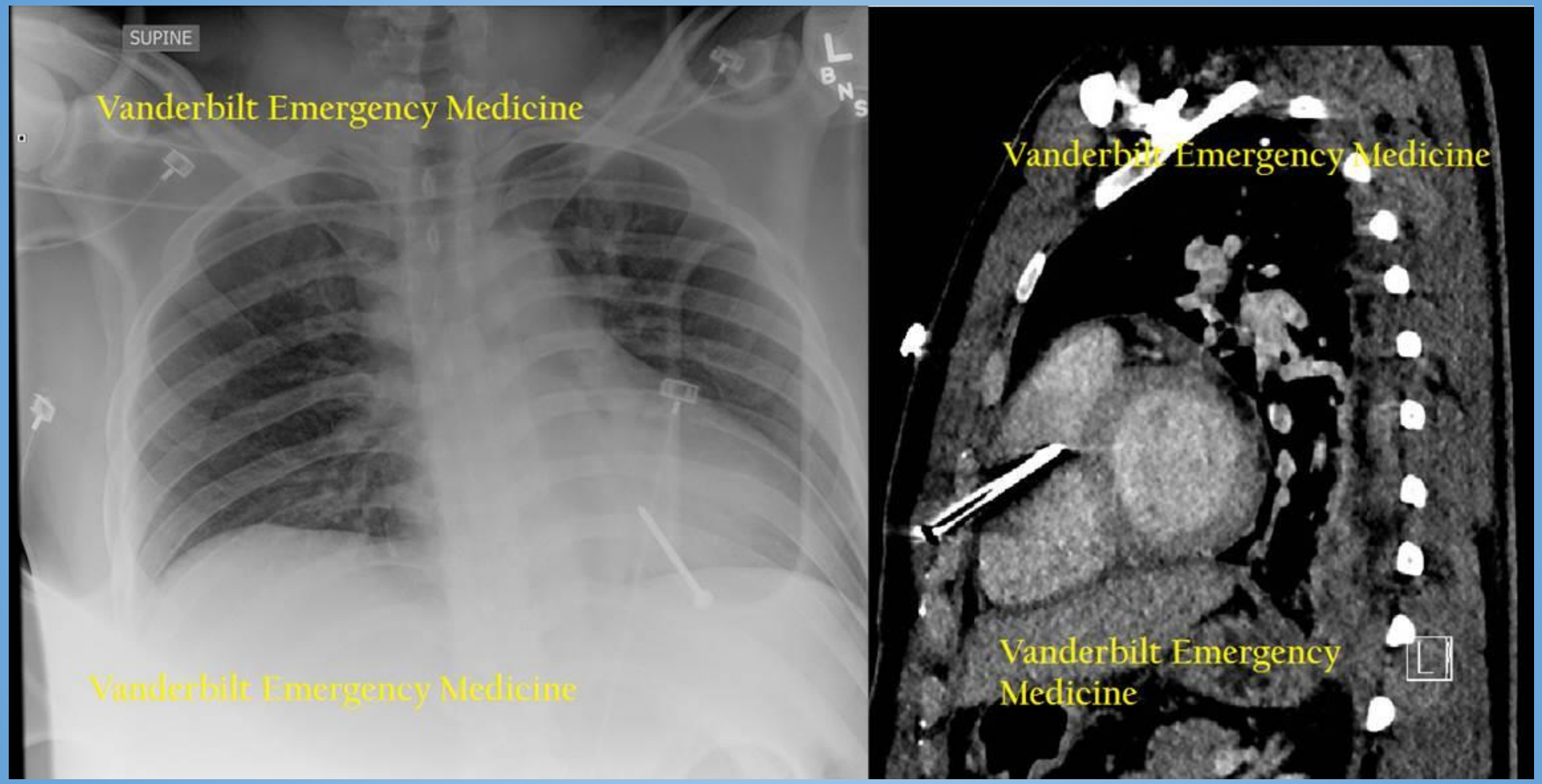
What ‘One in a Million” Means to Lloyd Christmas

So You're Telling Me There's a Chance…

Trauma surgeons spend much of their training preparing for injuries that they might never see…

Some of the Cool/Rare Things I've Seen

(or have pictures of…)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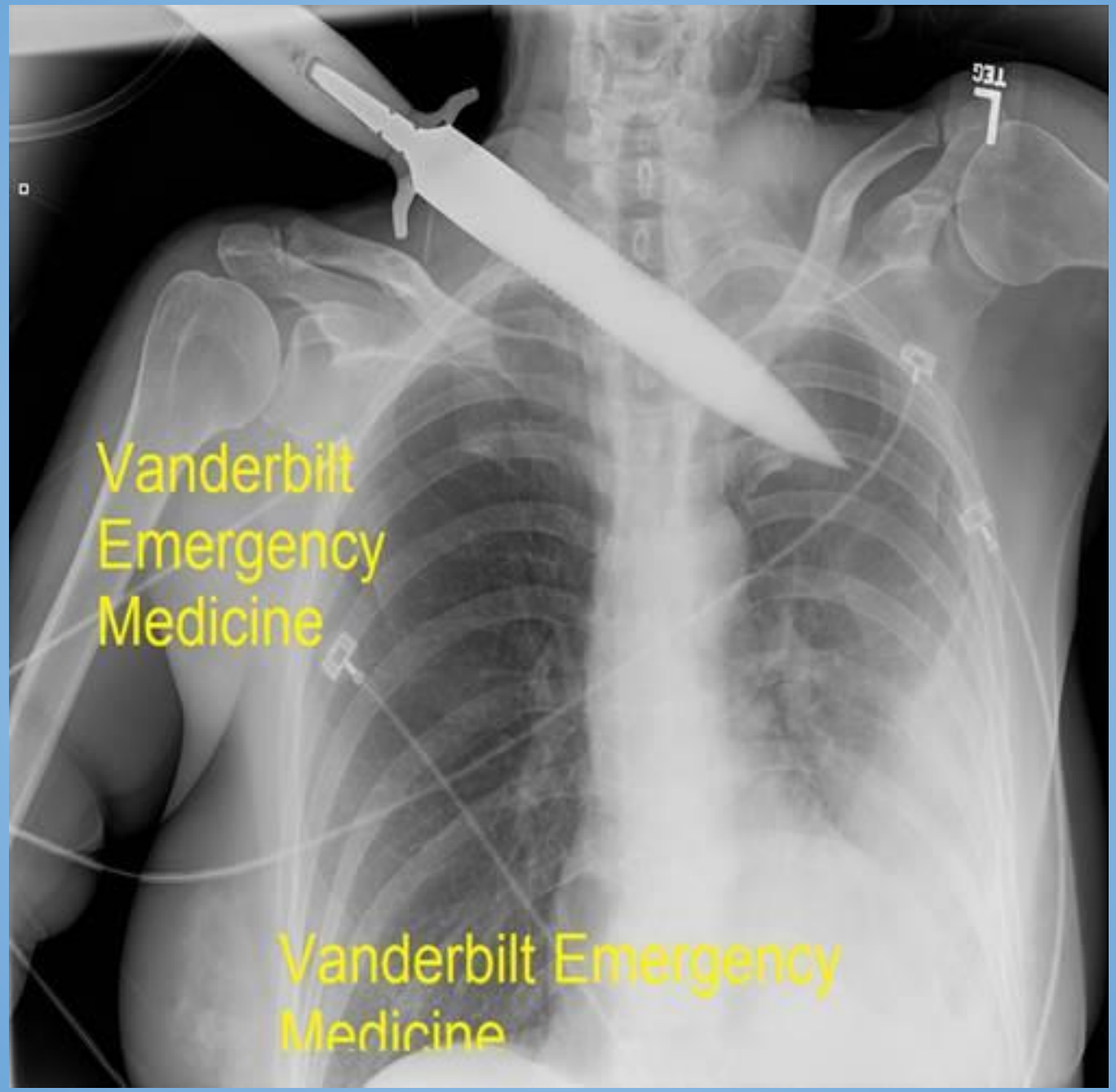
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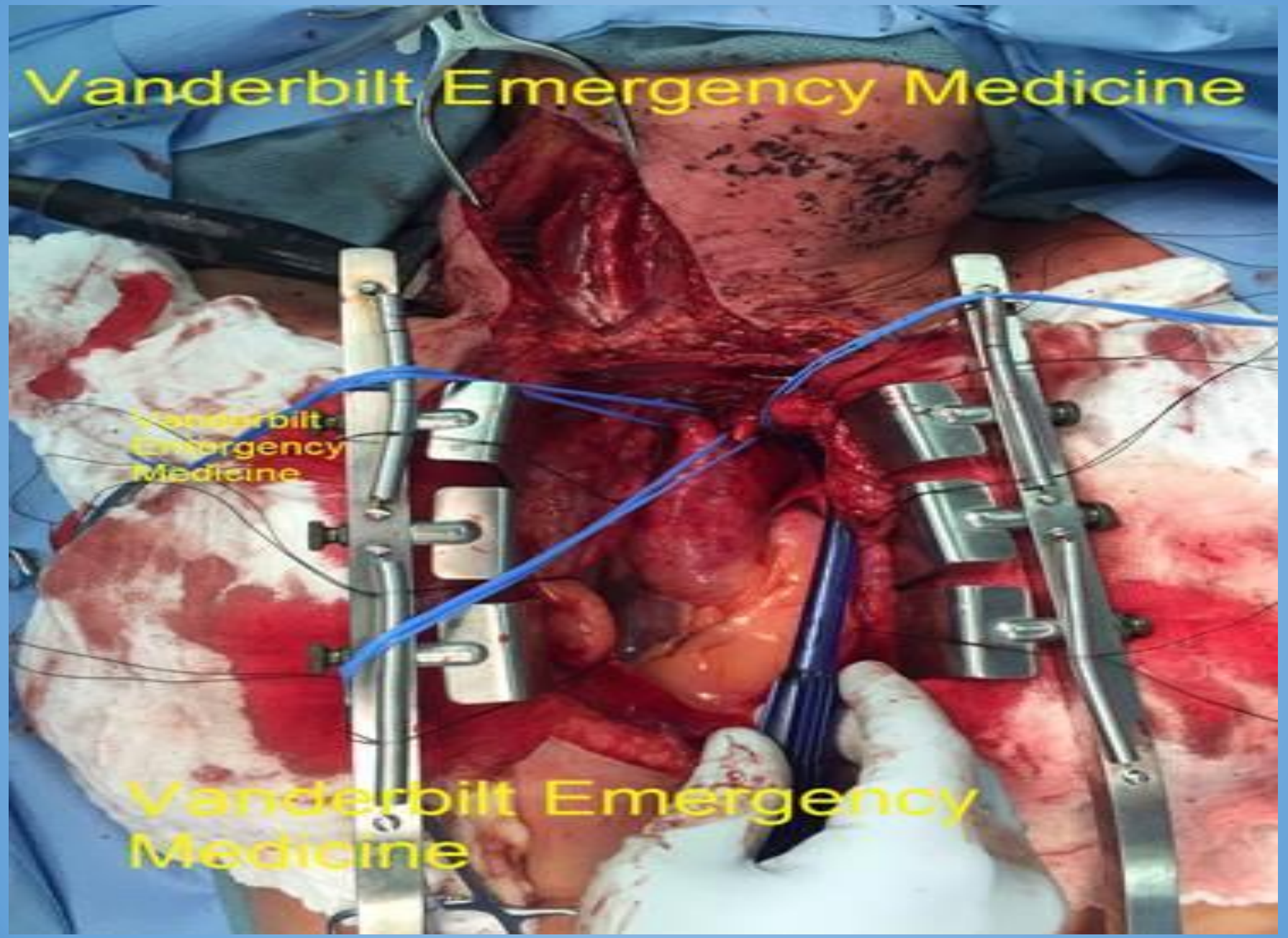
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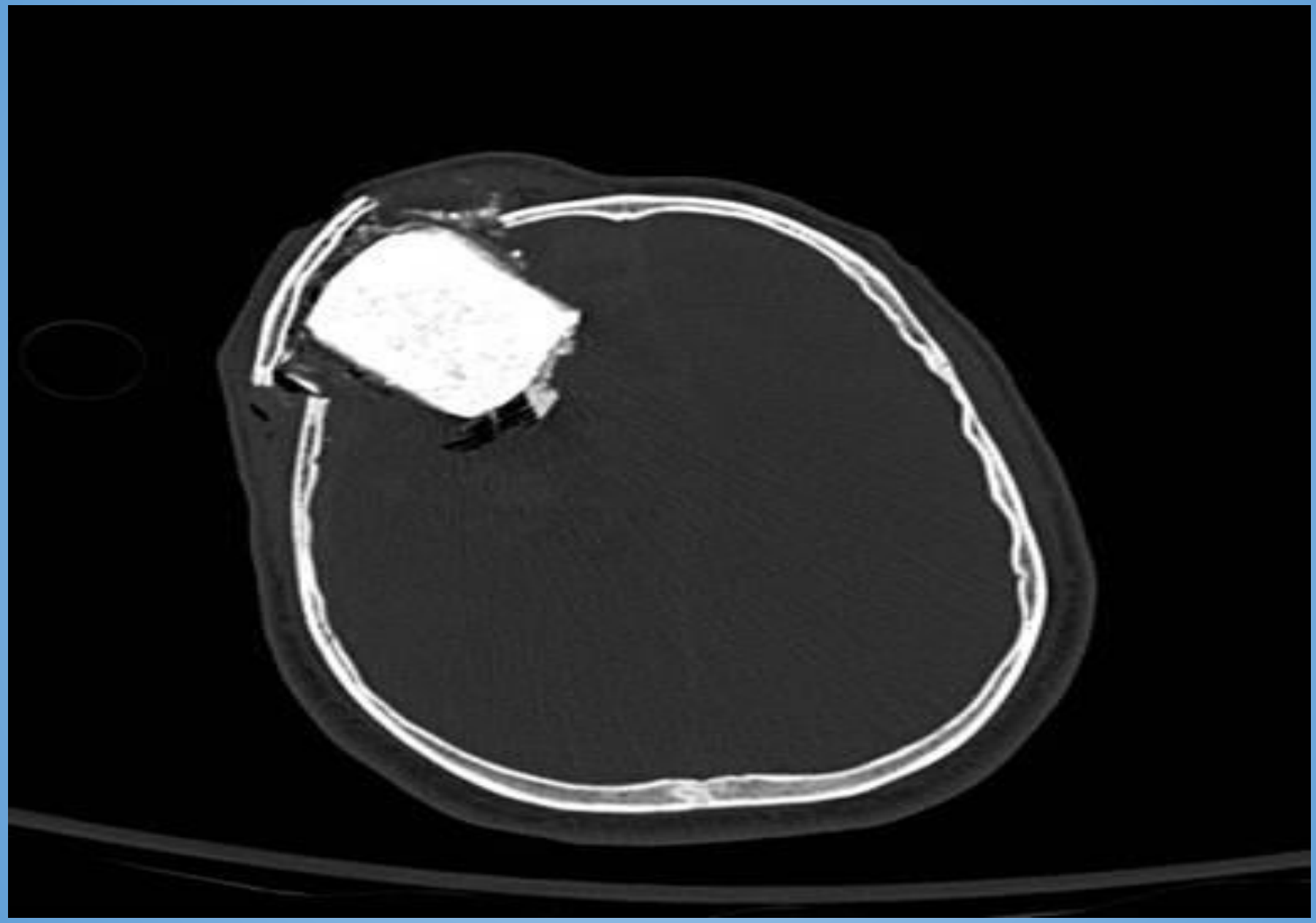

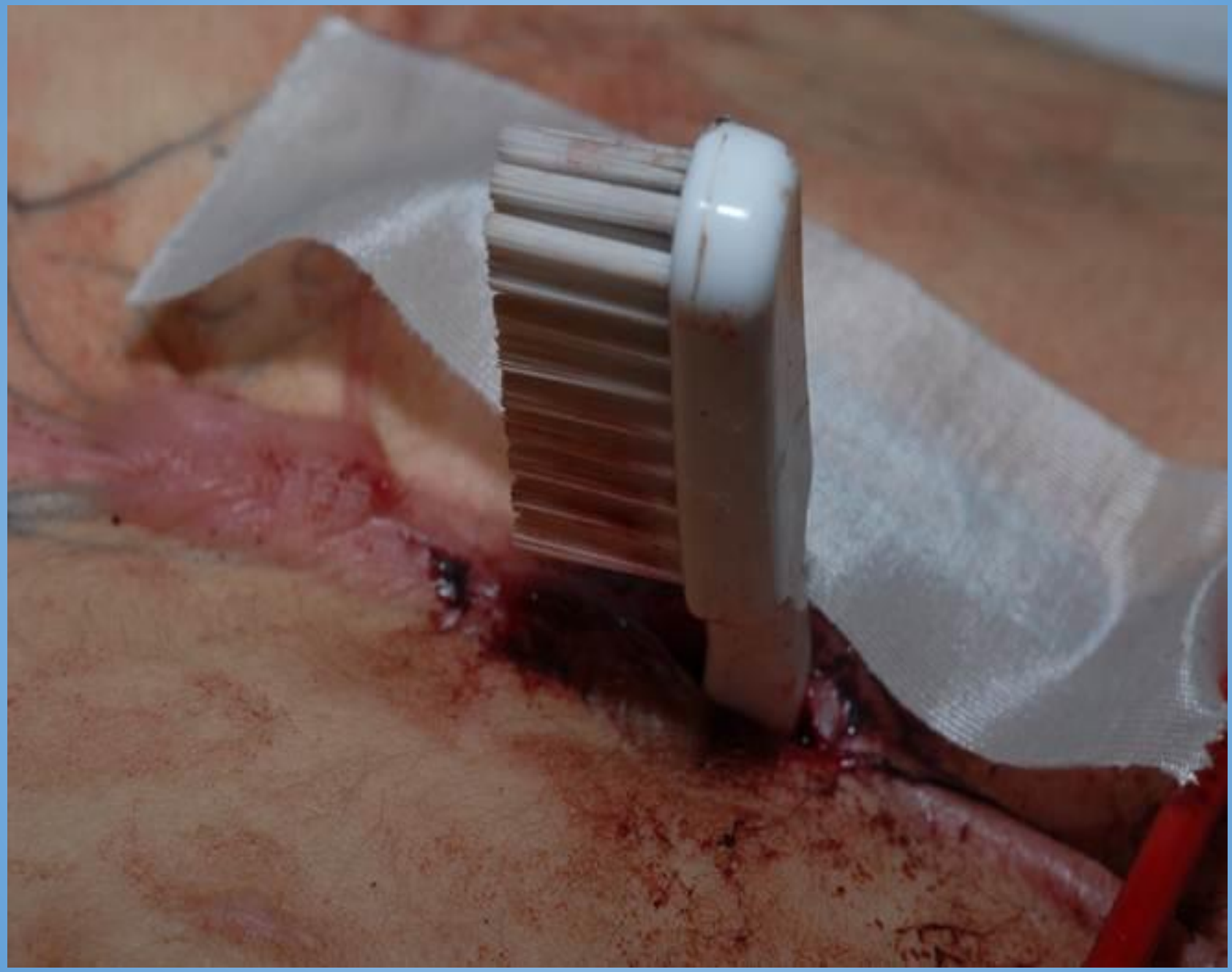

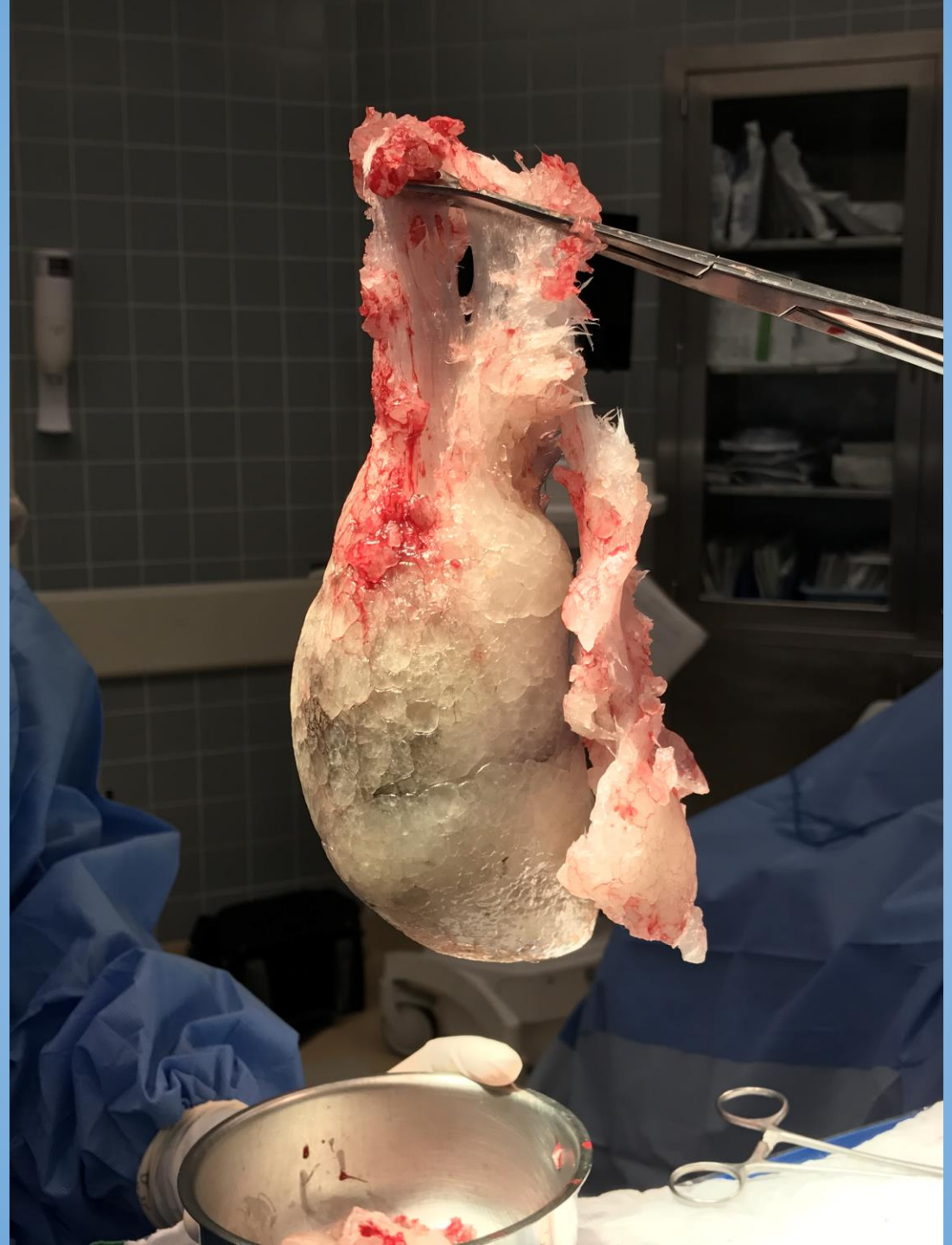

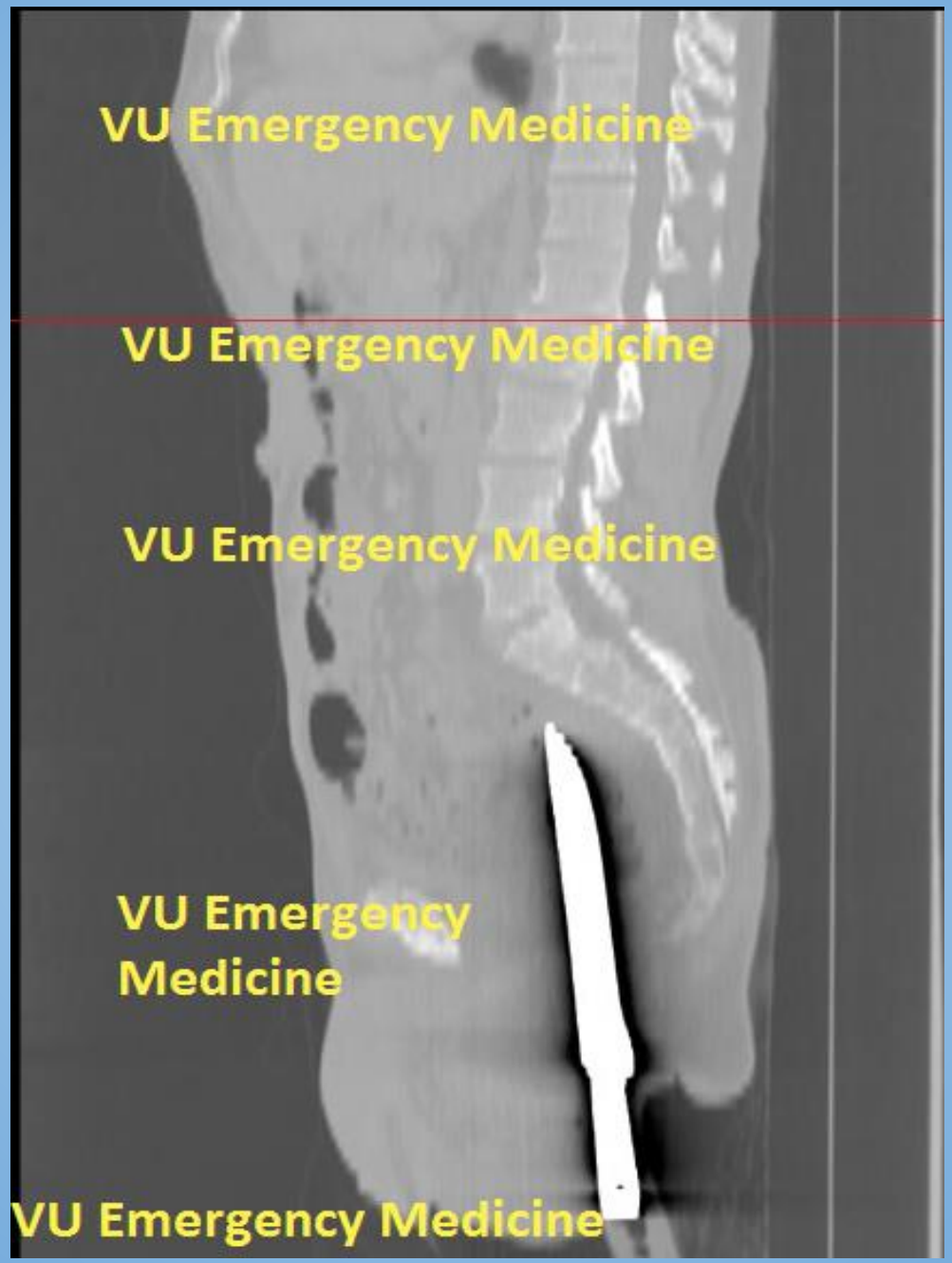
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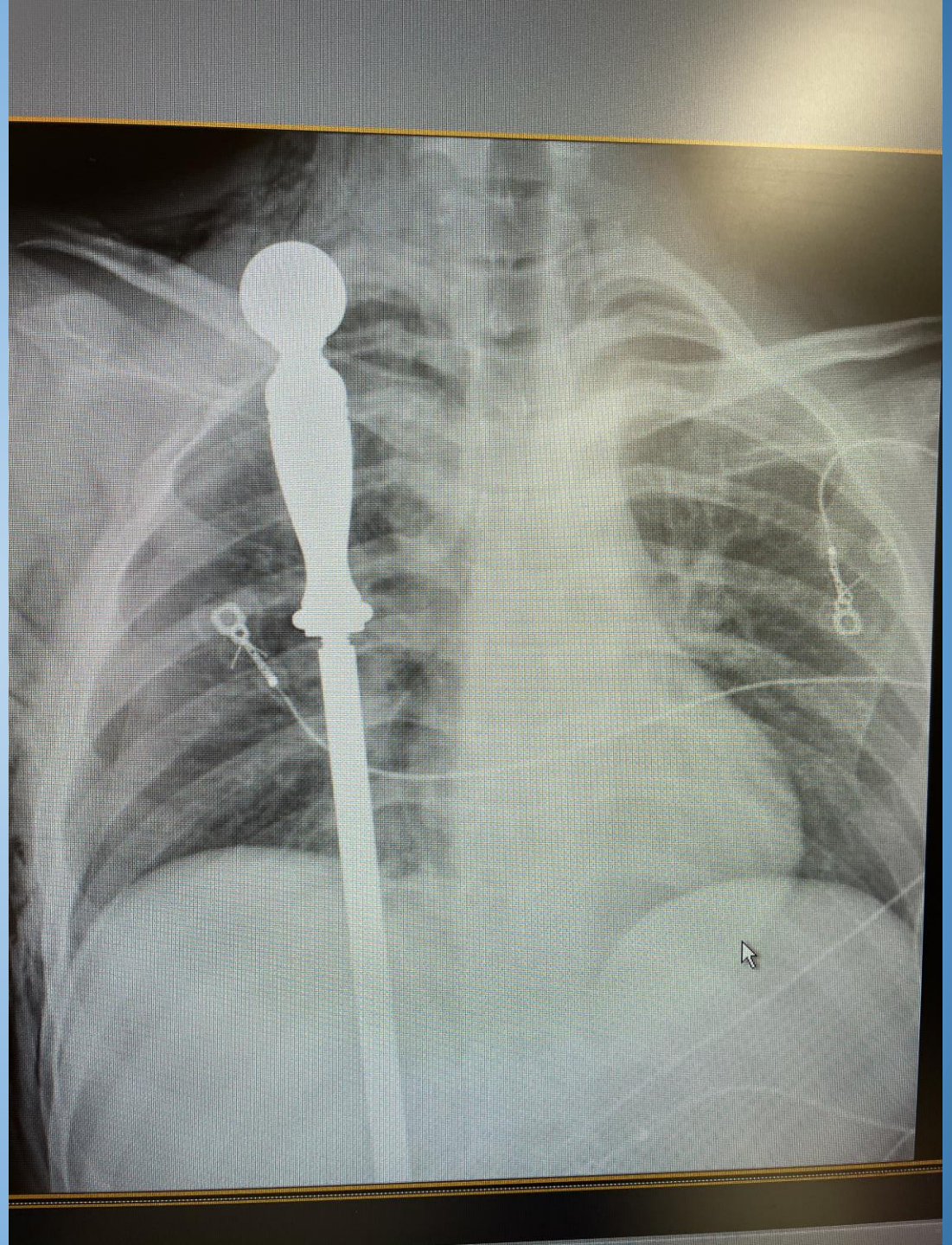


What Lessons Can We Learn Today re: Rare Injuries?

“The Eyes Don’t See What the Mind Doesn’t Know”

Case #1

- Level 2 trauma alert
- 6 y/o found on floor board of rear seat after head-on collision at highway speeds with stationary object.
  - Was in car seat that was not secured per report.
- On arrival, moaning but guards abdomen.
- BP 70/20's and tachycardic to 140s

Case #1

- VBG with initial ph 7.13, Hb 9.9, BE -13
- Pt intubated
- CXR and pelvis XR grossly unremarkable.
- Emergency blood given with positive fast in RUQ and pelvis
- Decision made to bring to OR for ex lap based on hypotension and positive fast.

Case #1 – In the OR

- 1. Exploratory laparotomy for trauma
- 2. Median sternotomy
- 3. Repair of retrohepatic/suprahepatic IVC injury
- 4. Ligation of avulsed hepatic vein(s)
- 5. Retroperitoneal packing
- 6. Negative pressure wound therapy dressing closure to thoracoabdominal incision

Case #2

- Level 1 trauma alert
- 55 y/o M s/p self-inflicted GSW to lower chest, with trajectory thought to be thoracoabdominal on cxr
- Hypotensive in 70’s on arrival
- Right chest tube placed with almost 1 liter out immediately
- Four units uncrossed blood given with MTP ordered and re-directed to OR.

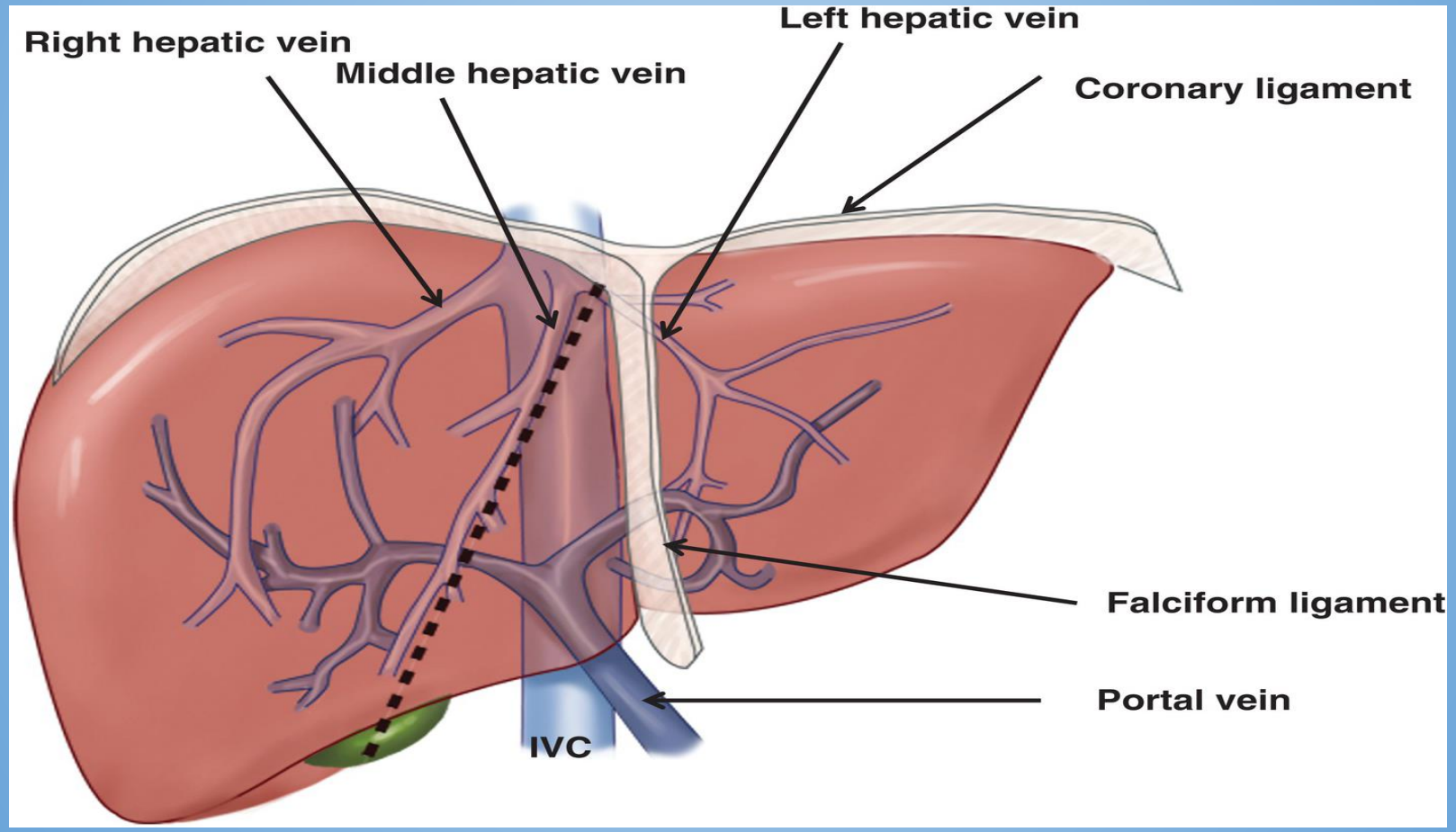
Case #2 – in the OR

- GSW entry site just above xiphoid process
- Moderate amounts of hemoperitoneum in upper abdomen on entry
- Pericardiotomy and diaphragm injury with drainage of venous blood into abdomen, without large ongoing bleeding from pericardium
- Trajectory through left lobe of liver, with complete separation of far left lateral portion
- Trajectory entering retroperitoneum through medial aspect of retrohepatic vena cava

Case #2 – In the OR

- Exploratory laparotomy with exploration of retroperitoneum
- Median sternotomy, pericardiotomy, pericardial patch repair of retrohepatic IVC
- Excisional debridement of devascularized left lateral lobe of liver
- Temporary abdominal and chest closure with negative pressure wound therapy dressing

Retrohepatic Vena Cava Injuries



Retrohepatic Vena Cava Injuries

- Retrohepatic venous injury presents as a rare but frequently lethal complication of trauma.
  - Half of patients with IVC injuries die before reaching the hospital
  - Those reaching the hospital have reported survival rates of 20-57%

- The anatomic arrangement makes management of these injuries difficult at best.

Retrohepatic Vena Cava Injuries

- Mortality decreased if the patient reaches the operating room
- Associated higher mortality with suprarenal injuries
- Late deaths from sepsis, DIC, or MSOF remain as significant causes of overall mortality

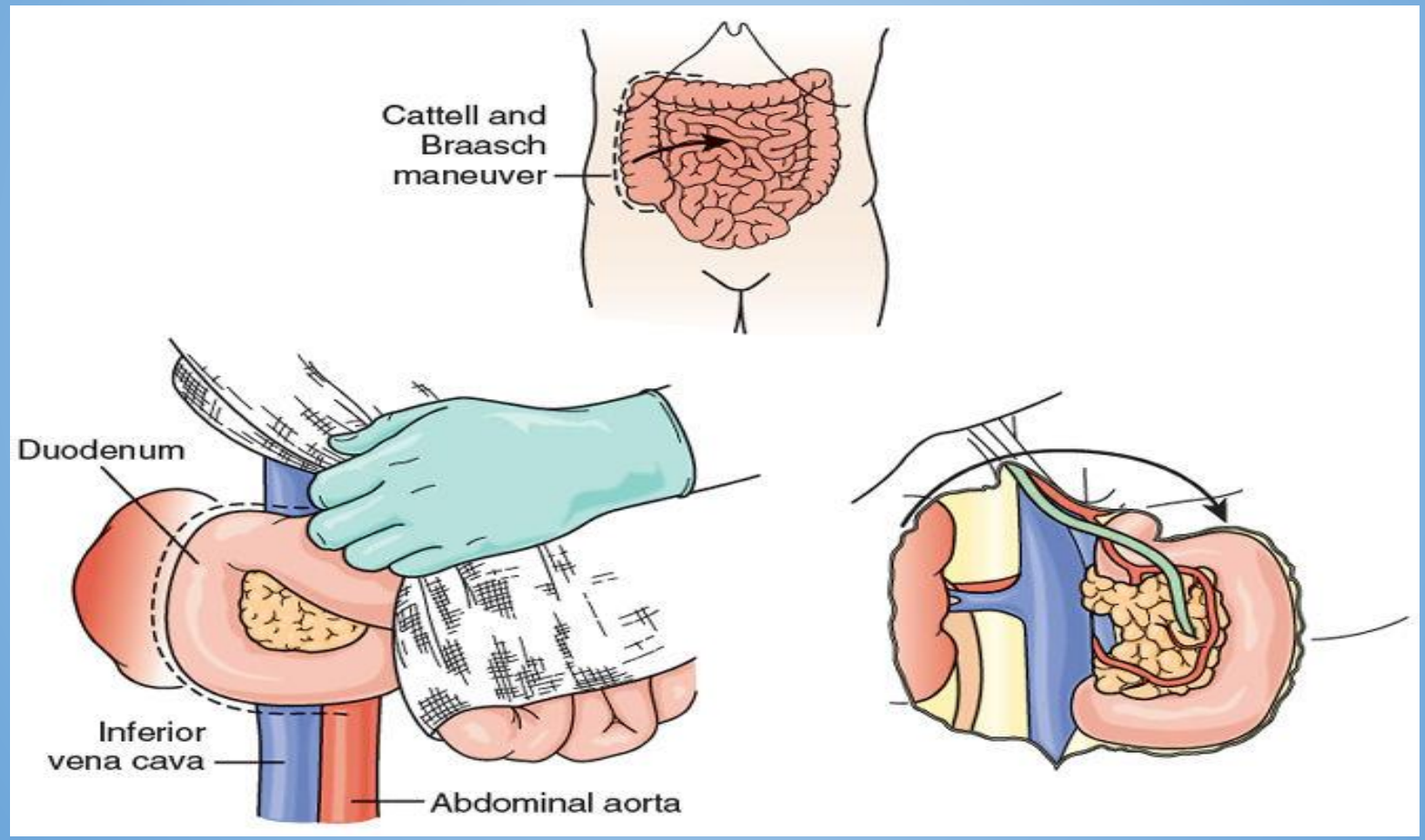
Operative Exposure and Isolation Techniques

- **Infrarenal/juxtarenal IVC**
  - Best exposed by medial rotation of the right colon, hepatic flexure of colon, and duodenum (Cattell Braasch maneuver)

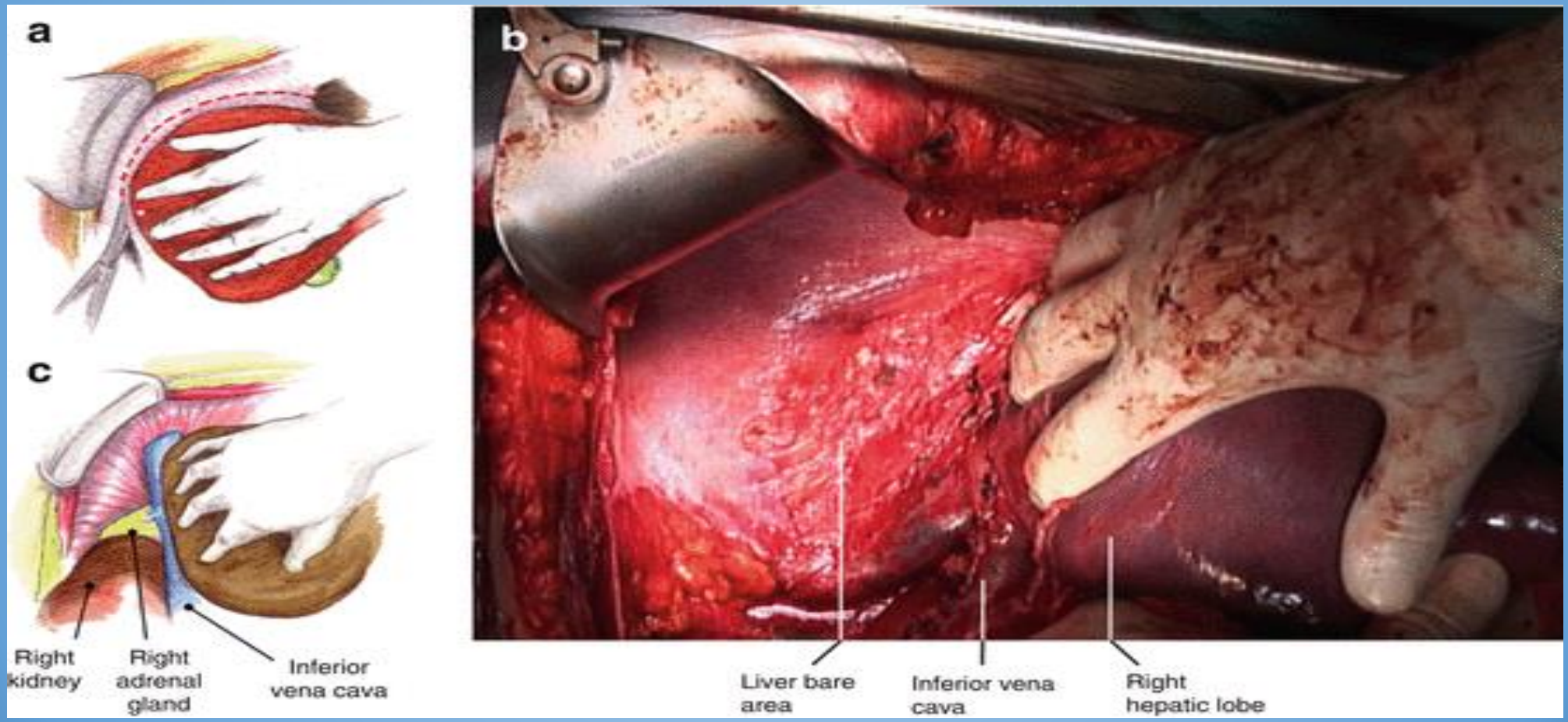
- **Total hepatic exclusion**
  - Cross-clamping the aorta, portal triad, suprarenal vena cava, and suprahepatic vena cava
  - Failure to clamp aorta first may result in severe hypotension and then cardiac arrest due to reduced venous return

- **Internal shunts**
  - Atriocaval/Schrock shunt

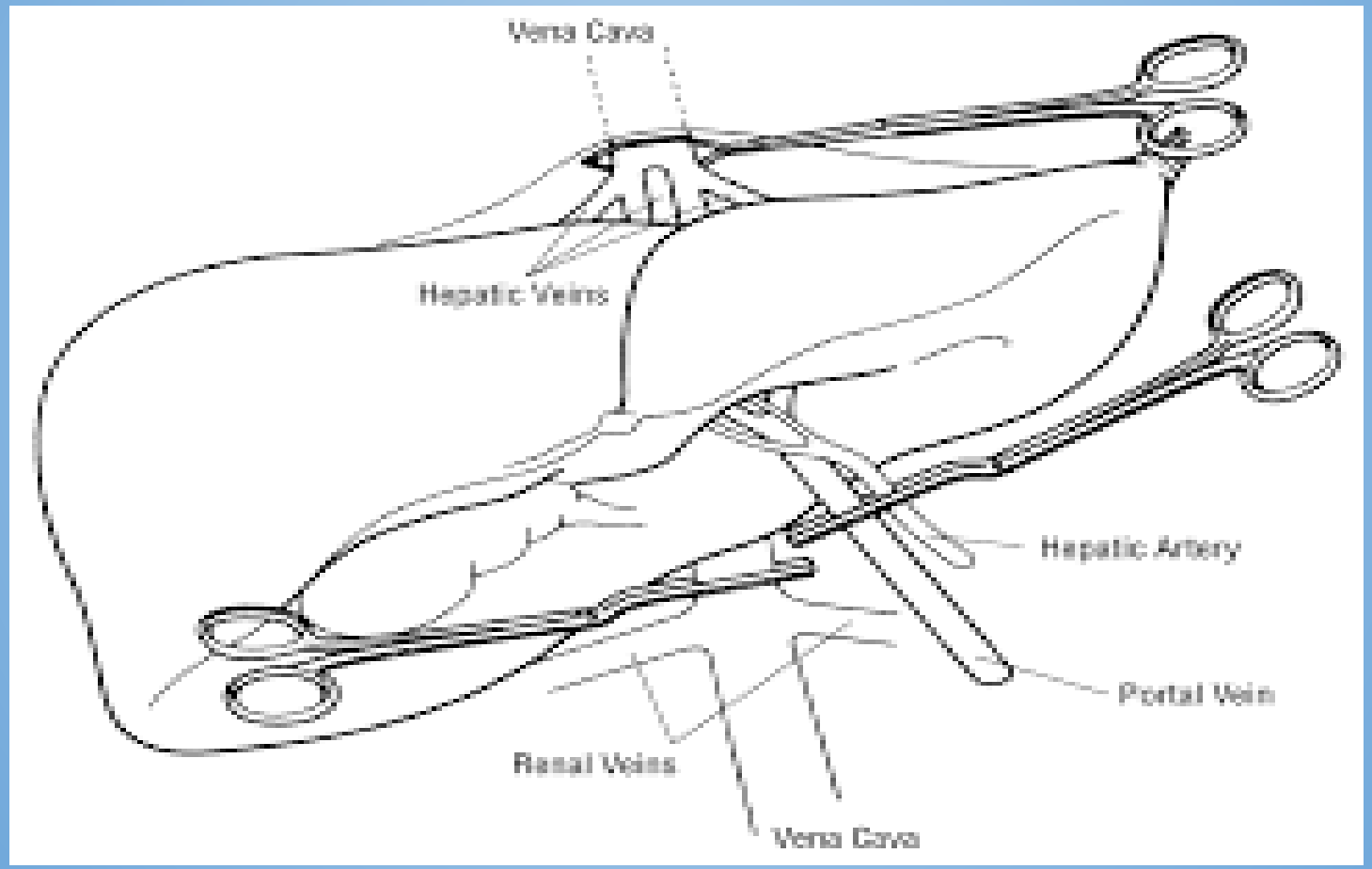
Cattell Braasch Maneuver



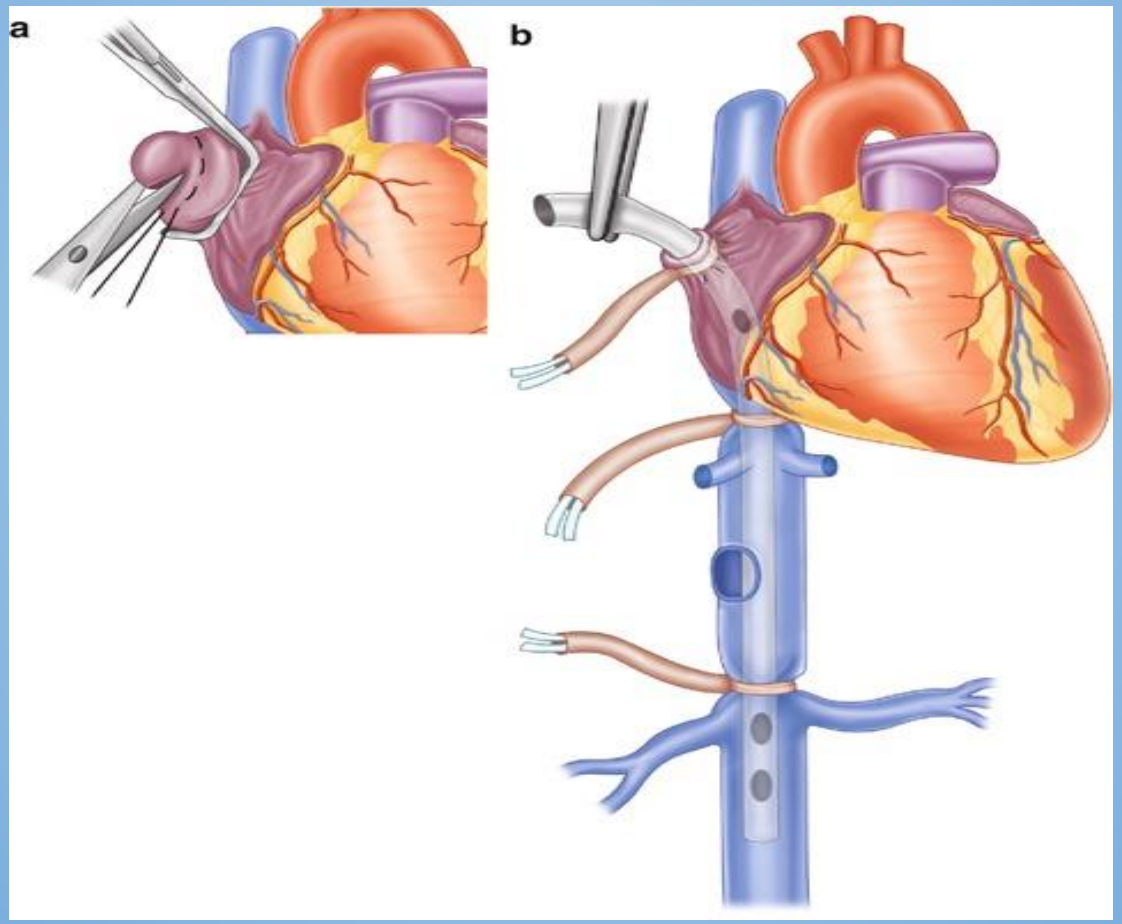
Exposure of Retrohepatic IVC



Total Hepatic Isolation



Atriocaval Shunt



https://www.youtube.com/watch?v=GoTBRUO_xkM

Ligation of IVC

- Can be considered below the renal veins in very unstable patients or those with significant stenosis after repair
- Post-op patients should have lower extremities wrapped in firm elastic bandages and elevated, edema usually subsides in several weeks
- Patients may develop compartment syndrome and require fasciotomies

Back to the Cases…

What happened??

Case #1 - A Nice Save….

- Intraoperative had end tidal co2 of zero for 5 mins
- Postop her venous return in her liver is collateralizing via her right hepatic vein into her cava on CT
- Discharged after 2 week hospital stay
- Follow up clinic appointment – Only complaint was of some chest pain when doing backflips off the couch….

Case #2 – Another Nice Save

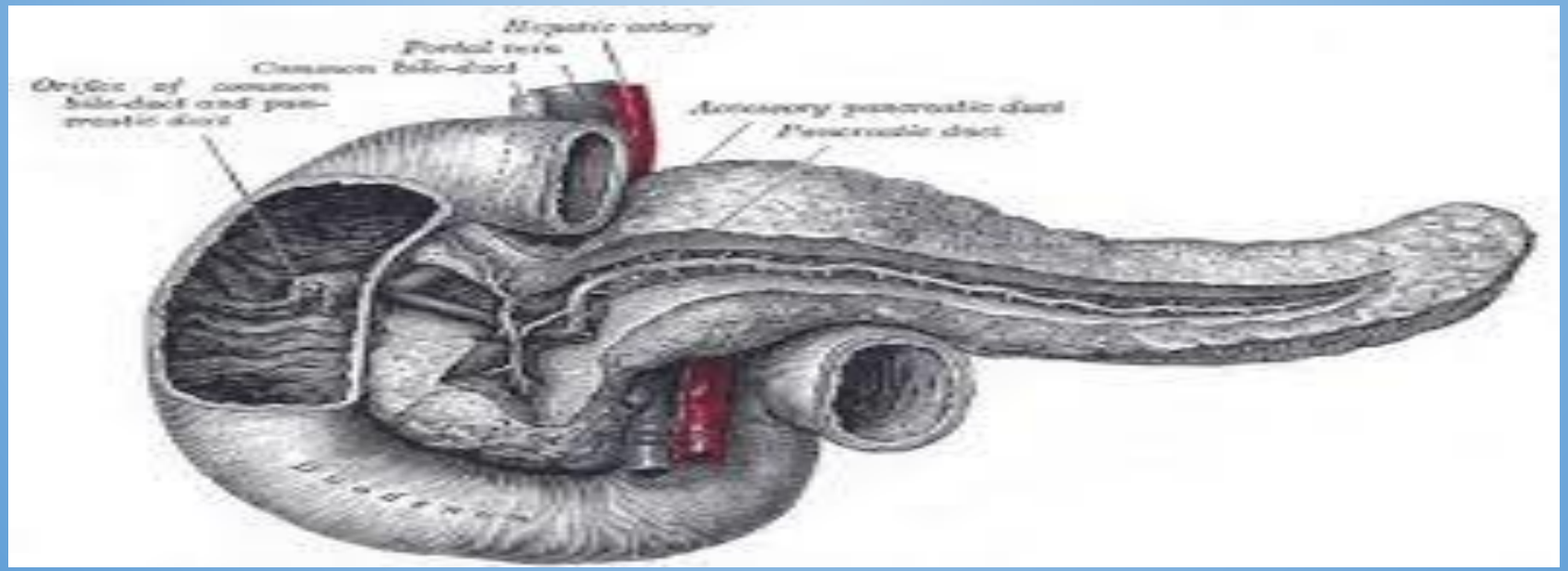
- Discharged after 2 week hospital stay
- Doing well on post-op clinic visit
- Awesome save considering he has been down for several days in his apt before he was even found

Case #3

- 9 y/o boy presents with epigastric pain x 3 weeks after fall on a bicycle handlebar
- Patient comfortable but mildly dehydrated
- Vitals stable, afebrile, abd TTP epigastrium
- Serum amylase 1864 U/L
- CT scan reveals pancreatic transection with pseudocyst formation
- Management?

Three Tenets of Surgical Training

- 1) Eat when you can
- 2) Sleep when you can
- 3) **Don’t *%$# with the pancreas**

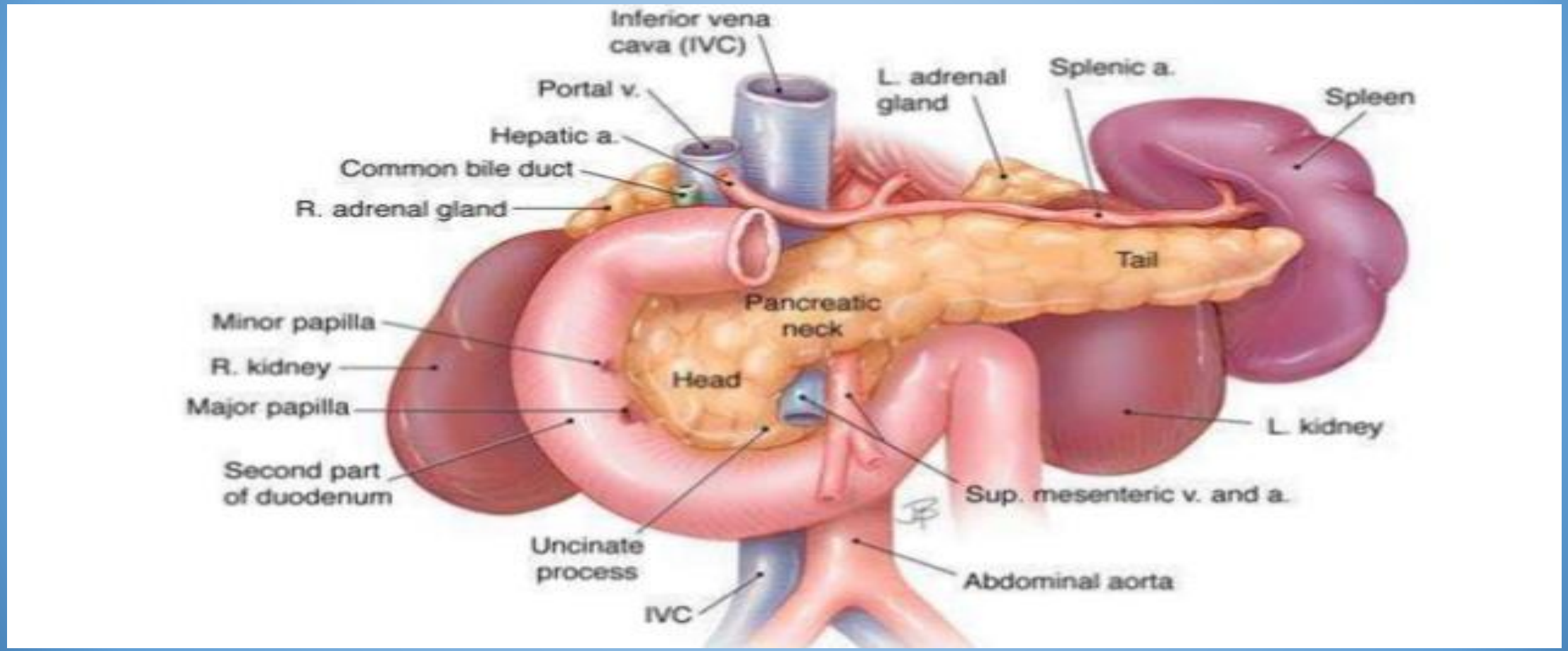


Anatomy

- Pancreas lies in a relatively protected position high in the retroperitoneum
  - Infrequently injured in typical blunt injuries (eg, MVC) compared with its splenic and hepatic counterparts
- Conversely, penetrating abdominal trauma
  - More frequently includes pancreatic injury
- Most patients with pancreatic injuries sustain multiple other significant injuries
  - Compounds an already high mortality rate

High Morbidity/Mortality

- Proximity of vascular structures to the head of the pancreas has a marked effect on morbidity and mortality
  - **Subhepatic IVC and the aorta**
  - **Superior mesenteric vein** coalesces in the **portal vein**
  - **Splenic artery** and **splenic vein**


Inferior vena cava (IVC)
Portal v.
Hepatic a.
Common bile duct
R. adrenal gland
L. adrenal gland
Splenic a.
Spleen
Tail
Pancreatic neck
Head
Minor papilla
R. kidney
Major papilla
Second part of duodenum
Uncinate process
IVC
Sup. mesenteric v. and a.
Abdominal aorta
L. kidney

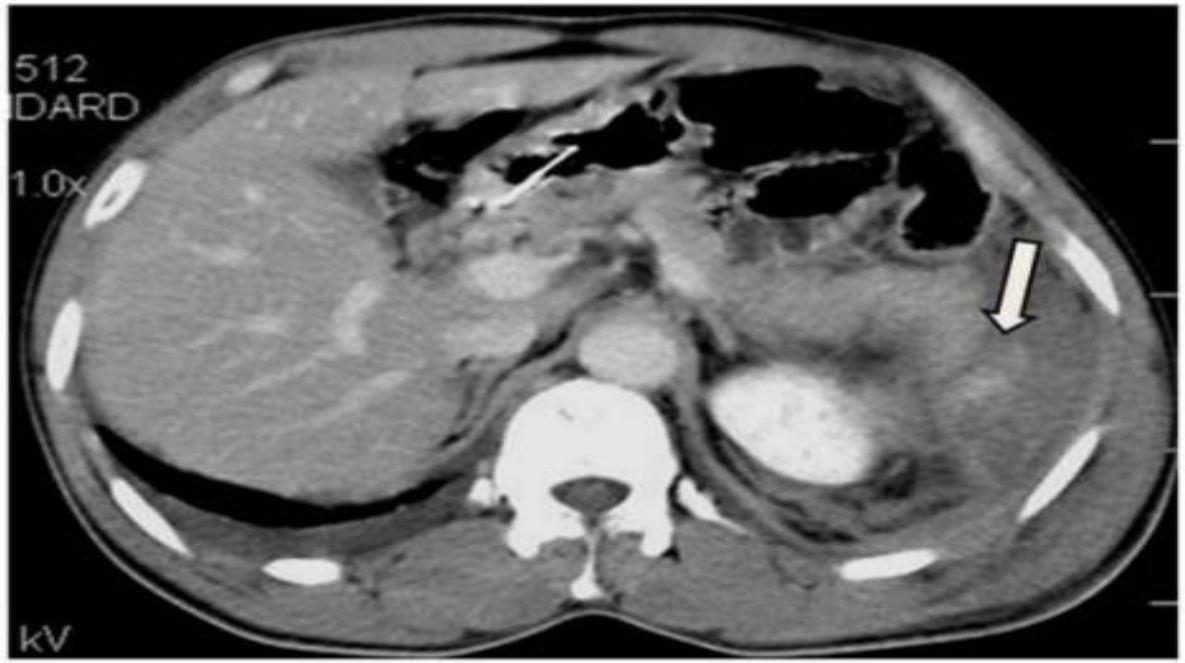
Physical Exam

- Seat belt marks
- Flank ecchymoses, or penetrating injuries
- Dull epigastric pain or back pain
  - Due to contained fracture of the spleen with retroperitoneal hematoma or leak
- Severe peritoneal irritation

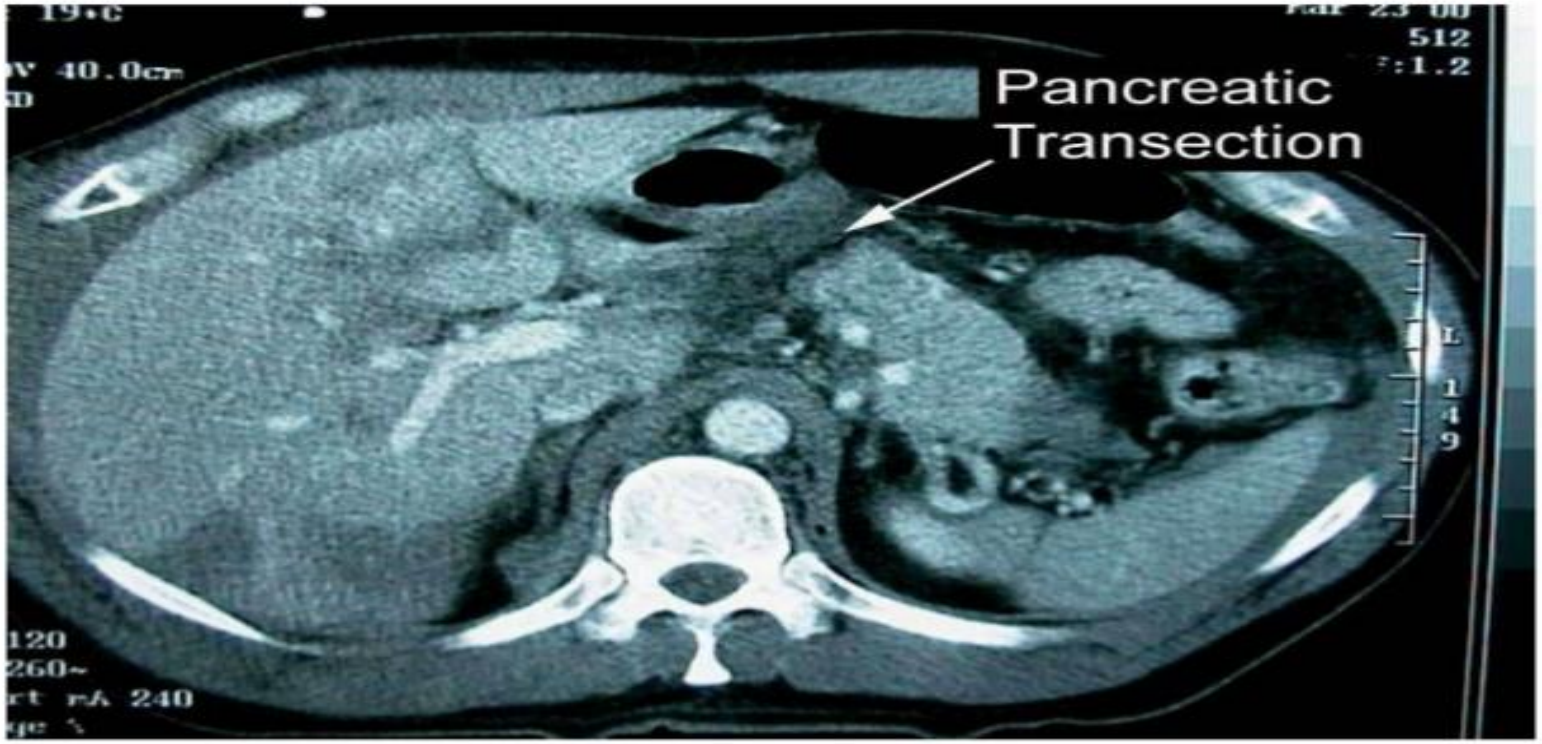
Indicators of injury

- In Blunt trauma
  - Retroperitoneal hematoma
  - Retroperitoneal fluid
  - Free abdominal fluid
  - Pancreatic edema

- In patients with penetrating trauma
  - Visualization of perforation
  - Hemorrhage or fluid leak (eg bile, pancreatic fluid)
  - Retroperitoneal hematoma around the pancreas



Grade II pancreatic injury: Superficial pancreatic laceration without duct Injury.



Grade 4 pancreatic transection

ERCP

- ERCP invasive and diagnostic/therapeutic (stents)

- Disadvantages of ERCP include risks of endoscopy, exacerbating a smoldering pancreatitis, and sepsis from overfilling of a disrupted duct

Exploratory laparotomy

- **Grade I** injuries are managed conservatively
- **Grade II** injuries require simple drainage/debridement
- **Grade III**. Pancreatic injury with ductal disruption at the body or neck left of the superior mesenteric vein can be managed by performing a distal pancreatectomy
  - Splenic salvage can be attempted but may not be feasible in hemodynamically unstable patients

Exploratory laparotomy

- **Grade IV**. Management of the pancreatic transection to the right of the SMV poses a great challenge
- A distal pancreatectomy requires almost 80% of the pancreas to be removed
- The appropriate procedure to be performed is central debridement or resection with distal pancreatojejunostomy

Exploratory laparotomy

- **Grade V**. May need ERCP/stenting of severed proximal duct
- Occasionally external drainage is the only modality required (controlled fistula)
- Whipple only if major pancreatic duct and ampulla involved

Take Home…

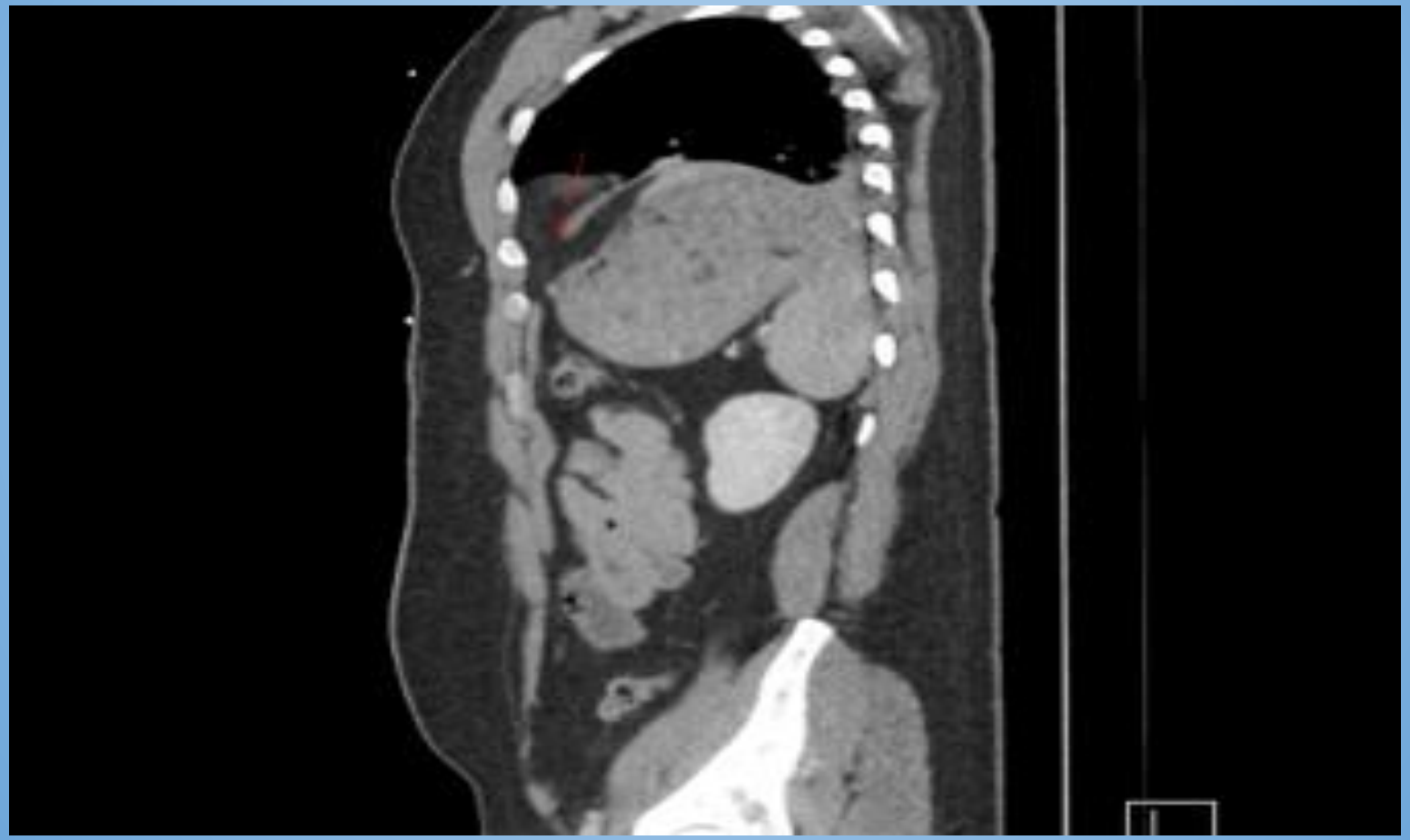
- A high degree of clinical awareness is necessary to ensure that pancreatic injuries are not overlooked or missed

- The type of injury (ie blunt vs penetrating) and information about the injuring agent (eg GSW, knife) help focus the clinician on the possibility of pancreatic injury and its treatment modalities

Case #4

- 19 y/o M to outlying ER s/p stab wounds x 5 to L lateral chest
- HD stable, P.E. unremarkable other than stab wounds
- PCXR – blunting of L cost-phrenic angle
- CT – locules of air within subq tissues of L lateral and anterior chest wall


RESUS@
85KV/6.4

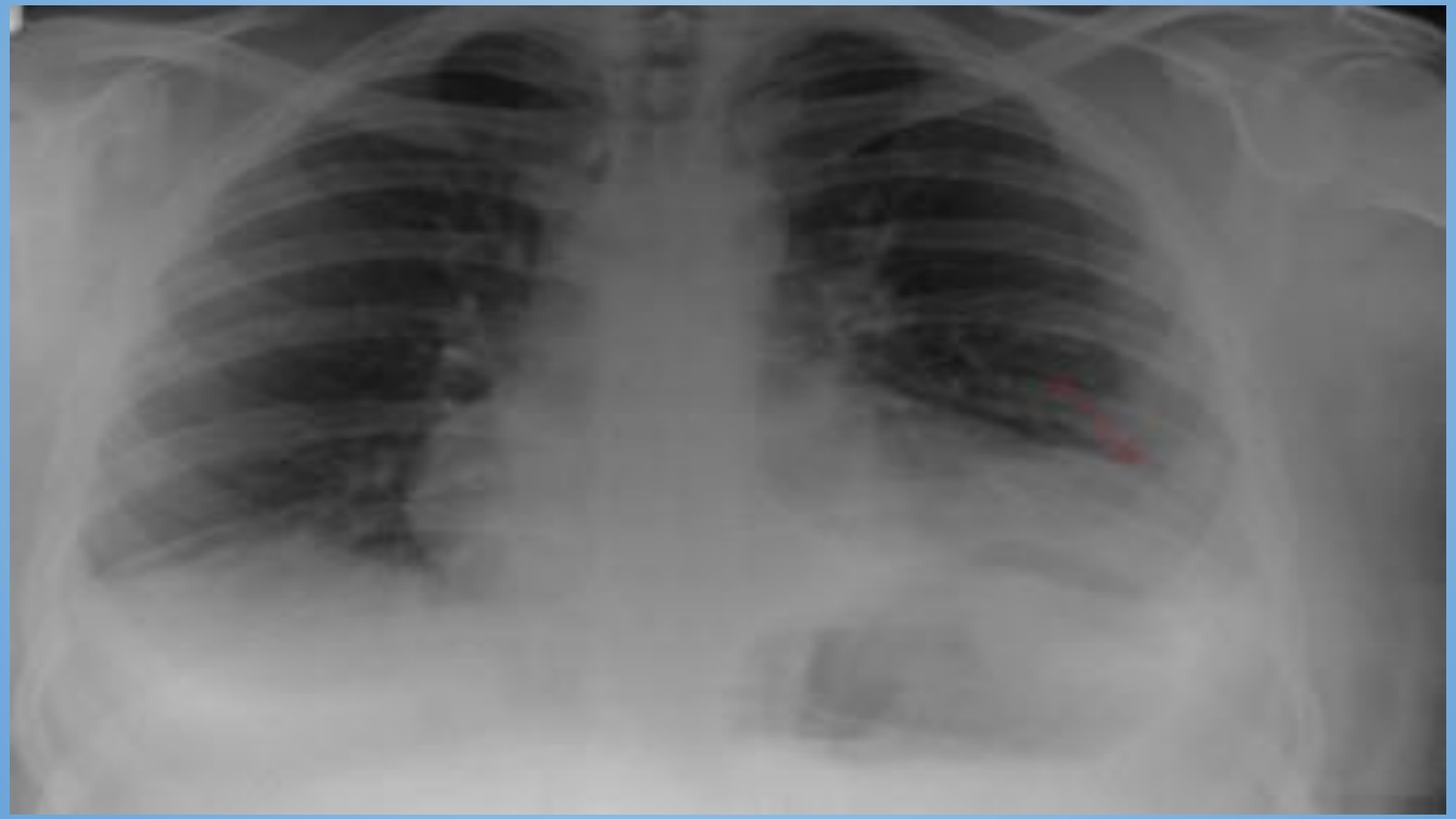


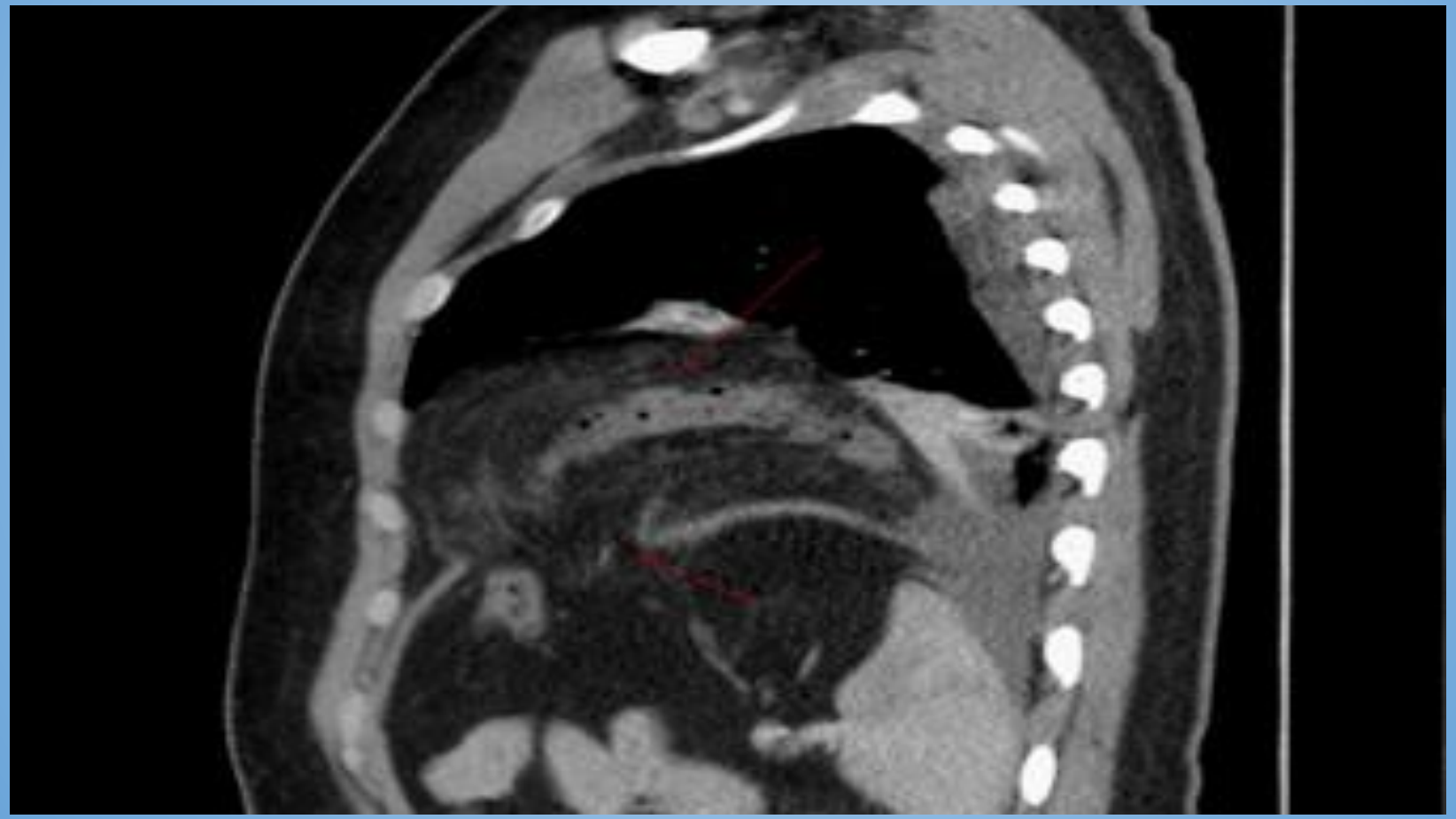
Case #4

- Wounds closed primarily
- Admitted for Observation
- Discharged after serial PCXR, abdominal U/S revealed no evidence of diaphragmatic injury
  - U/S confirmed no pleural effusion, intra-abdominal fluid, or adjacent fat stranding
  - L hemidiaphragm margins were well demarcated

One week later…

- Patient presents to our ER with intermittent abd pain and SOB on exertion
- PCXR – LLL consolidation
- CT – Herniation of splenic flexure through a large diaphragmatic defect





To the OR

- Patient underwent L posterolateral thoracotomy
- Herniated contents reduced through large diaphragmatic defect, and defect repaired
- Discharged 10 days later

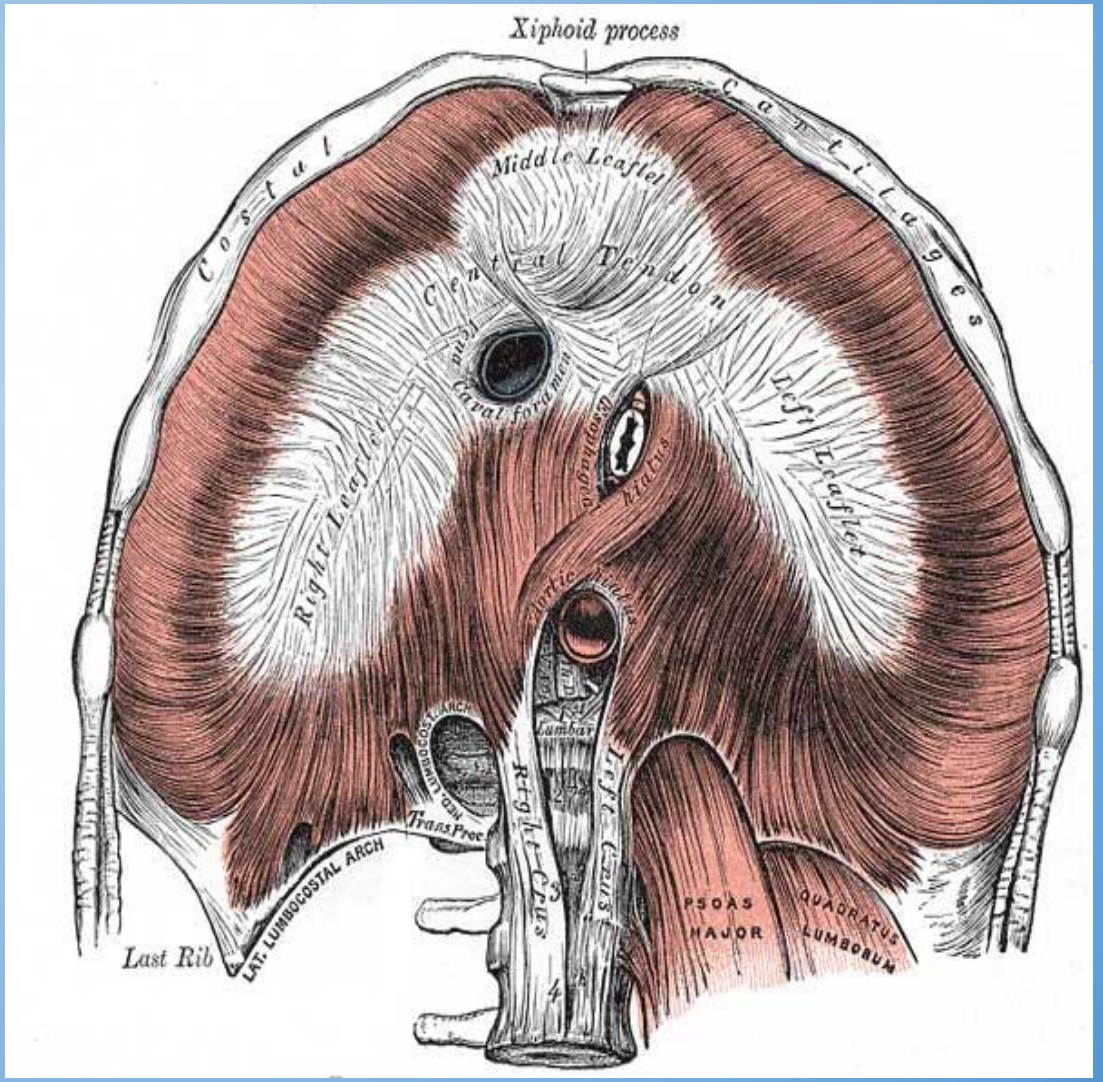
Story Doesn't End There…

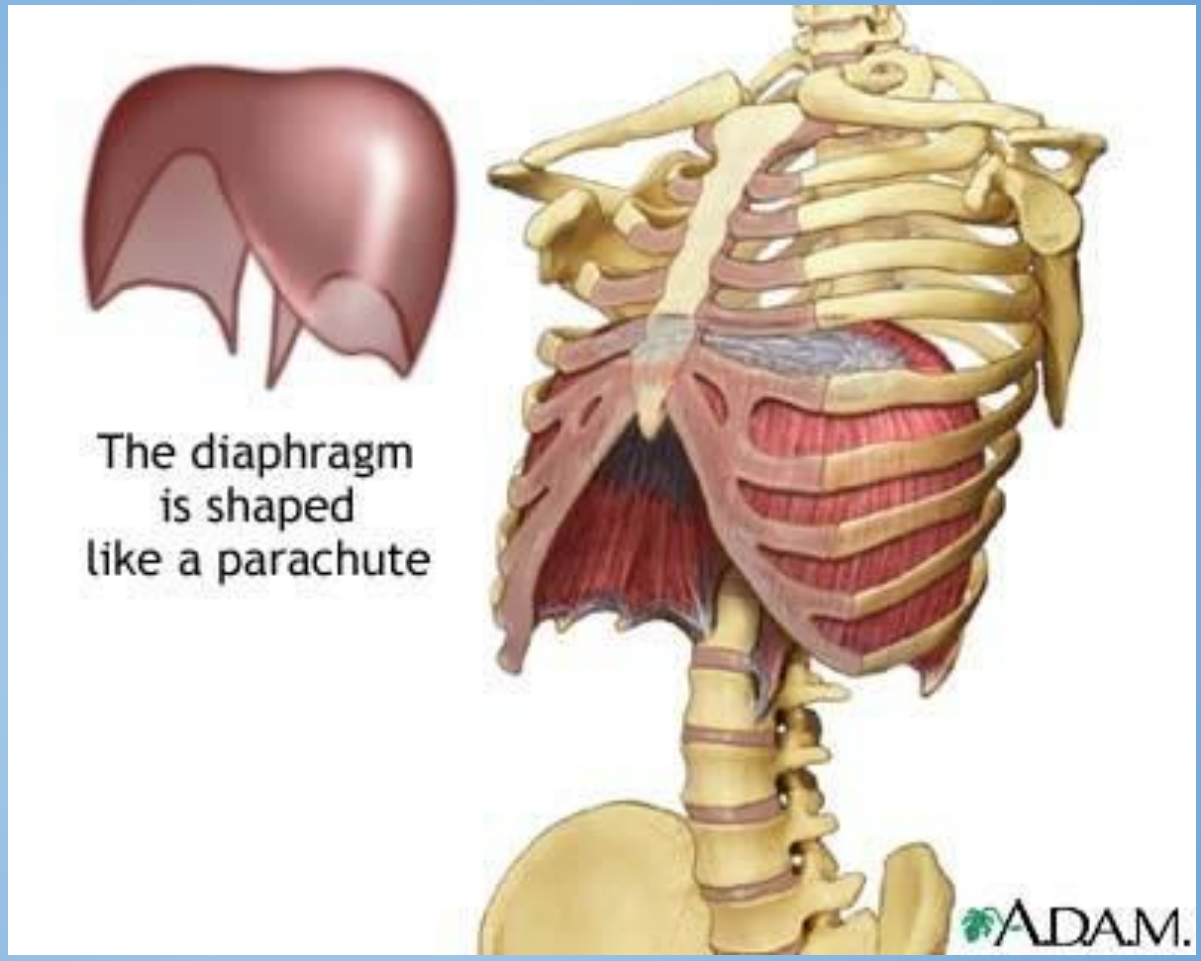
- Presented to ER a 3rd time 2 months later with c/o "clicking" and "bubbling" in L chest
  - CT – small L hydropneumothorax
  - Managed conservatively with spontaneous resolution of symptoms

Diaphragmatic Injuries

Anatomy

- Dome shaped musculoaponeurosis dividing
- Bordered by:
  - Left pleural cavity
  - Pericardial space
  - Right pleural cavity
  - Peritoneal cavity





Xiphoid anteriorly to
T12 posteriorly

Physiology

- Normal tidal volume produced by 3-5 cm bidirectional movement
  - Intraperitoneal pressures +2 to +10 cm H_20
  - Intrapleural pressures -5 to -10 cm H_20
  - Resting gradient is +7 to +20

Physiology

- Maximal inspiration abdominal pressure +150 to 200 cm H_20
  - Sudden transfers of these pressure gradients
    - Causes injury
    - Herniates abdominal contents
    - Lead to respiratory and hemodynamic derangements

Incidence – “Uncommon but not rare.”

- 3% of abdominal injuries
- Penetrating to blunt ratios 3-1:1
- Left 75% Right 23% Bilateral 2%

History and Physical

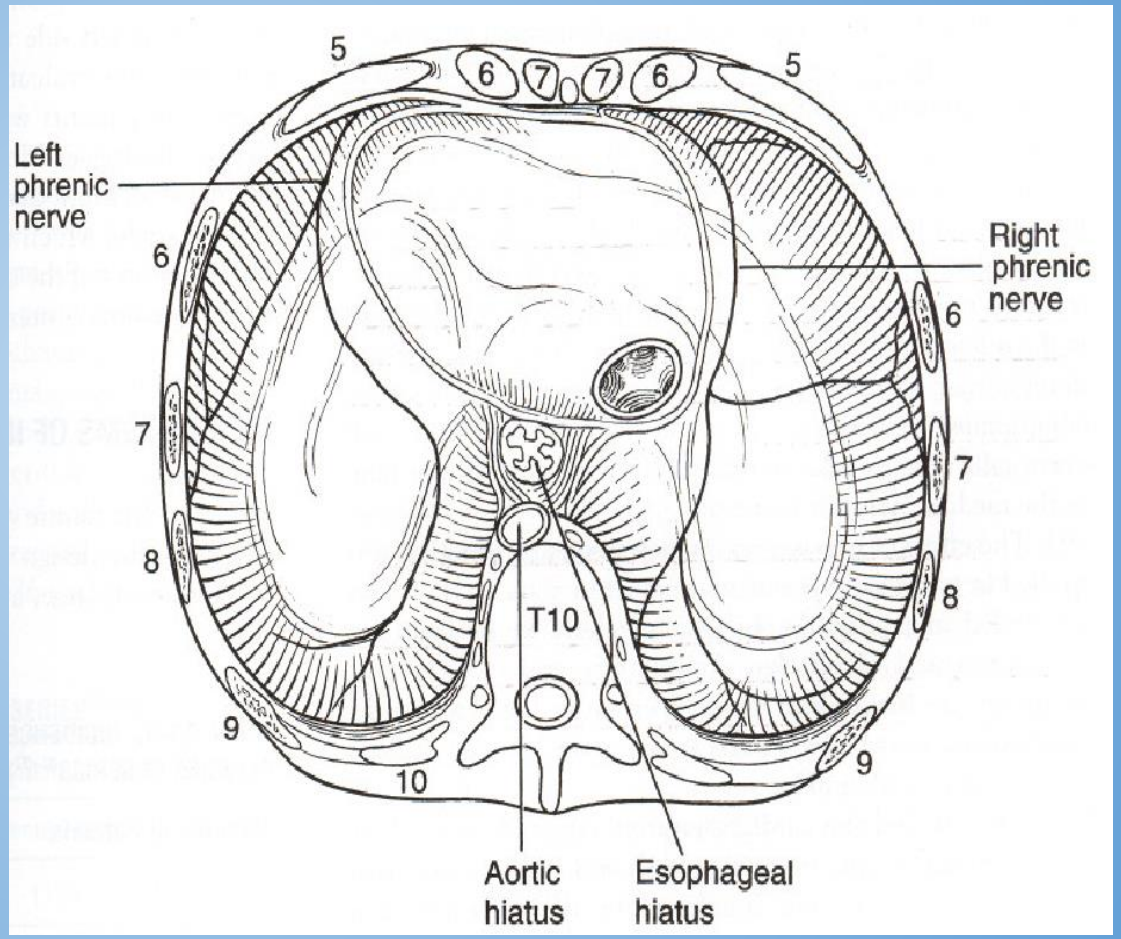
- Falls
- High speed MVC
- Crush injuries
- GSW
- Stab wounds
- Asymptomatic
- Δ breath sounds
- Δ abdominal exam
- Resp. collapse (81%)
- CV collapse (54%)

OUTCOME

- Mortality due to associated injuries
  - Meta-analysis of 33 series 13.7%
- Blunt
  - Beal et al. 40.5%
  - Holm et al 33%
  - Morales et al 26.7%
- Penetrating
  - Demetriades et al 4.9%
  - Aronoff et al 4.3%

Morbidity

- Nearly 100%
  - Atelectasis
  - Pneumonia
  - Systemic sepsis
  - Prolonged respiratory failure
  - Empyema



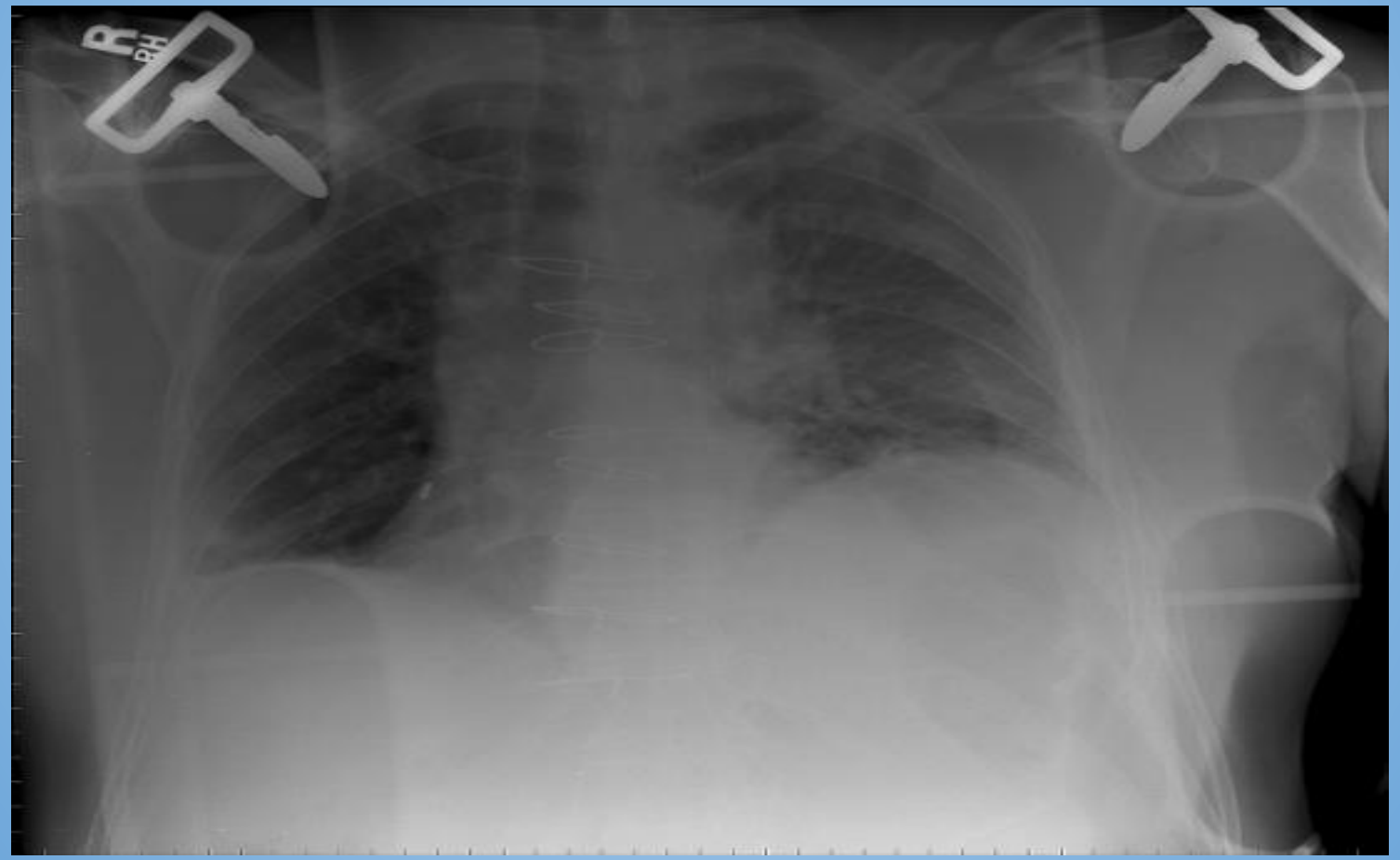
Diagnosis is the hard part - **42% found on ex lap**

- Noninvasive
  - CXR
  - GI contrast studies
  - BE
  - US
  - CT
  - MRI

- Invasive
  - DPL
  - Thorascopy
  - Laparoscopy
  - Laparotomy

PCXR

- Findings can be subtle and are often missed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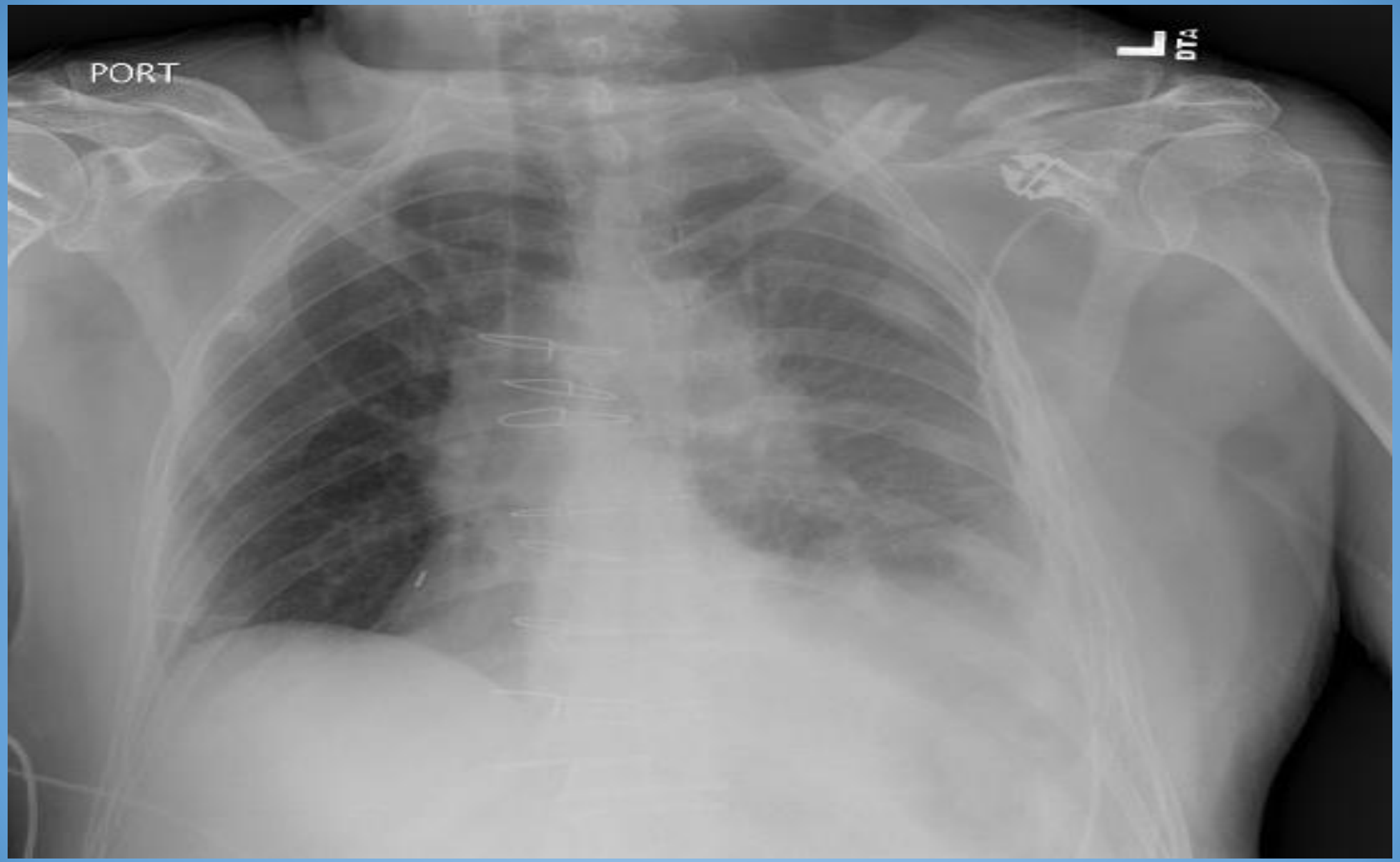
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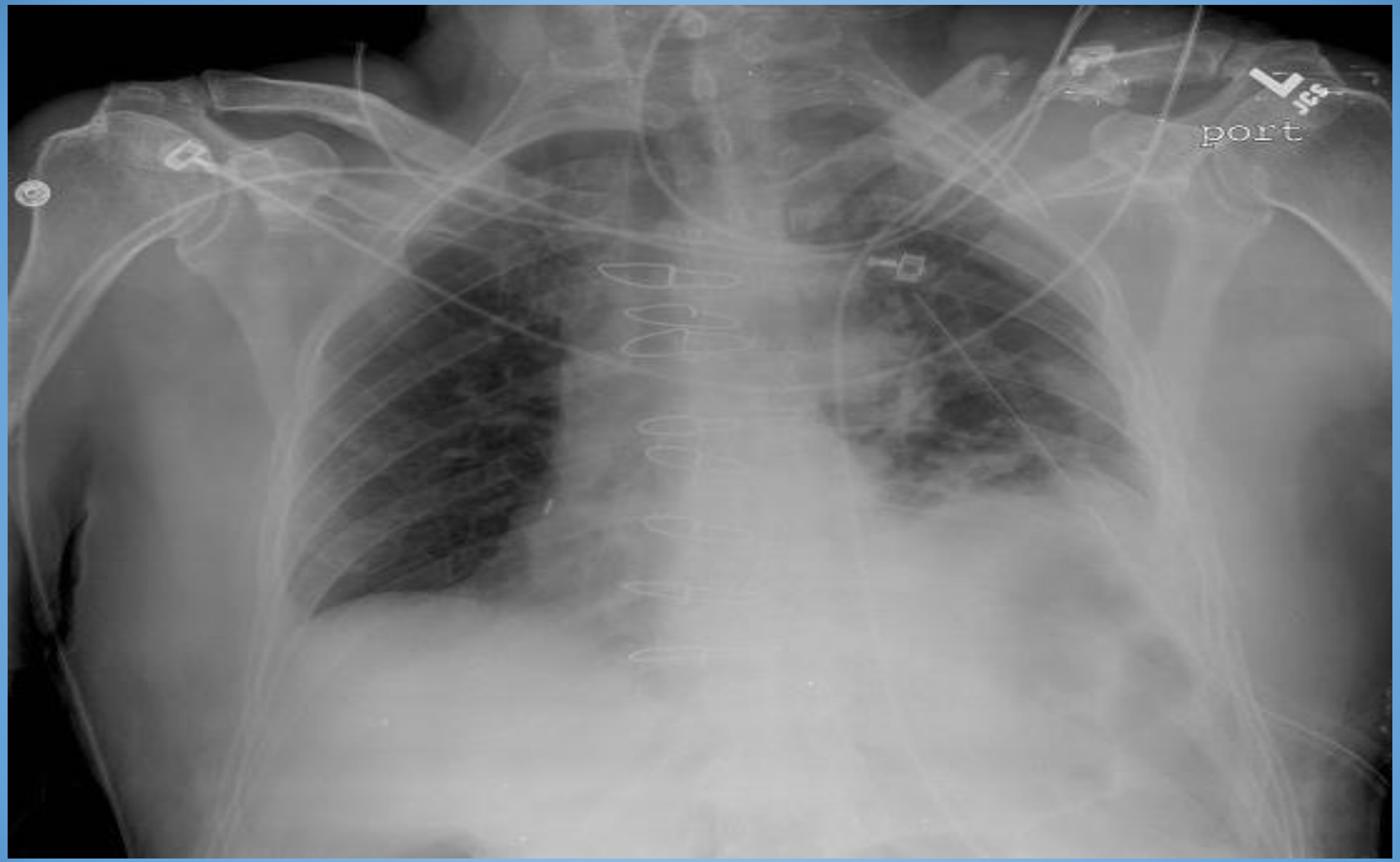
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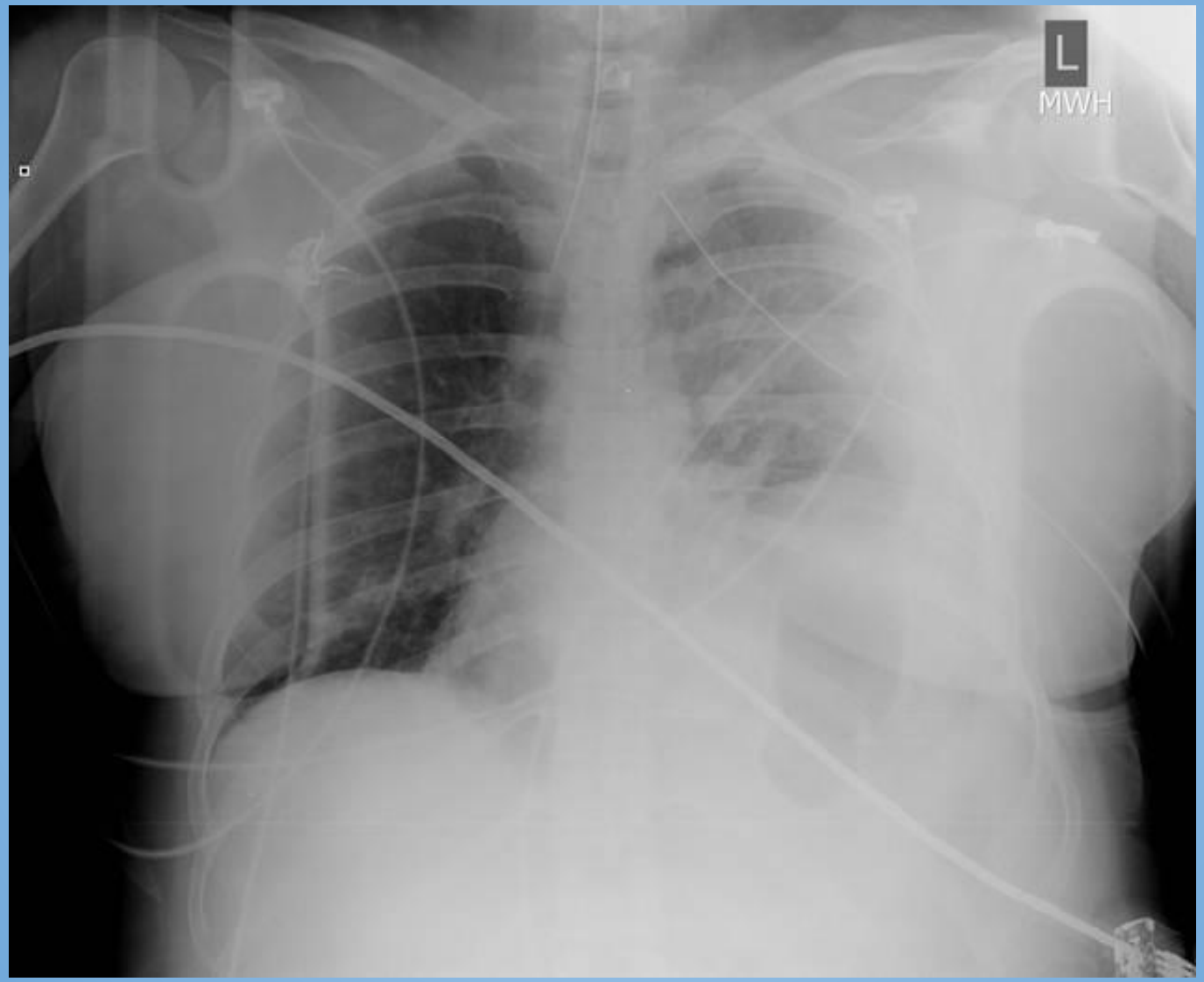
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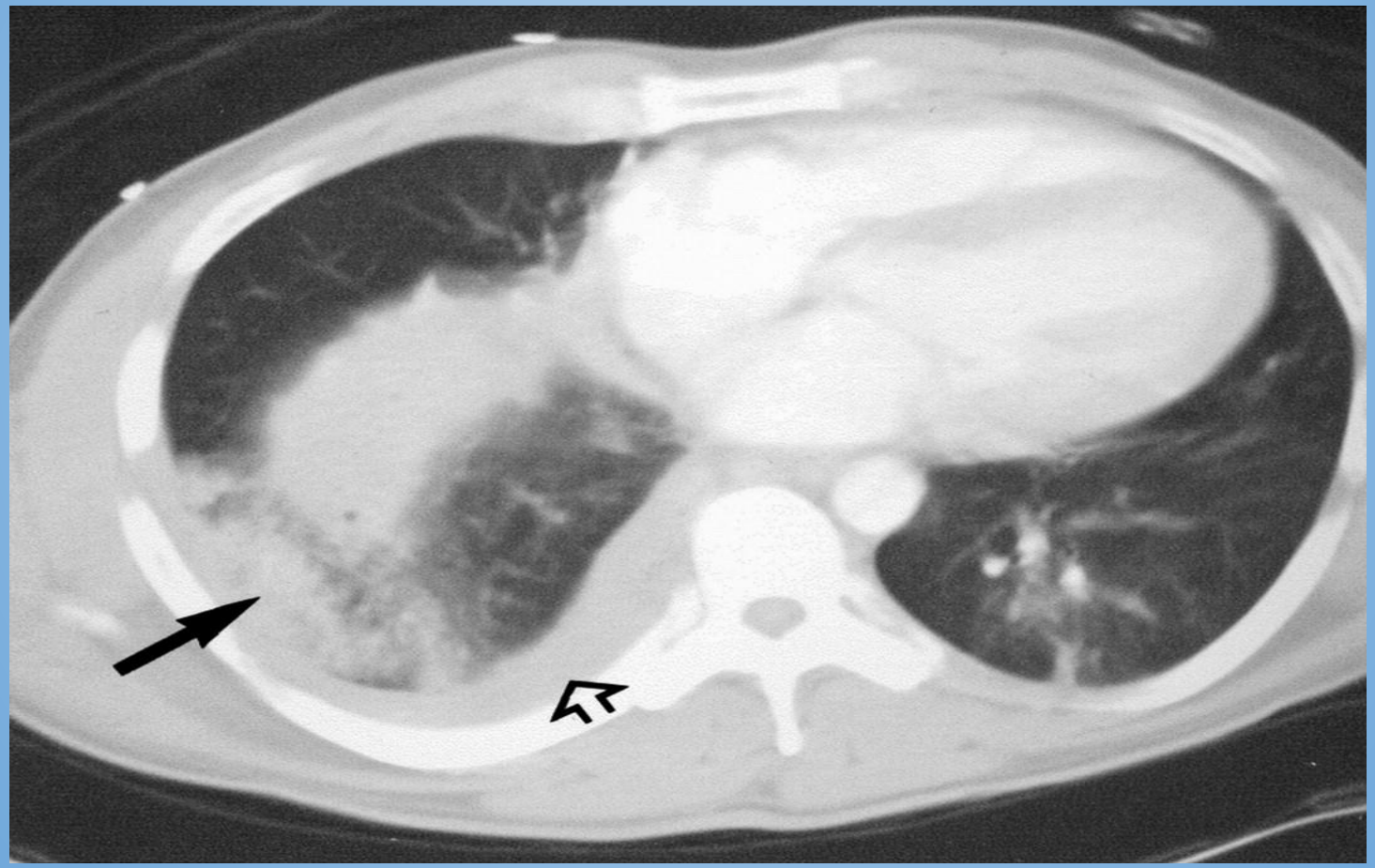
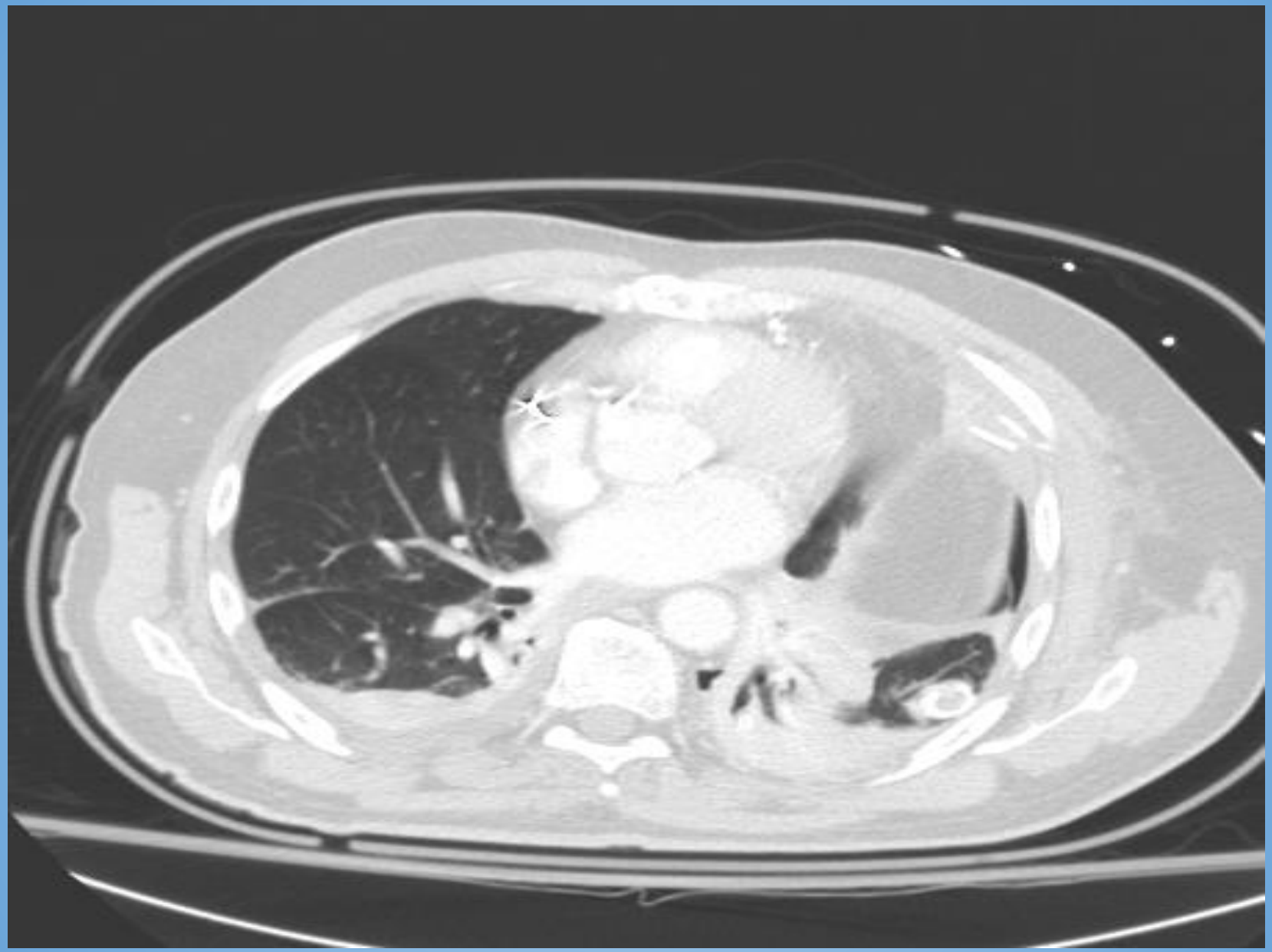
CT to see…





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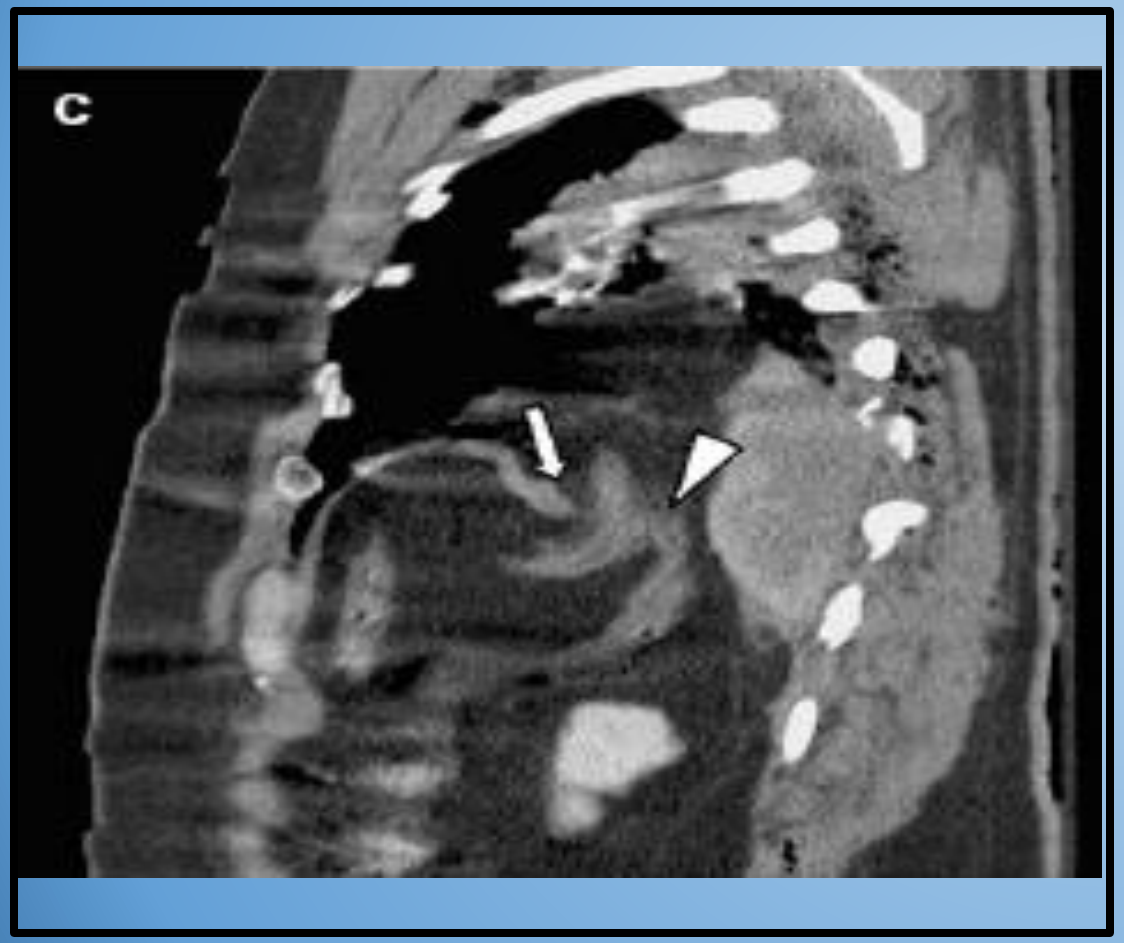
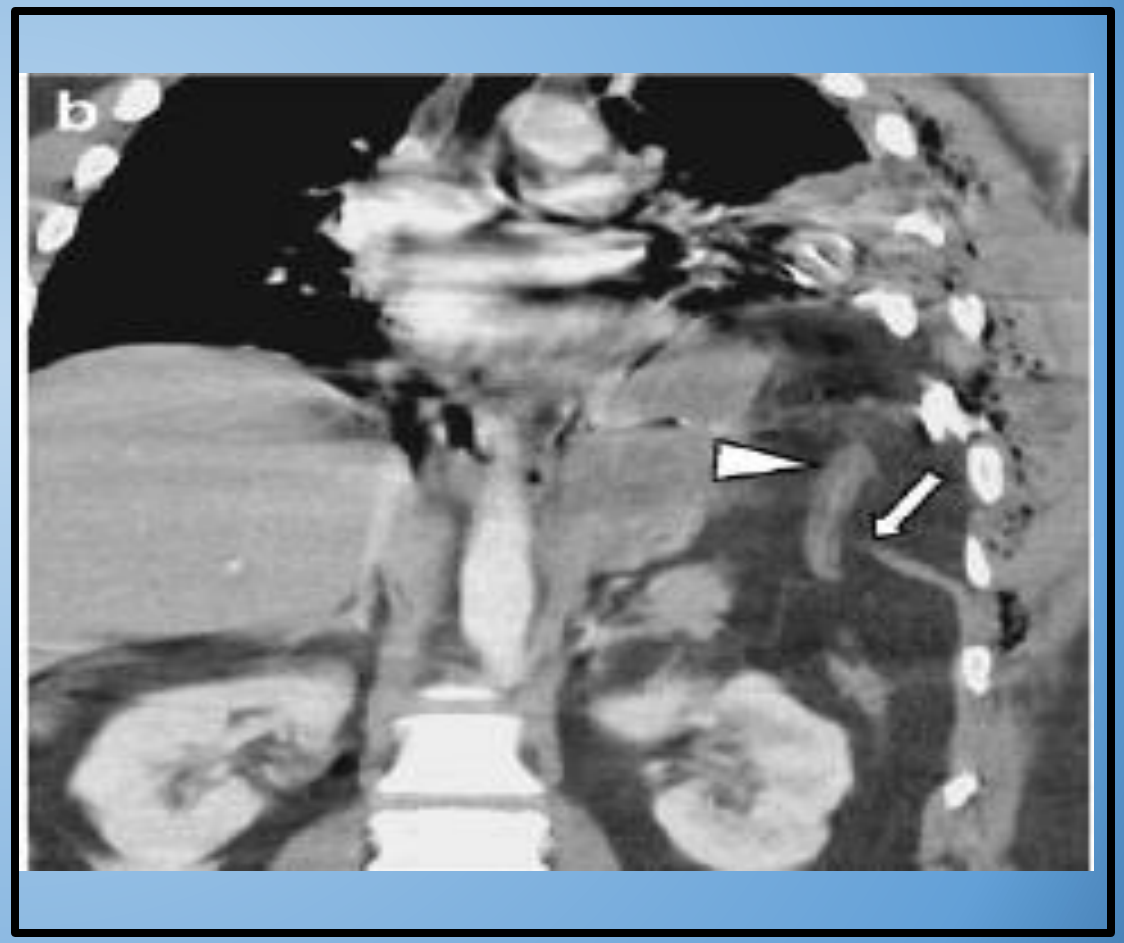
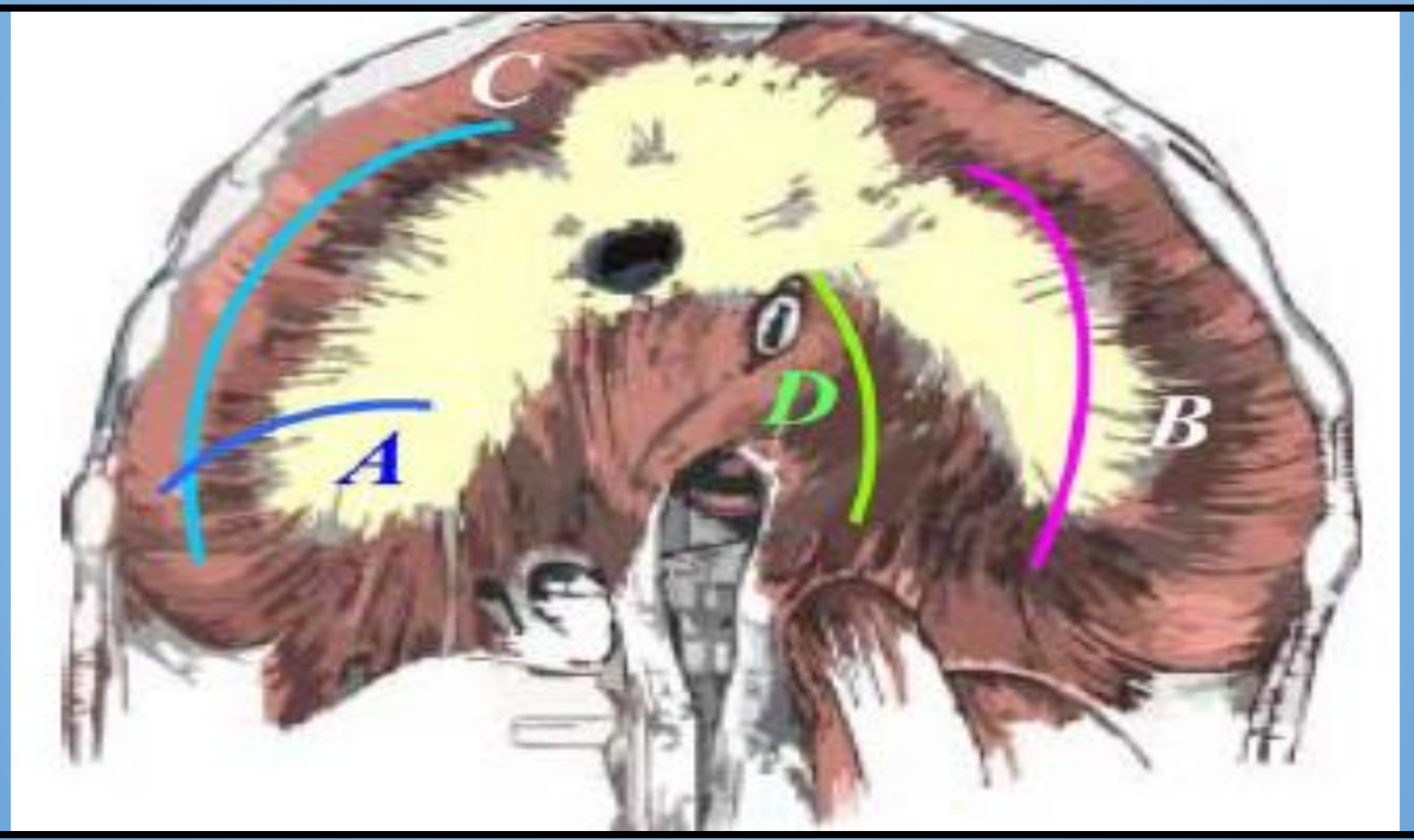
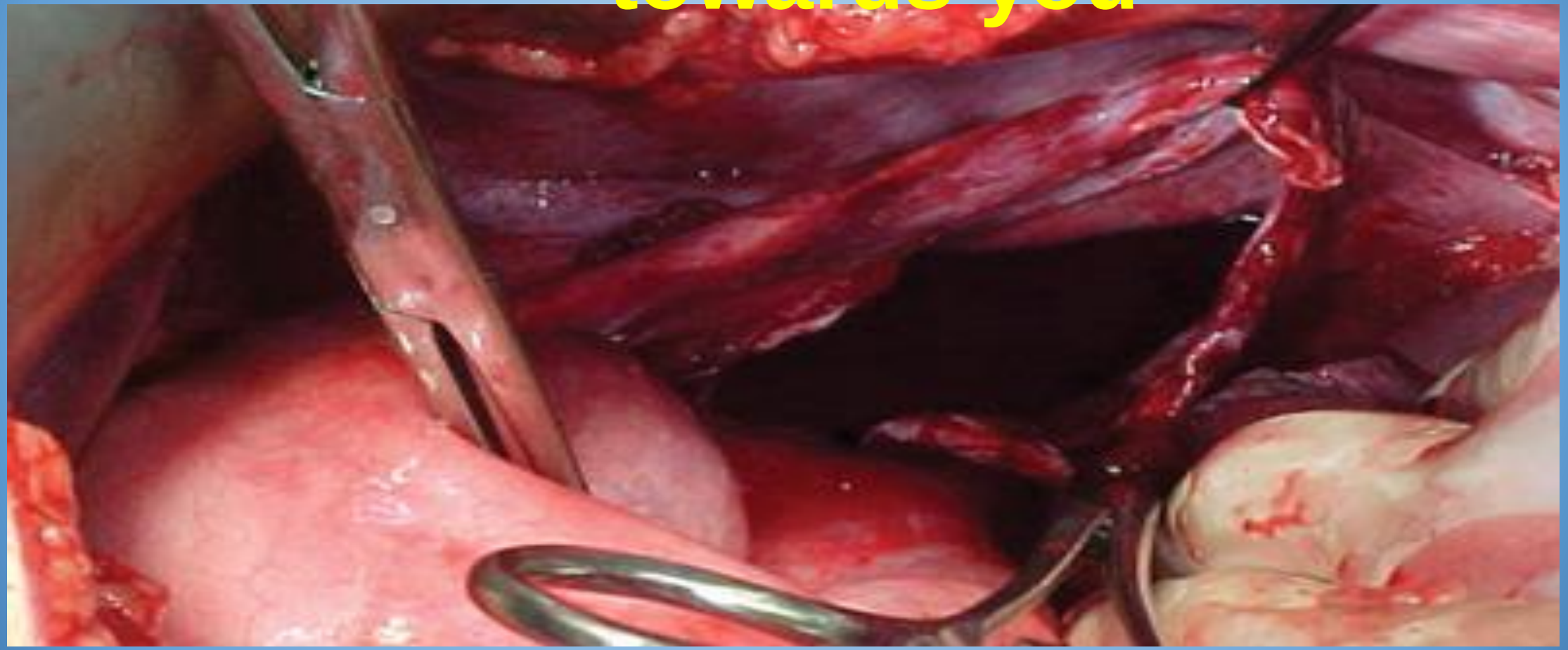


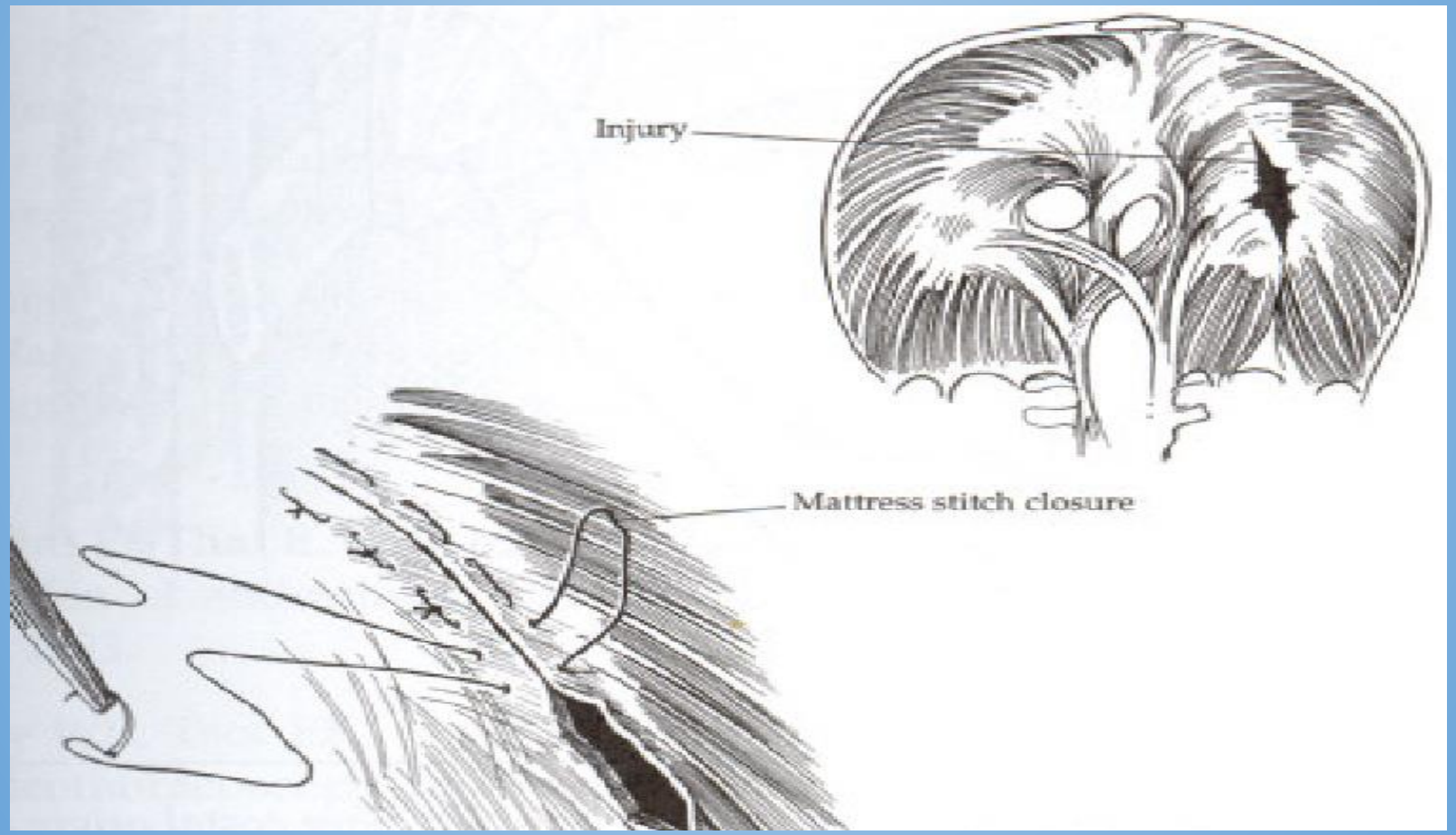


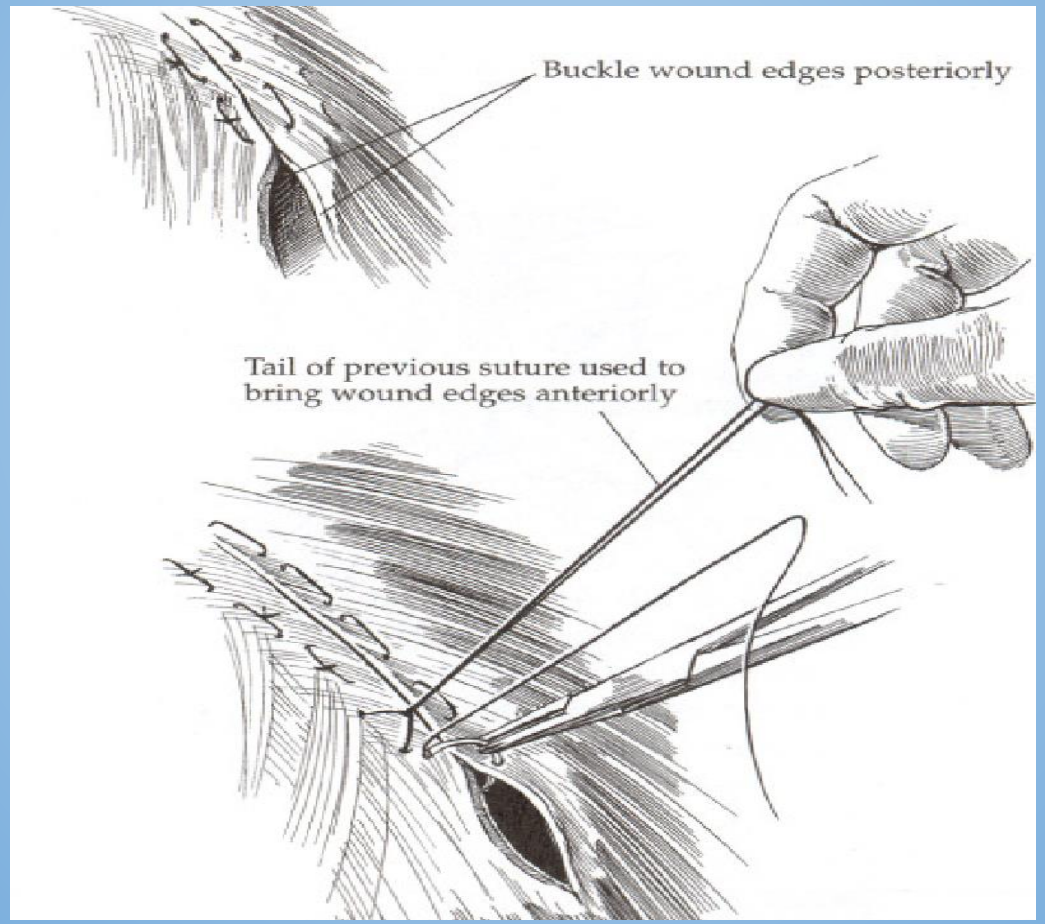
Location, Location, Location

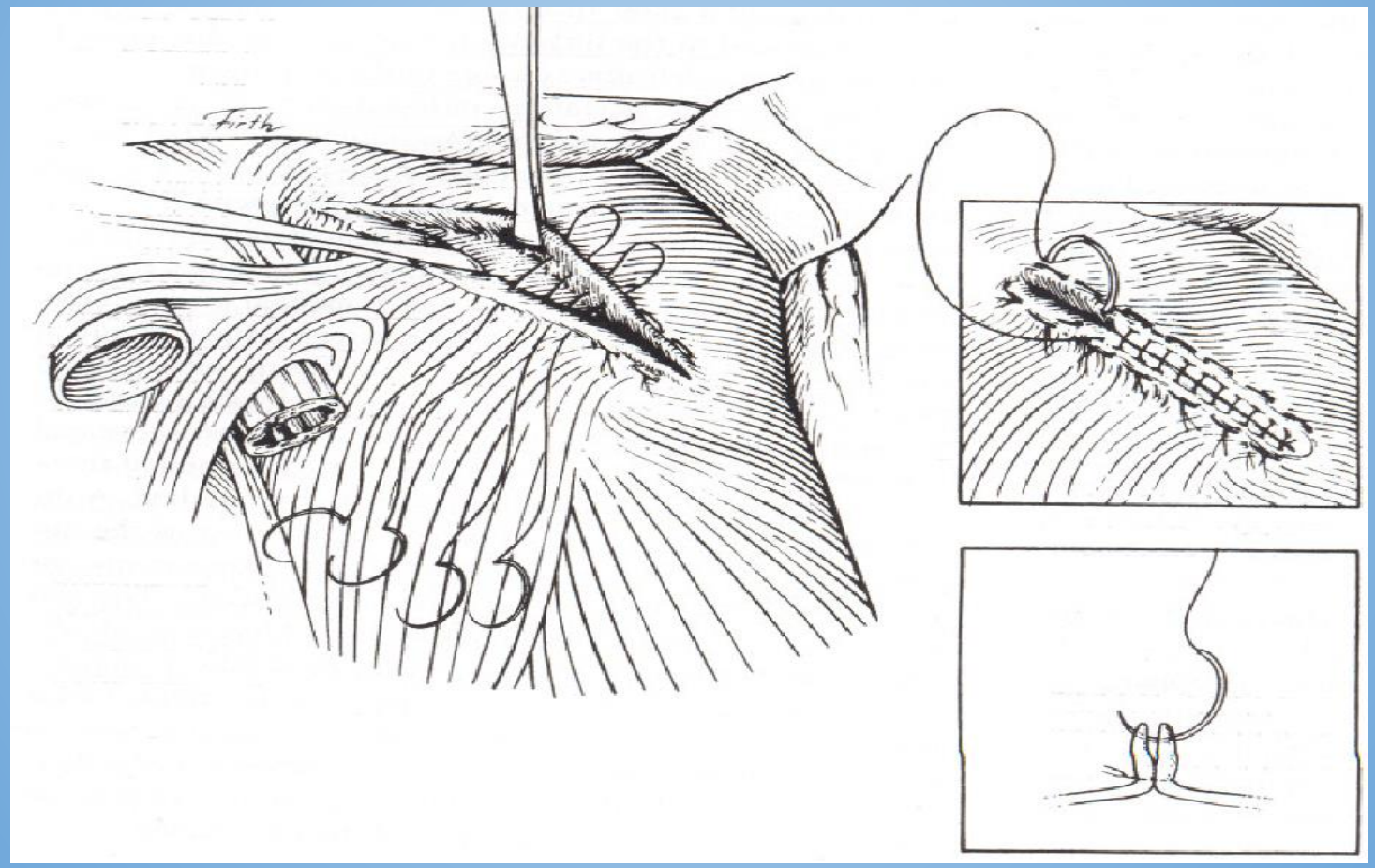


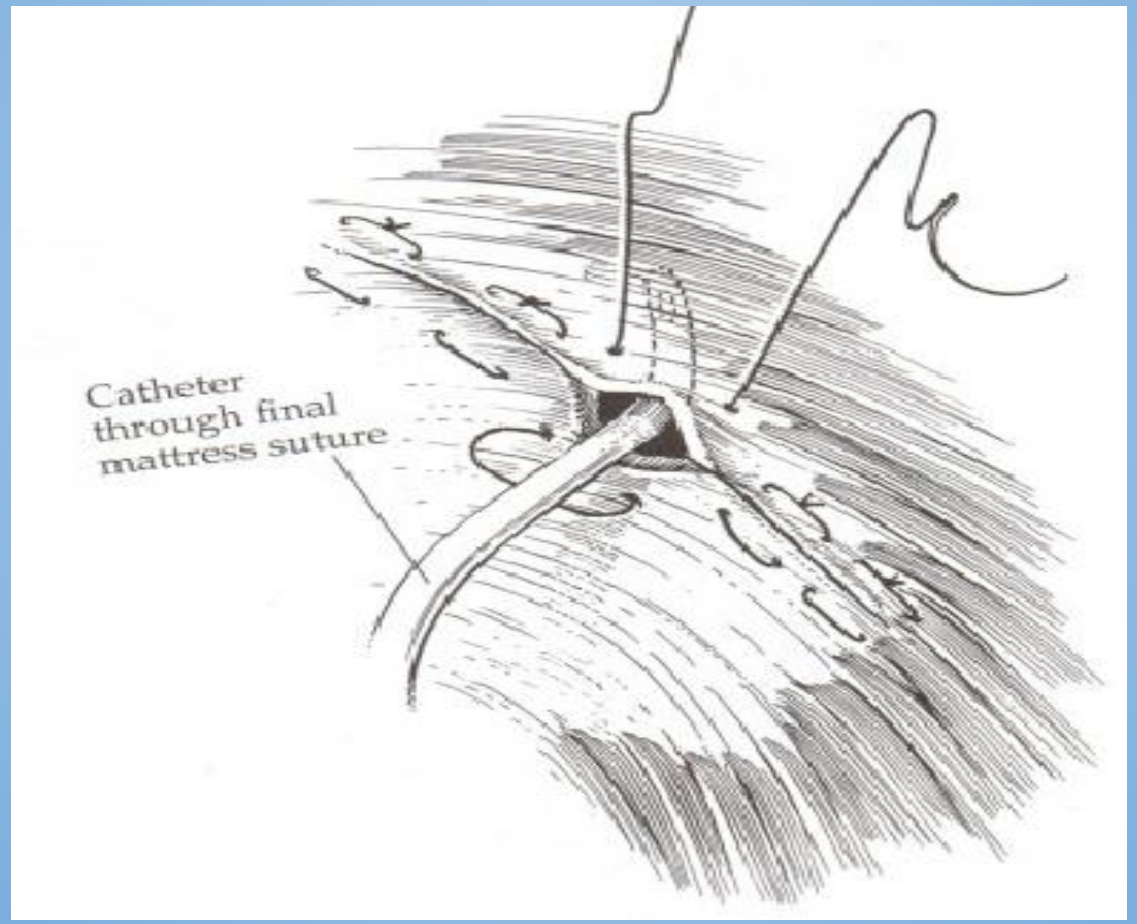
Pull the diaphragm towards you

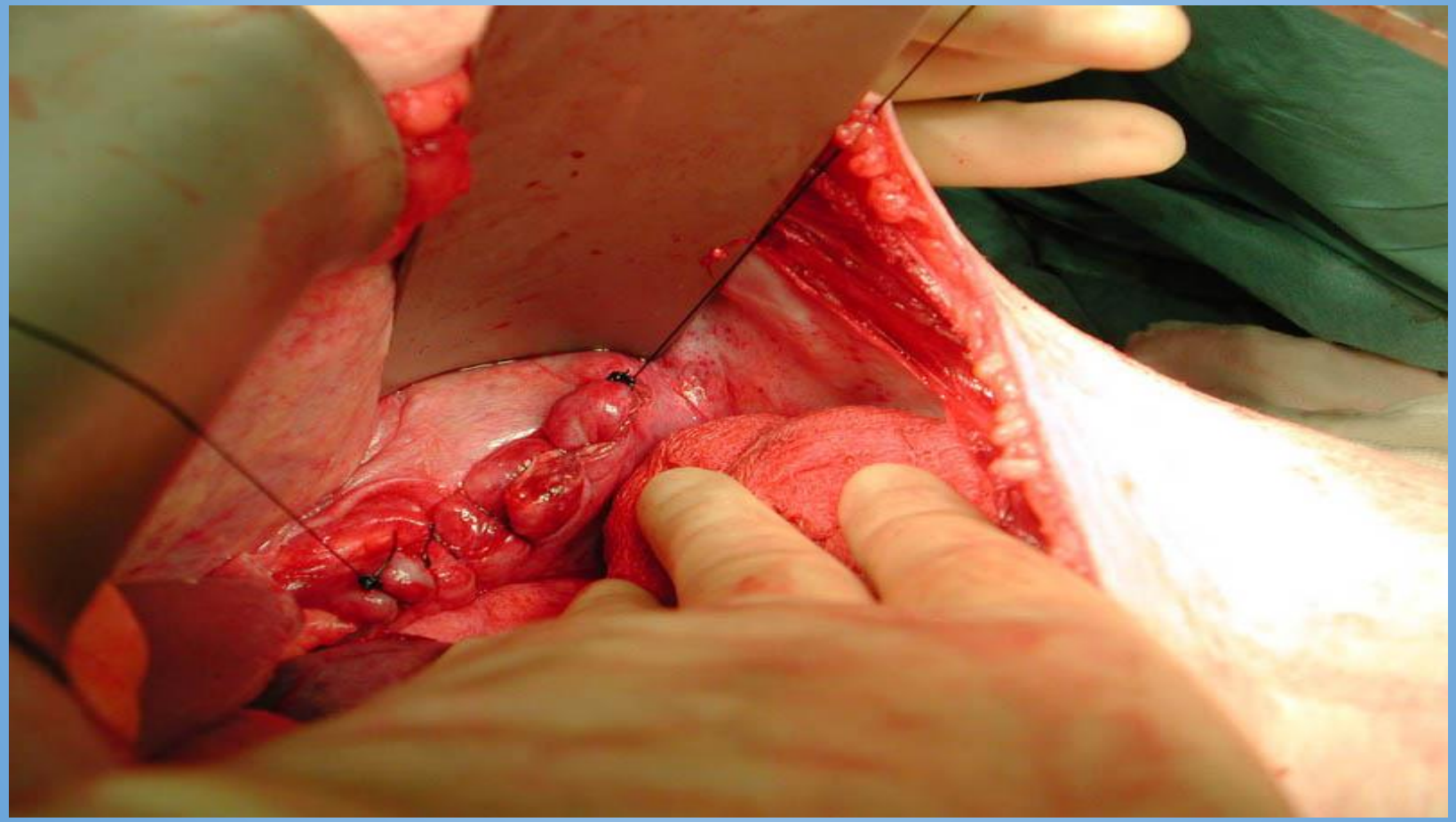


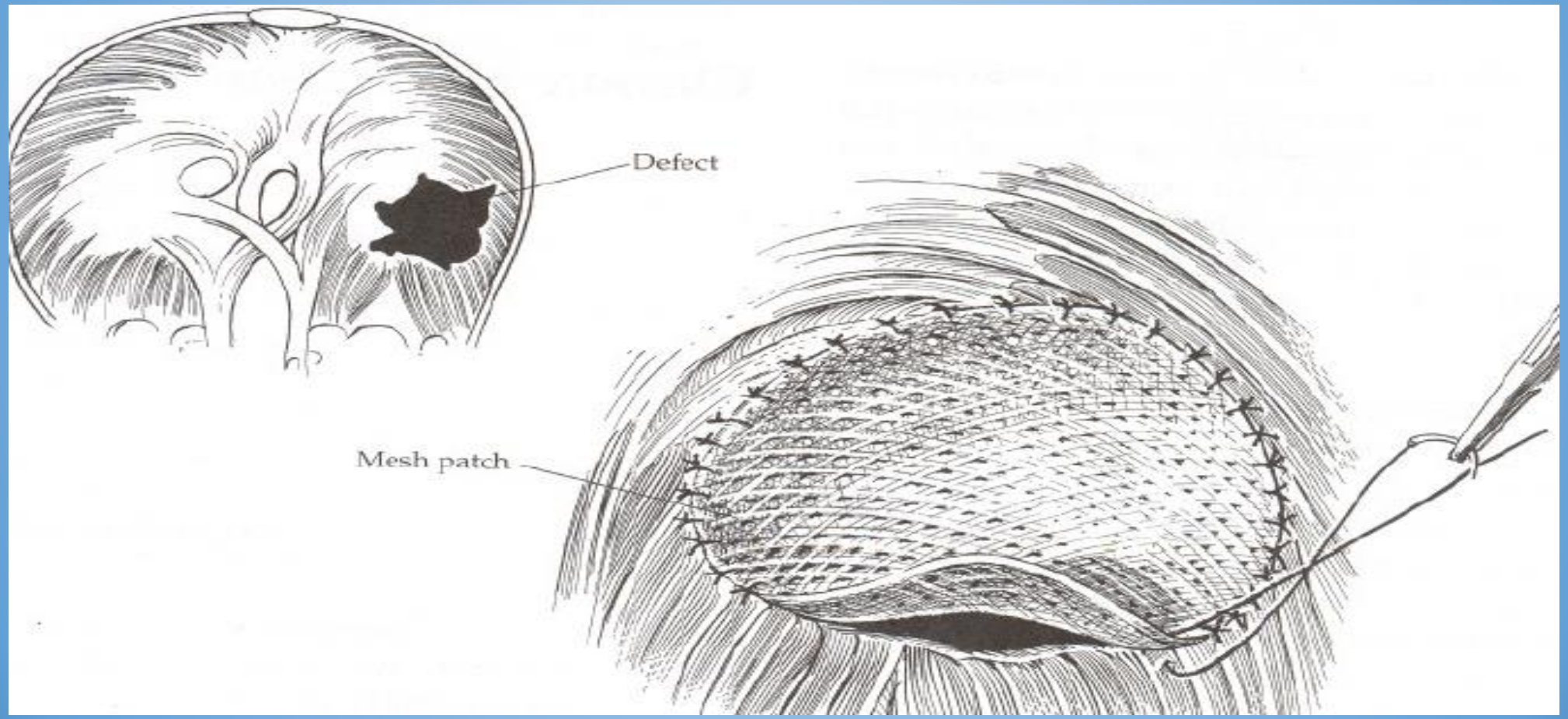

Injury
Mattress stitch closure

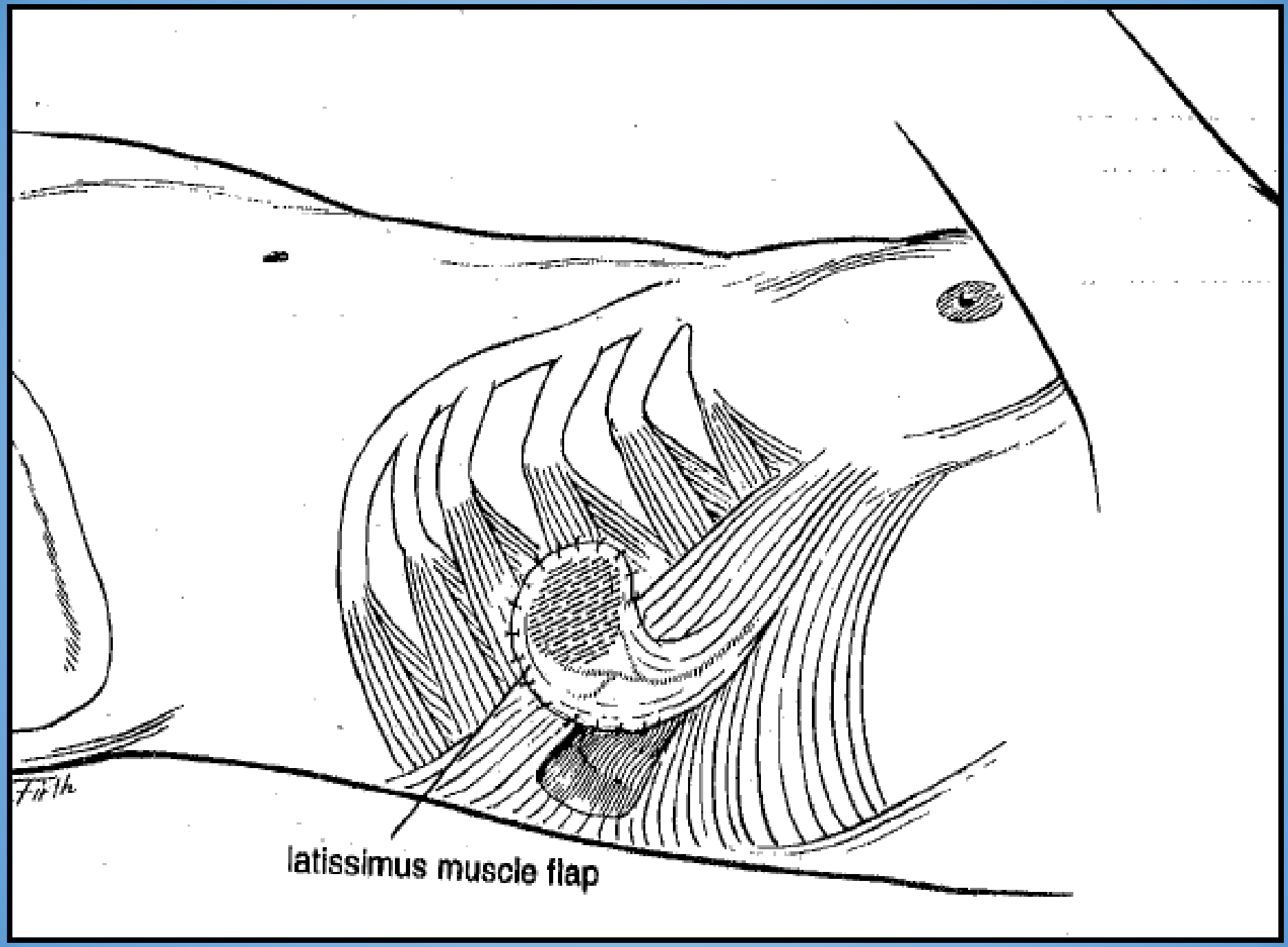

Buckle wound edges posteriorly
Tail of previous suture used to bring wound edges anteriorly




Catheter
through final
mattress suture




Defect
Mesh patch


latissimus muscle flap

Conclusions

- Diligence to diagnose – Morbidity of missed injury is high…and more difficult to repair
- Push to laparoscopy/thoracoscopy
- Overall repair is easy when seen


SEAT
BELTS
SAVE
LIVES
BUCKLE UP EVERY TIME

Case #5

- Level 1 activation – 31 y/o F s/p MVC
  - Retrained backseat passenger, required extrication
- Awake but uncooperative
  - (+) ETOH
- Tachycardic and unable to obtain BP with automatic cuff
  - Emergent blood requested and started on its arrival
  - BP improved to 90-110s after 2 units blood, bicarb, calcium and NS

Case #5

- Guards to palpation of seatbelt contusion on abdomen. Has contusion across left breast/chest as well
- Logrolled and has gross deformity to upper lumbar region.
- FAST exam performed - negative for significant free fluid.
- CT with T12/L1 injury and extensive abdominal wall and bowel injury identified
- While waiting for OR hemodynamics progressively deteriorated. Total 4 units of blood given prior to OR and additional bicarb and antibiotic given.

Injuries Case #5

- Complex abdominal wall shear injury
- Complex shear injury to small bowel and colon
- T12-L1 fracture dislocation with spinal cord injury
- Spinal shock
- Paraplegia
- Acute Respiratory Failure
- Left hemopneumothorax
- Left 8-12 rib fractures
- Traumatic bowel rupture: small and large intestine
- Gallbladder transsection: chronic cholecystitis and cholelithiasis
- Complex L upper eyelid laceration - repaired
- L hemothorax - resolved with thoracostomy tube placement
- Left renal laceration
- Left adrenal hemorrhage

Case #6

- Level 1 trauma activation – 10 y/o M s/p MVC
- Stable on initial evaluation with impressive seatbelt contusion.
- Pt awake and alert, with extensive contusions.
- Lower abdomen diffusely tender to palpation and has early patchy skin necrosis in lateral aspects of seatbelt contusion.

Case #6

- CT with extensive abdominal wall degloving injury, with at least 50% circumference with fascial disruption, suspected colon injury given distribution and severity of injury at level of belt

- Vascular injury apparent in left common iliac artery and IMA.
  - He has collateral flow to left leg but pt complaining of increasing thigh pain and has early subtle mottling, despite doppler signals

Case #6

Seatbelt Sign

- Contusions and abrasions on the abdomen of a restrained occupant involved in a motor vehicle crash.

- **Seat belt syndrome** - injury to the abdominal organs or spine

- Seat belts save lives by reducing the number of people dying from head injury after a car crash.
  - However, they do so by diverting energy from the head to the chest and abdomen.

Seatbelt Sign

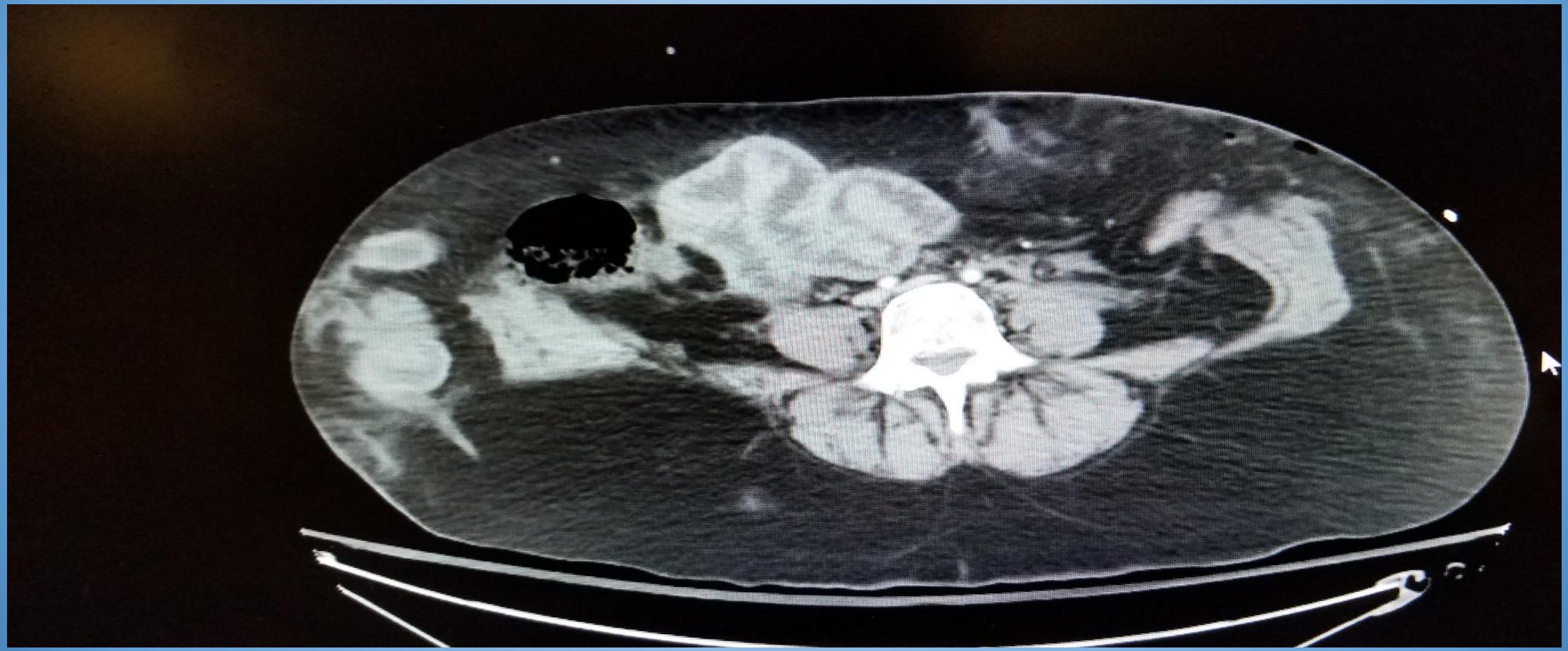
	No Seatbelt	Seatbelt	Seatbelt Sign
Any abdominal injury	10%	15%	64%
Small bowel injury	2%	6%	21%

Relative risk of small bowel injury is x4.7 with seatbelt sign

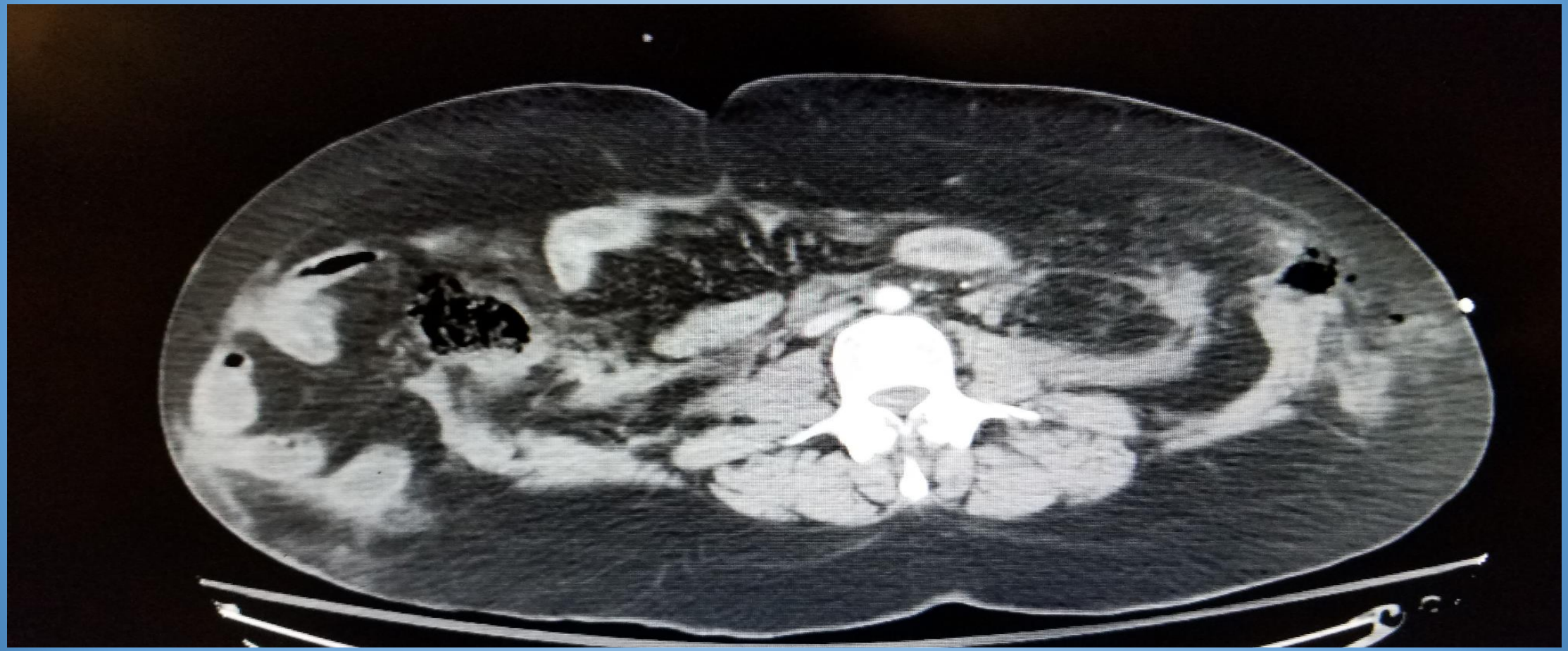
Seatbelt Sign

- As seat belt use increases, seat belt signs are becoming more common.
- Any patient with a seat belt sign must have an abdominal CT.
  - If any abnormal findings are noted, a surgeon must be consulted because it is very likely that operative intervention will be required.

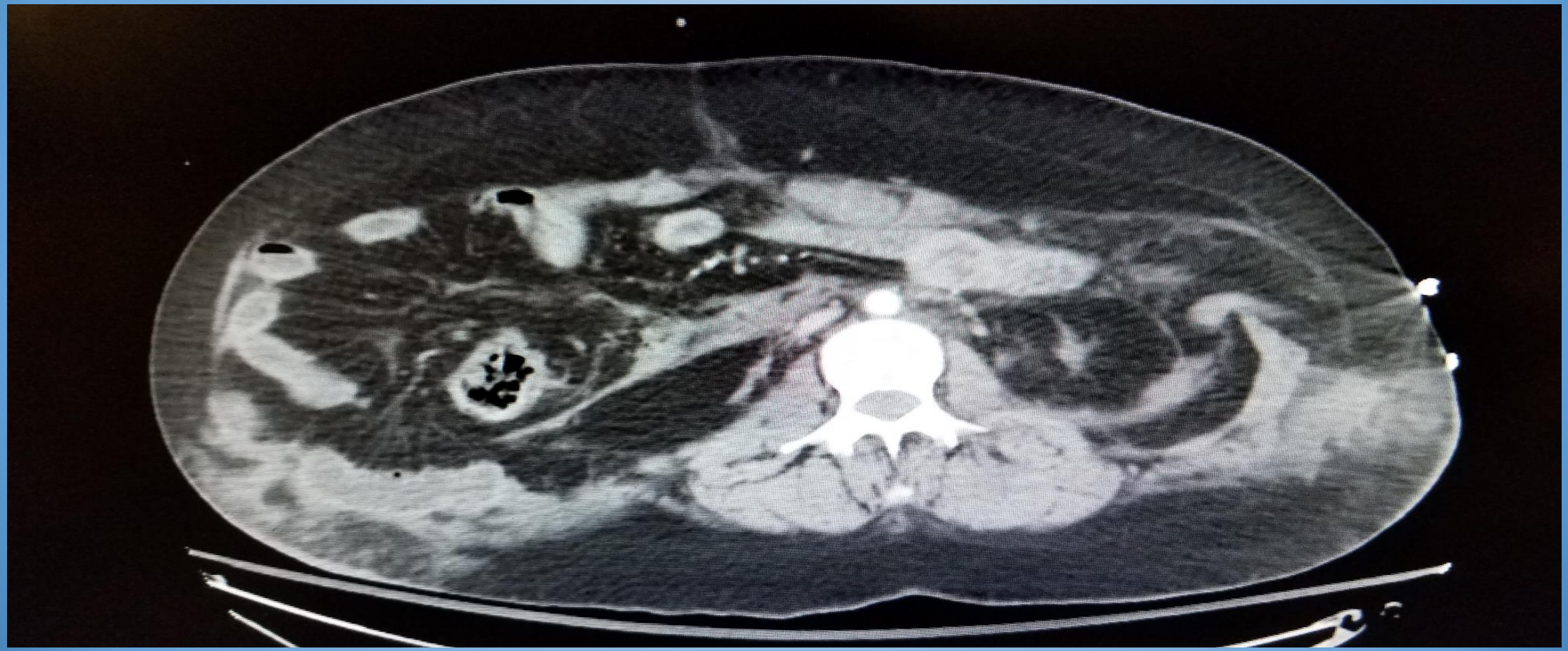
CT Case #5



CT Case #5



CT Case #5



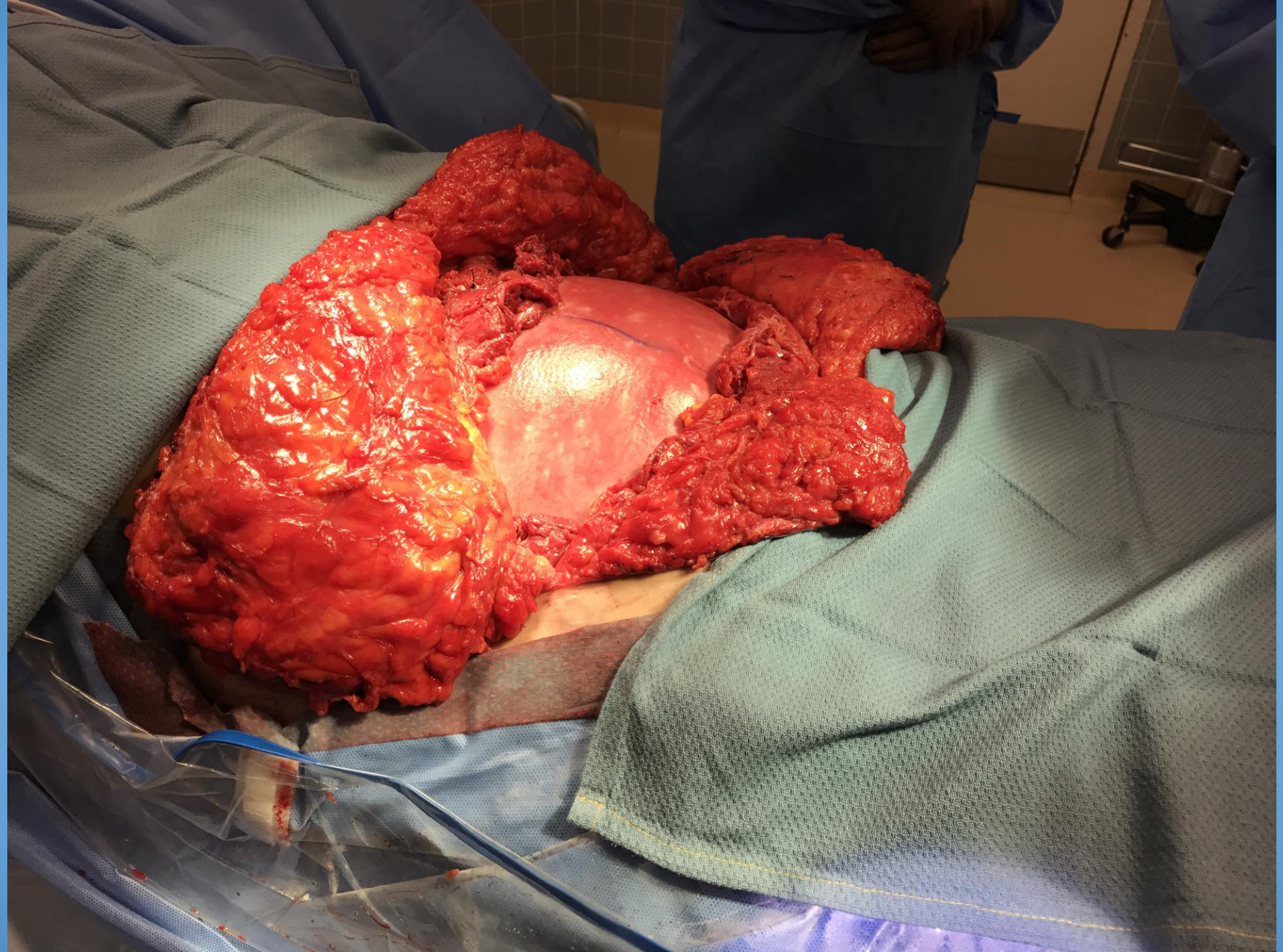
CT Case #6

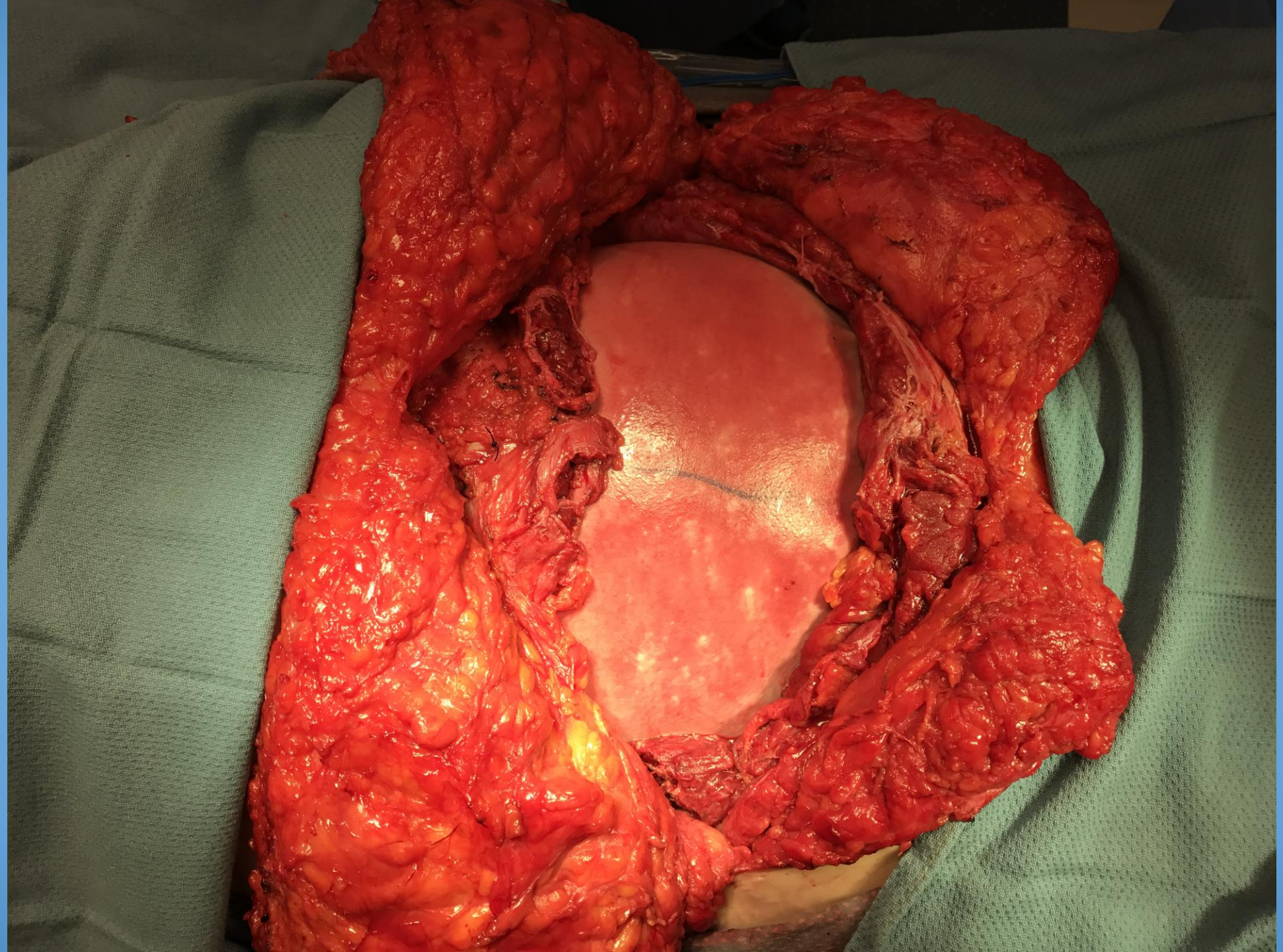
Traumatic Abdominal Wall Hernia

- Multiple other attempts at classification but broadly;
  - **Low energy, focused**, injuries – such as handlebar
  - **High energy, diffuse**, injuries with tissue destruction, shear and associated abdominal injuries – such seatbelt
- >75% of these injuries occur in the lower abdomen
- 53% had other intra-abdominal injuries
- Early repair advised, but late can be safe

Treatment

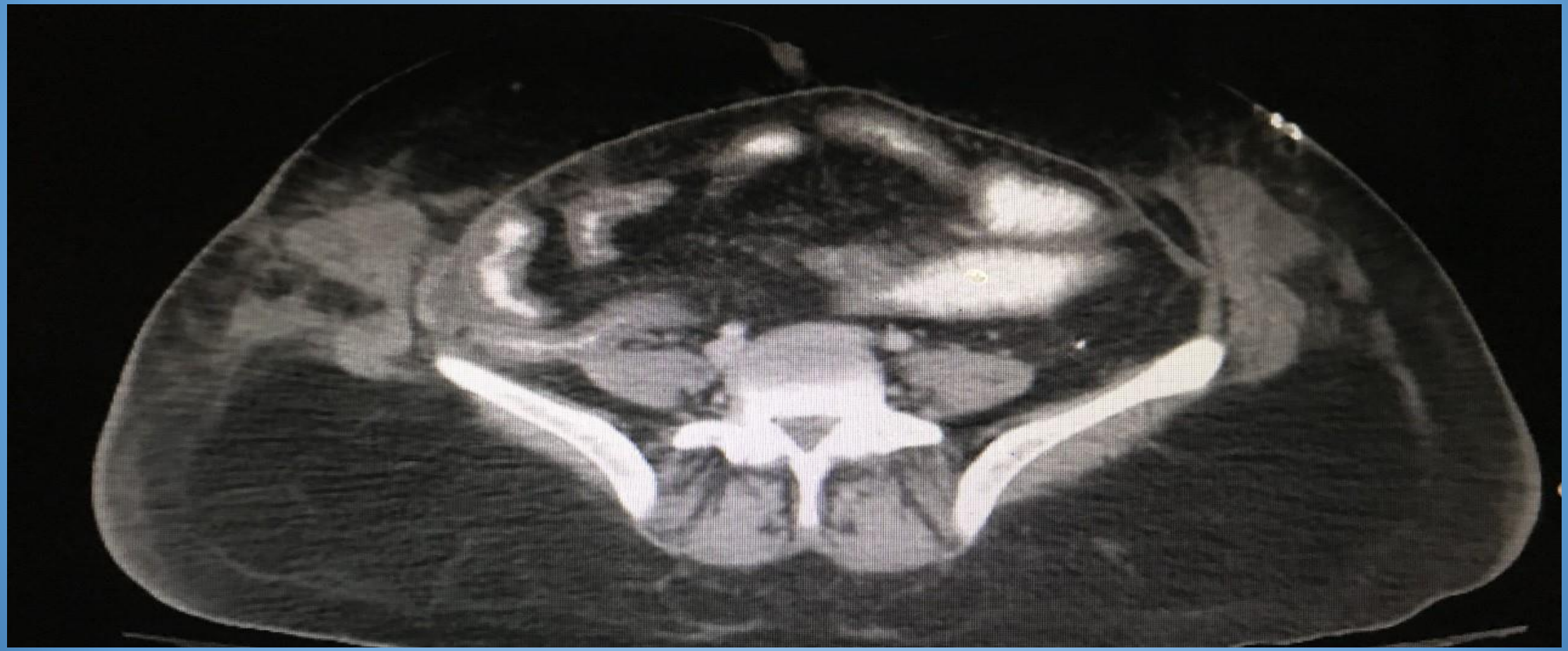
- All should be treated
- Timing dependent upon presence/absence of other injuries – esp bowel/vascular
  - *'Lethal triad' of hernia, bowel and vascular injury*
- Repair with mesh – biological or prosthetic
- Little data on this
  - 1 series had a 10% recurrence rate at 10 years with prosthetic mesh
- No up to date data





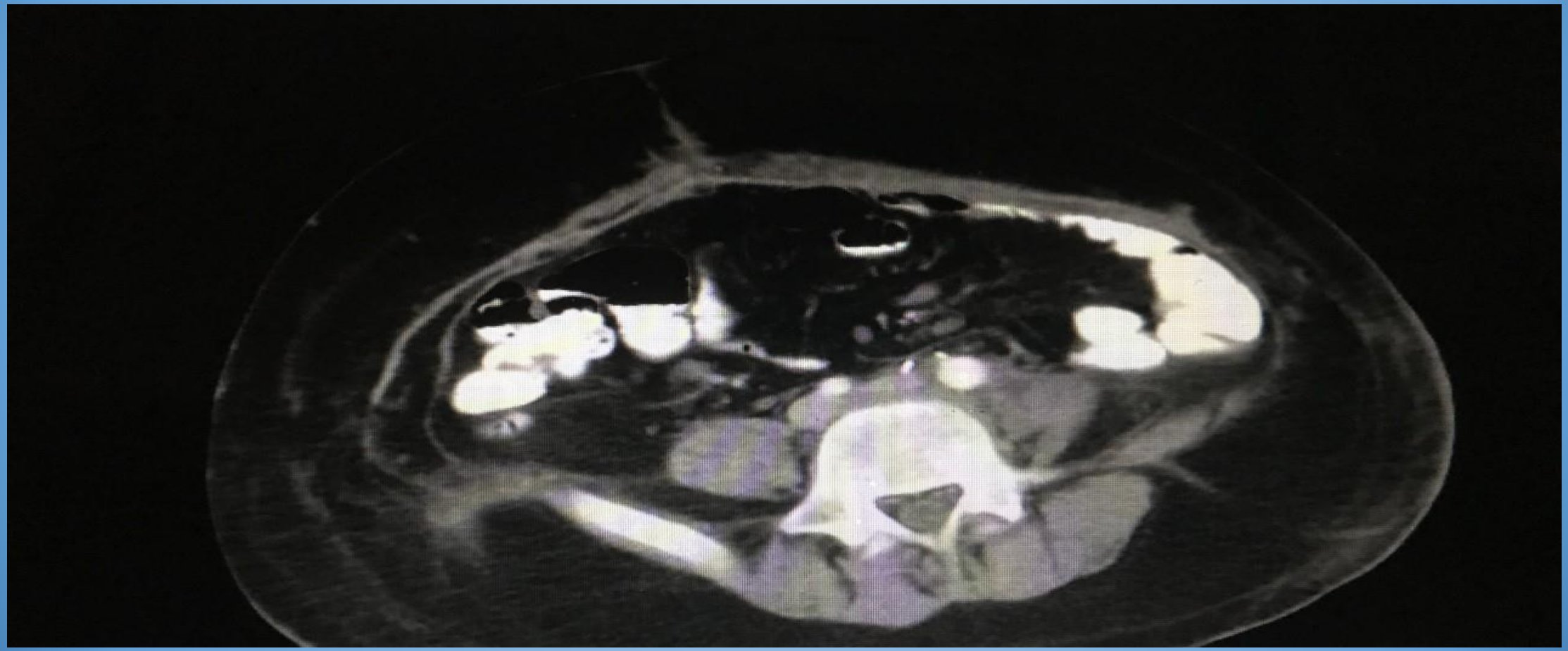
Case #5 – One Week s/p Repair

Case #5 – One Week s/p Repair

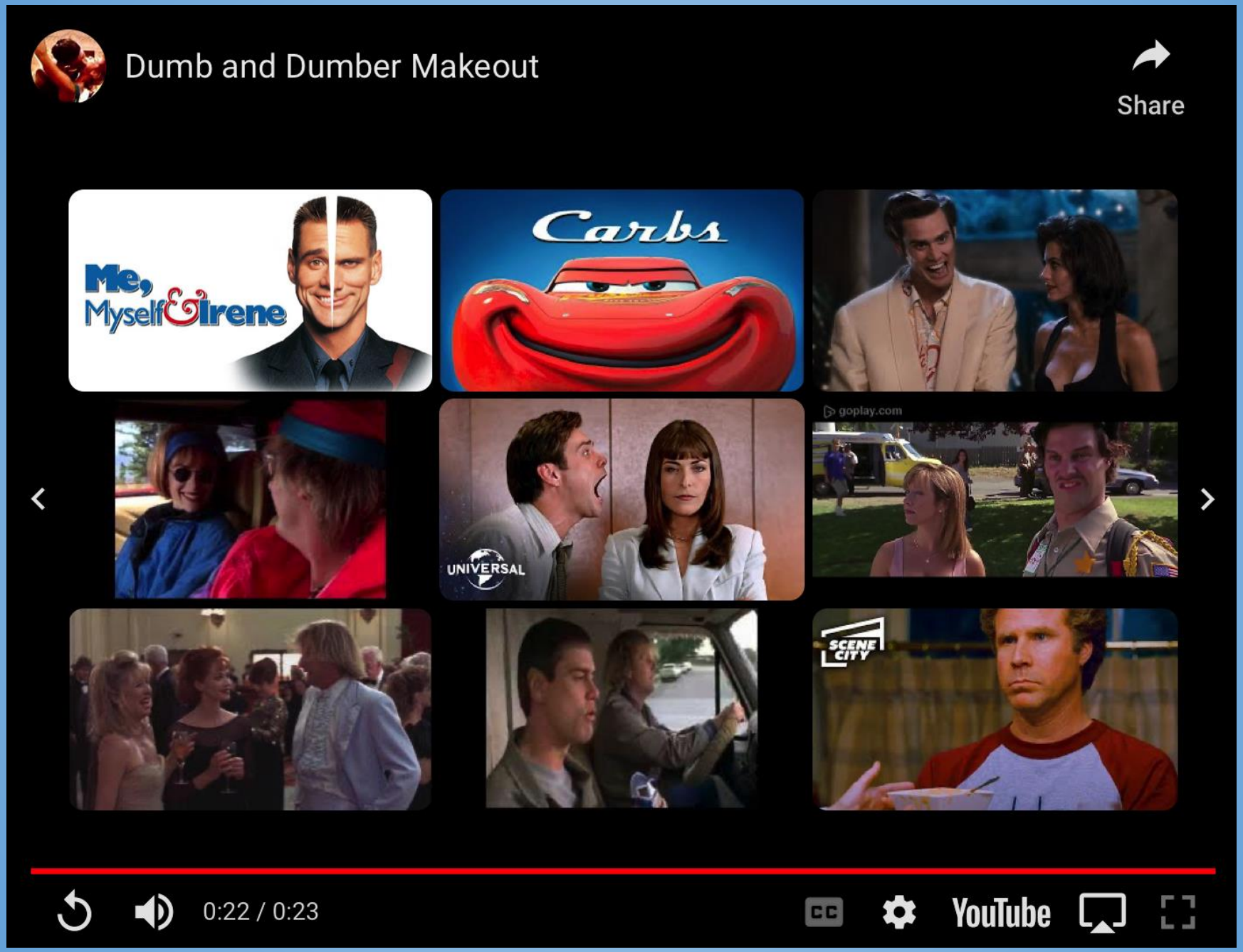


Case #6 – One Month s/p Repair

Case #6 – One Month s/p Repair



What Can We/Lloyd Christmas Learn From The "One in a Million" Chances?


Dumb and Dumber Makeout
Share
Me, Myself & Irene
Carbs
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UNIVERSAL
SCENE CITY
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YouTube


PREPARE AND PREVENT,
DON'T REPAIR AND REPENT.
~AUTHOR UNKNOWN
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LifeFlight
JET A