

OPERATIVE TREATMENT OF INJURIES TO THE CHEST WALL

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Outline

- Background/Literature Review
 - Rib fracture
 - Sternal fracture
- Diagnostic Evaluation
- Indications for operation
- Operative techniques
 - Rib fixation
 - Sternal fixation
- Illustrative Cases
- Outcomes (personal and literature)
- Use in flail chest patients

Background: Rib Fixation

- Until the late 1990's, there was only a rare report on operative rib fixation
- Beginning in early 2000's, there has been an ever-increasing experience reported with operative rib fixation
- Over 50 paper published since 2002 in trauma, orthopedic, and thoracic surgery literature

Background: Sternal Fixation

- Richardson published first series using wire-fixation in 1975 for over-riding fragments with severe pain and for non-union
- Occasional reports since with ORIF-plate fixation (largest series Louisville)
- Scattered reports but not robust as with rib fractures

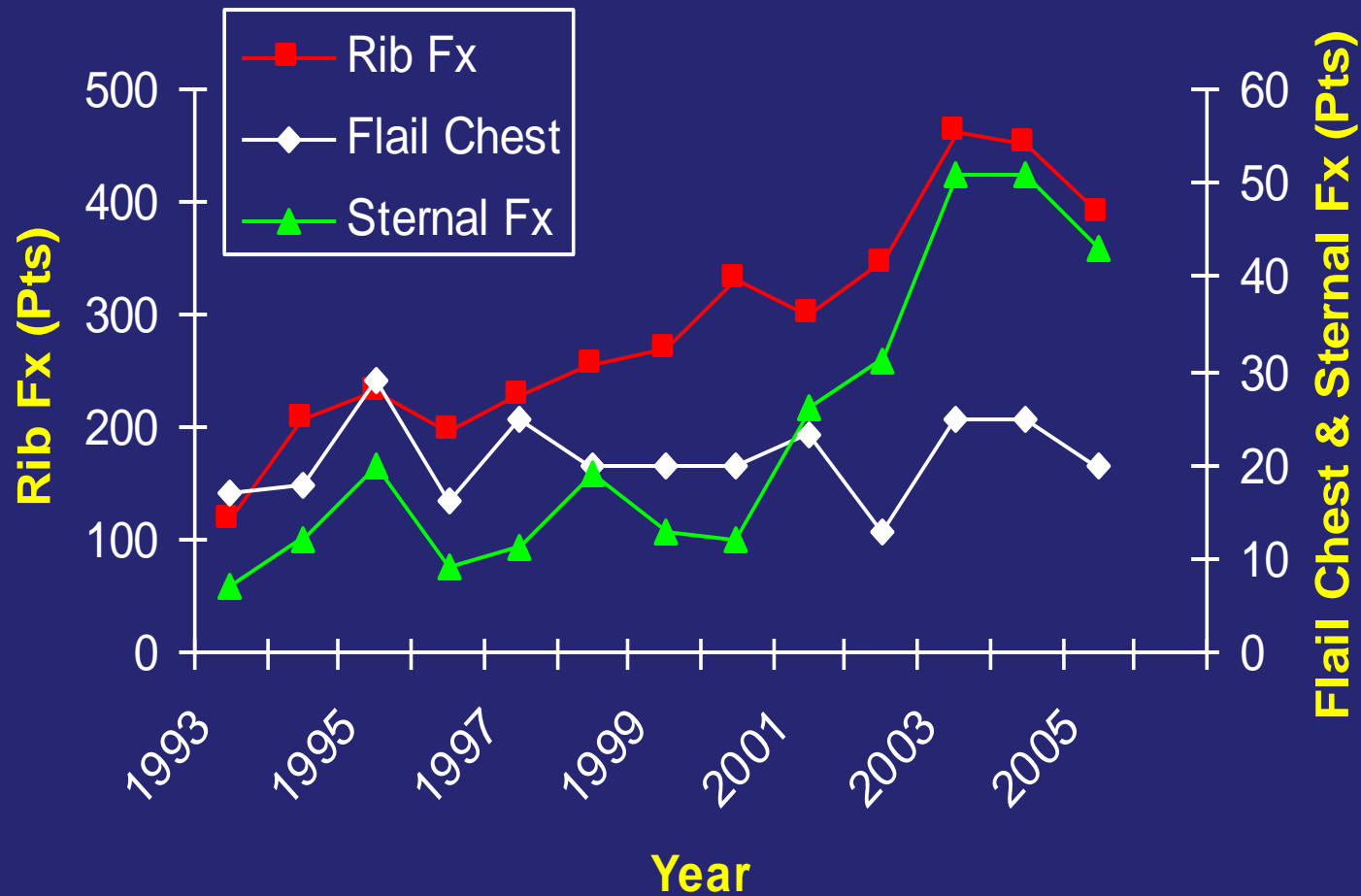
Rib Fixation: Summary of Literature Review

- Only one series of greater than 100 cases
- Rate of fixation of all rib fractures treated ranges from 0.5% to 2.8%
- Most papers do not discuss indications for operation or case selection
- Techniques vary greatly among papers
- Results usually quite good

Diagnostic Evaluation

- With advent of CT scanning of the chest, rib fractures commonly diagnosed
- 3-D reconstruction is very helpful (essential?) in determining need for operation
- Key features: number and location of fractures; over-riding of rib fragments
- Sternal fractures: lateral chest view and CT scan

Incidence of Boney Chest Injuries

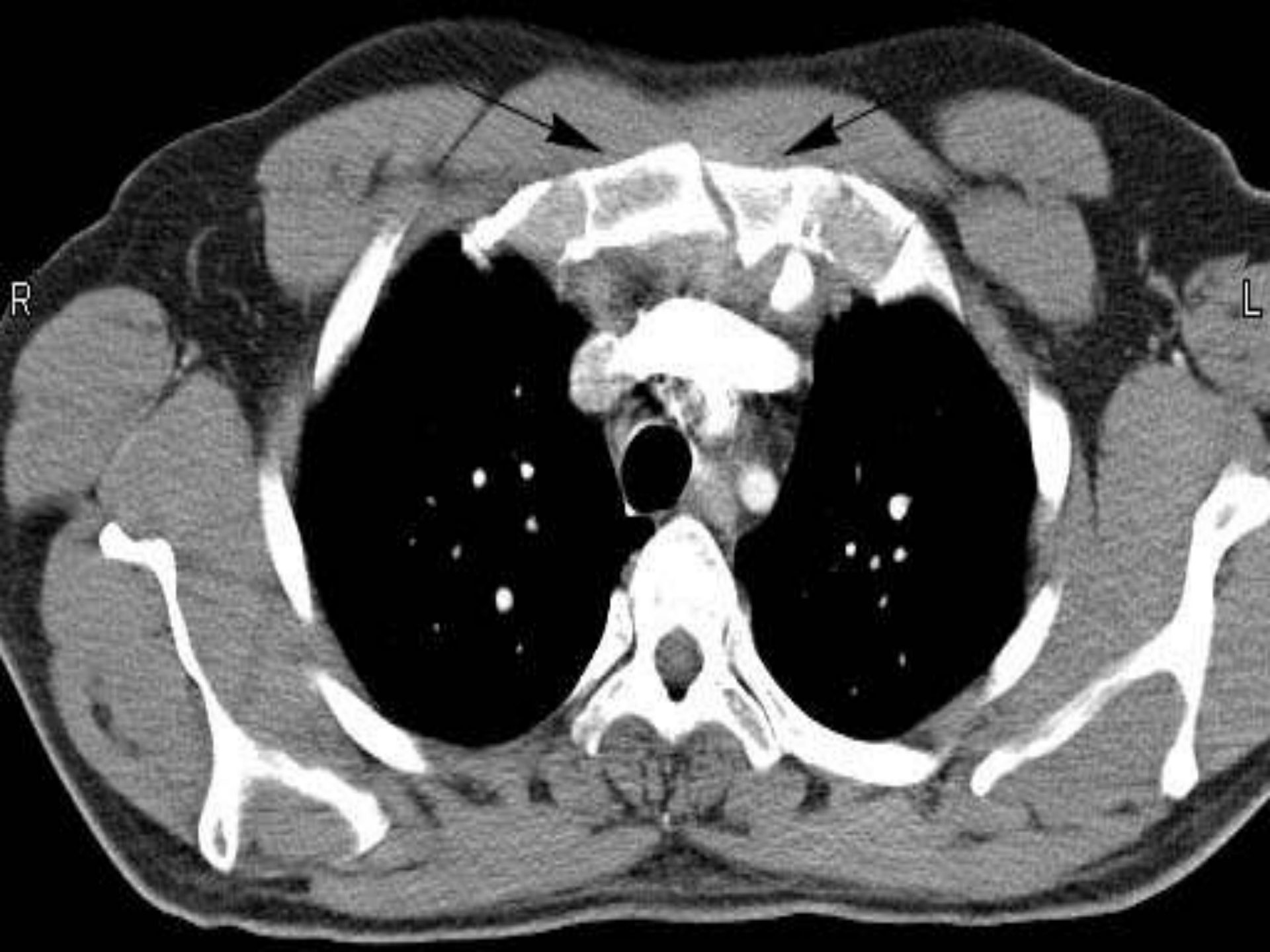


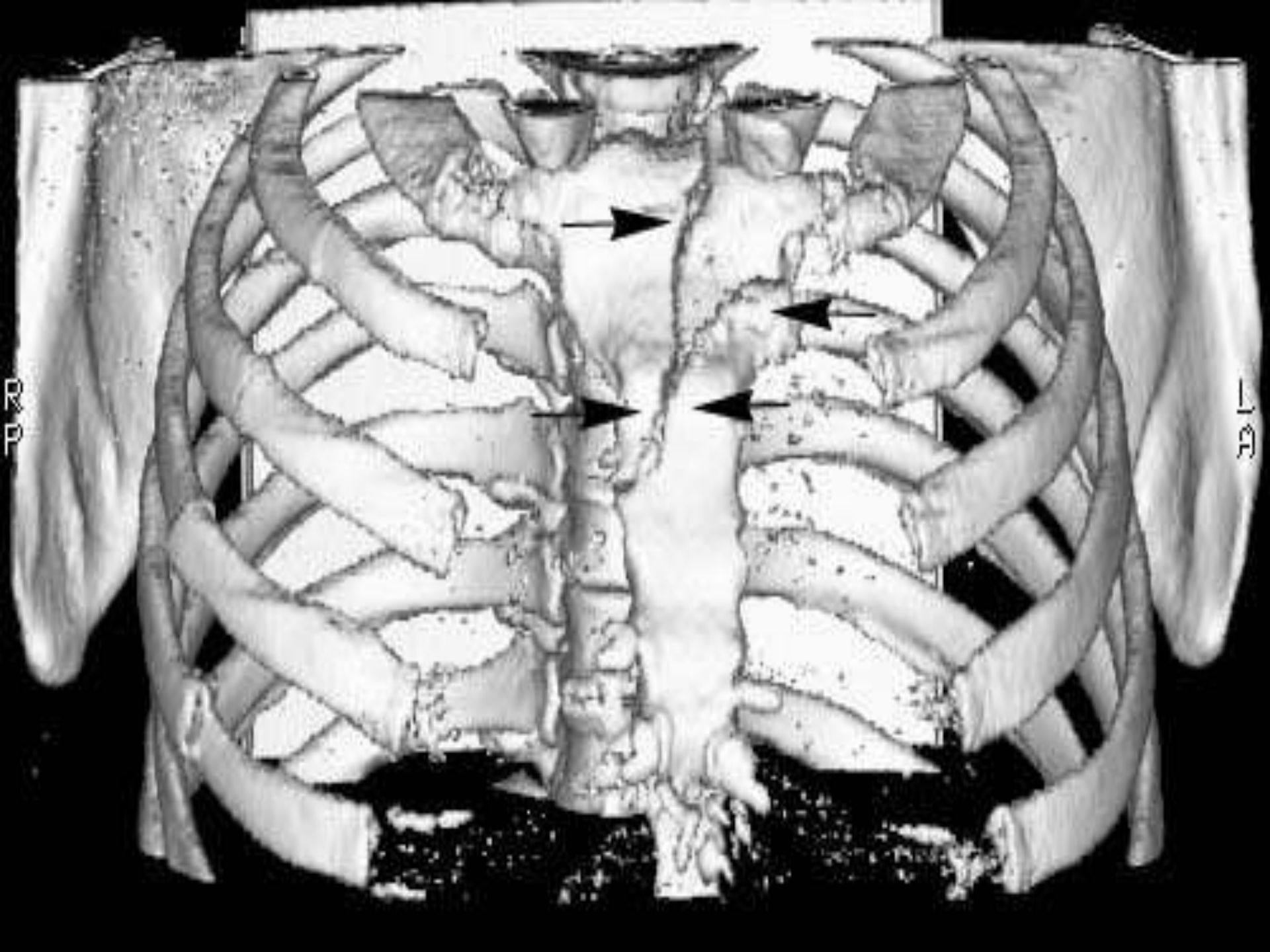
Incidence

- Rib fractures represent most commonly broken bone in the body
- Sternal fractures have increased 7-fold in past 10 yrs. in our hospital
- “Epidemic” of sternal fractures with seat belts and air bags reported in literature
- Most chest wall fractures heal without specific treatment

HOWEVER

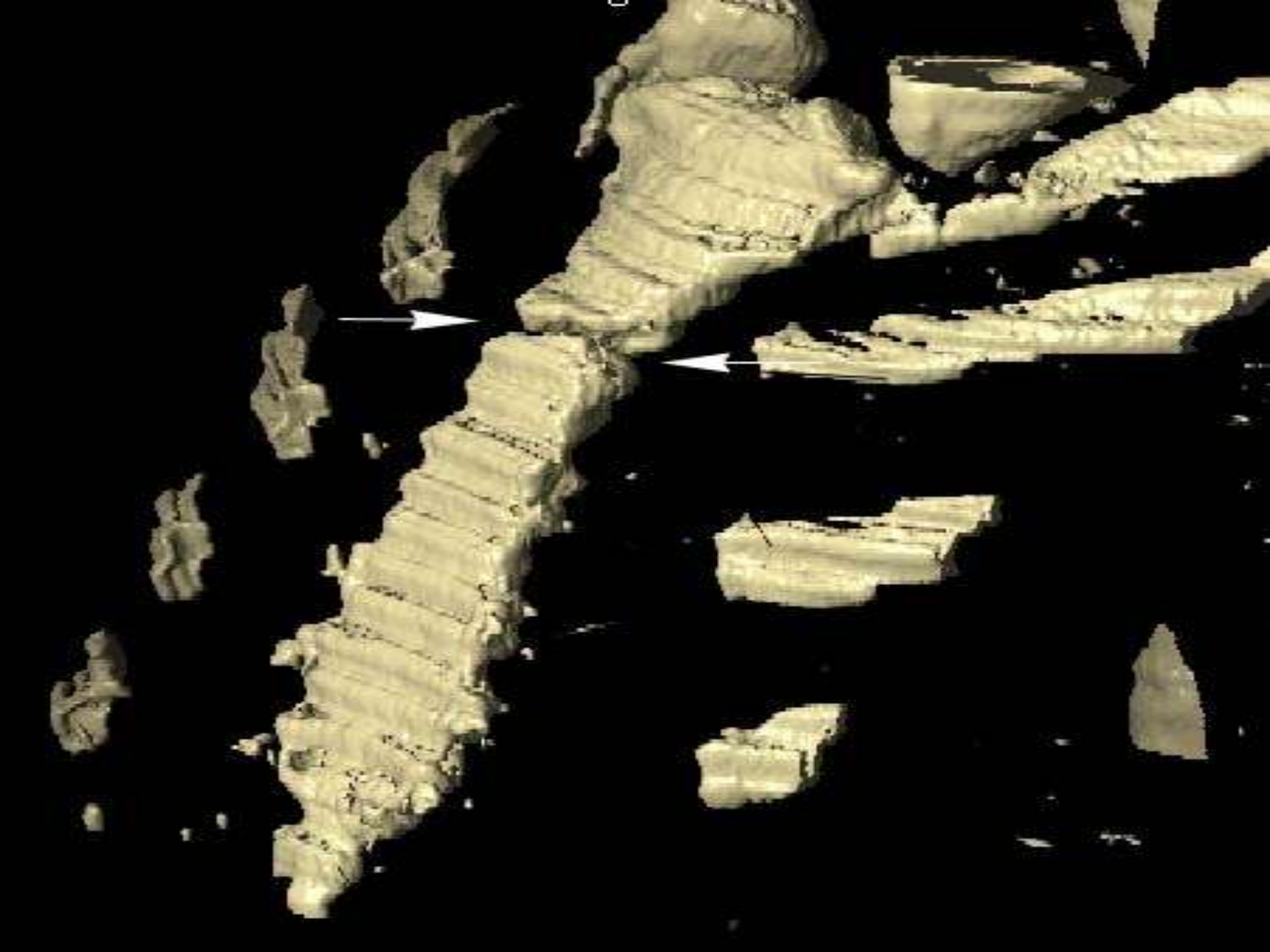
- A small subset of pts have severe displaced rib or sternal fractures that are highly symptomatic and do not heal normally





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132



Indications For Fixation of Chest Wall Fractures

- Given that a busy trauma center will see hundreds of rib fractures and a similar number of sternal fractures, the most critical issue hinges on the indications for operation
- In my opinion, this is a subjective decision. There are no objective scores to aid in the recommendation for fixation.

Generally Accepted Indications For Fixation

- Severe pain with likelihood of non-union (over-riding, unopposed fragments)
- Non-union (as a chronic problem)
- Lung herniation (rare)
- Closing an unstable chest after thoracotomy for another indication
- Flail chest (a complicated topic discussed last)

My Indications for Rib Fixation

- Over 90% of rib fixation done for severe pain with multiple over-riding or unopposed rib segments
- 3 cases of chronic non-union remote from injury
- 1 operation for lung hernia requiring rib fixation
- 6 cases of fixation after thoracotomy for another indication (in several others I considered but wanted to quickly terminate the case)
- 6 cases of flail chest (I worry about these patients)

My Indications for Sternal Fixation

- Patients with severe pain and over-riding rib fragments (over 40 cases)
- 20 cases of chronic non-union (including 4 physicians who reviewed literature!); 14 were initially treated at another hospital

Operative Techniques: Rib Fixation

- Kirschner wires (k-wire) – no personal experience
- Fixation with absorbable plates
- Hardware that is fashioned to the ribs (e.g., low-profile mandibular plates)
- Hardware designed to contour to the rib (e.g., Synthes^R system) (no personal experience)

Pros and Cons

PRO

CON

K-WIRE

Less operative exposure

Require removal, erode into adjacent tissue

ABSORBABLE

No removal required

Theoretical risk of non-union; infection resistance

CONFORMABLE HARDWARE

Very robust and reliable

Require bending of the plates; ?? More operative exposure

SYNTHES

Made to contour to ribs

Not as strong for some severe over-riding ribs

Operative Technique

- Muscle sparing thoracotomy when possible
- Minimize incision
- Some authors mentioned routine VATS (but I rarely use for this problem)
- Important to obtain solid union with rib opposition
- The injury often has violated the pleura so one must be prepared to enter the chest

Case 1

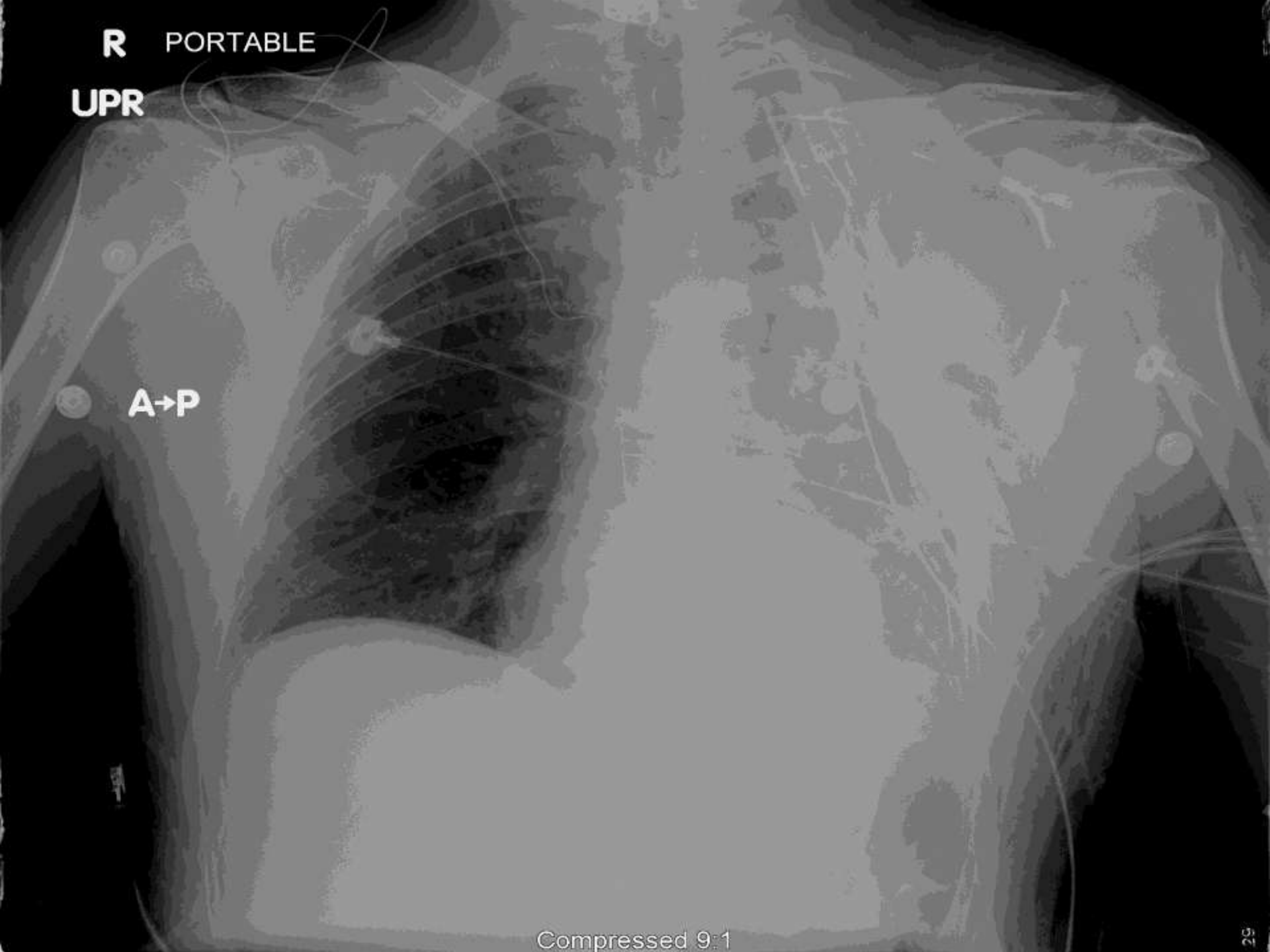
- 49 year old jockey sustained a fall from his horse at Churchill Downs racetrack
- Lt. chest crushed by stampede
- Sustained 8 rib fractures and flail chest
- Did not require ventilation but borderline respiratory status
- Severe pain with each breath despite thoracic epidural and supplemental narcotics, NSAIDS, Ketamine, Neurontin
(pain management team)

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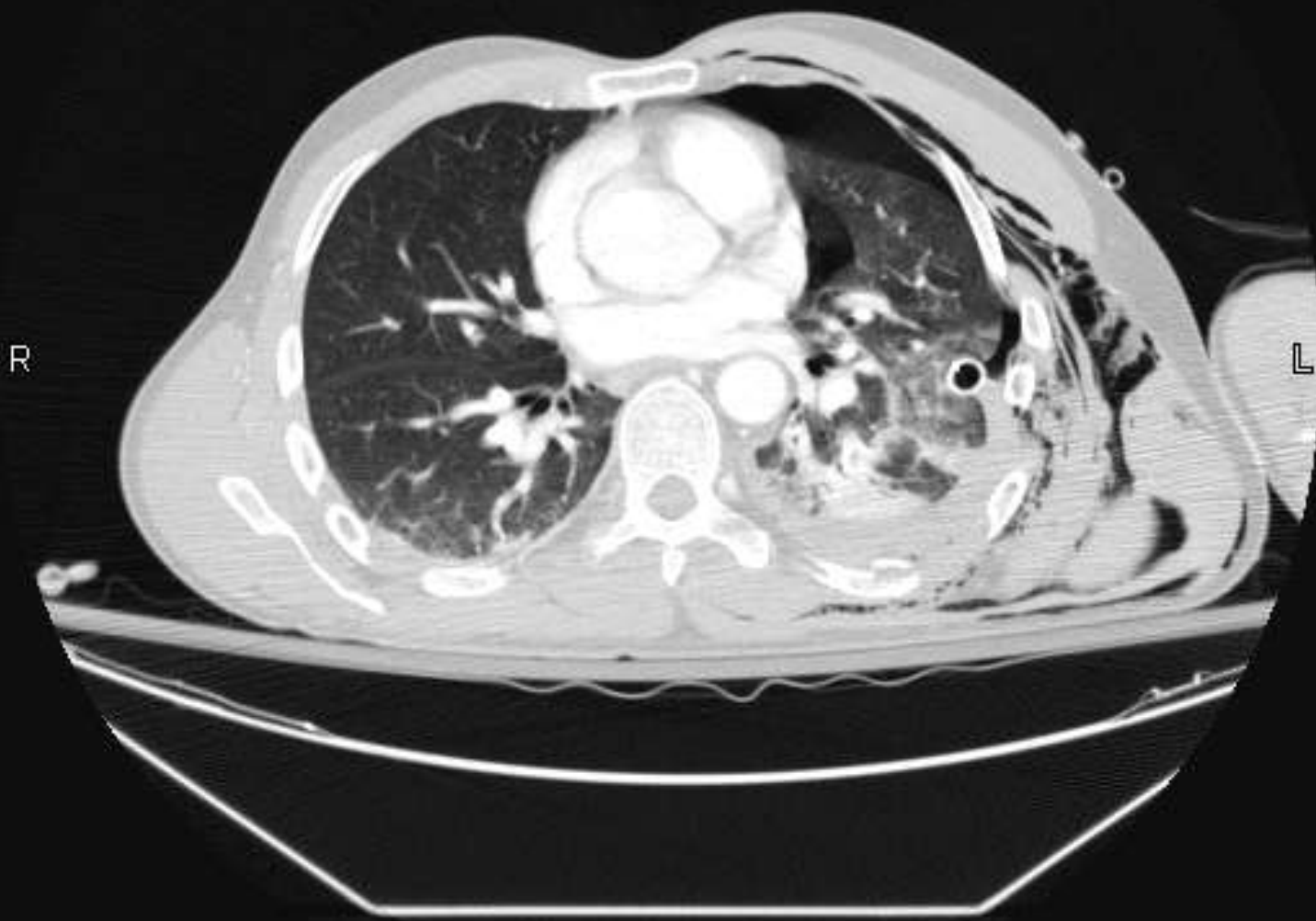
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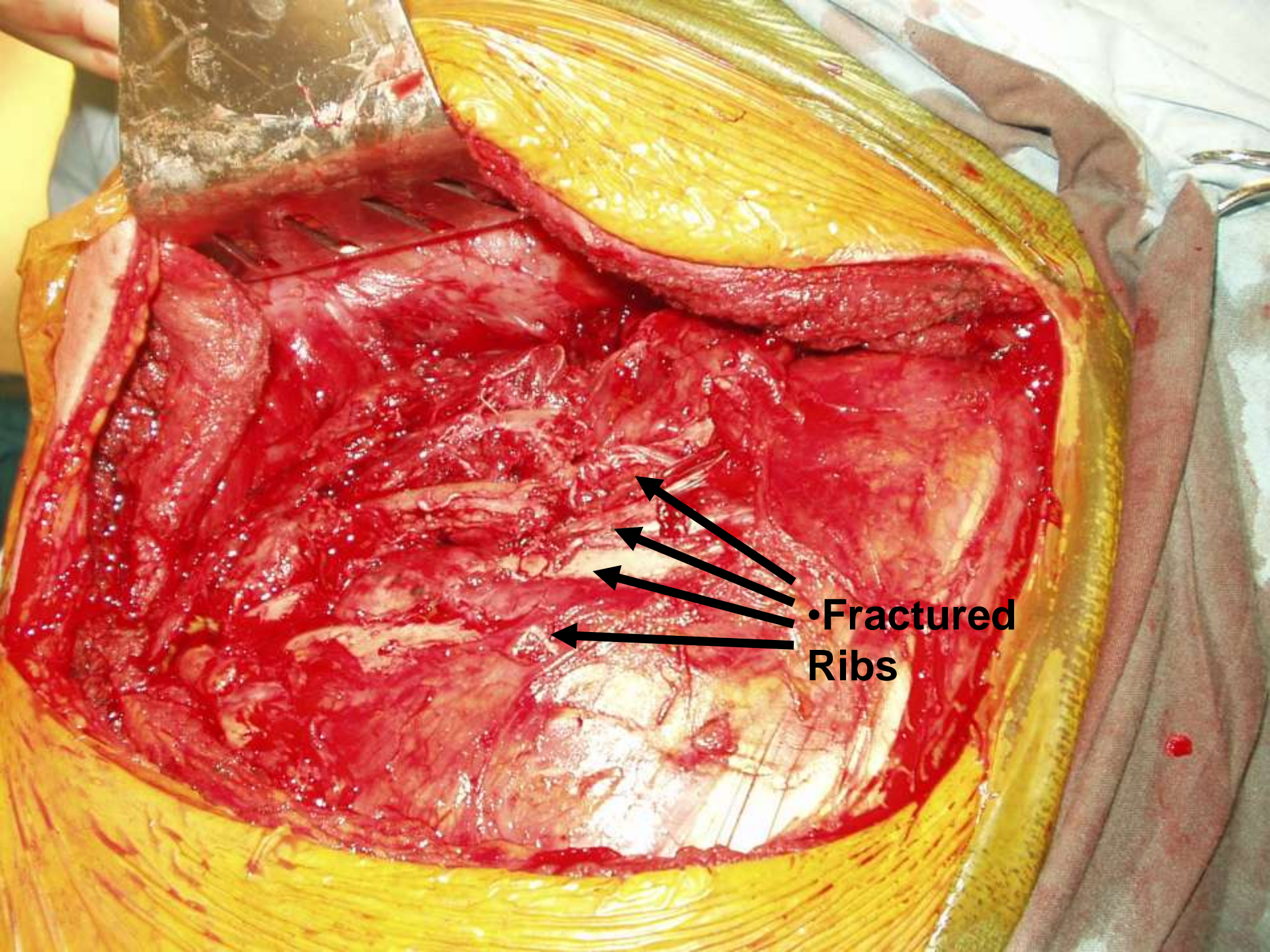
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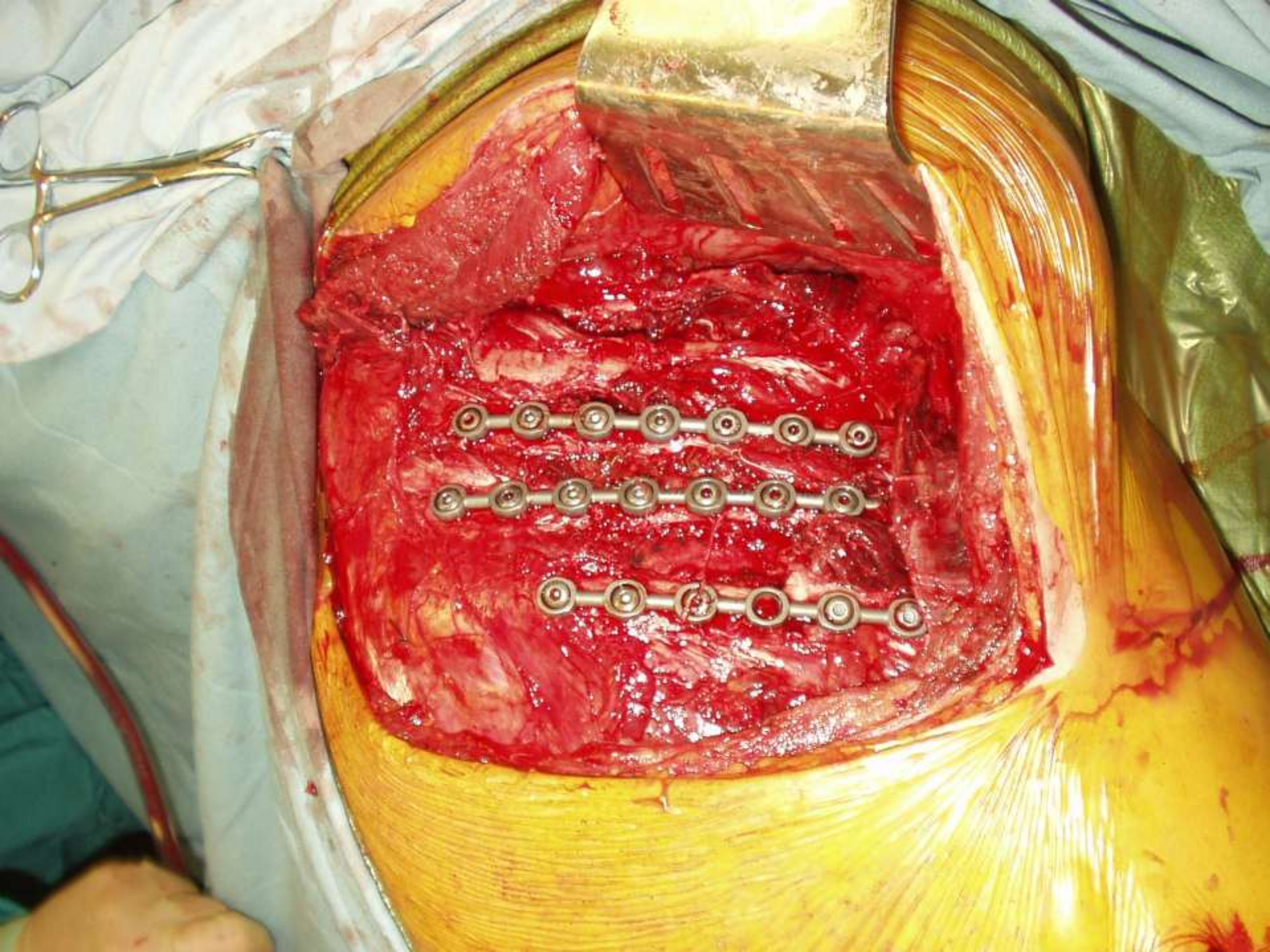
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•Fractured
Ribs



Operative Repair

- Required operation on post-op Day 6
- Lt thoracotomy incision
- Fixed 4 ribs with titanium plates and screws
- Pt transferred from ICU in 2 days and discharged in 4 days

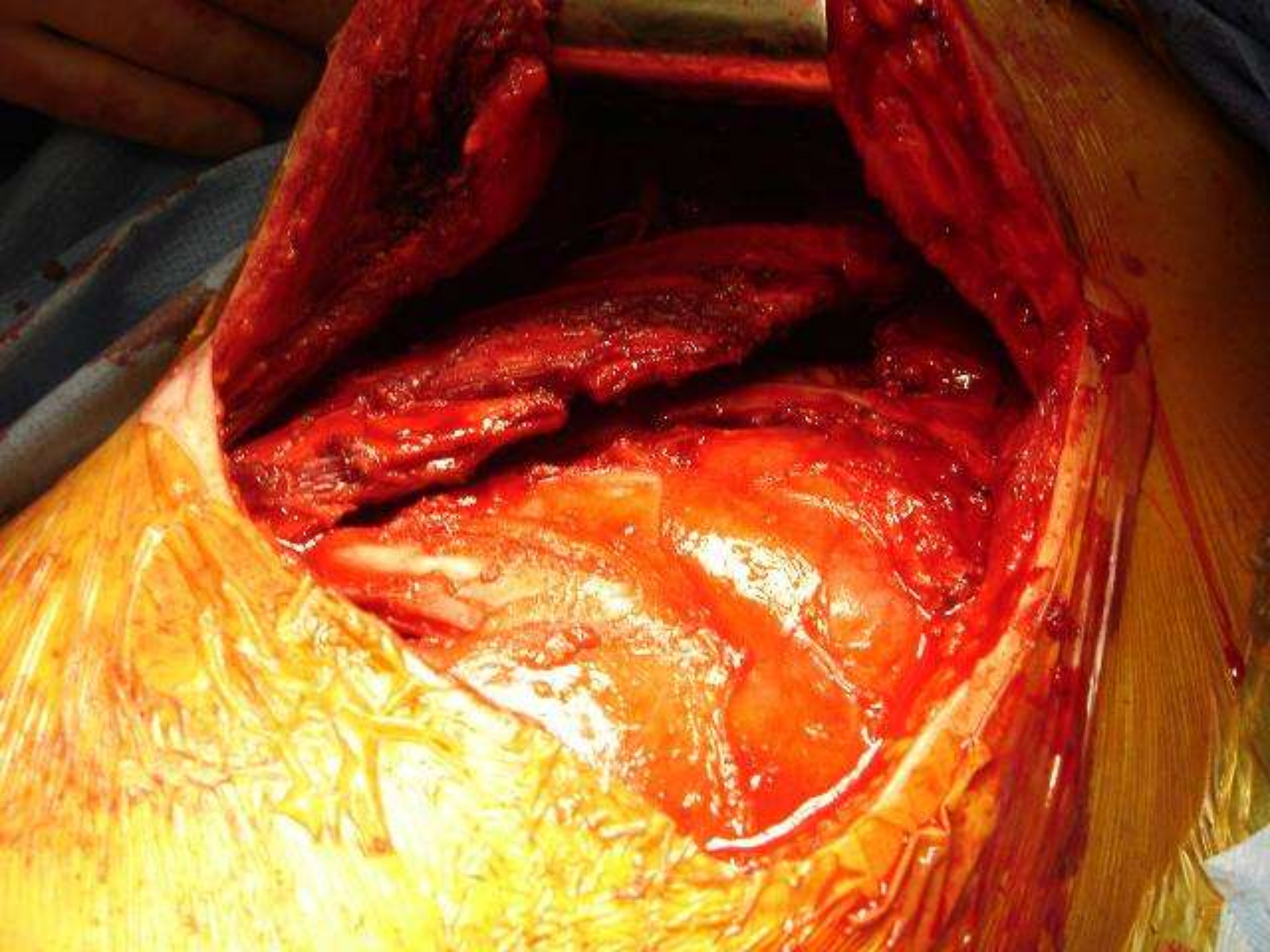
Case 2

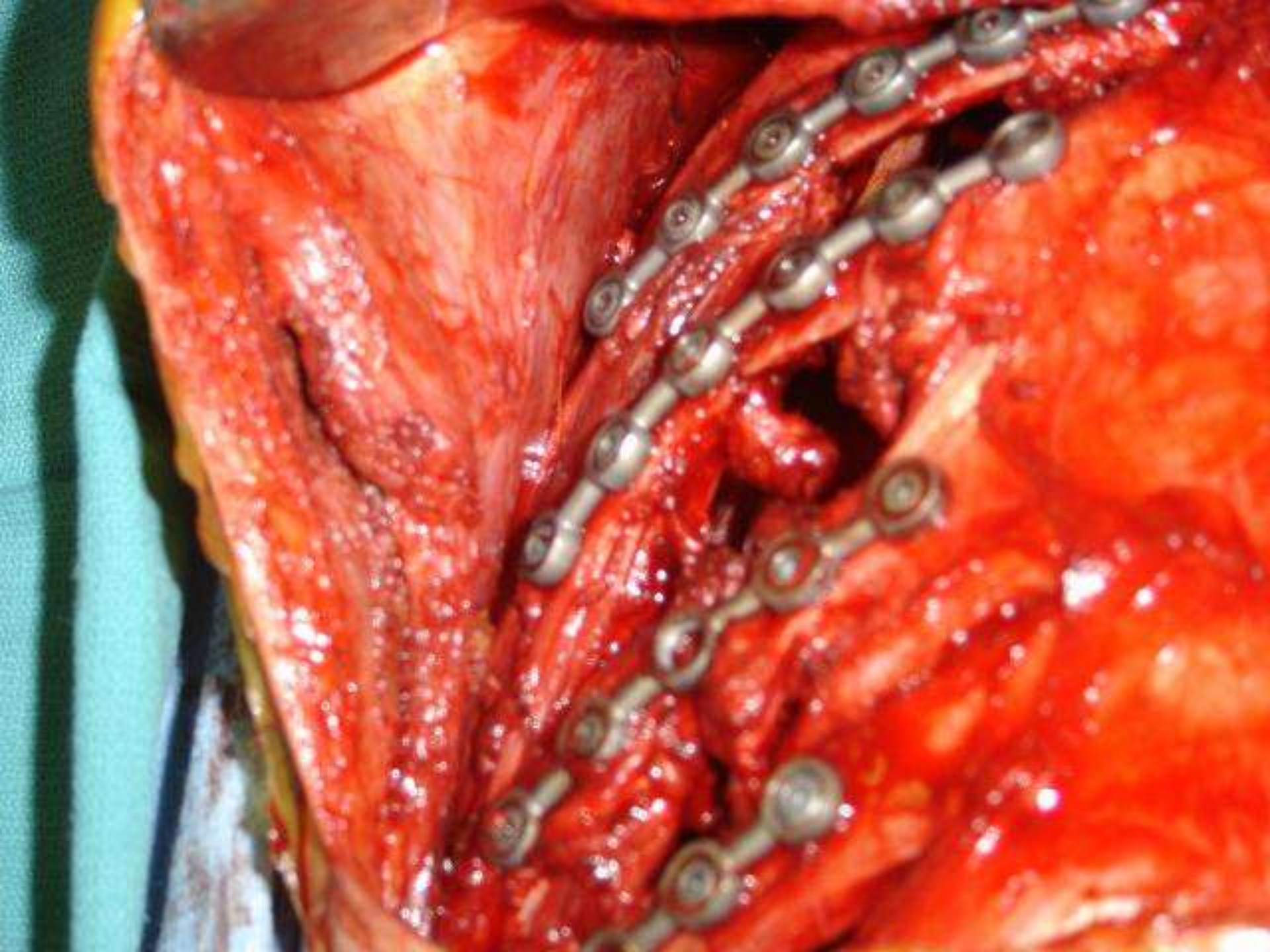
- 33 y.o. woman sustained a crushed left chest in motor vehicle crash
- Despite thoracic epidural & aggressive pain management, she had borderline pulmonary status due to severe pain
 - Inability to breathe deeply
- Eight rib fx & scapula fx were her only injuries

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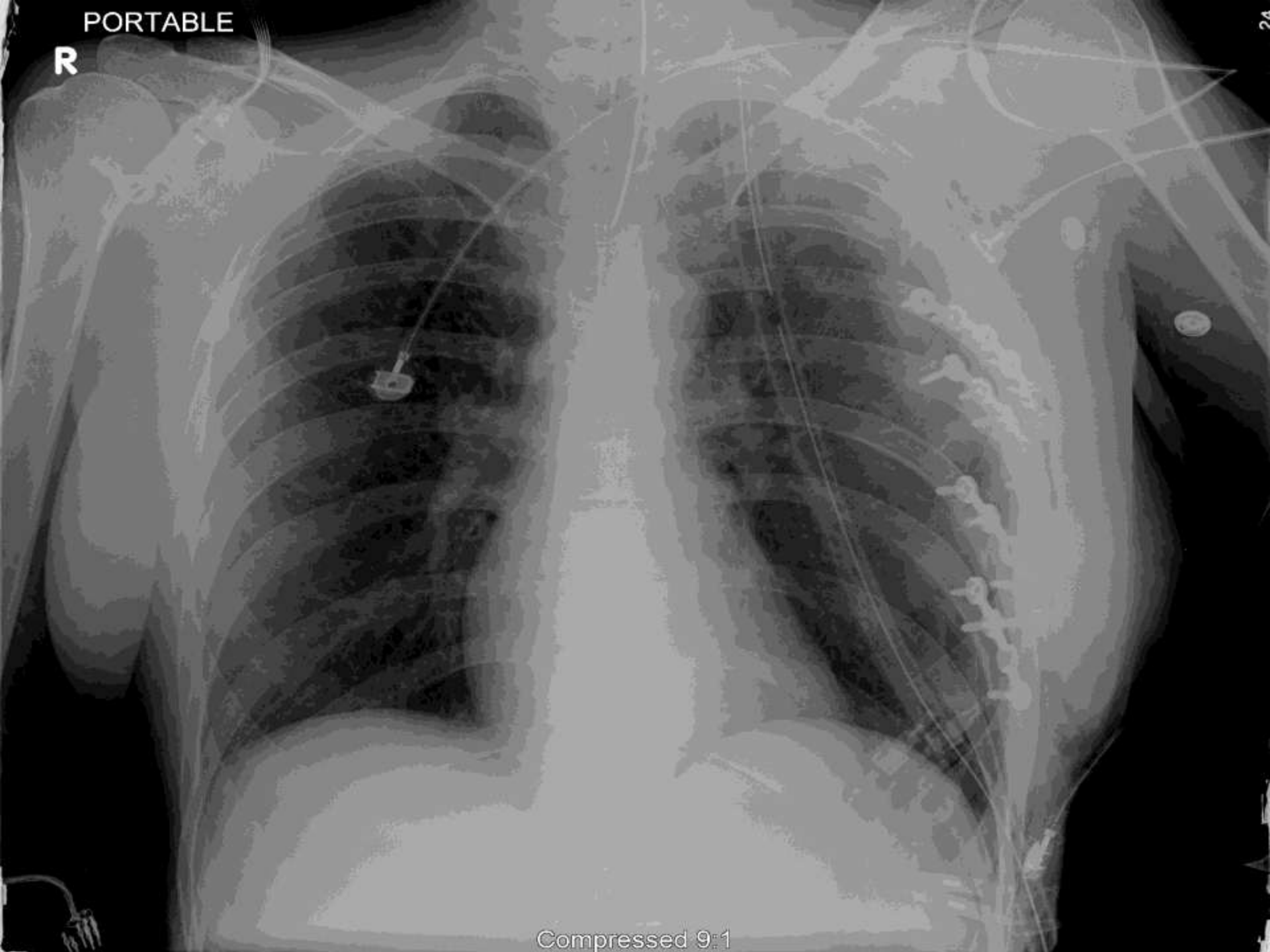
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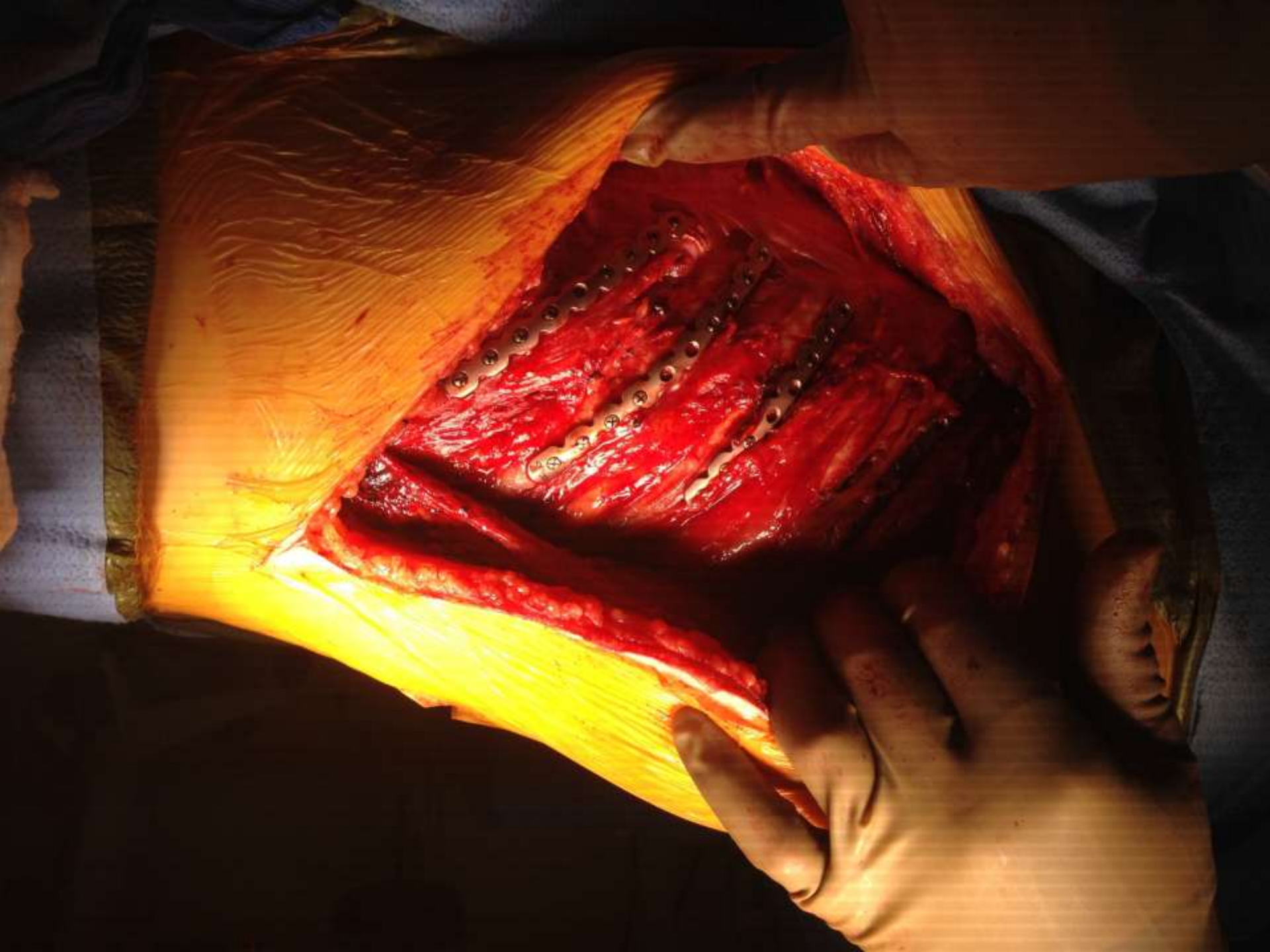


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Operative Technique

Sternal Fixation

- Vertical incision over fracture
- Reduce overriding fragments
- Titanium mandibular plate applied with plate and screws
- 2 plates used



OUTCOMES: RIB FIXATION

- Our unit has done 62 cases of rib fixation
- No deaths or complications
- Usually dramatic pain relief
- Ventilated patients promptly weaned (most were not on ventilator)
- No infections or non-union
- Excellent long-term results (3 plates later removed)
- Mirrors results found in literature

RESULTS: STERNAL FRACTURE

- 1 disastrous result!
- 63 year old man underlying COPD sustained comminuted sternal fracture
- Treated with ORIF with excellent early pain results and started weaning
- Required mechanical ventilation
- Patient self-extubated twice pre-op and post-op #2 and unable to be re-intubated
- Patient died during cricothyrotomy
- Death less than a month after abstract submission

Other Results: Sternal Fracture

- Remainder of patients had excellent results
- Good pain relief
- No infection or non-union
- No long-term pain medication use
- 3 plates removed after healing

Indications for Rib Fixation in Flail Chest

- Literature very muddled
- Indications for operation rarely clearly stated
- While results generally good the patients are high selected
- **Proper patient selection is crucial**

Problems With Flail Chest

- Mechanical with chest wall
- Pain preventing adequate ventilation
- Underlying pulmonary contusion
- Associated injuries (e.g., neurologic)
- While fixation may aid first two issues, anesthesia required may worsen the latter two

Randomized Trial

- Australian study randomized 46 patients to fixation versus conventional treatment
- Criteria: no prospect for extubation with next 48 hours
- Ventilator days post-randomization was 6.3 in operative group vs. 7.5 in conventional group (22 operated patients, saved 5 ICU days overall)
- No other differences noted

Selection of Patients for Fixation (My Indications)

- Relatively isolated flail where chest wall mechanics or flail are primary problem
- Avoid operation with major component of pulmonary contusion
- This has resulted in very occasional use