가장 가까운 의료 혁신
SMART PNUH

2021 전공의 연수교육

Conservative and Surgical treatment In patient with Chest wall injury

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2021. 05. 13

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Pusan National University Hospital

늑골골절

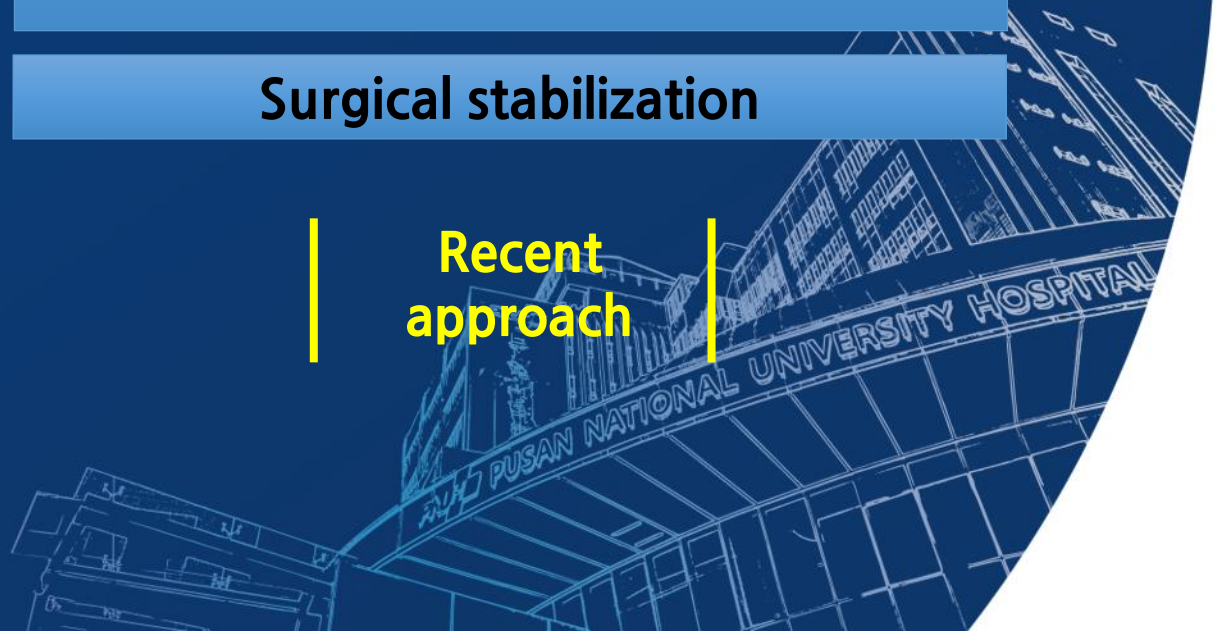
흉부 둔상의 가장 흔한 손상은 늑골골절

Traditional approach

- Pain control with narcotics
- Internal pneumatic stabilization with mechanical ventilation

Recent approach

- Multidisciplinary
- Protocolized
- Selective use of locoregional anesthesia, non-narcotic oral & IV adjuncts
- Surgical stabilization



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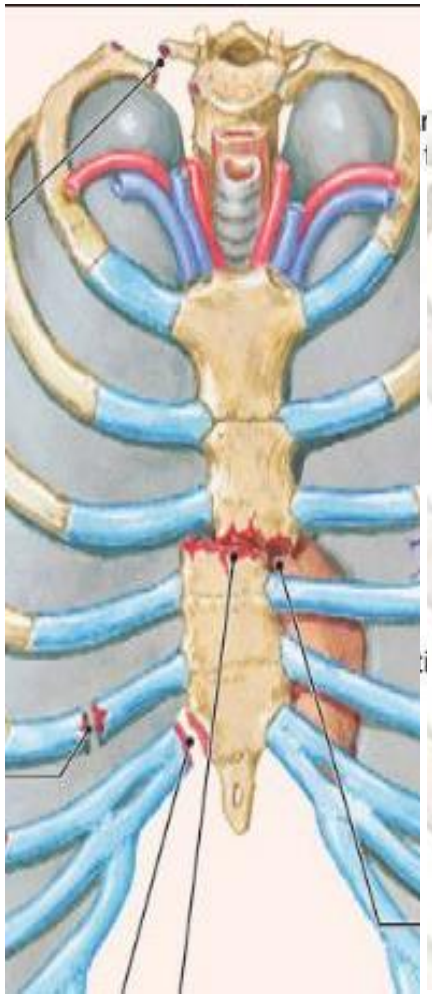
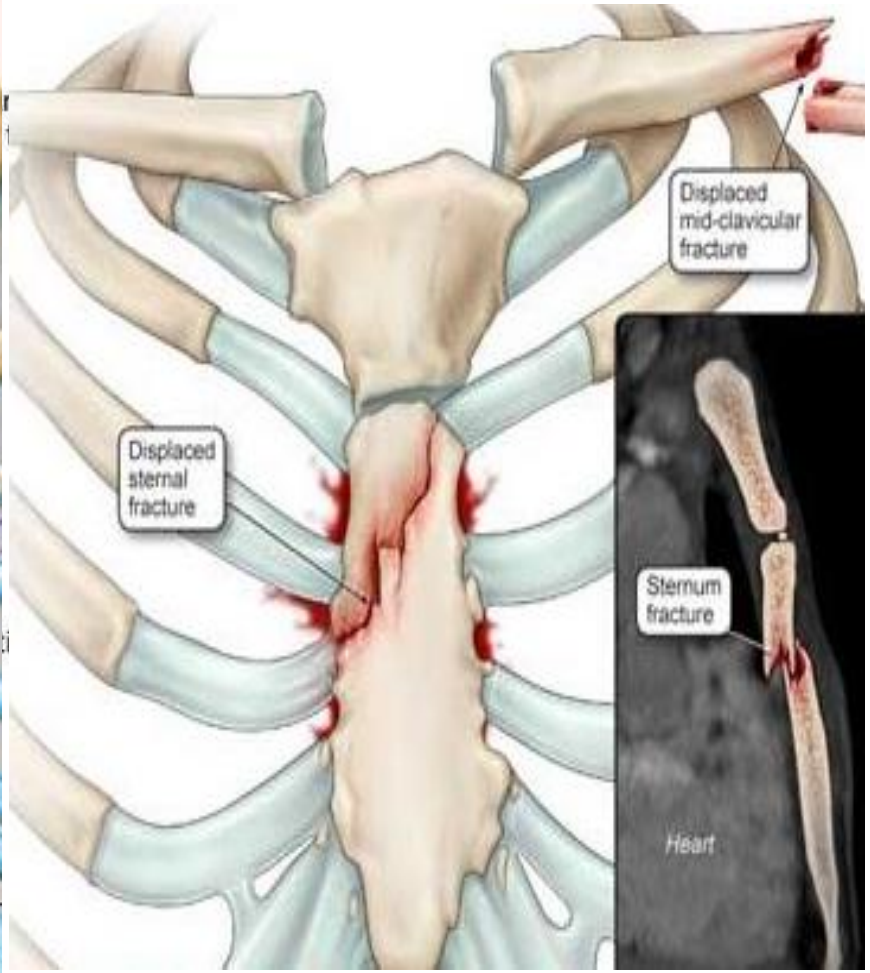
Sternal Fracture



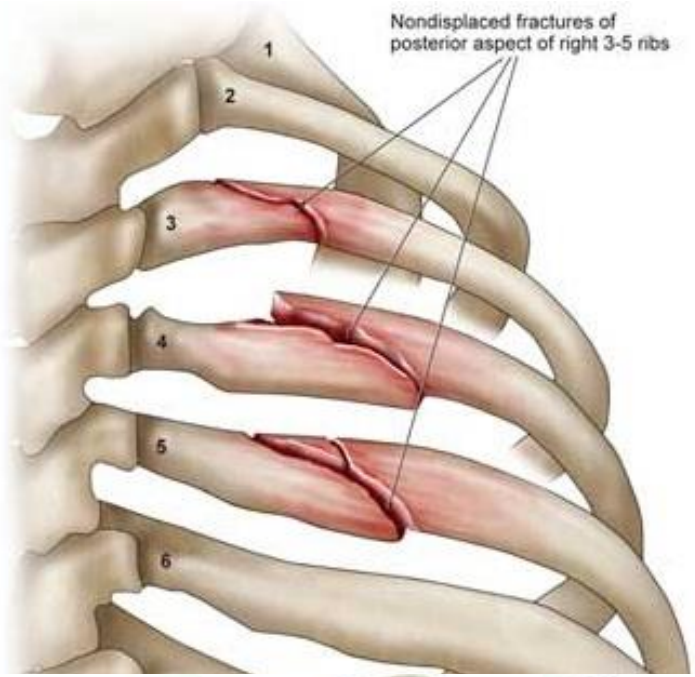


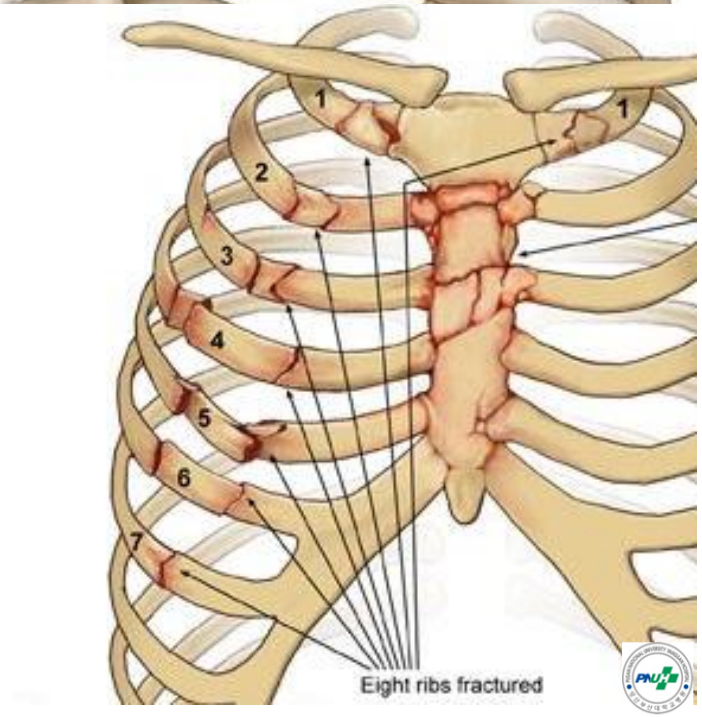
Blunt trauma/ CPR

- Diagnostic tool
  - Sternal lateral view
  - Chest CT(sagittal view)
- Cardiovascular injury
  - Cardiac contusion
  - Cardiac enzyme
  - Echocardiography
  - EKG
- Transverse, oblique shape
- Posterior displacement

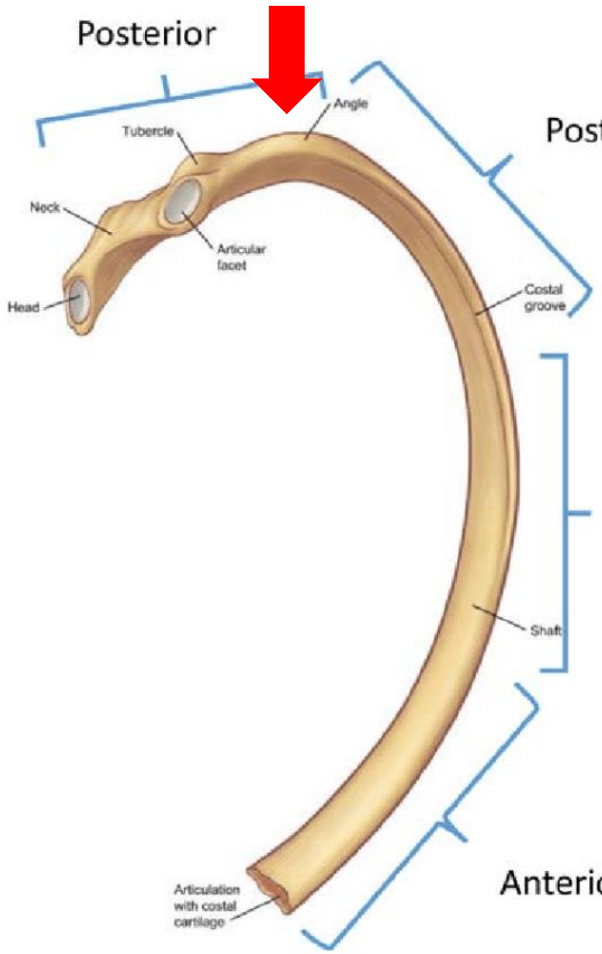
Multiple rib fracture

- 10-15% of all traumas
- Hemopneumothorax: 32%
- Lung contusion: 26%
- Mortality: 12%
- Morbidity
  - pneumonia: 16%
  - respiratory failure: 17%

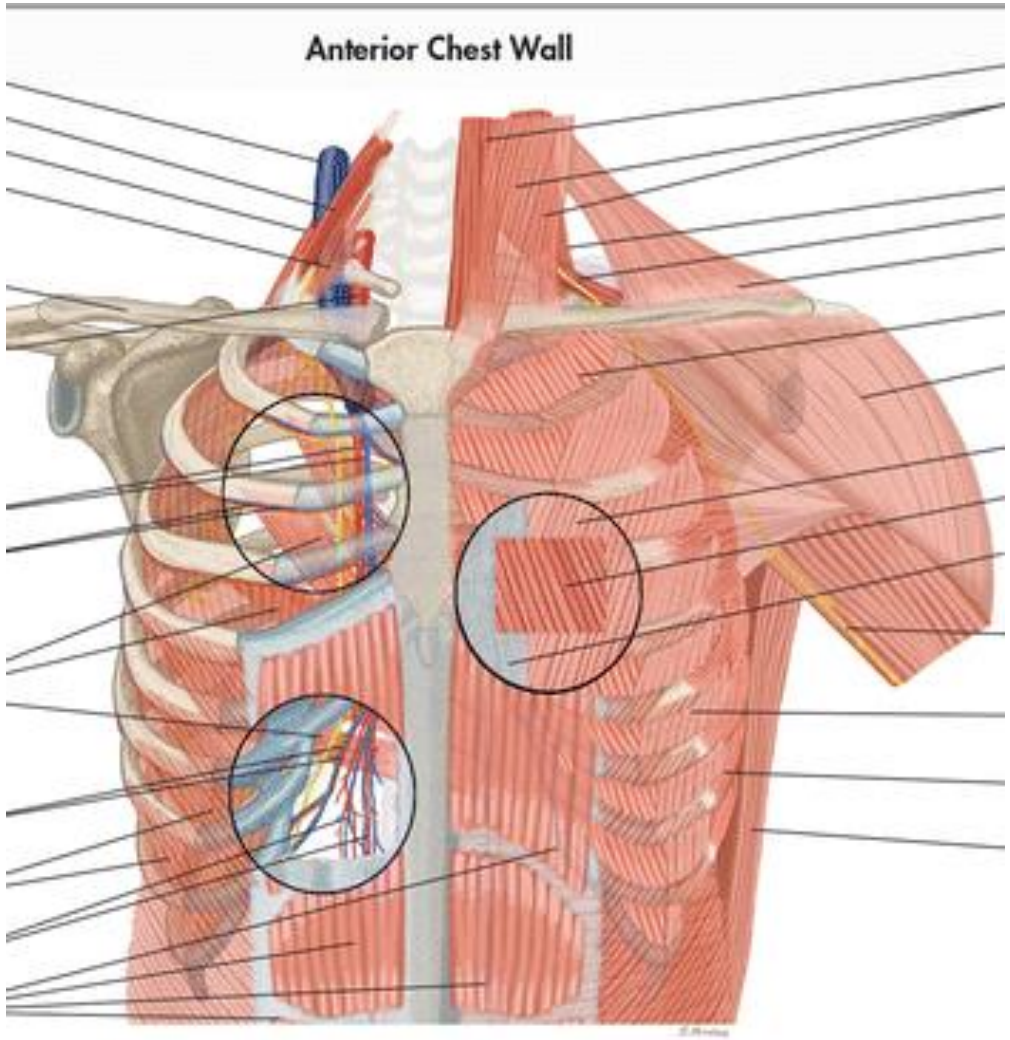




Rib Anatomy



- Tiwisted
- Conical
- Flexible

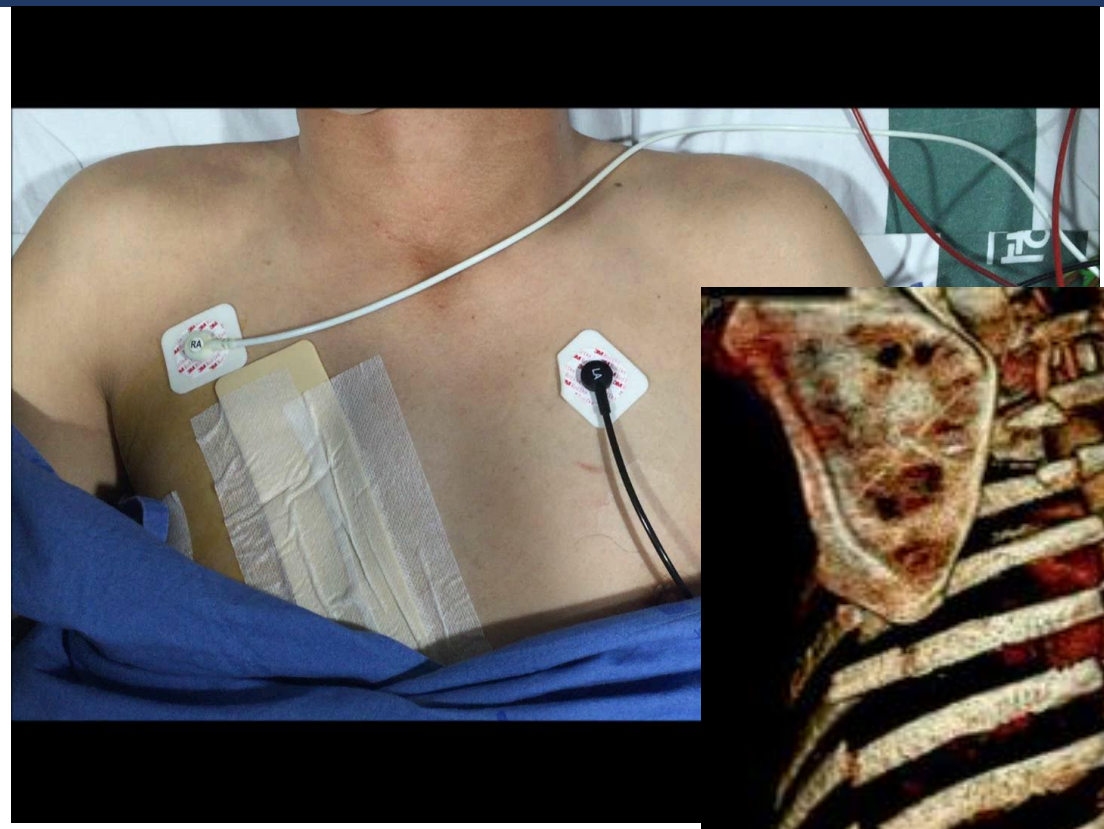


Intercostsal, scalene, subclavius, serratus, abdominal muscles

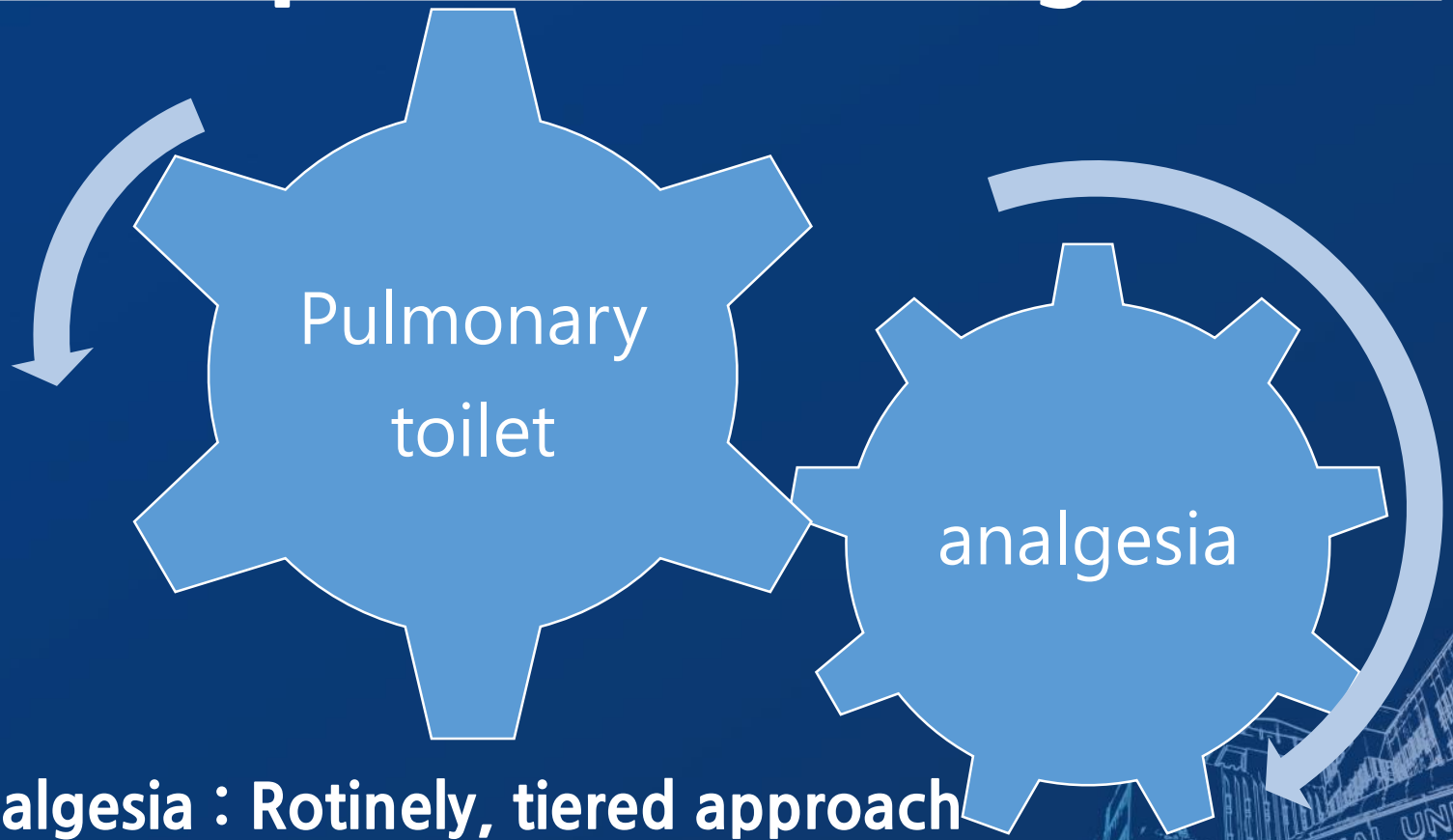
Flail chest → Flail segment

- 손상척도분류(AIS):coding rules: Rib fractures.
  - "Flail chest" is defined as three or more rib fractured in more than one location(e.g. posterolateral and anterolateral) and/or resulting paradoxical chest movement.

  "동요흉"은 모순적 흉벽운동이 나타나거나 나타나지 않거나 관계없이 3개 이상의 늑골에서 2부위 이상(예, 후측방과 전측방)의 골절이 있는 경우로 정의한다.



02 Non-operative management



Multimodal analgesia : Rotinely, tiered approach

01-1 Tiered approach

ANALGESIA PMG FOR INPATIENTS WITH RIB FRACTURES

BEGIN (Tier I)

Ice and heat to soft tissues
Ketorolac 15 mg IV q6H for 48 hours then ibuprophen 600 mg PO q6H
Acetaminophen 650 mg PO q6H
Diazepam 5 mg PO TID PRN (if age <65 years)
Oxycodone 5–10 mg PO q4H PRN
IV narcotic push × 2 (if ≥2 doses required, move to Tier II)

Tier II

Locoregional modalities*
Thoracic epidural catheter
or Pain pump (bupivacaine infusion)
or Liposomal bupivacaine intercostal nerve blocks
or Erector spinae (ESP) catheter

Tier III

Narcotic PCA
Ketamine infusion (as per PAD order set)
Lidocaine infusion**

Advance to next tier if SCARF score remains ≥2 after intervention(s)

SCARF Score

Parameter	Points
Numeric pain score ≥5	1
Incentive spirometry <50% predicted	1
Respiratory rate ≥20	1
Poor cough	1

ior to choice, consult research team to evaluate for study enrollment
equires PCU/ICU admission and attending authorization

02 Surgical management

보험급여기준

급여 기준(심평원 결정사항/복지부 행정 해석 내용)

1. 적응증

가. 3개 이상의 늑골골절이 편측에 있으며, 다음의 1)~4) 중 하나에 해당되는 경우

1) 동요흉으로 인공호흡기 제거(weaning)가 72시간 이내에 불가능한 것으로 확인된 경우

2) 2개 이상의 늑골에 중복분절골절이 존재하여 기호흡(paradoxical respiration)을 보이는 동요흉(flail chest)인 경우

3) **양측 전방(bilateral costochondral separation) 또는 전측방(anterolateral)의 다발성 불안정 골절이 확인된 경우**

4) **전위가 심하여 불유합(nonunion) 또는 부정유합(malunion)이 흉곽기형을 초래할 경우로써 급성기 통증조절에 실패*한 경우**

*IV PCA,PCEA,IV/PO NSAID 등 통증조절을 충분히 하였음에도 6점 이상의 pain score가 수상 후 3일(72시간)을 초과하여 지속되는 경우

나. 늑골골절로 인한 흉강 내 장기 손상으로 개흉술을 시행한 경우

다. 흉부 둔상에 의한 흉강 내 장기 손상으로 개흉술 시행 시 동반된 늑골골절이 해당 늑골의 폭 이상 벗어나 전위가 심한 경우

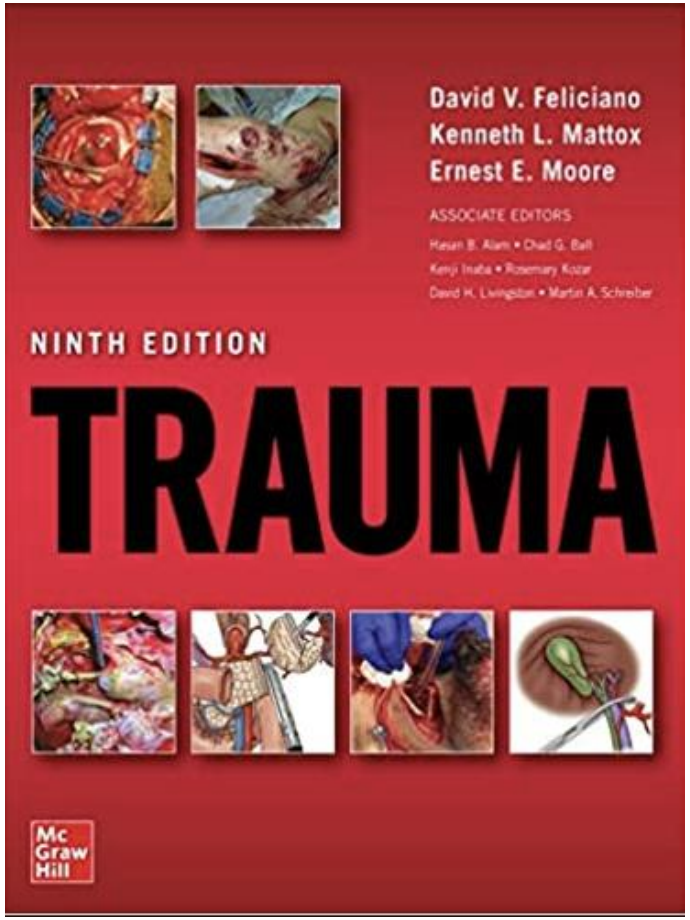
라. 자154-1 흉골골절 관혈적 정복술 시행시 동반된 전방 늑골골절이 있는 경우

2. 자53나 늑골 골절 관혈적 정복술은 편측 당 최대 3부위까지만 산정함.

(고시 제2018-281호, 2019.1.1 시행)

Indication of sternal fracture

- Deformity
- Loss of sternal continuity
- Complete displacement
- Sternomanubrial joint dislocation or fracture
- Persistant sternal mobility/clicking



Best timing for Surgical rib fixation(SRF)?

AAST 2017 PLENARY PAPER

of surgical

): 1-10

Osman, MD,
te, MD,
ado

- Early SSRF : less operative time, favorable outcome
- "SSRF should occur as early as possible"

- Ideally within 48hrs

- Shock with active resuscitation
- unstable spine, pelvic injury, ruptured aorta, Intracranial hypertension,
- position limitation d/t ext. fixator

- Expected long-term vent care
- Pulmonary contusion

- Stability to OR, position
- Potential One-lung ventilation

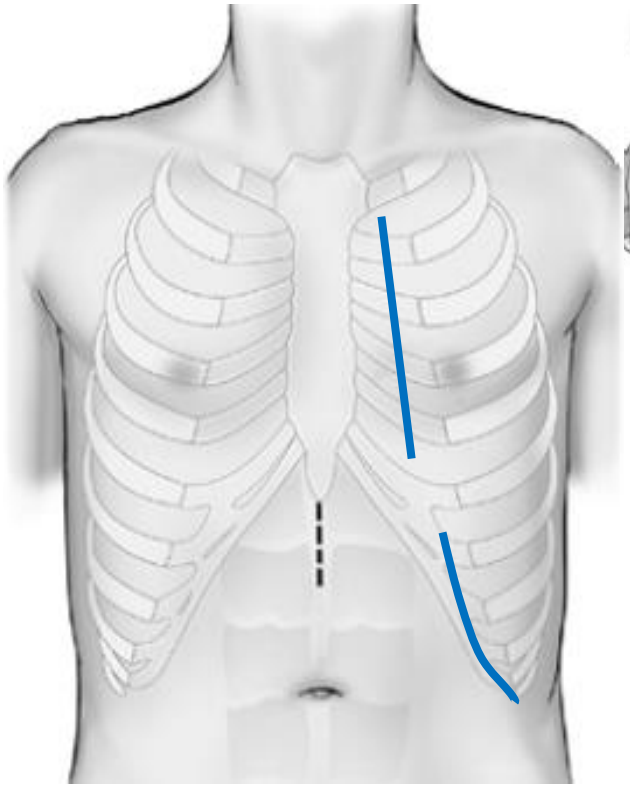
Fix all fractures?

Mainly 3-10th rib fracture, severe displaced costal fracture

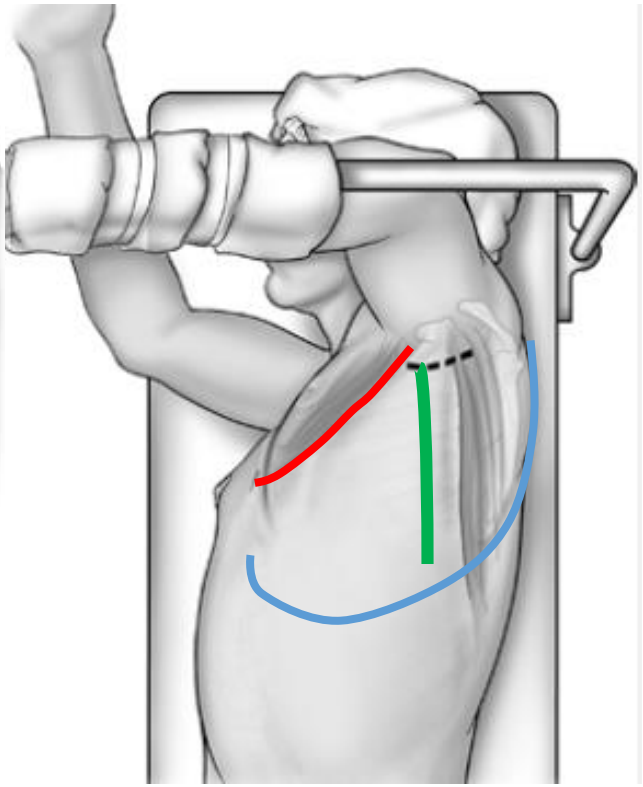
- Ribs 1, 2
  - Exposure is extremely challenging
  - No impact of functional outcome significantly due to bulky muscles.
- Ribs 11, 12: Free-floating rib –little impact of outcomes
- Both fractures in case of flail chest?
  - Controversial!
- Very anterior fracture?
  - Long-term outcome of costal fracture is unknown.
  - Severely displaced ant. fracture – pain relief, restore respiratory mechanics
- Very posterior fracture?
  - Technical complexity near costovertebral junction
  - Unlikely to provide benefit because of additional ligamentous support.

Operative treatment of chest wall injuries: indication, techniques, and outcomes.
Lafferty M. 2011 J Bone Joint Surg Am.
Analysis of bone healing in flail chest injury: do we need to fix both fractures per rib?
Marasco S. 2014 J Trauma Acute Care Surg
Surgical stabilization of severe rib fractures.Pieracci F. J Trauma Acute Care Surg 2015

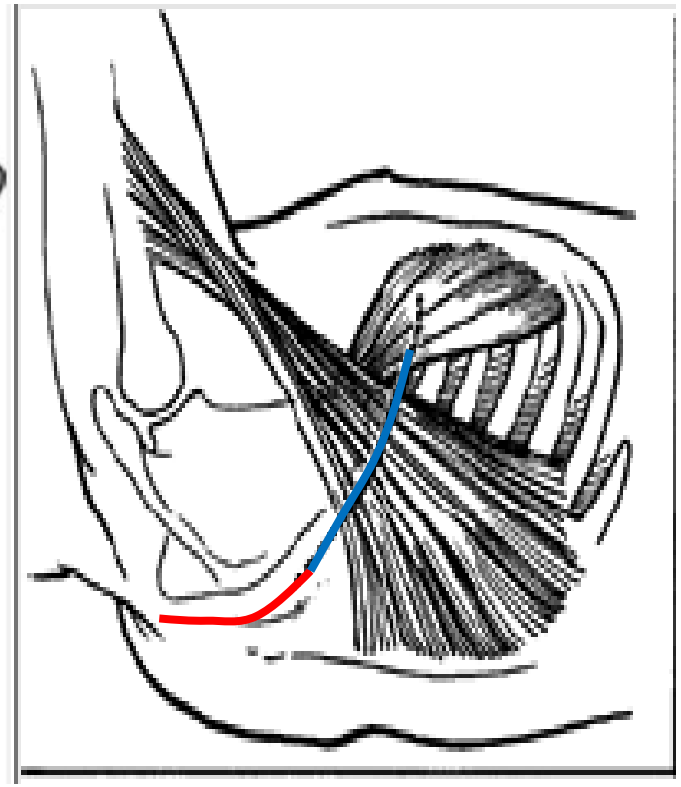
Surgical incision and exposure



-Parasternal vertical incision
-Anterior vertical incision

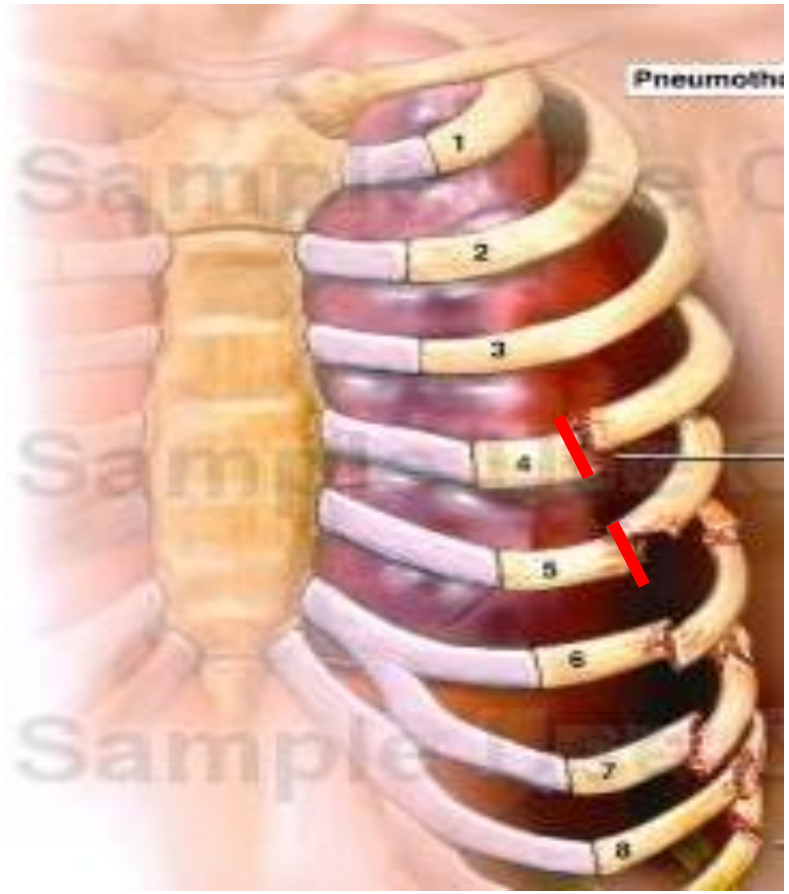


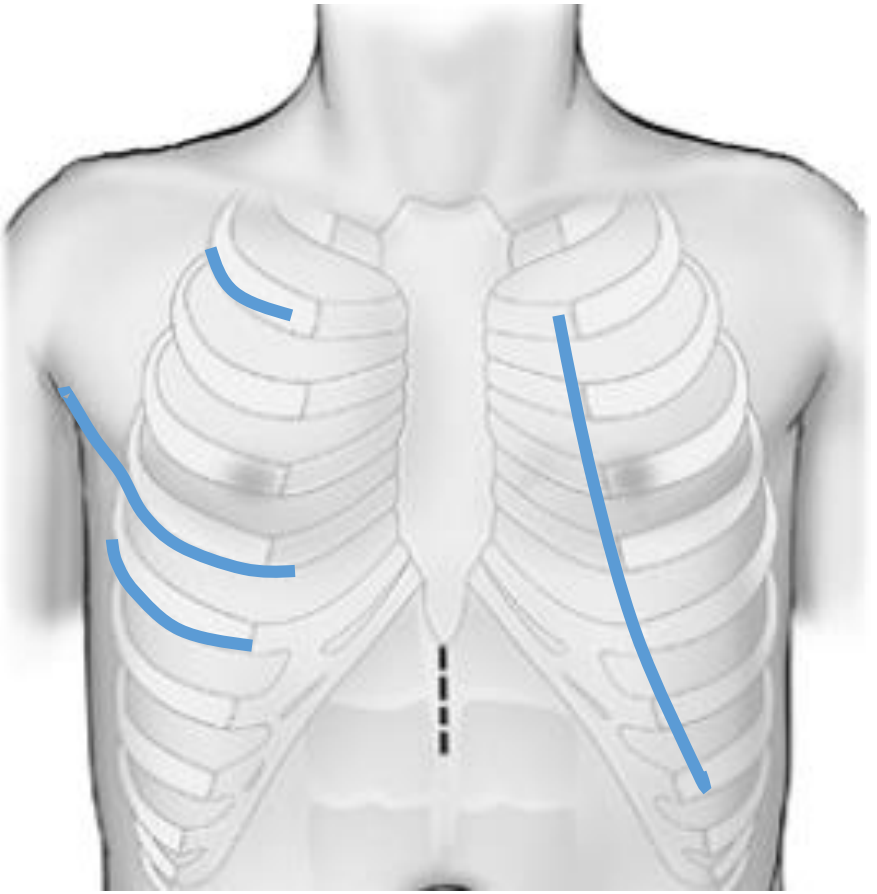
-Thoracotomy incision
ant./lat./post.
- Submammary incision
- Axilla-vertical incision



-Posterior thoracotomy incision
high/low- 5th rib

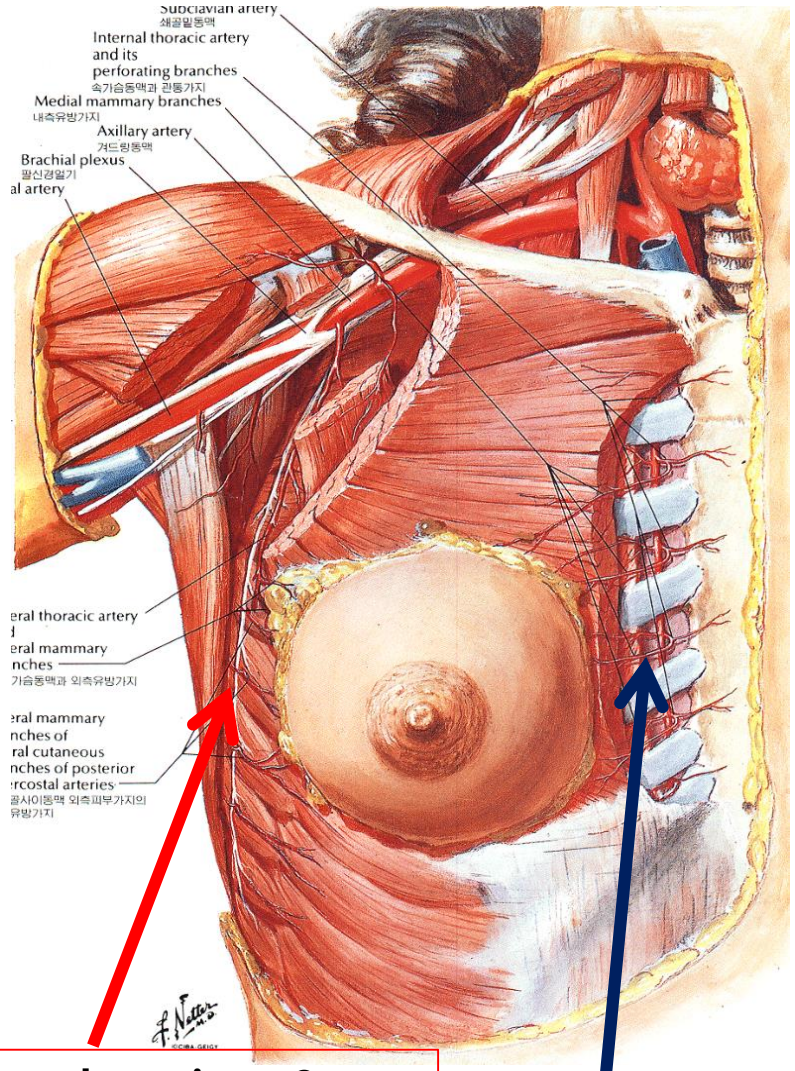
Anterior type approach

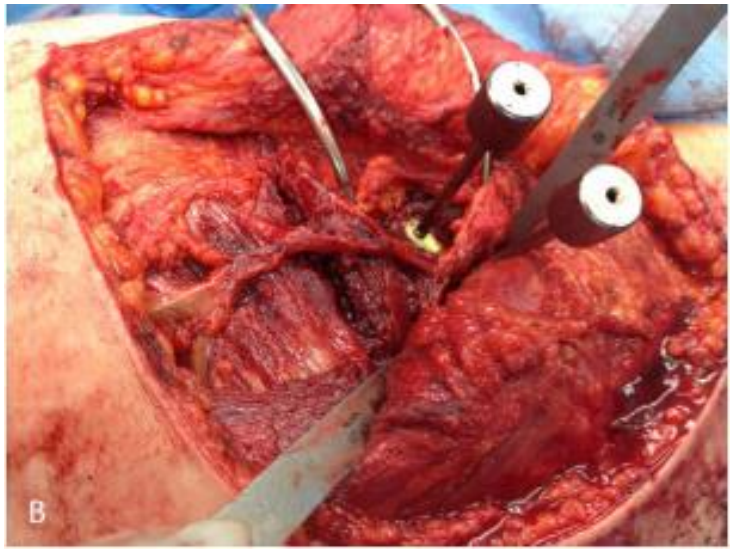




- Parasternal vertical incision
- Submammary incision
- Ant. Thoracotomy incision

Caution!!

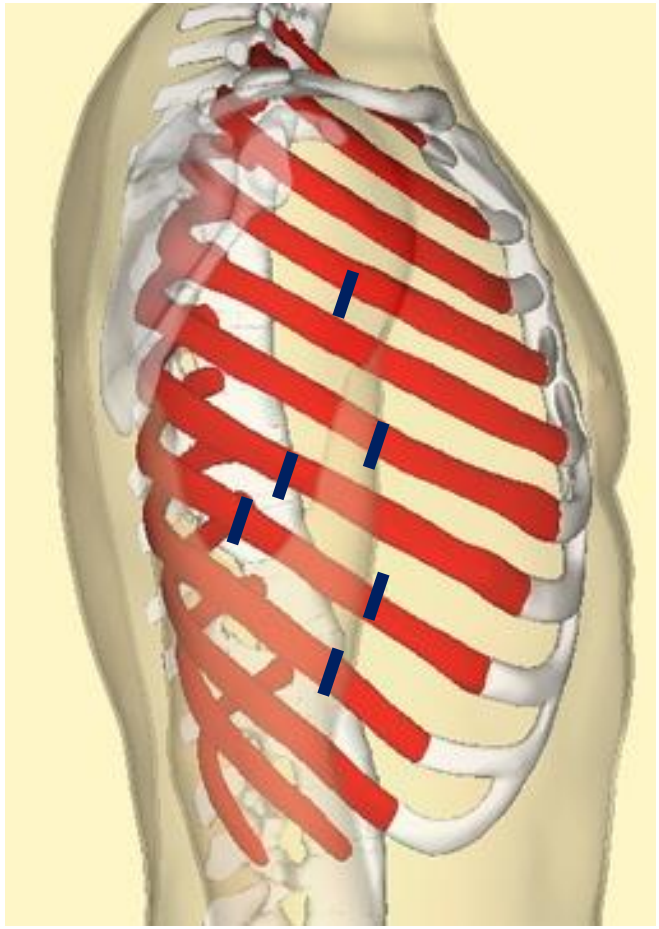


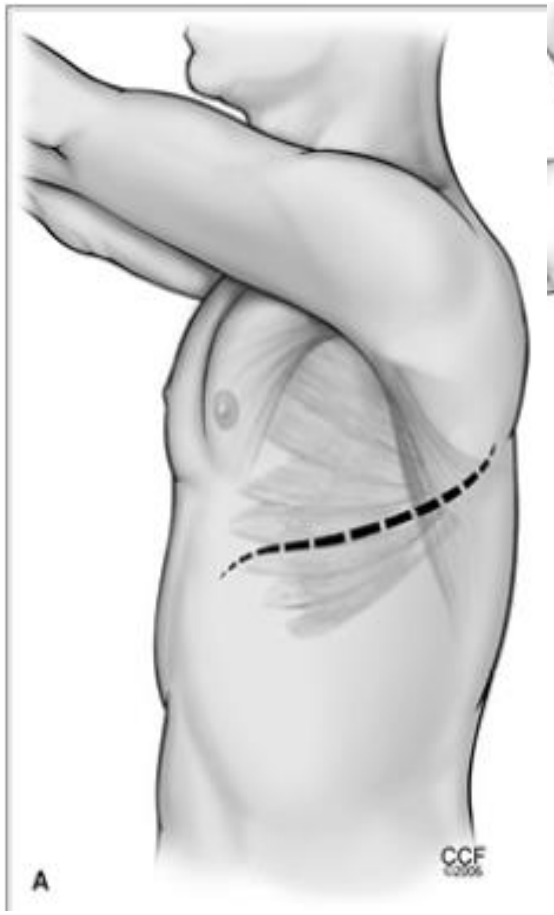


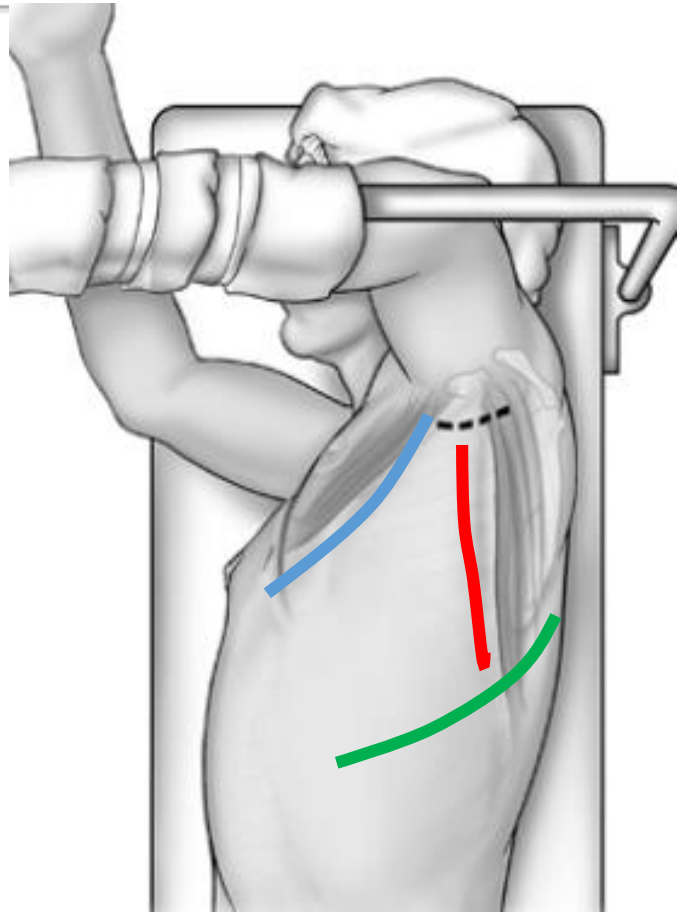
Long thoracic a. & n.

Internal thoracic vessel

Lateral type approach

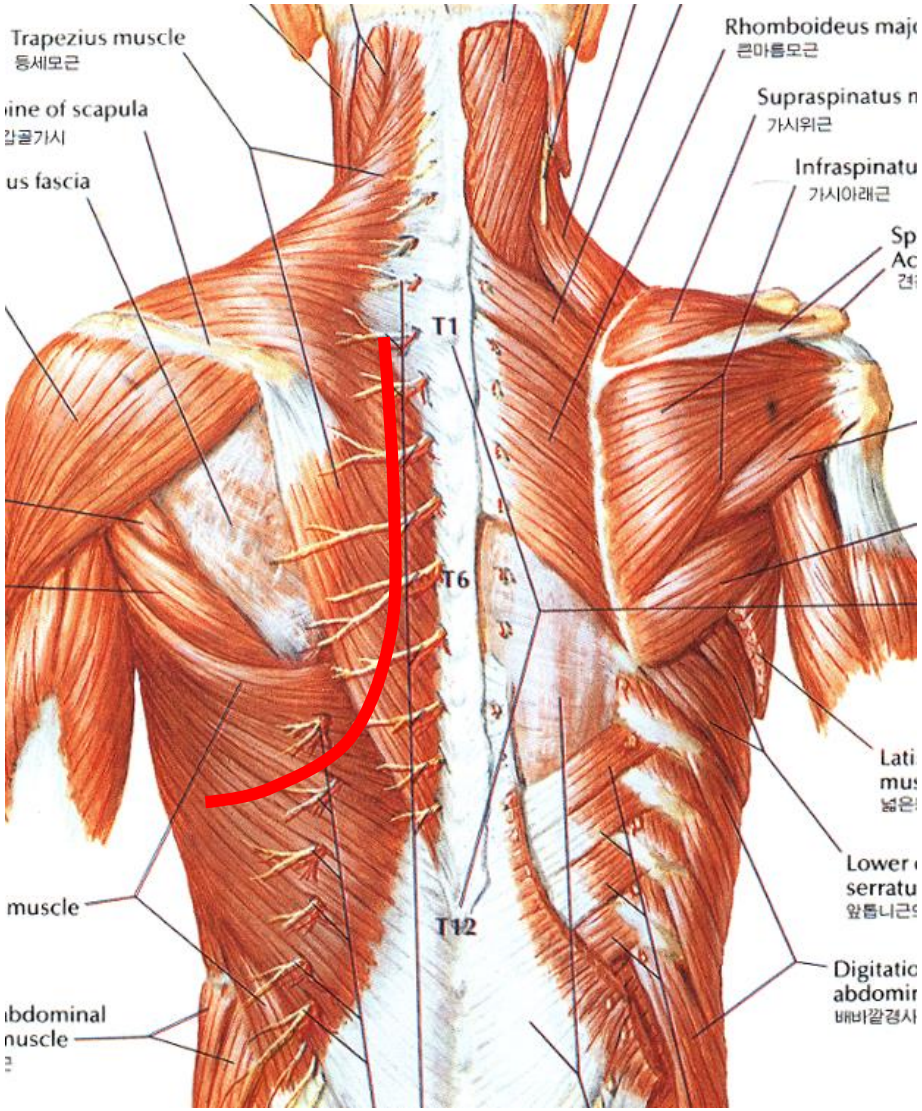


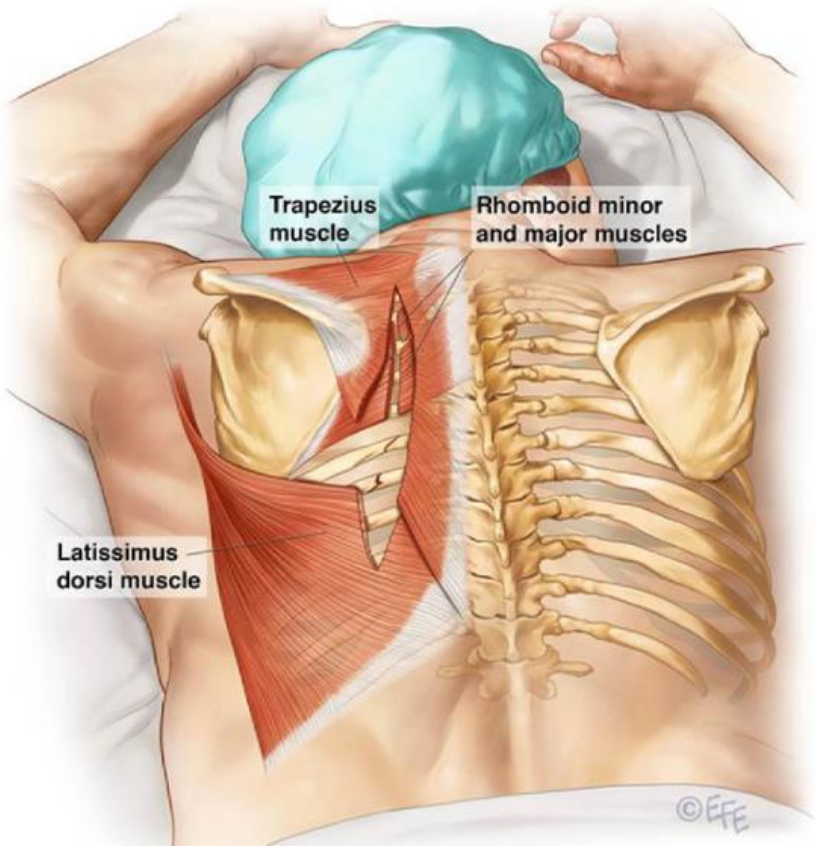




- Lat. Thoracotomy incision
- Axilla vertical incision
- Submammary incision

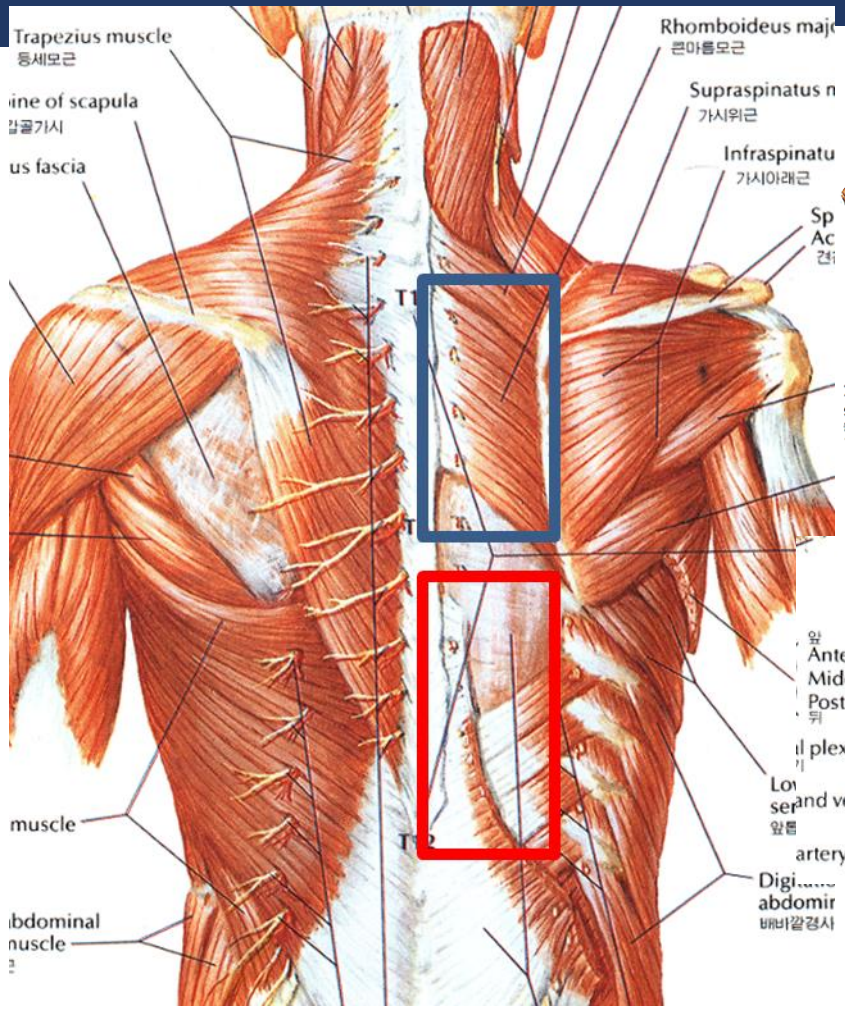
Posterior type approach

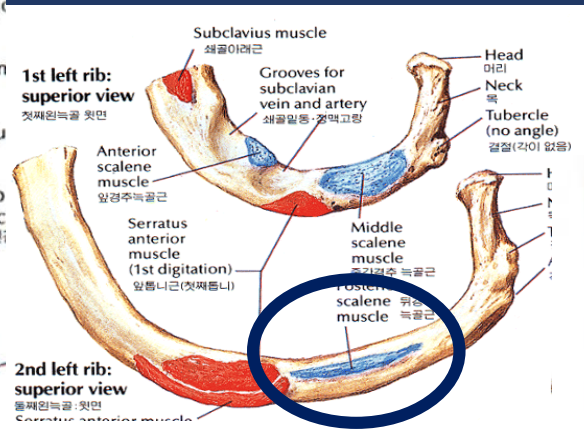


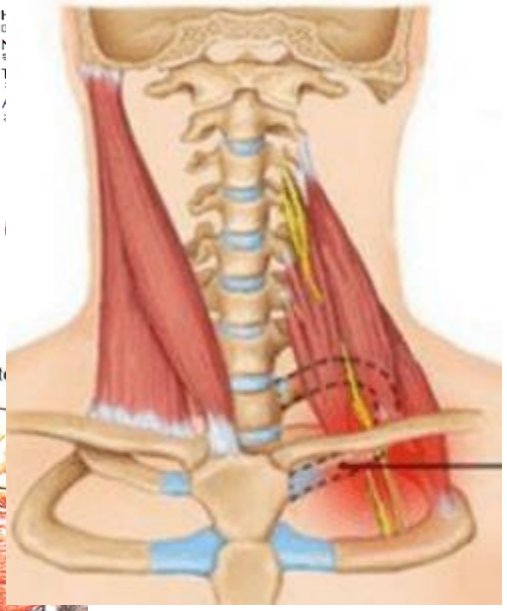


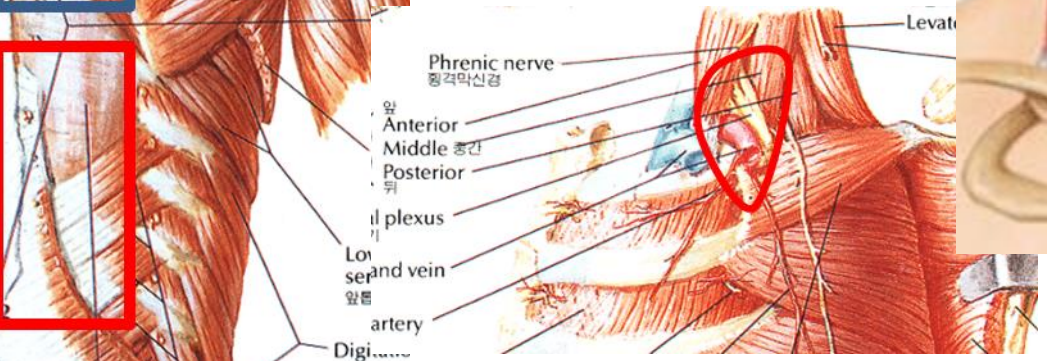
- **Posterior thoracotomoy incision**
- **High posterior :2-5th exposure**
- **Low posterior**

Caution!!









Rhomboid major muscle: lat. Scapular winging
Paraspinal muscle: back pain, weakness

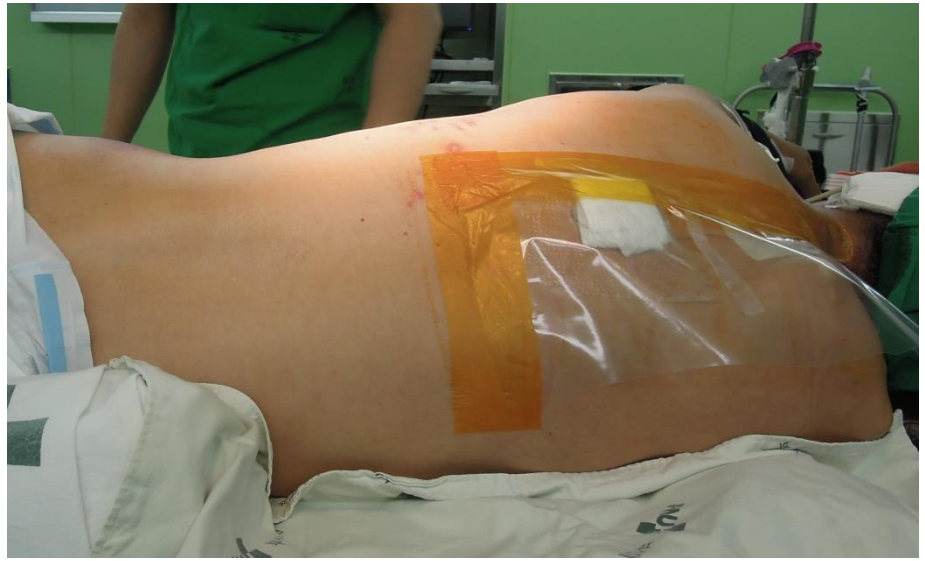
High posterior incision
-Post. Scalene muscle
-Mid. Scalene muscle
·Brachial plexus, subclavian artery

Patient position: semi-supine

Anterolateral exposure

Patient position: semi-prone/ Prone

Posterior exposure

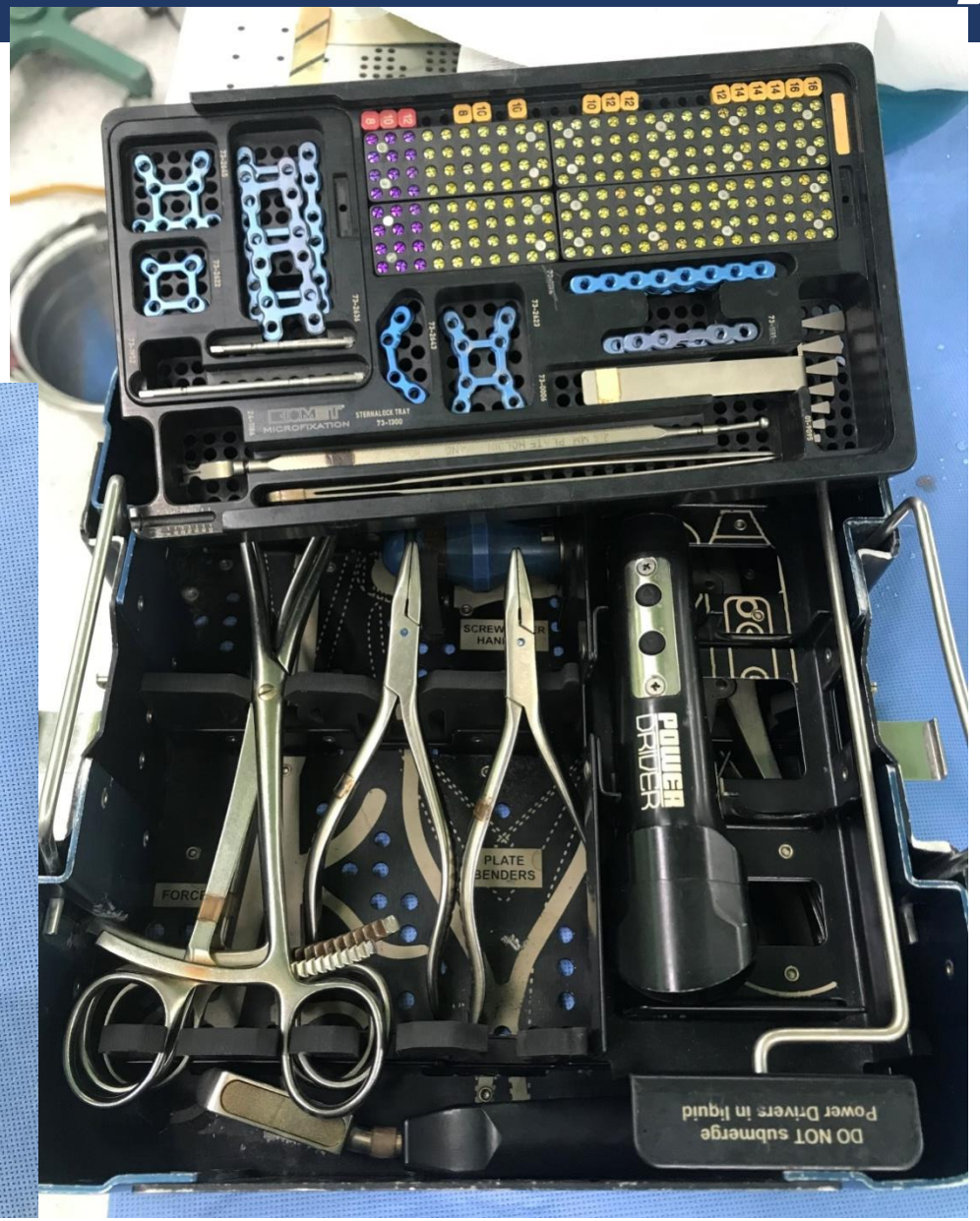


Patient position: Lateral decubitus

Lateral exposure

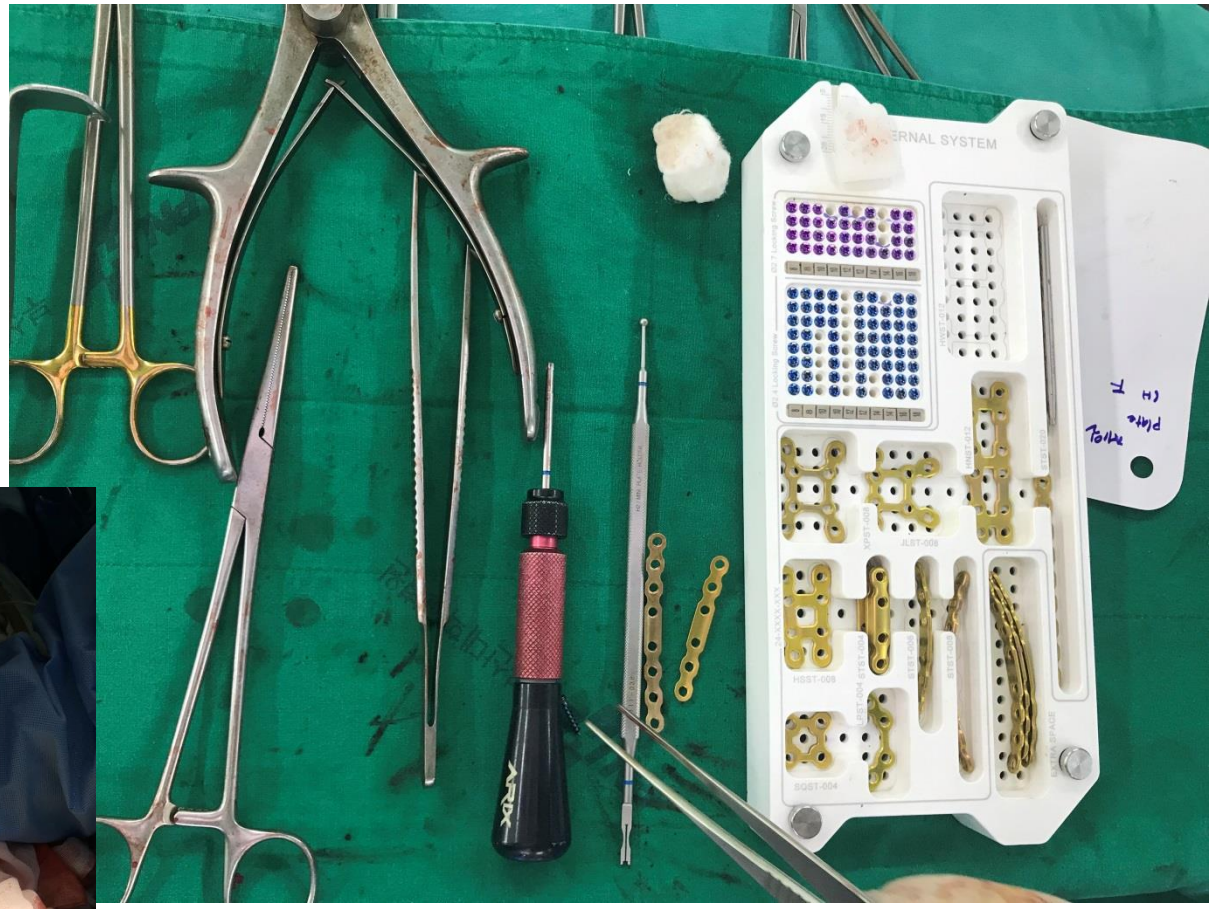
Instrument

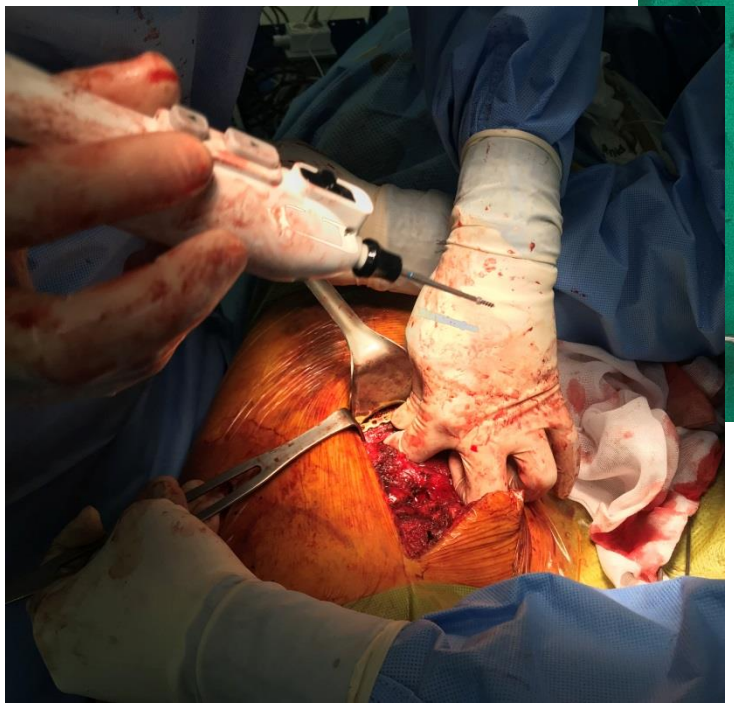
- **Sternal lock Plate (Biomet)**
  - Non-precontuoured plate
  - 90˚-angled drill
  - Self-drilling driver
  - Plate stabilizer
  - Depth measure



Instrument

- **JEIL Plate**
  - Pre-contoured, long
  - 6mm screw
  - Disposable Self-drilling driver





Instrument

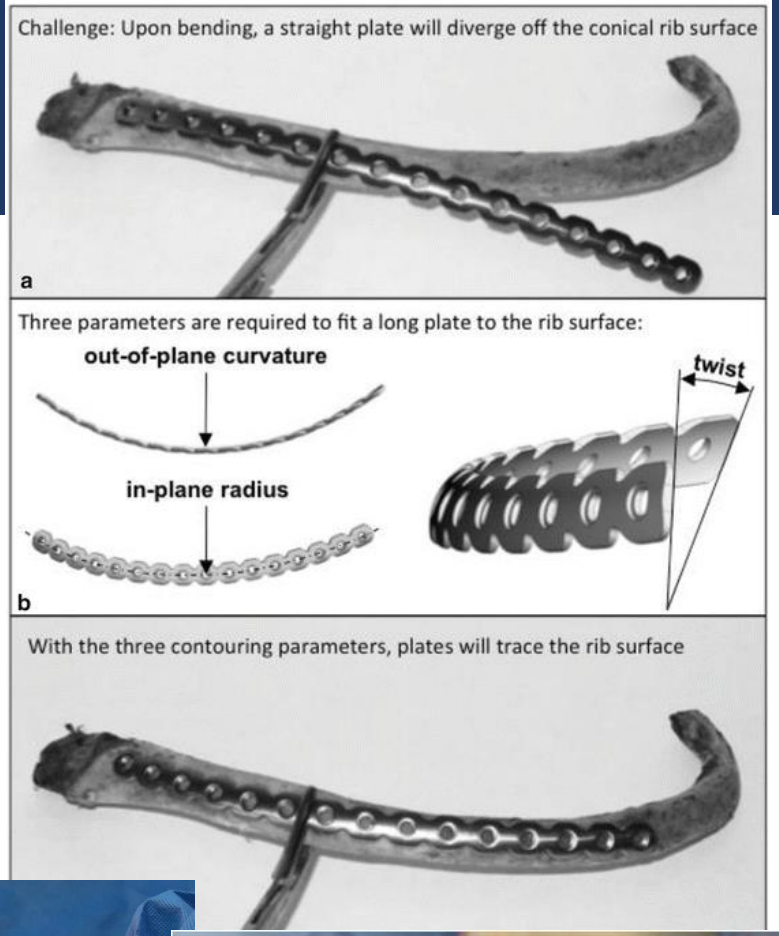
- **JEIL Plate**: pre-contoured , long plate

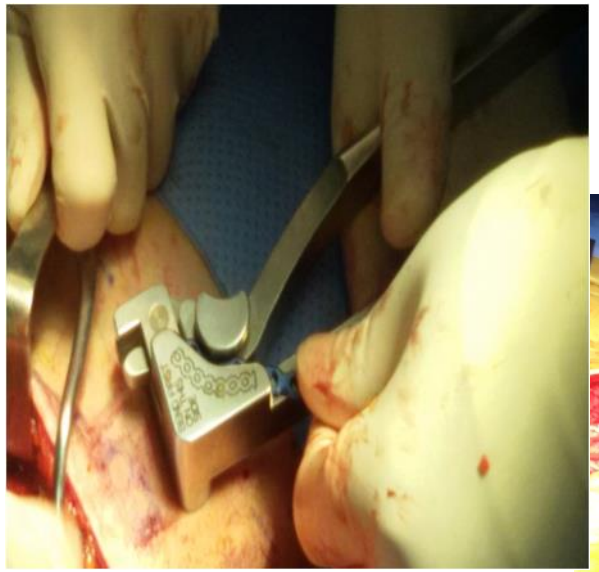
Instrument

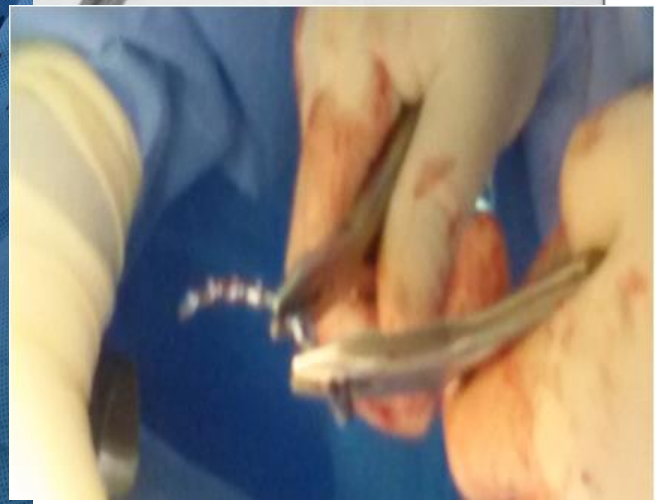
- **APIS plate**
  - Pre-contoured
  - Straight, Curved plate
  - 90˚-angled drill

Instrument

- **Plate bending**
  - Roller bender
  - Lateral bender
  - Twisting bender

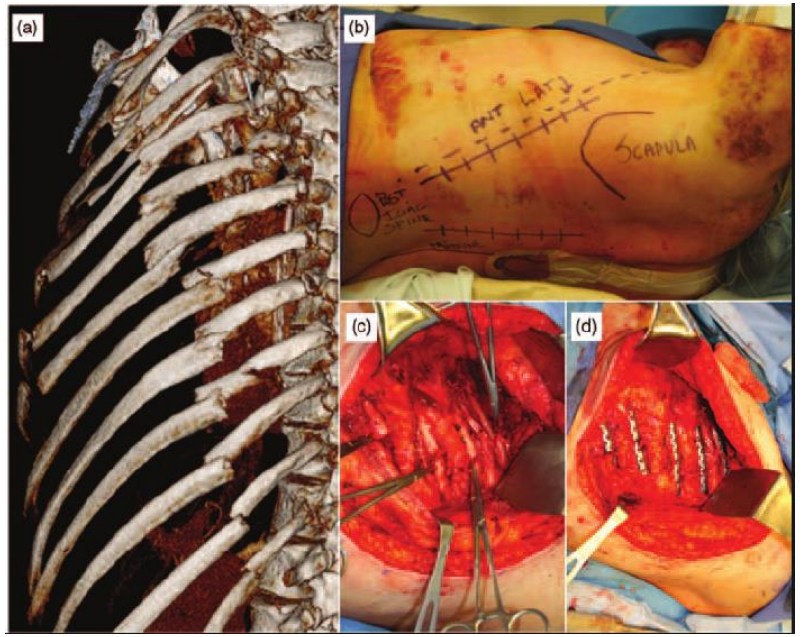






Tips for exposure

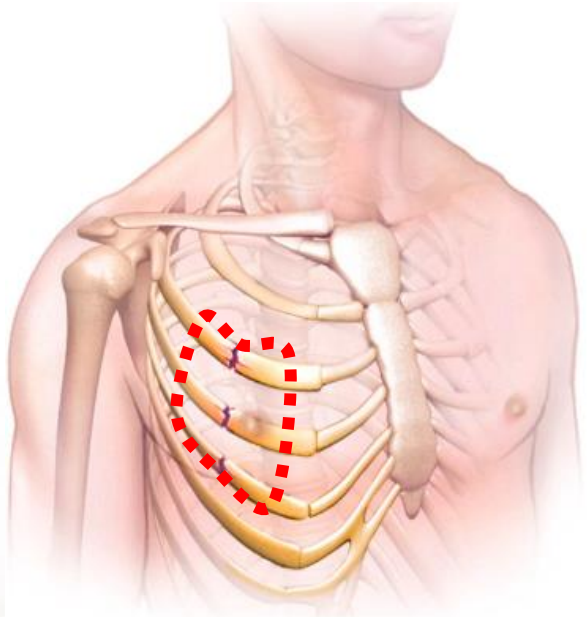
- Preoperative planning!-3D CT
- Vertical incision: chest wall numbness, postop seroma incidence ↑
- Muscle splitting, self-retaining retractor
- Greater dissection: seroma formation, drain, wound infection risk
- Long thoracic nerve, intercostal bundle !

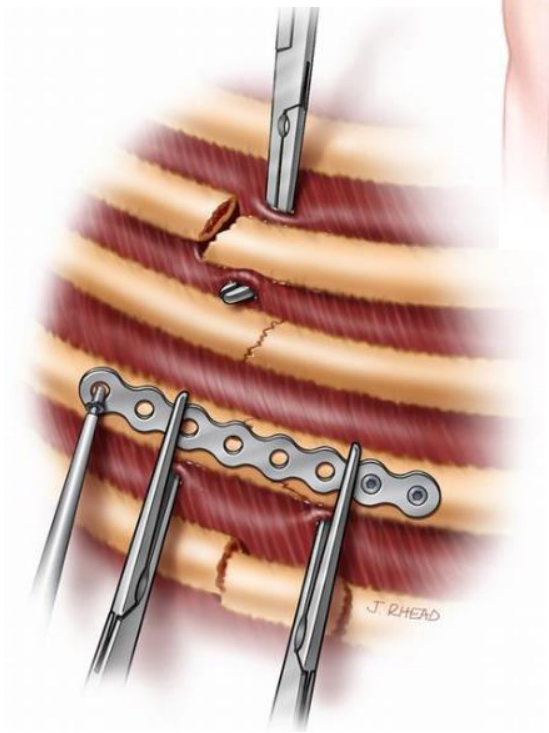


Surgeon should be comfortable!!

Fracture reduction and stabilization Tips

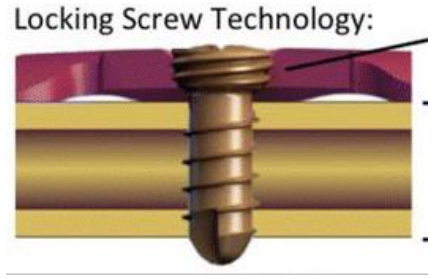
- Periosteum 가능한 남긴다.
  - Devascularization, bone healing 관계
  - Fracture line 앞뒤로 3-5cm 박리
- Pleurotomies
  - related to postop pain
  - Should be minimized

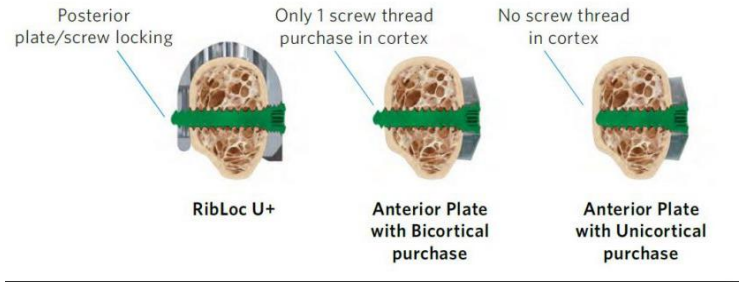


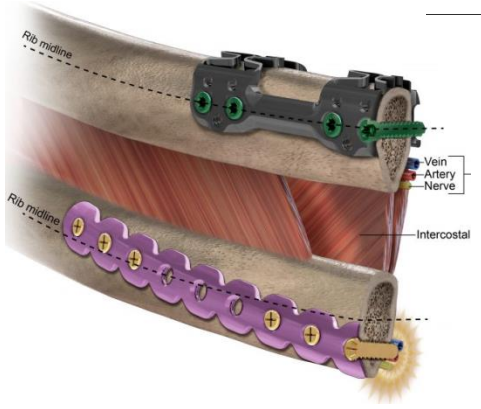


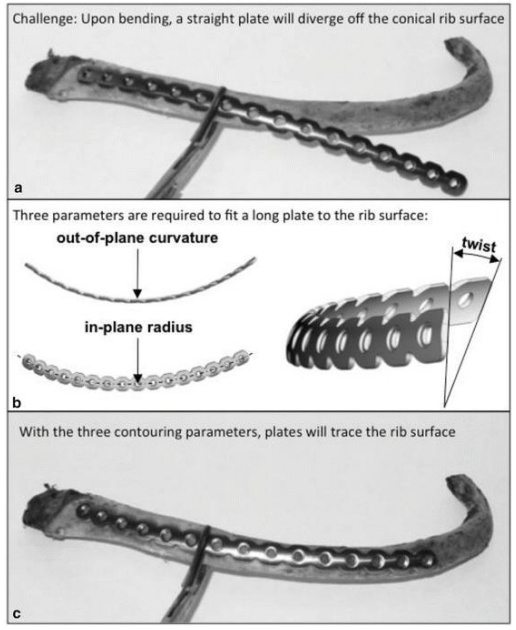
Fracture reduction and stabilization Tips

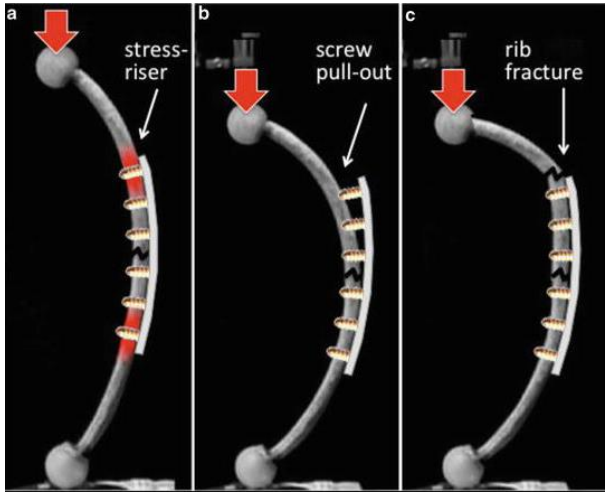
- **Bicortical** screwing using locking screw
- Plate 는 rib body 중앙에 오도록 하며 들뜨면 안된다. (**posterior, anterior angulation, twisting 주의)**
- Fracture line 에 screwing 되면 안됨**(oblique fx. 주의)**
- Perpendicular plane drilling, screwing
- Plating이 잘 되었다면 Fracture callus 가 small gap은 cover 가능.

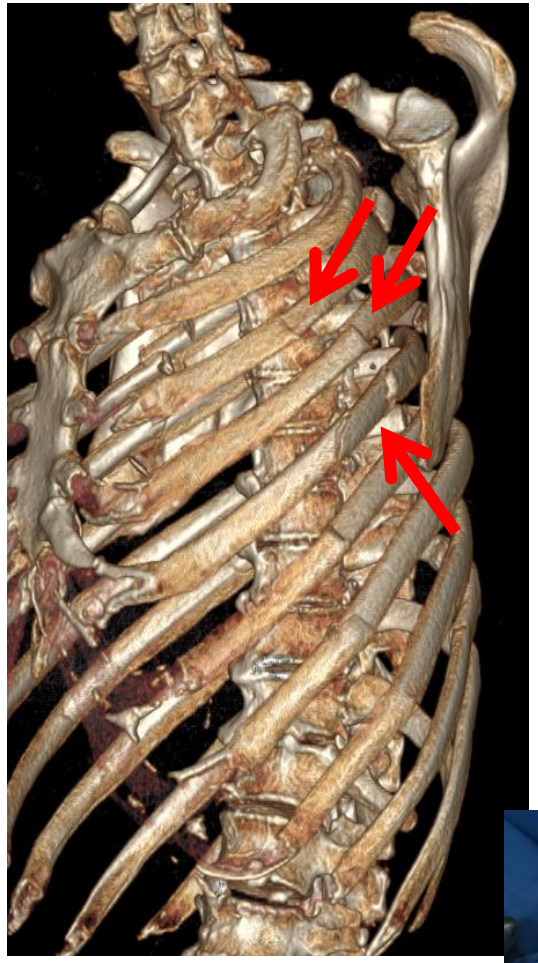


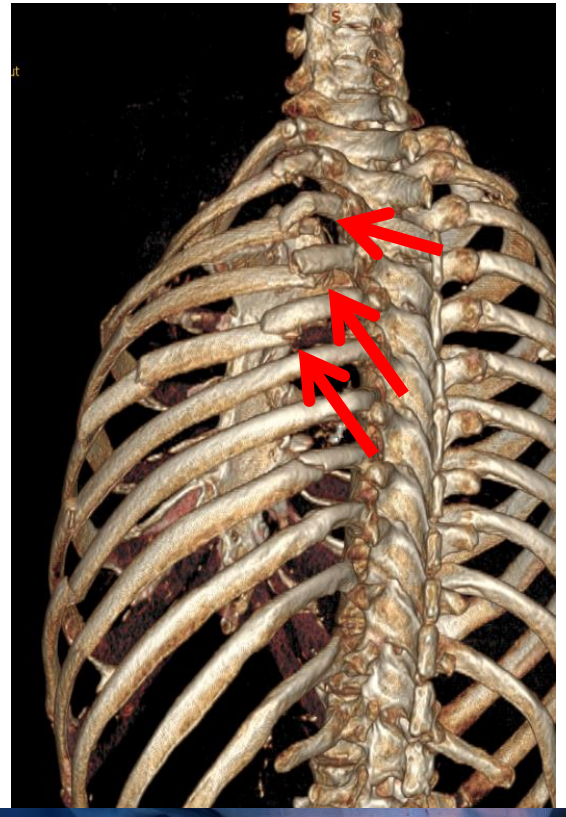


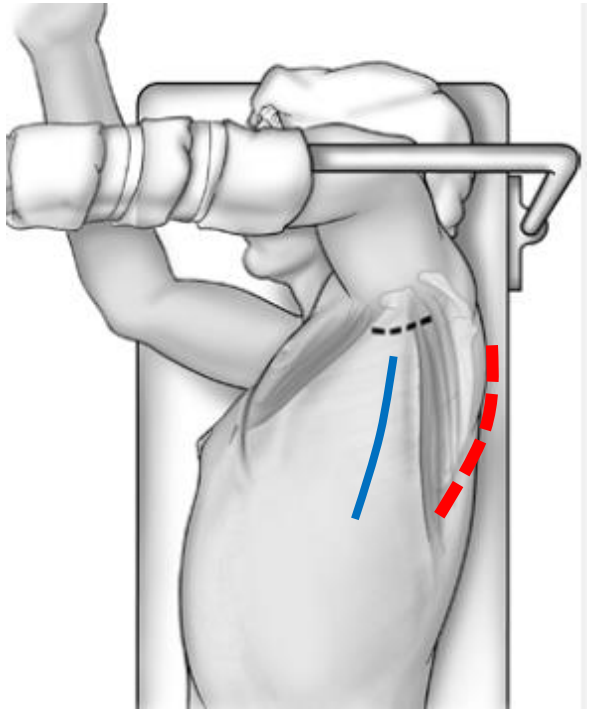




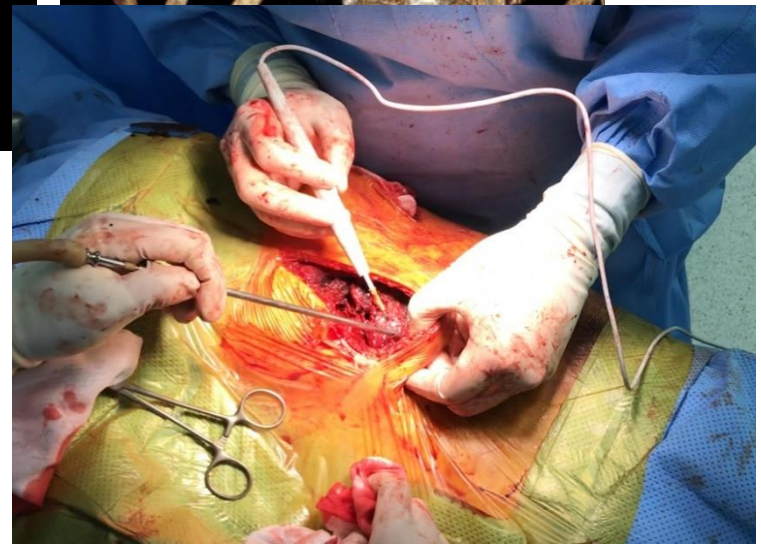


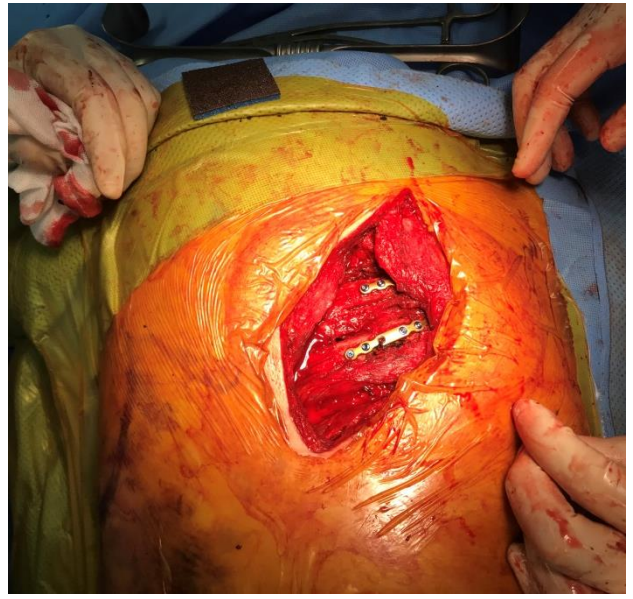




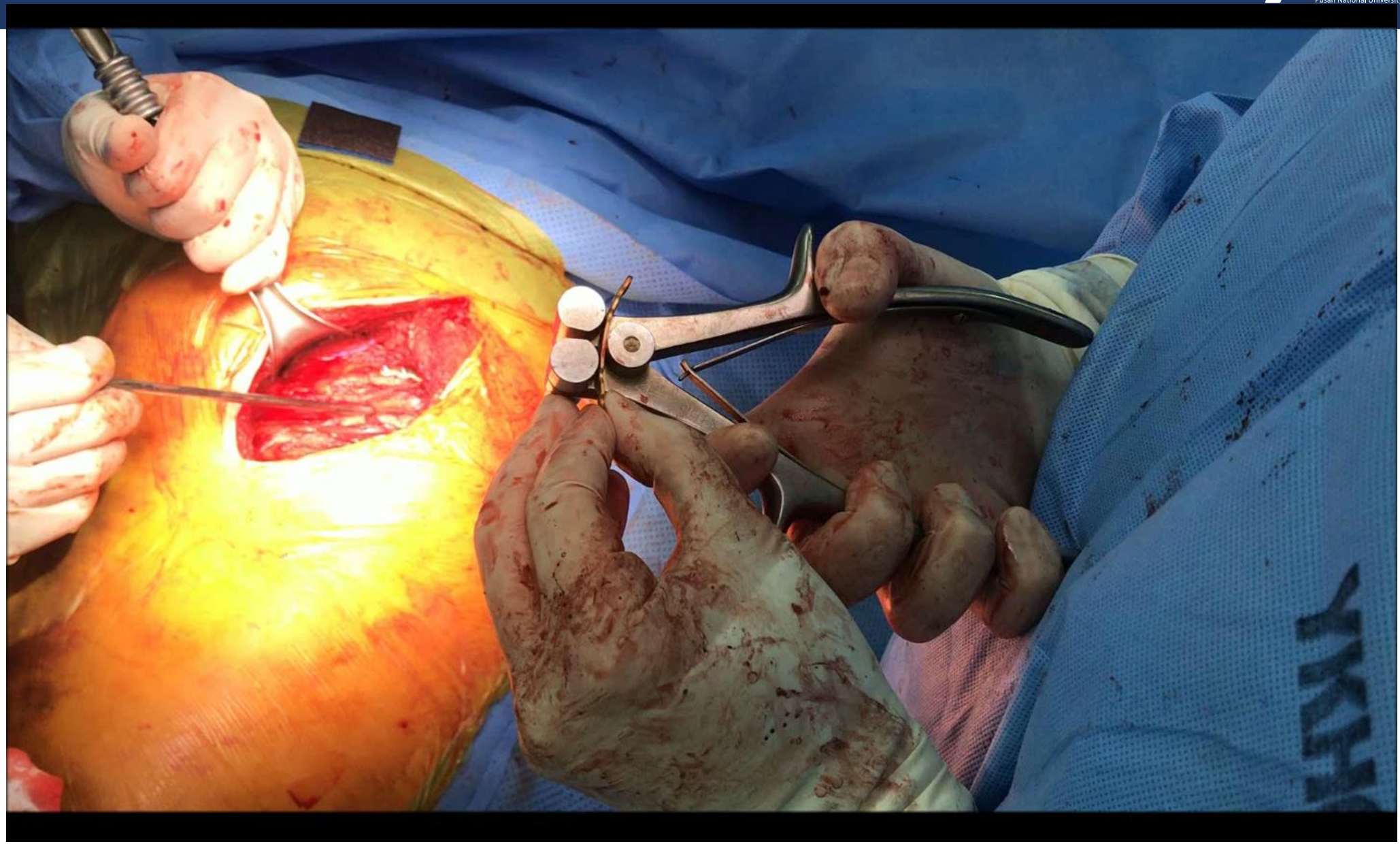


M/59, Outcar TA
PL type
segmental fx.
L 3-5,8

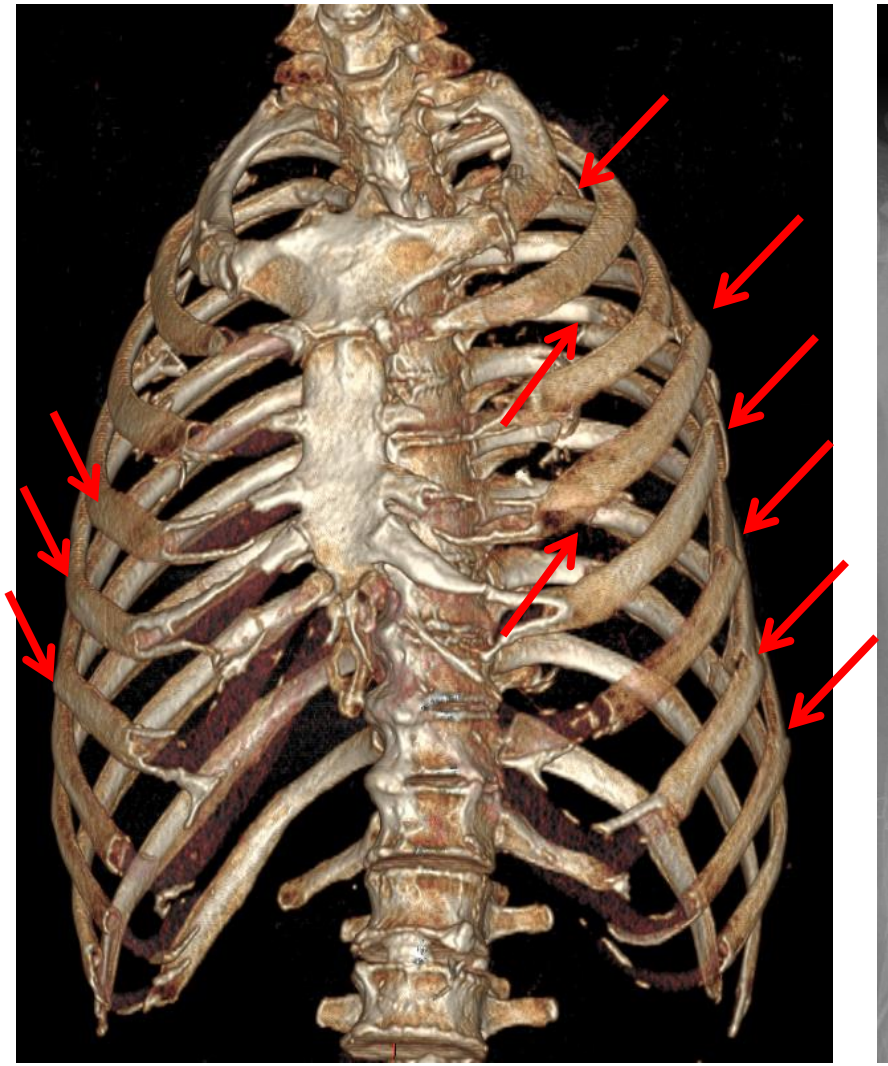


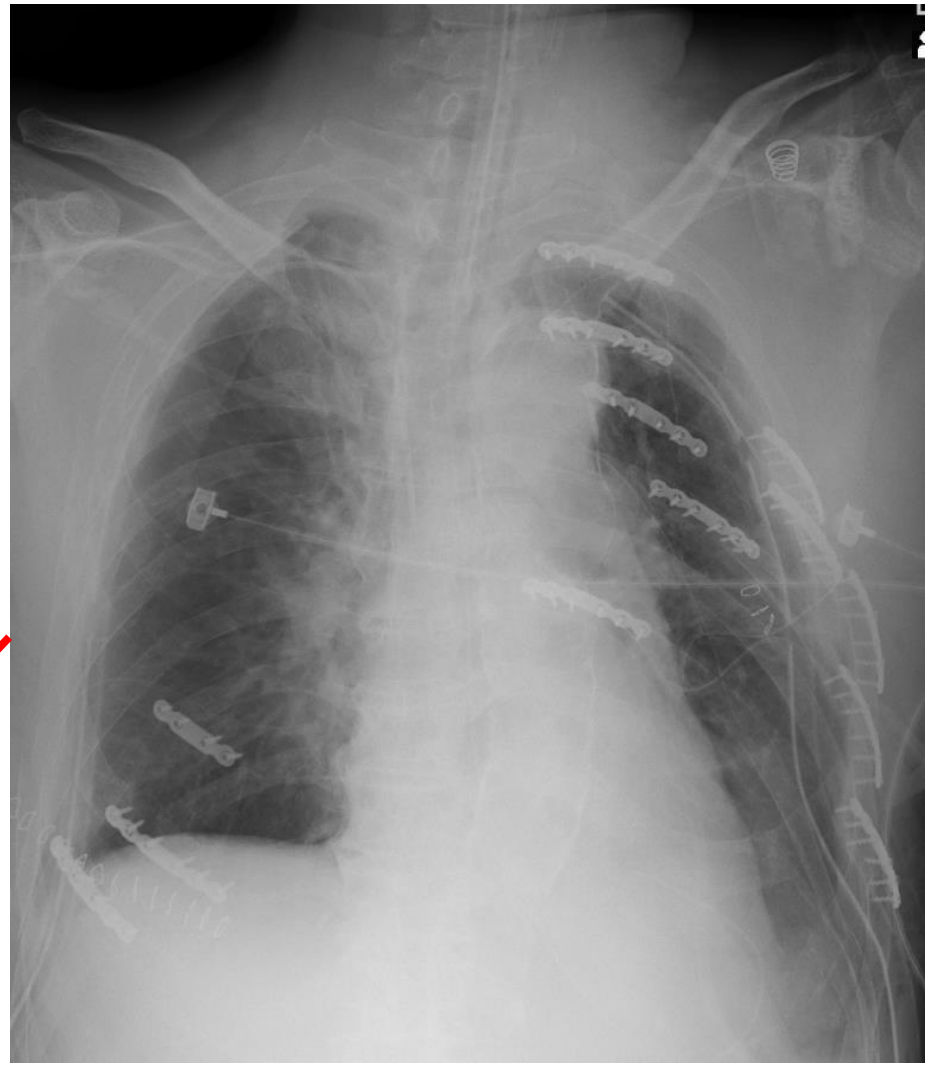


Rib fixation



ORIF Lt.P3-6,8,L4-8, Rt.A4-6





Summary

- **SRF can improve outcomes** of the patient with severe rib fractures.
  - Flail chest (higher evidence)
  - Relatively multiple rib fractures
- Surgical approaches for SRF can be made **depending on the level of the fractures.**
  - Axillary/ anterolateral region is relative easy to approach.
  - Essential to achieve the correct contouring on the rib plate.
  - Essential to press plate flush on the ribs.

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Thank you for your attention.

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