

## GESTIONE DEL TRAUMA DI INTERESSE CHIRURGICO

Gestione integrata del trauma maggiore dalla scena dell'evento alla cura definitiva

31 maggio - 1 giugno 2023 - Petralia Sottana (PA)

# Thoracic damage control in unstable patient

G. Di Grezia

# Thoracic trauma: what we know

- **Second cause of death** for trauma
- Causing **20%** of deaths
- Most injuries can be **treated without surgery**
  - 90% blunt trauma
  - 70/80% **penetrating trauma**

# Severe chest trauma and the trauma system

- The **trauma system** does **not** always **succeed** in **primary centralization** due to:
  - **Penetrating** trauma
  - **Severity** of clinical conditions
  - Hub center **distance**
- The general surgeon may be **out** of his **comfort zone**:
  - **Abolition** of the **residency** in emergency surgery by the EU
  - **Abdominalization** of emergency surgery



# The unstable patient with closed or penetrating chest injury

- Agonic

- U

Misurati (37.0°C)

pH ↓ 7.30

pCO<sub>2</sub> ↑ 54 mmHg

pO<sub>2</sub> ↓ 54 mmHg

**TABLE 3-1 SIGNS AND SYMPTOMS OF HEMORRHAGE BY CLASS**

PARAMETER	CLASS I	CLASS II (MILD)	CLASS III (MODERATE)	CLASS IV (SEVERE)	
Approximate blood loss	<15%	15-30%	31-40%	>40%	g/dL
Heart rate	↔	↔/↑	↑	↑/↑↑	%
Blood pressure	↔	↔	↔/↓	↓	%
Pulse pressure	↔				%
Respiratory rate	↔				mmol/L
Urine output	↔	↔	↓	↓↓	mmol/L
Glasgow Coma Scale score	↔	↔	↓	↓	mmHg
Base deficit*	0 to -2 mEq/L	-2 to -6 mEq/L	-6 to -10 mEq/L	-10 mEq/L or less	mmol/L
Need for blood products	Monitor	Possible	Yes	Massive Transfusion Protocol	%

peripheral perfusion monitoring

↓

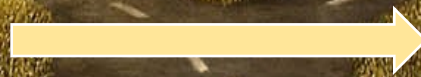
\* Base excess is the quantity of base (HCO<sub>3</sub><sup>-</sup>, in mEq/L) that is above or below the normal range in the body. A negative number is called a base deficit and indicates metabolic acidosis.

# Thoracic damage control

**Thoracic damage control surgery**



**Resuscitative thoracotomy in the shock room**



**Urgent thoracotomy in the operating theatre**

# Resuscitative thoracotomy

- **Heart injuries**
  - **Most** patients with traumatic heart injuries **die** on the **trauma scene**
- Patients arriving **alive** in the **emergency department** in agonic conditions are **candidates** for **resuscitative thoracotomy**
  - Penetrating trauma
  - PEA
  - Signs of life

## Thoracotomy Guideline

Mechanism	Penetrating thoracic	Yes	Yes
	Penetrating thoracic	No	Maybe
	Penetrating extra-thoracic	Yes	Maybe
	Penetrating extra-thoracic	No	Maybe
	Blunt	Yes	Maybe
	Blunt	No	No

**Signs of Life**

- pupillary response
- spontaneous ventilation
- presence of carotid pulse
- measurable or palpable BP
- extremity movement
- cardiac electrical activity

**Proceed with EDT?**

Yes: "strongly recommend"  
Maybe: "conditionally recommend"  
No: "conditionally recommend against"

# Resuscitative thoracotomy outcome

Injury	Survival (%)	Neurologic outcome (%)	Recommendation
Penetrating Thoracic with Signs of Life	182/853 (21.3)	53/454 (11.7)	++
Penetrating Thoracic without Signs of Life	76/920 (8.3)	25/641 (3.9)	+
Pen. Extrathoracic with Signs of Life	25/160 (15.6)	14/85 (16.5)	+
Pen. Extrathoracic without Signs of Life	4/139 (2.9)	3/60 (5)	+
Blunt with Signs of Life	21/454 (4.6)	7/298 (2.4)	+
Blunt without Signs of Life	7/995 (0.7)	1/825 (0.1)	NR

++- strong recommendation

+ - conditional recommendation

NR- Not Recommended

## Summary

Patients most likely to respond favorably to EDT include victims of penetrating trauma with signs of life upon presentation to the emergency room or patients who lose signs of life within 10 minutes of arrival

# History of resuscitative thoracotomy

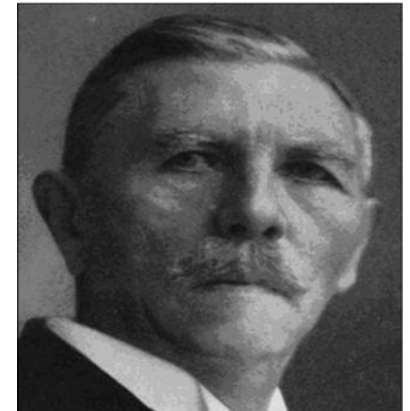


**1895**

Axel Cappelen

**1896**

Ludwig Rehn

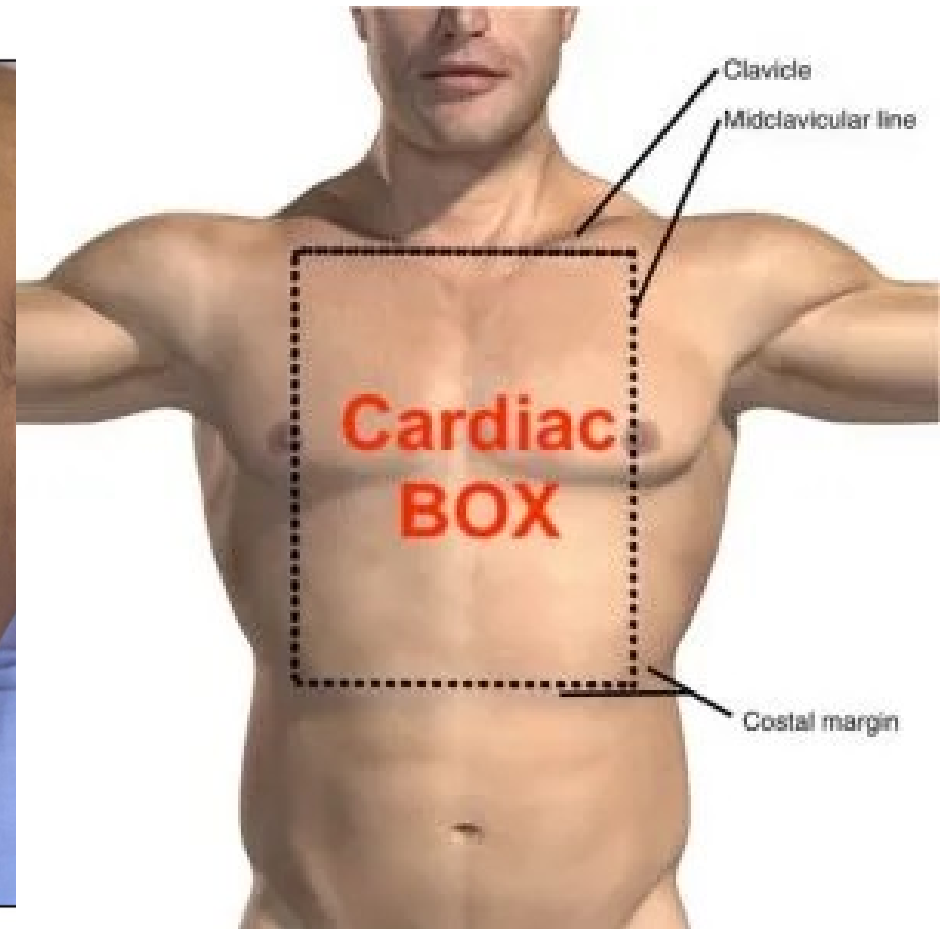


**1897**

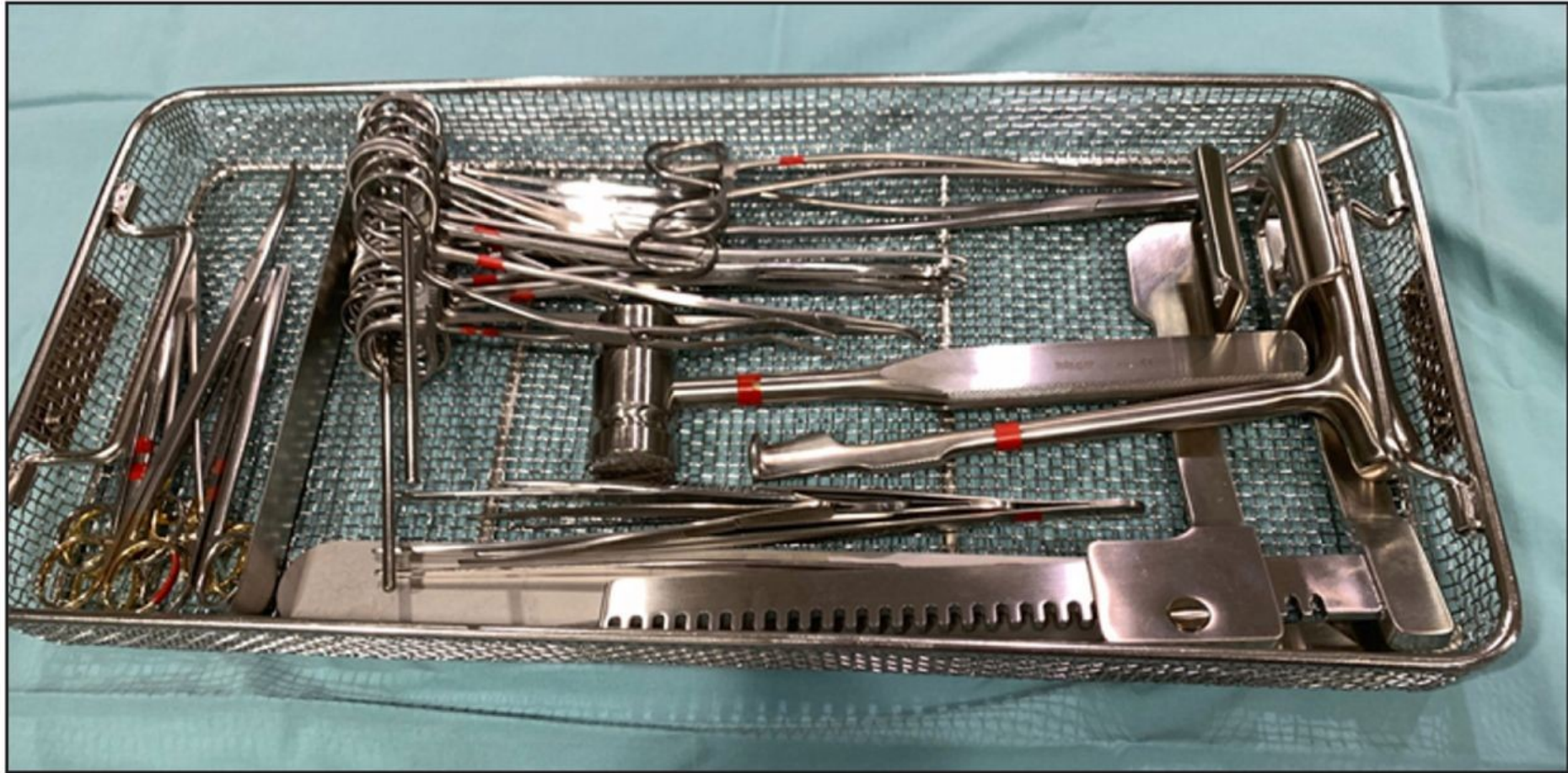
Antonio Parrozzani



# Cardiac box

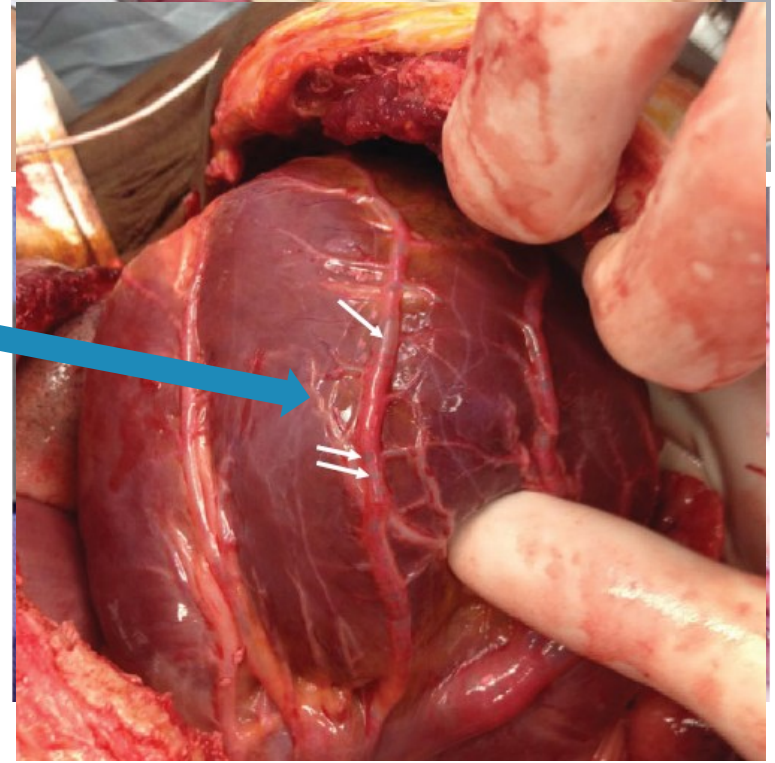
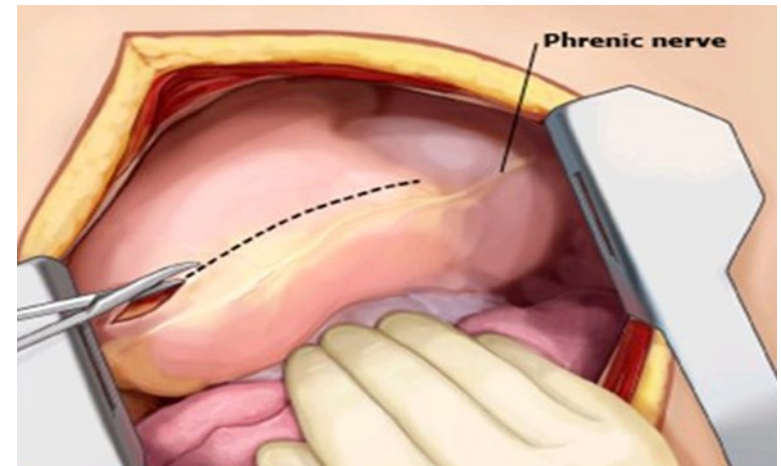


# Surgical kit



# The five objectives of resuscitative thoracotomy

- Pericardiotomy (cardiac tamponade)
- Initial treatment cardiac injuries
- Descending aorta cross clamping
  - Blood flow centralization
  - Clamping above the diaphragm (minimize spinal hypoperfusion)
- Internal cardiac massage
- Pulmonary hilum clamping
  - Risk of gas embolism
  - Reduction of bleeding in severe lung injury



# Cardiac injury in resuscitative thoracotomy

# Urgent thoracotomy: main enemies

AIR

- Tension pneumothorax
- Persistent pneumothorax
  - Tracheobronchial tear

The main goals of TDCS are to **stop bleeding** and maintain oxygenation through the **reduction of positive intrathoracic pressures**

Blood

- **Hemorrhage from systemic vessels**
  - e.g. intercostal, mammary, supraaortic great vessels
- **Pulmonary parenchyma**
  - Peripheral, hilar/perihilar injuries
- **Hemopericardium/cardiac lesion**

**EVERYTHING ELSE IS SECONDARY IF THESE OBJECTIVES ARE ACHIEVED**

# Which patients?

## Dynamics

- **Penetrating (stab wound + / gunshot wound -)**
- Blunt

## Hemodynamics

- BE - lactate – parameters ( BP, capillary refill)
- **Fluid/blood response**

## Basic diagnostic exams

- **E-FAST- thoracic x-ray (shock room)**
- CT if it does not delay a clear surgical choice



## Thoracostomy tube

- **Output**

# Urgent thoracotomy: indications

- Thoracotomy performed within the first two hours is considered as “**urgent thoracotomy**”
- Main indicators for urgent thoracotomy:
  - Chest tube output **>1500 mL**
  - Evidence of persistent bleeding **200 to 300 ml/h**
  - **Hemopericardium** without tamponade
  - **Severe hemodynamic conditions**

# Which chest incision?

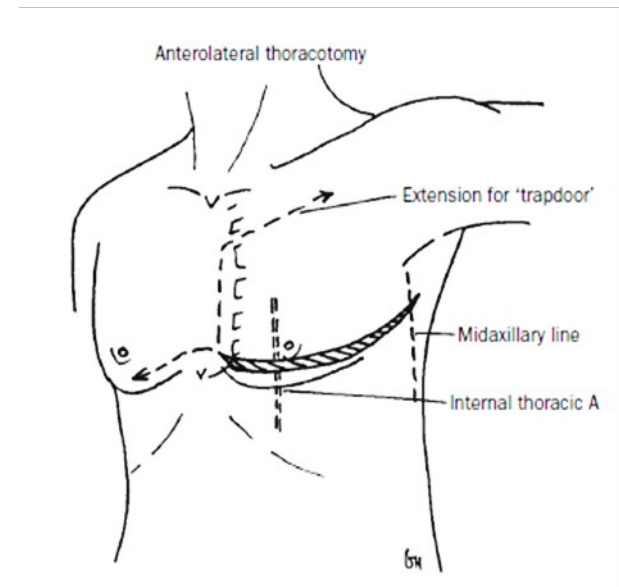
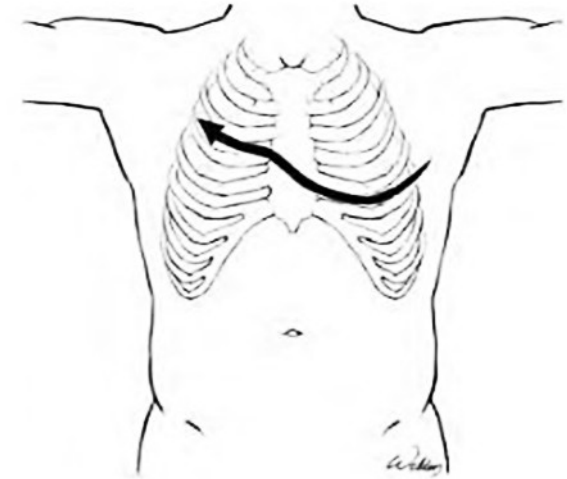
- There are three main types of thoracotomy:
  - **Anterolateral**
  - Posterolateral
  - Median sternotomy
- The anterolateral thoracotomy
  - Quick
  - Minimal muscle sacrifice
  - It's an excellent incision for
    - Anterolateral mediastinum and pleural cavity
    - Lung peripheral surgery
- Starts from the sternal border at the level of the 5th intercostal space and extends to the posterior axillary line



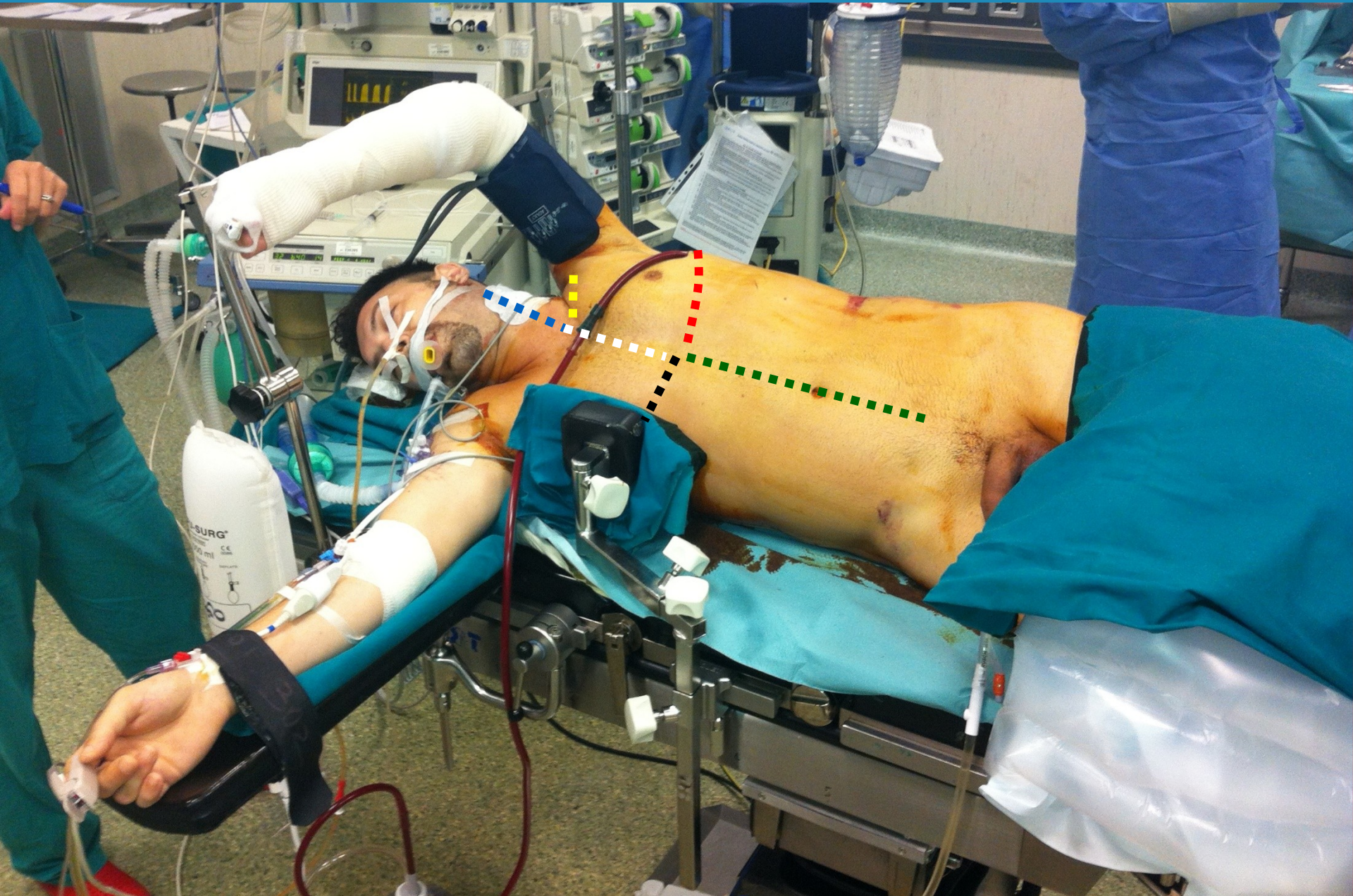


# Antero-lateral thoracotomy

- Advantages
- **Possibility of extension**
  - Transversal section of the sternum with ascent to the IIIrd space or symmetrical (**clamshell**)
  - Median sternotomy (trapdoor)
  - Possible further extension supraclavicular (subclavian injury)
  - Laparotomy
- Lung parenchymal domain (+/-)



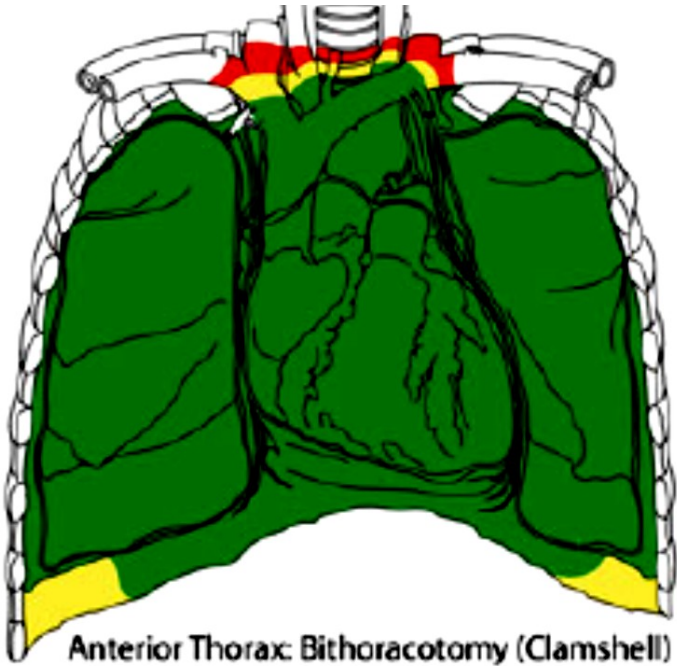
# Damage control approach to the chest



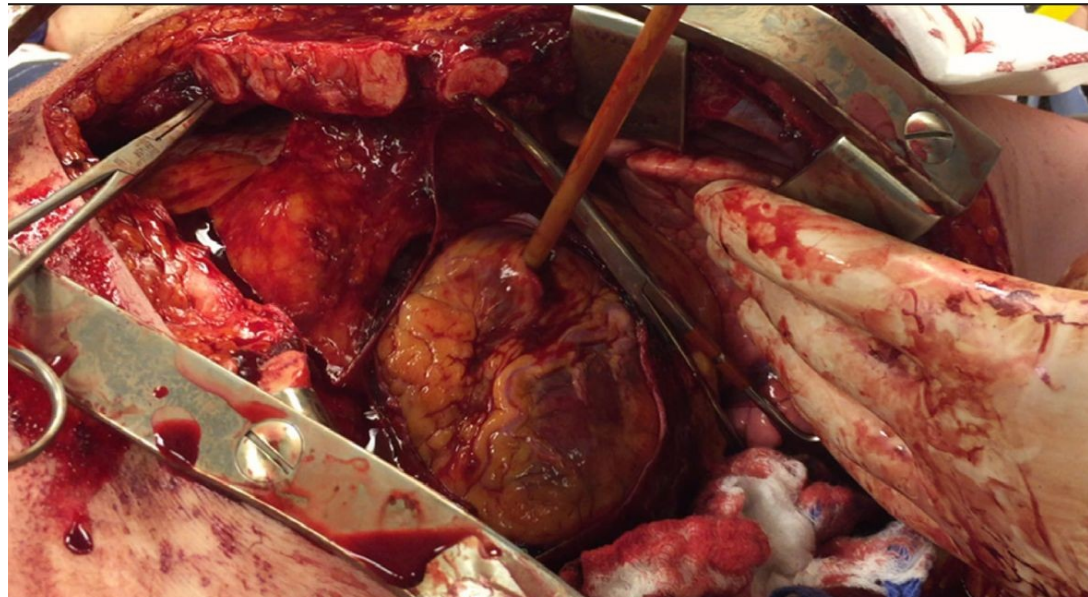
# Clamshell

Although several incisions have been described for use in ET, the clamshell incision is the superior incision for patients arriving at the hospital in extremis. While the LAT and RAT may have utility in specific injury patterns, they remain a wise choice only because of ease of conversion to clamshell incision if further control is mandated. Median thoracic structures in ET. For physicians with only modest experience with ET, the clamshell incision is the only incision needed to optimize a patient's chance of survival. For trained surgeons, the clamshell incision may also be considered the initial incision of choice for an ET.

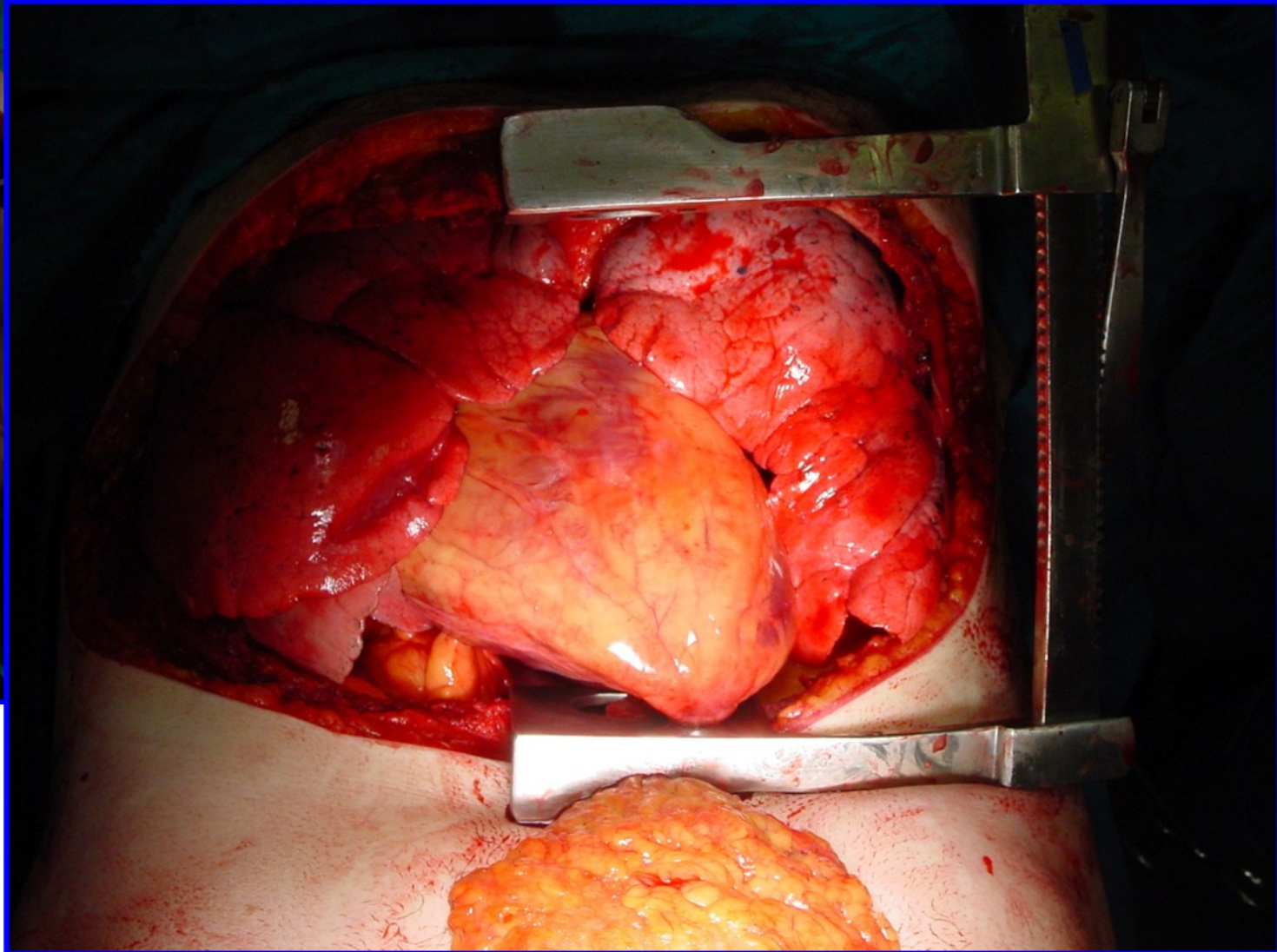
# Clamshell



Inferoposterior Heart: Bithoracotomy



# Clamshell



# The great doubt of the unlucky surgeon

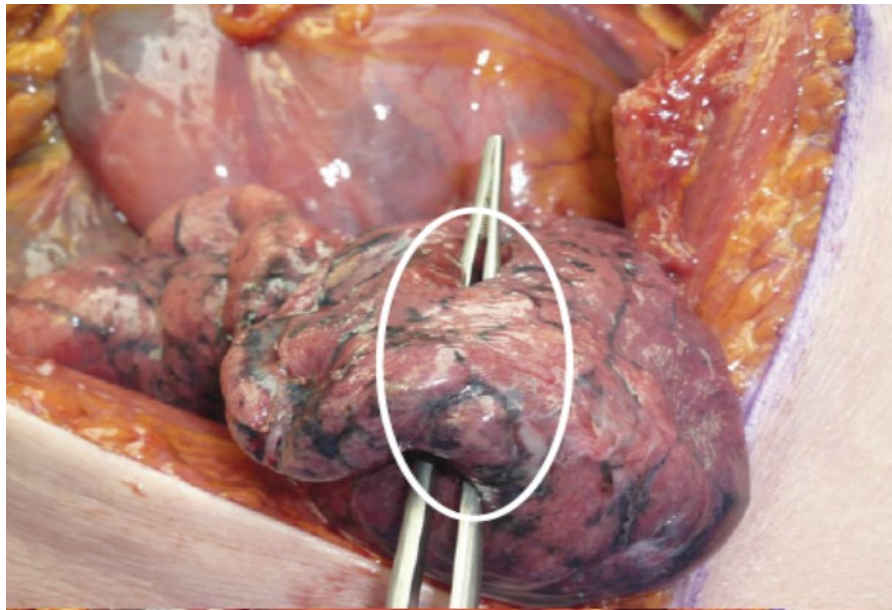
**“Will I be able to stop the bleeding?”**



# The lung injury

- The surgeon rarely encounters a lung lesion with difficult bleeding control
  - Pulmonary vascularization: **high flow and low pressure**
  - Pulmonary parenchyma rich in **thromboplastin**
- However, there are situations where the bleeding can be massive
  - **Anatomical location** of the lesion
  - Lesions **deeply penetrating** the parenchyma
  - **Hilar injuries**
  - **Multiple/diffuse** parenchymal lesions
  - **Patient's metabolic exhaustion** (coagulopathy + acidosis + hypothermia)

# Pulmonary tractotomy



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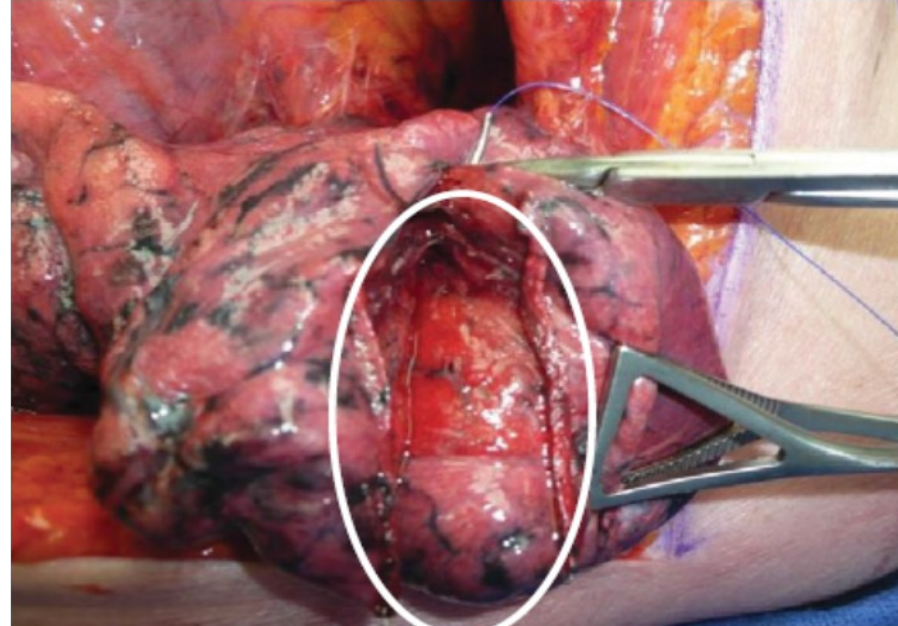
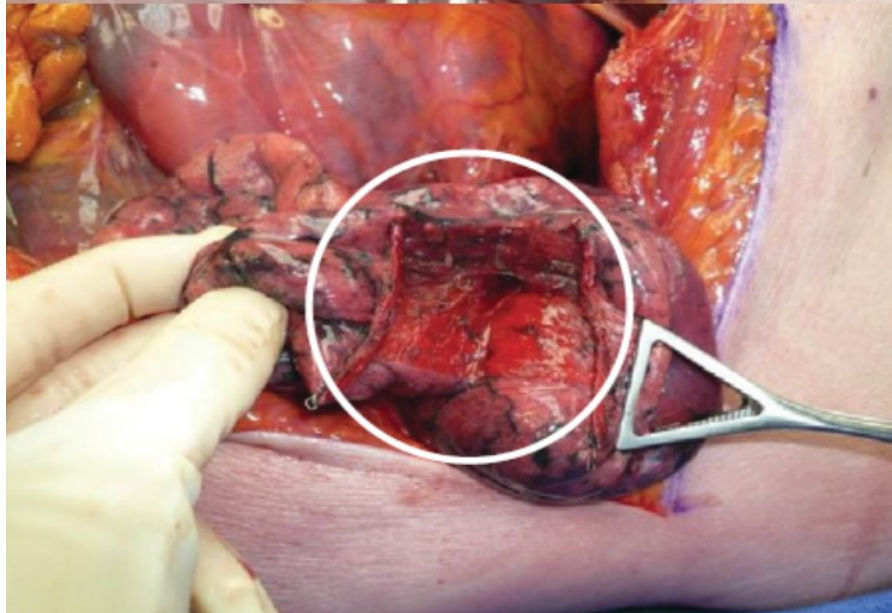
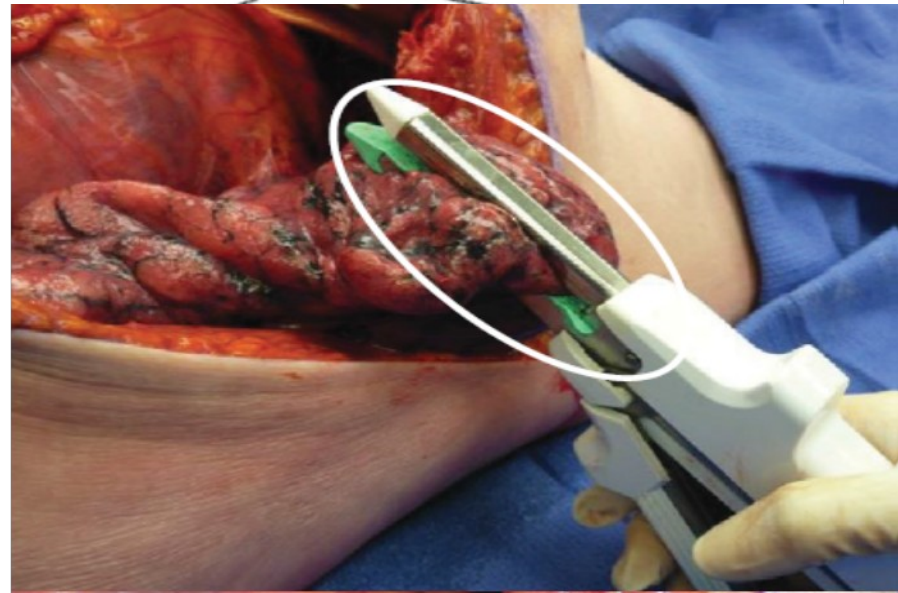
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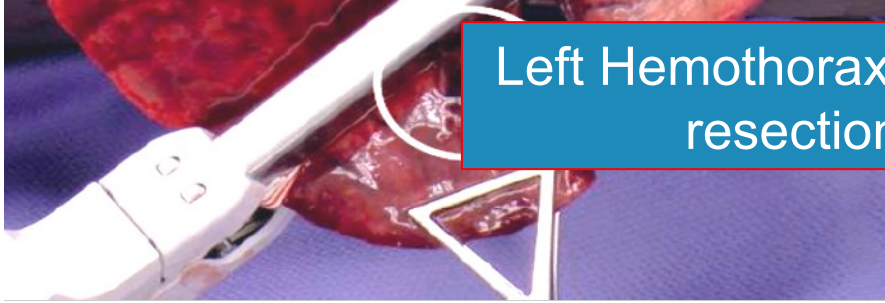
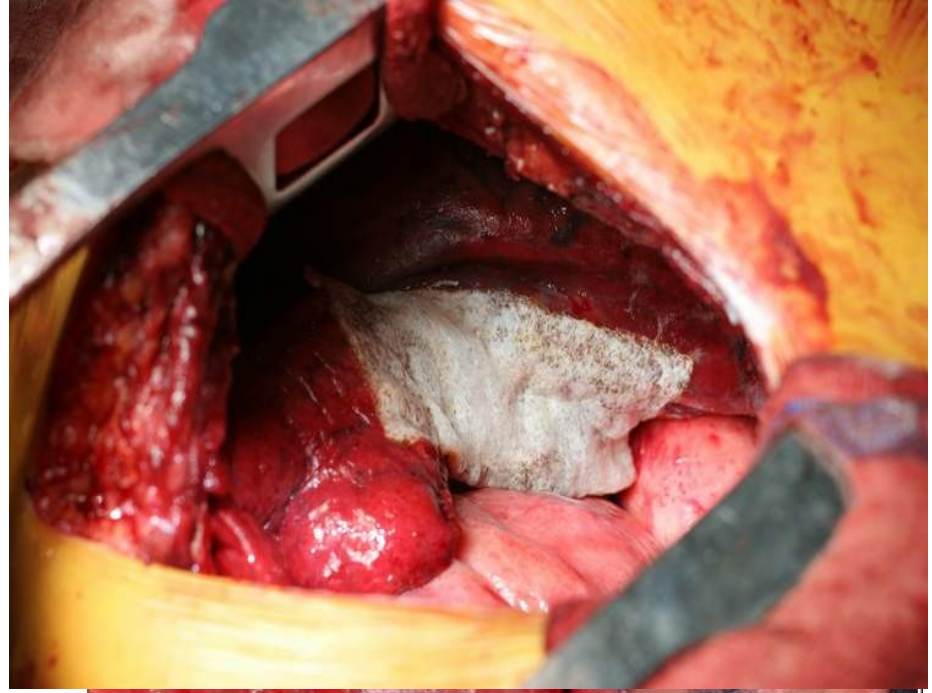
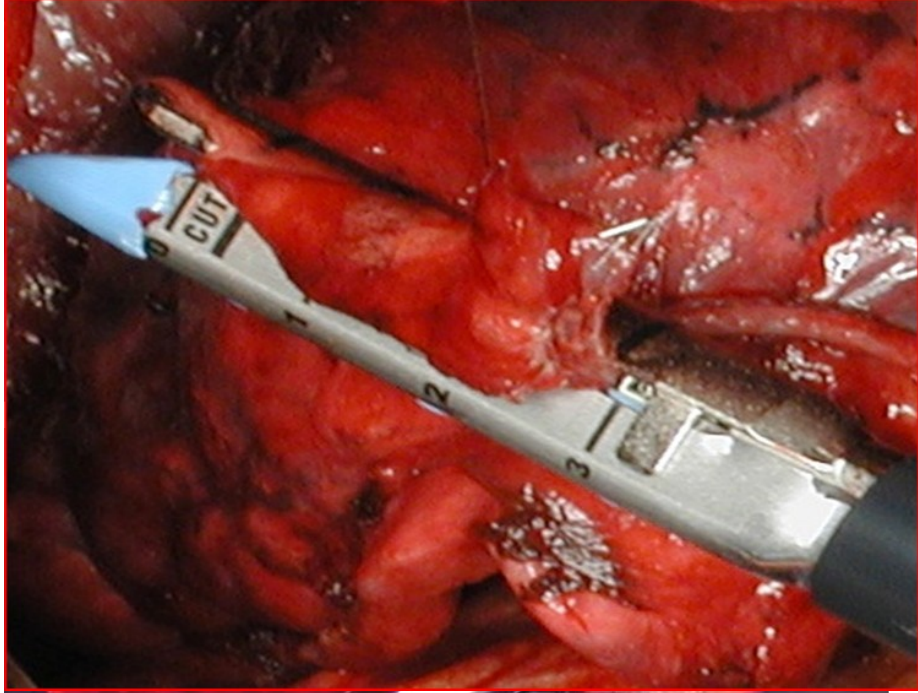
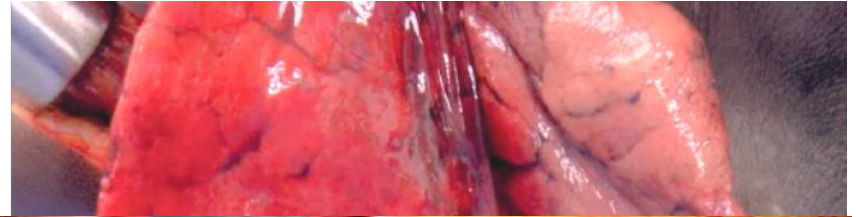
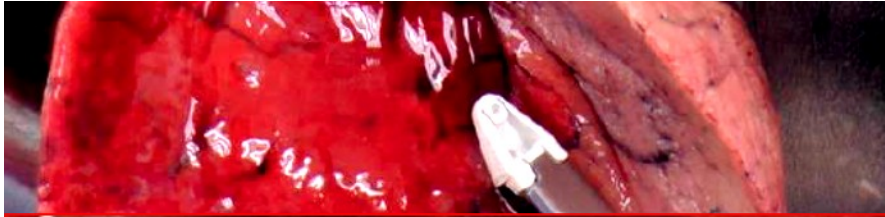
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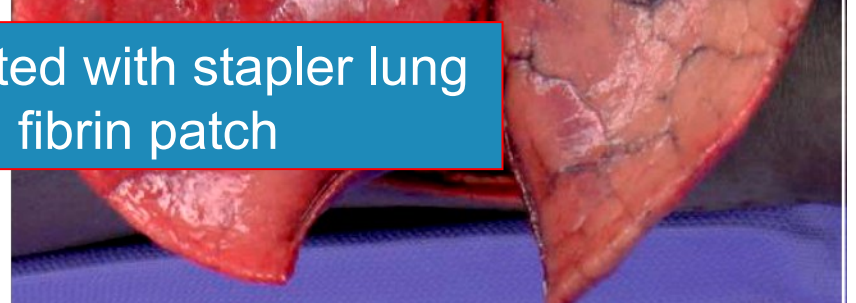




# Wedge resection



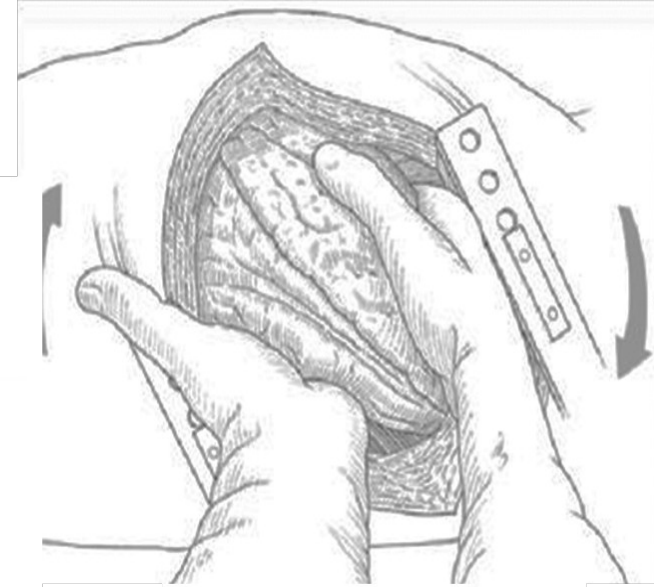
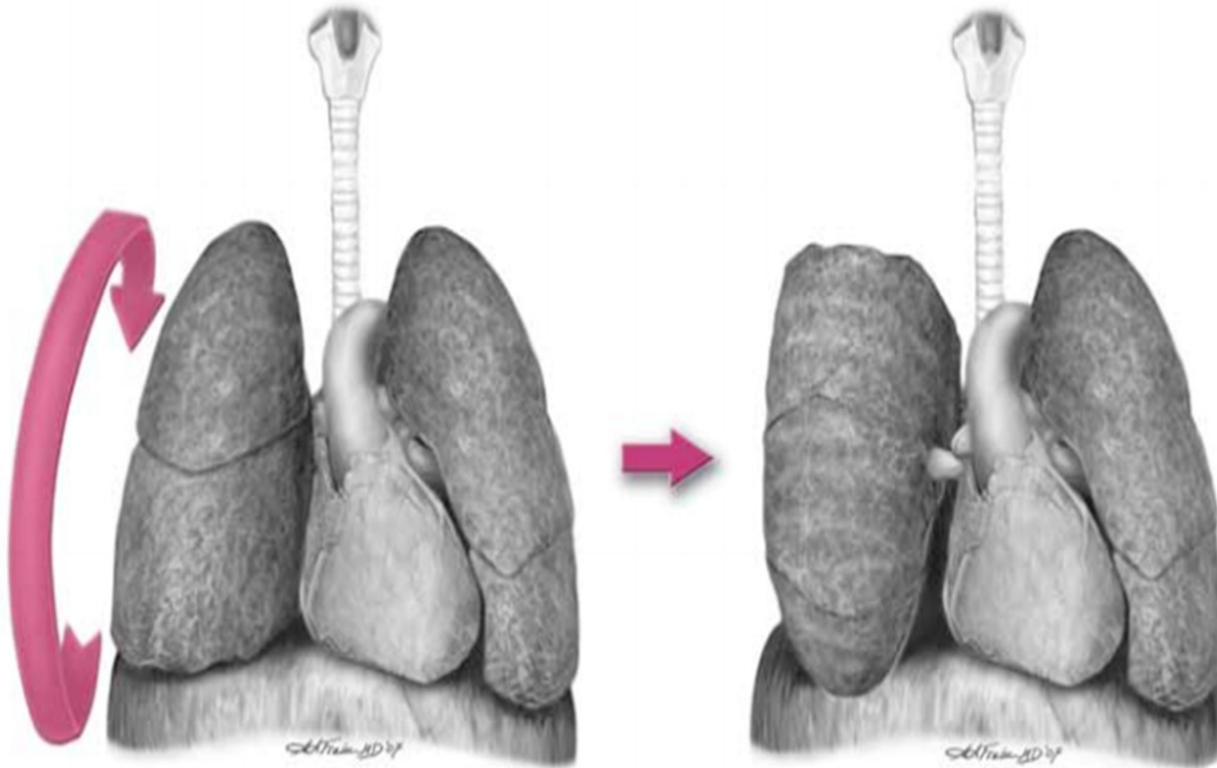
Left Hemothorax treated with stapler lung resection and fibrin patch



# Pulmonary hilum injury

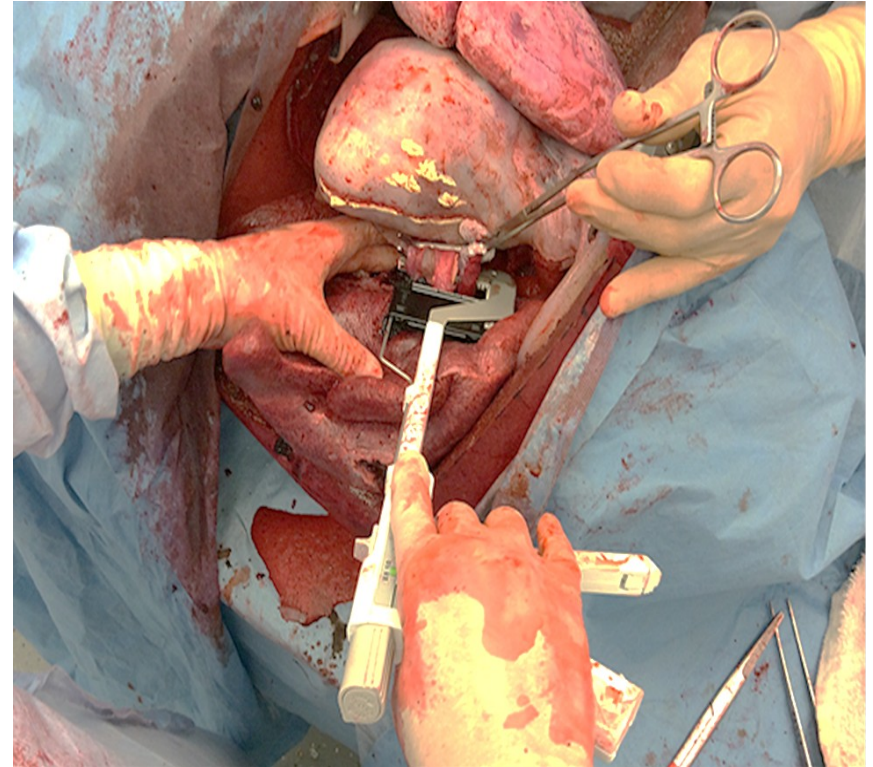
- Injury often fatal
  - Very critical patients
  - Profuse bleeding into the pleural cavity
- Emergency thoracotomy mandatory
  - Initial manual or tourniquet hilar bleeding control
  - Lung mobilization (inferior pulmonary ligament section)
  - Placement of a large vessel clamp around the hilum
- Check for the reparability of the hilar vascular lesion (quickly!)
  - Maneuver not tolerated well by the patient
  - The partial arterial lesions or the lateral venous lesions can be repaired
  - Venous transection implies a corresponding lobectomy
  - Total hilar injury usually requires a pneumonectomy (high mortality rate)

# Temporary hemostasis: lung twist



# Last resort: the pneumonectomy

- When pneumonectomy is unavoidable, it can be done quickly using a stapler with a vascular charge (TA better!!!! ....too bad they don't produce them any more)
- After stapling and pneumonectomy, do not release the stapler
  - Reinforce mechanic suture on the emerging vascular and bronchial structures



# Outcome / lung sparing

## Management of traumatic lung injury: a Western Trauma Association Multicenter review.

Karmy-Jones R, Jurkovich GJ, Shatz DV, Brundage S, Wall MJ Jr, Engelhardt S, Hoyt DB, Holcroft J, Knudson MM.

143 patients (28 blunt - 115 penetrating)	
surgery	mortality
Suture	9%
Tractotomy	13%
Wedge resection	30%
Lobectomy	43%
Pneumonectomy	>65%

# Thoracic packing

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European Journal of Trauma and Emergency Surgery  
<https://doi.org/10.1007/s00068-020-01428-8>

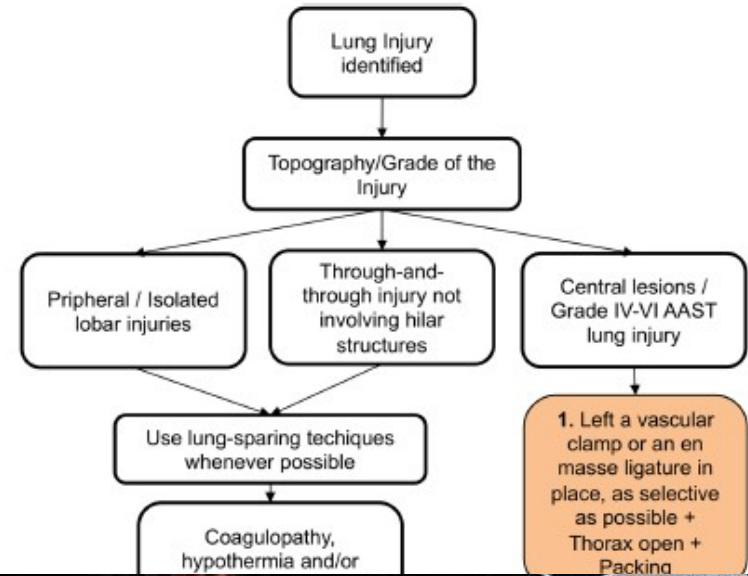
REVIEW ARTICLE



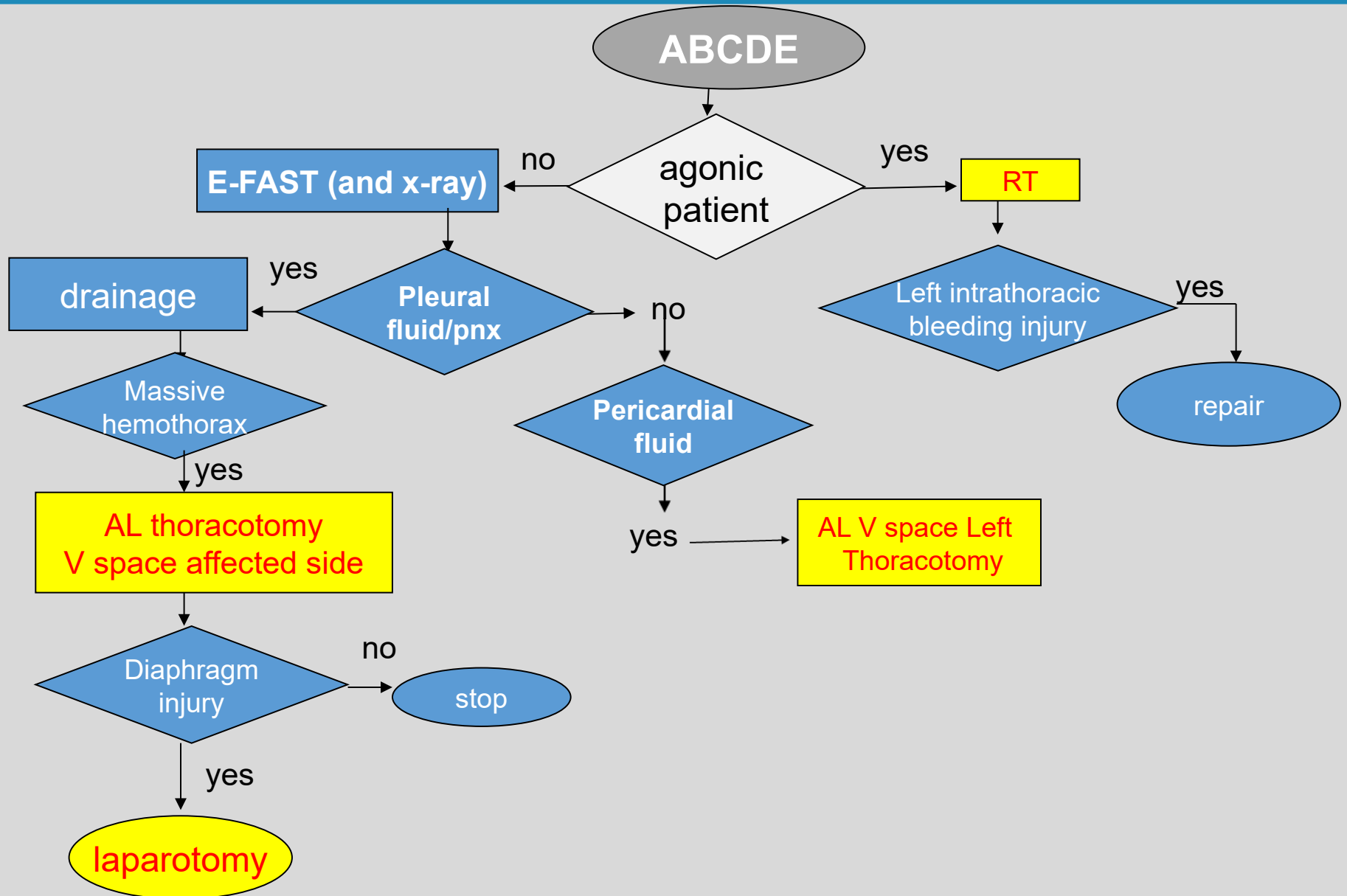
## The tenets of intrathoracic packing during damage control thoracic surgery for trauma patients: a systematic review

Ramiro Manzano-Nunez<sup>1,2</sup> · Julian Chica<sup>1,2</sup> · Alexandra Gómez<sup>1</sup> · Maria P. Naranjo<sup>1</sup> · Harold Chaves<sup>3</sup> · Luis E. Muñoz<sup>3</sup> · Javier E. Rengifo<sup>4</sup> · Isabella Caicedo-Holguin<sup>5</sup> · Juan C. Puyana<sup>6</sup> · Alberto F. García<sup>2,3</sup>

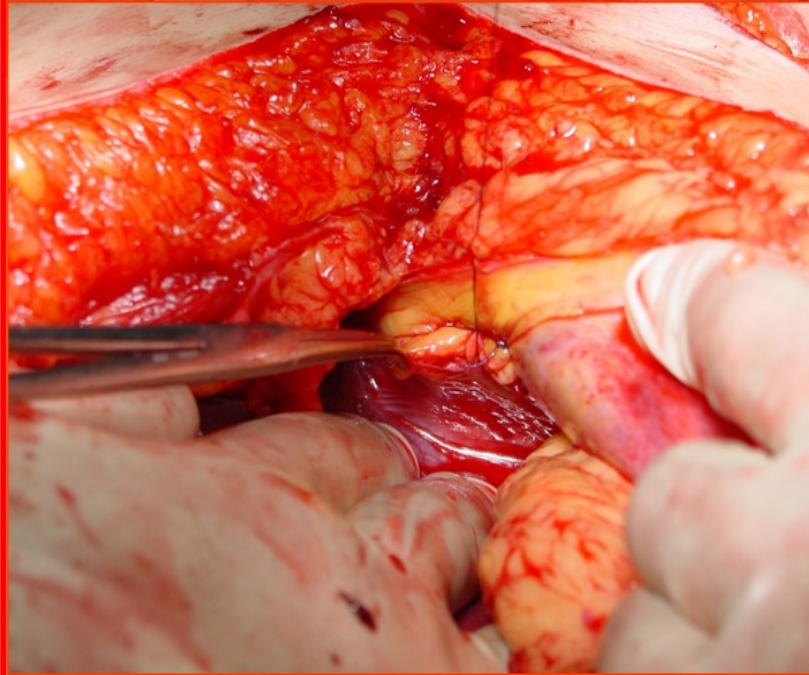
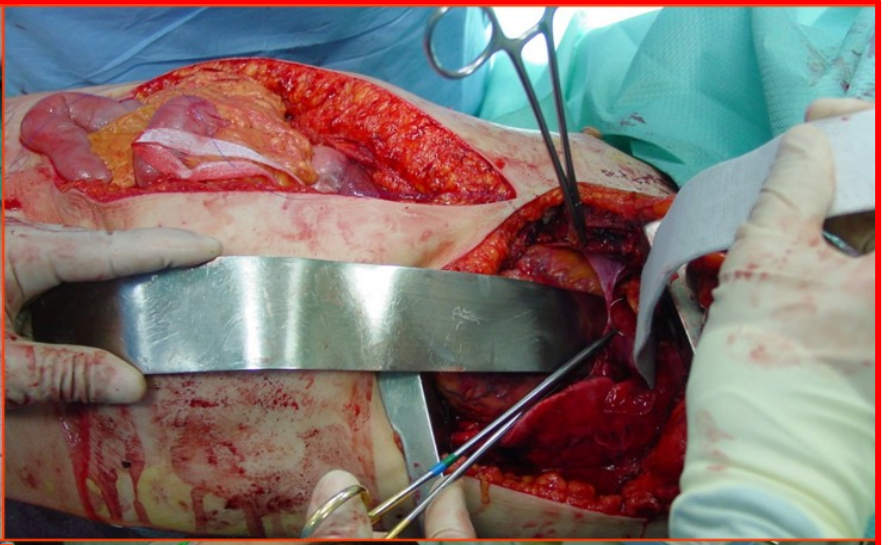
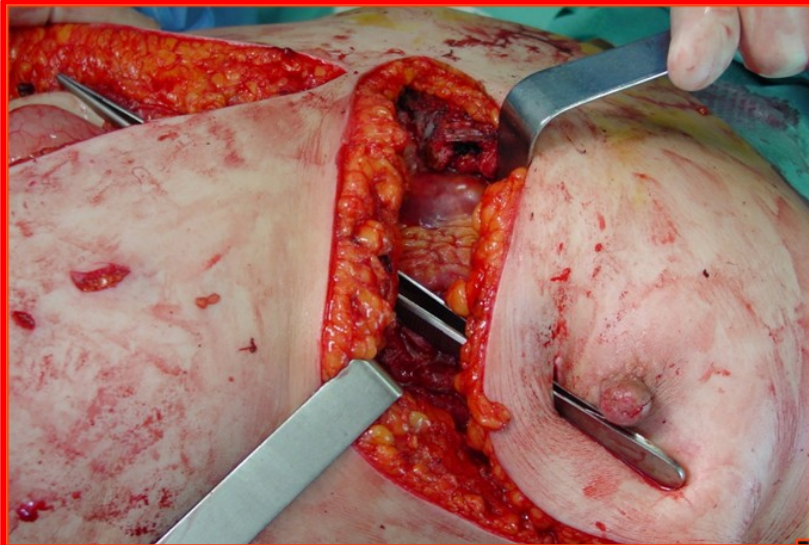
### Conclusion



# Algorithm



# Thoraco-abdominal stab wound





# Conclusions

- In penetrating chest wounds bilateral or thoraco-abdominal injuries may require a sequential approach

- In agonic patient start always with EDT. Following steps are indicated by intra-operative findings

- In unstable, non-agonic patient approach primarily the affected side as indicated by E-FAST/xray

- With preparation, emergency surgeon can streamline the response to one of the most acute, time-dependent and complex surgical case

# How to train for this?



**CONTROLLO VASCOLARE AVANZATO  
NELLE EMORRAGIE TORACO-ADDOMINALI**

**-CAVAVER LAB XIX EDIZIONE-**

**CON IL PATROCINIO**



**16-17 NOVEMBRE**

Via Rita Levi Montalcini 4 - Pieve Emanuele (MI)

Presidente del Corso **Franco Stagnitti**

Direttore del Corso **Giovanni Bellanova**

Faculty

**Giovanni Bellanova, Stefano Calderale,  
Francesco Ceci, Elvio De Blasio,**

SURGICAL TRAINING ACADEMY

staf.courses@gmail.com

https://www.staf-ets.org

segreteria organizzativa



**2 day  
8 learners  
12 readings  
6 hours of surgical  
practice  
2 reperfused and  
reventilated  
cadavers**

Il Corso prevede un numero massimo di otto discenti e si sviluppa in due giornate. Al fine di sviluppare una corretta comunicazione tra l'equipe chirurgica e quella anestesiologica in un setting di emergenza è prevista la partecipazione al corso di un numero massimo di quattro discenti osservatori (anestesisti-rianimatori).

Prima Giornata: La prima giornata (6 ore) è incentrata in lezioni frontali interattive che fissano i principi anatomici su cui si basano le tecniche chirurgiche da adottare in situazioni di emergenza critica per un rapido controllo delle gravi emorragie toraco-addominali, ed una serie di scenari clinici discussi in gruppo che hanno l'obiettivo di definire i principi diagnostici e di strategia chirurgica. Seconda Giornata: La seconda giornata prevede una sessione chirurgica di 6 ore, in cui i discenti, in numero di quattro per tavolo ed assistiti da docenti, eseguono procedure chirurgiche ed isolamenti vascolari su preparato anatomico reperfuso e reventilato.

## Programma

### 1° Giorno (11.30-17.30):

11.00 : Registrazioni  
11.30-12.00: Introduzione ed obiettivi del Corso  
F. Stagnitti - G. Di Grezia  
12.00-12.20: L'emorragia critica. E. De Blasio  
12.20-12.40: Trauma bacino  
Packing pelvico extraperitoneale G. Tugnoli  
12.40-13.10: Coffe break  
13.10-13.30: L'emoperitoneo massivo:  
Manovra di Pringle-Isolamento elementi peduncolo epatico D. Del Fabbro  
13.30-13.50: Clampaggio sovraclavicolare aorta addominale F. Ceci  
13.50-14.10: Trauma epatico:  
Packing epatico G. Tugnoli  
14.10-14.50: L'ematoma retroperitoneale zona 1-2 :  
La manovra di Cattell-Baasch S. Calderale  
La manovra di Mattox L. Fogato  
14.50-15.10: L'emo torace massivo:  
Toracotomia sinistra allargata in damshell G. Di Grezia  
15.10-15.30: I problemi anestesiologici della chirurgia toracica in emergenza D. Liberati  
15.30-15.50: Chiusura temporanea dell'addome G. Bellanova  
15.50-16.10: ATLS e la formazione chirurgica G. Di Grezia  
16.10-16.20: L'opinione degli esperti

### 2° Giorno (8.30-14.45):

8.30: Inizio lavori in Camera Operatoria in collegamento audio/video con aula.  
Esecuzione delle procedure chirurgiche da parte dei discenti.  
Il corso prevede una parte dedicata a:  
- parte di lettura e discussione di casi  
- parte di simulazione  
- parte di discussione dei lavori e consegna attestati

**Grazie per l'attenzione**

Per formalizzazione e iscrizione: segreteria@treatsrl.it IBAN IT10R0310401002000000820782

Nella causale del bonifico specificare: Iscrizione corso "Controllo vascolare avanzato nelle emorragie toraco-addominali maggiori" Pieve Emanuele 16-17/11/2023 Dott. ....