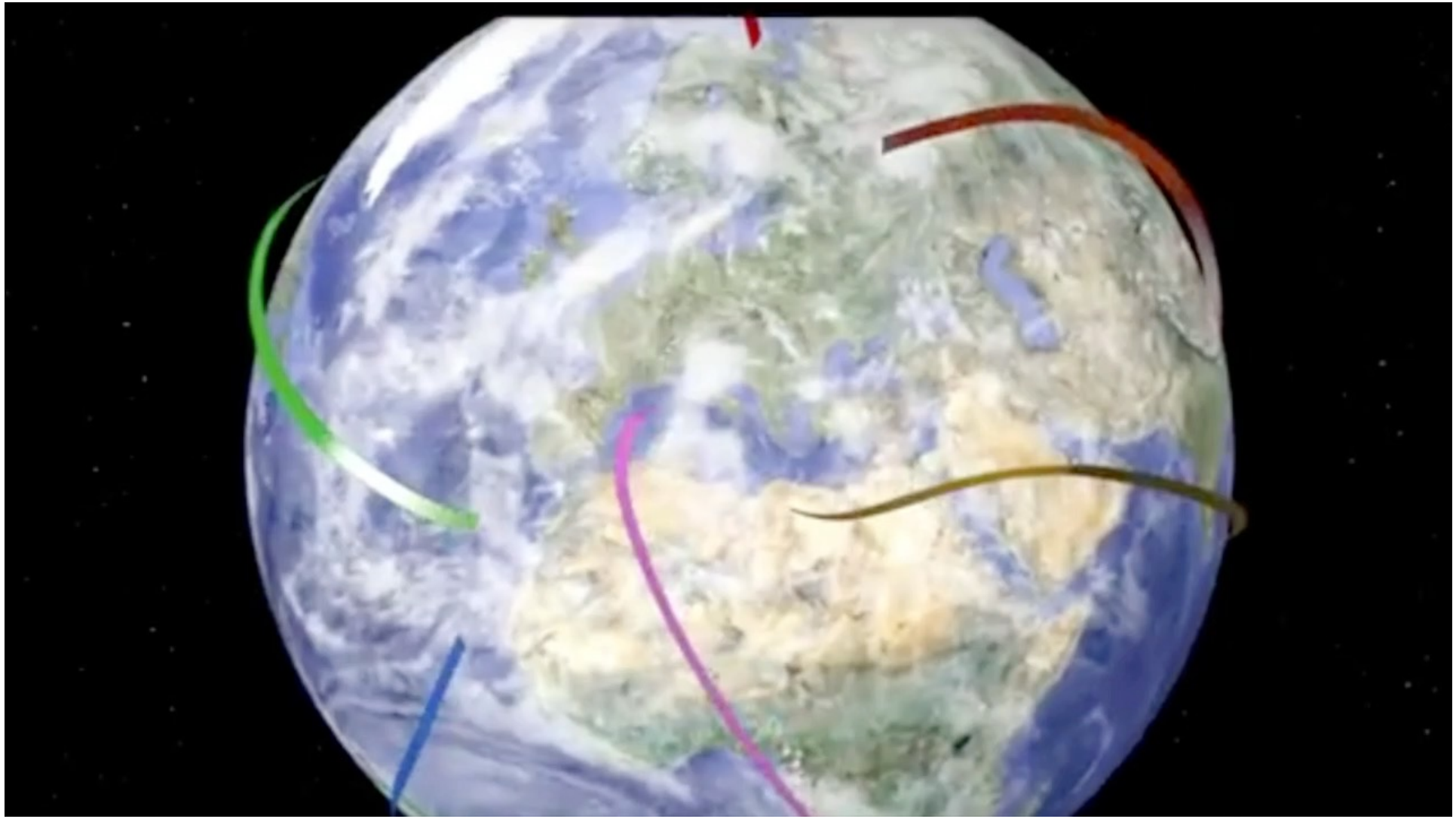
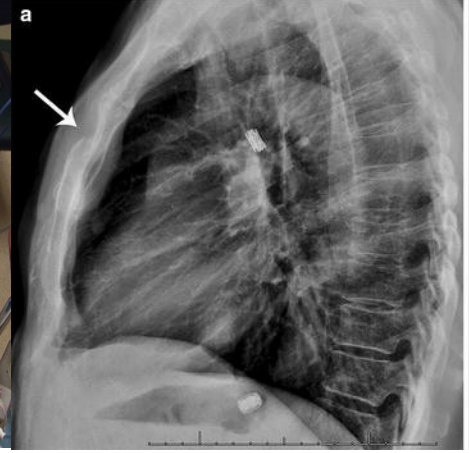
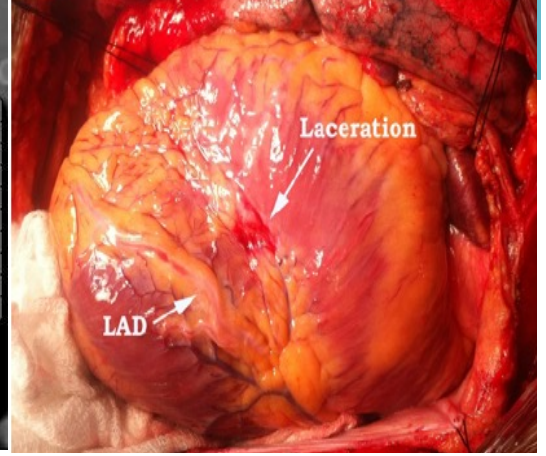
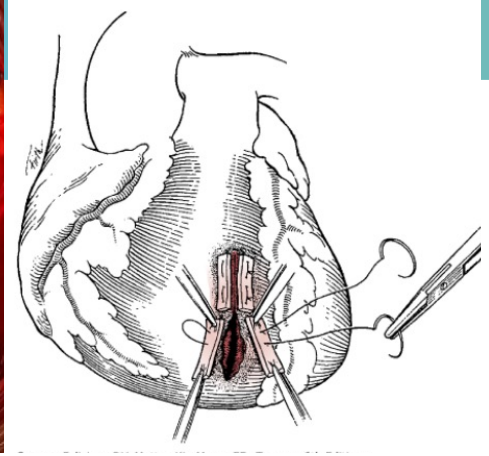
Cardiac Trauma







Cardiac Trauma

Mustafa CIKIRIKCIOGLU, MD, PhD, FETCS

Médecin Adjoint Agrégé & Chargé de Cours

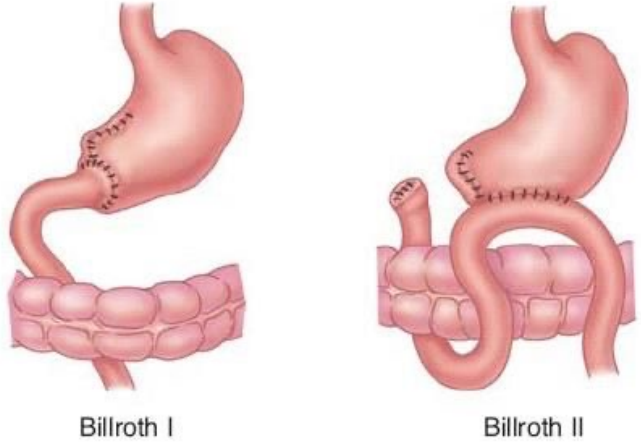
Department of Surgery, Division of Cardiovascular Surgery,
University Hospital – Faculty of Medicine,
Geneva, Switzerland

"The surgeon who should attempt to suture a wound of the heart would lose the respect of his colleagues !!!"

Theodore Billroth-1883

Chair of Clinical Surgery

University of Zurich



"Surgery of the heart has probably limits set by nature:

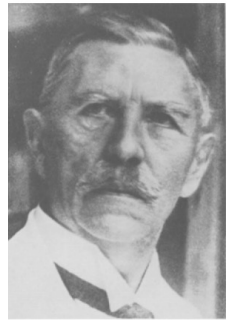
No new method, and no new discovery, can overcome the natural difficulties that attend a wound of the heart."

Stephen Paget- 1896

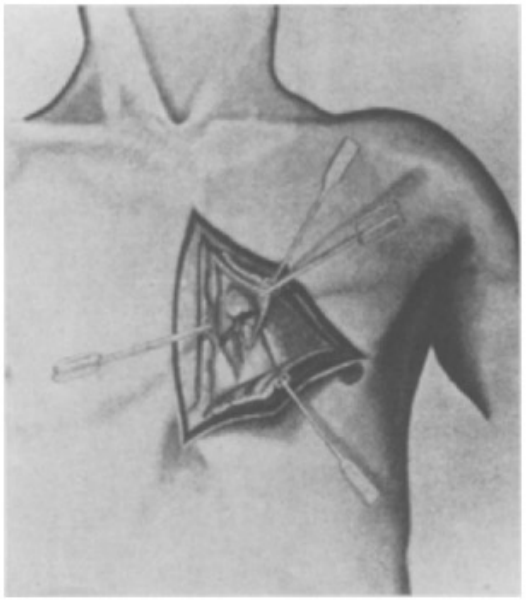
"Wounds of the Heart"

The Surgery of the Chest

- The first surgery on the heart itself was performed by **Axel Kappelen** on 4 September 1895 at Rikhospitalet in Kristiania, now Oslo.
  - Cappelen ligated a bleeding coronary artery in a 24-year-old man who had been stabbed in the left axilla and was in deep shock upon arrival. Access was through a left thoracotomy. The patient awoke and seemed fine for 24 hours, but became ill with a fever and died three days after the surgery from mediatinitis.



- The first successful suture of a wound of the heart was performed by **Ludwig Rehn** in Frankfurt, Germany on 7 September, 1896.
  - A 22-year-old young man arrived at Rehn's hospital, as a victim of a chest stabbing. Rehn had been traveling and didn't learn of the case until his return to the hospital two days later. By that time, the patient was fading fast and his prognosis without any action being taken was fatal.
  - Right ventricular wound was sutured through a 14-cm-long incision in the left fourth intercostal space.
  - The patient survived following surgery and he returned back to his regular life.



THE AMERICAN ASSOCIATION FOR THE
SURGERY OF TRAUMA
ADVANCING TRAUMA AND ACUTE CARE SURGERY THROUGH COMPASSION, DISCOVERY, AND DEDICATION

AAST Organ Injury Scale for the Heart

Heart injury scale

Grade	Description of injury	ICD-9	AIS-90
I	Blunt cardiac injury with minor ECG abnormality (nonspecific ST or T wave changes, premature arterial or ventricular contraction or persistent sinus tachycardia)	861.01	3
	Blunt or penetrating pericardial wound with out cardiac injury, cardiac tamponade, or cardiac herniation		
II	Blunt cardiac injury with heart block (right or left bundle branch, left anterior fascicular, or atrioventricular) or ischemic changes (ST depression or T wave inversion) without cardiac failure	861.01	3
	Penetrating tangential myocardial wound up to, but not extending through endocardium, without tamponade	861.12	3
III	Blunt cardiac injury with sustained (≥6 beats/min) or multilocal ventricular contractions	861.01	3-4
	Blunt or penetrating cardiac injury with septal rupture, pulmonary or tricuspid valvular incompetence, papillary muscle dysfunction, or distal coronary arterial occlusion without cardiac failure	861.01	3-4
	Blunt pericardial laceration with cardiac herniation		
	Blunt cardiac injury with cardiac failure		
IV	Penetrating tangential myocardial wound up to, but extending through,	861.01	3-4
	endocardium, with tamponade	861.12	3
	Blunt or penetrating cardiac injury with septal rupture, pulmonary or tricuspid		
	valvular incompetence, papillary muscle dysfunction, or distal coronary arterial	861.12	3
	occlusion producing cardiac failure		
	Blunt or penetrating cardiac injury with aortic mitral valve incompetence		
	Blunt or penetrating cardiac injury of the right ventricle, right atrium, or left atrium		
	Blunt or penetrating cardiac injury with proximal coronary arterial occlusion		
	Blunt or penetrating left ventricular perforation		
	Stellate wound with < 50% tissue loss of the right ventricle, right atrium, or of left atrium	861.03	5
V	Blunt avulsion of the heart; penetrating wound producing > 50% tissue loss of a chamber	861.03	

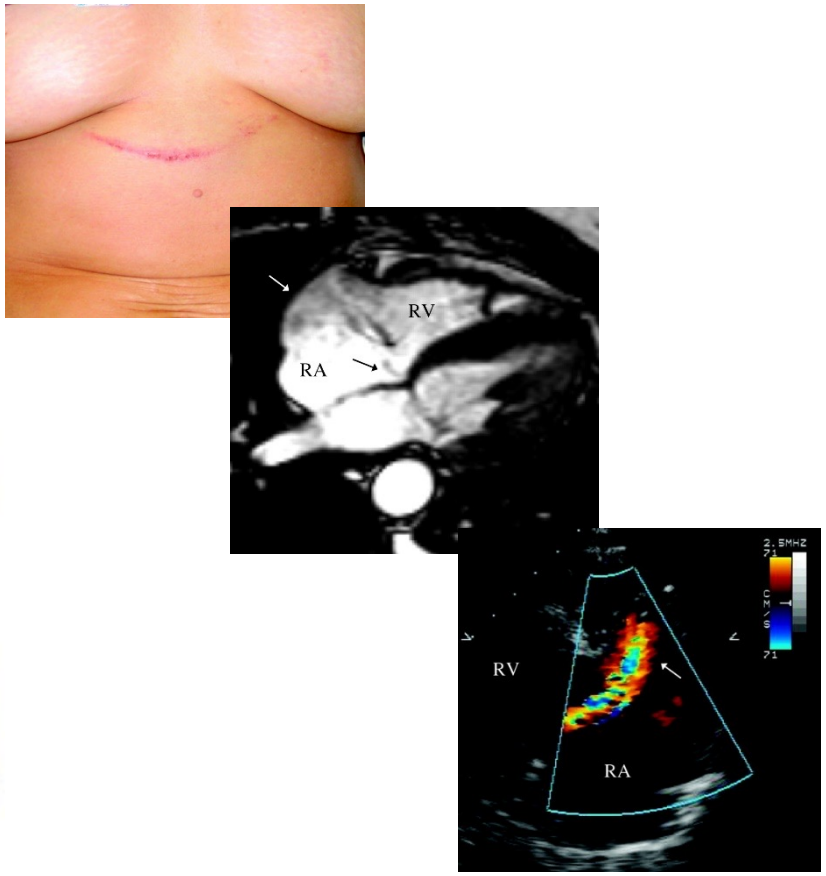
Stable Injuries

Unstable Injuries

Lethal

Types of Cardiac Traumas

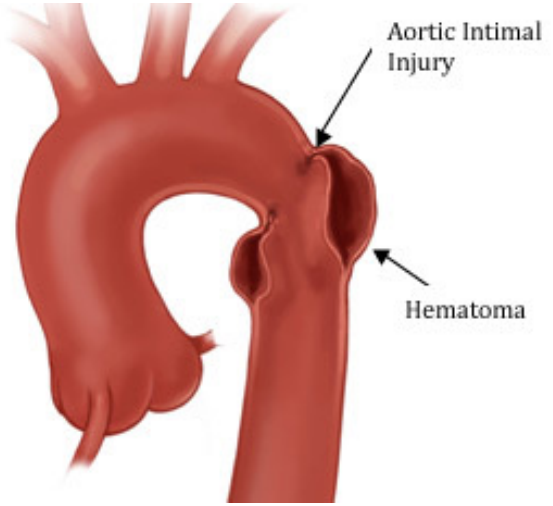
Blunt Cardiac Trauma (BCT)

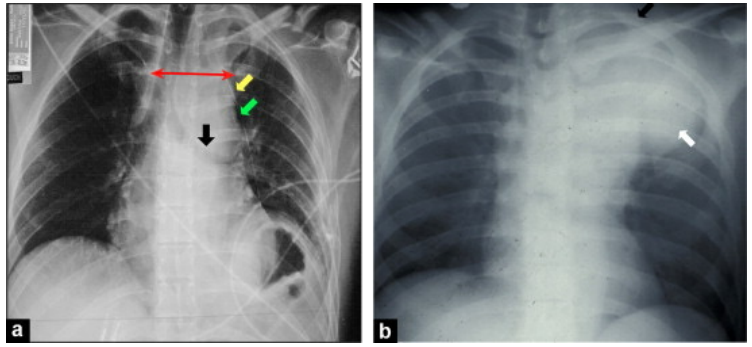


Penetrating Cardiac Trauma (PCT)

Types of Cardiac Traumas

Blunt Cardiac Trauma (BCT)





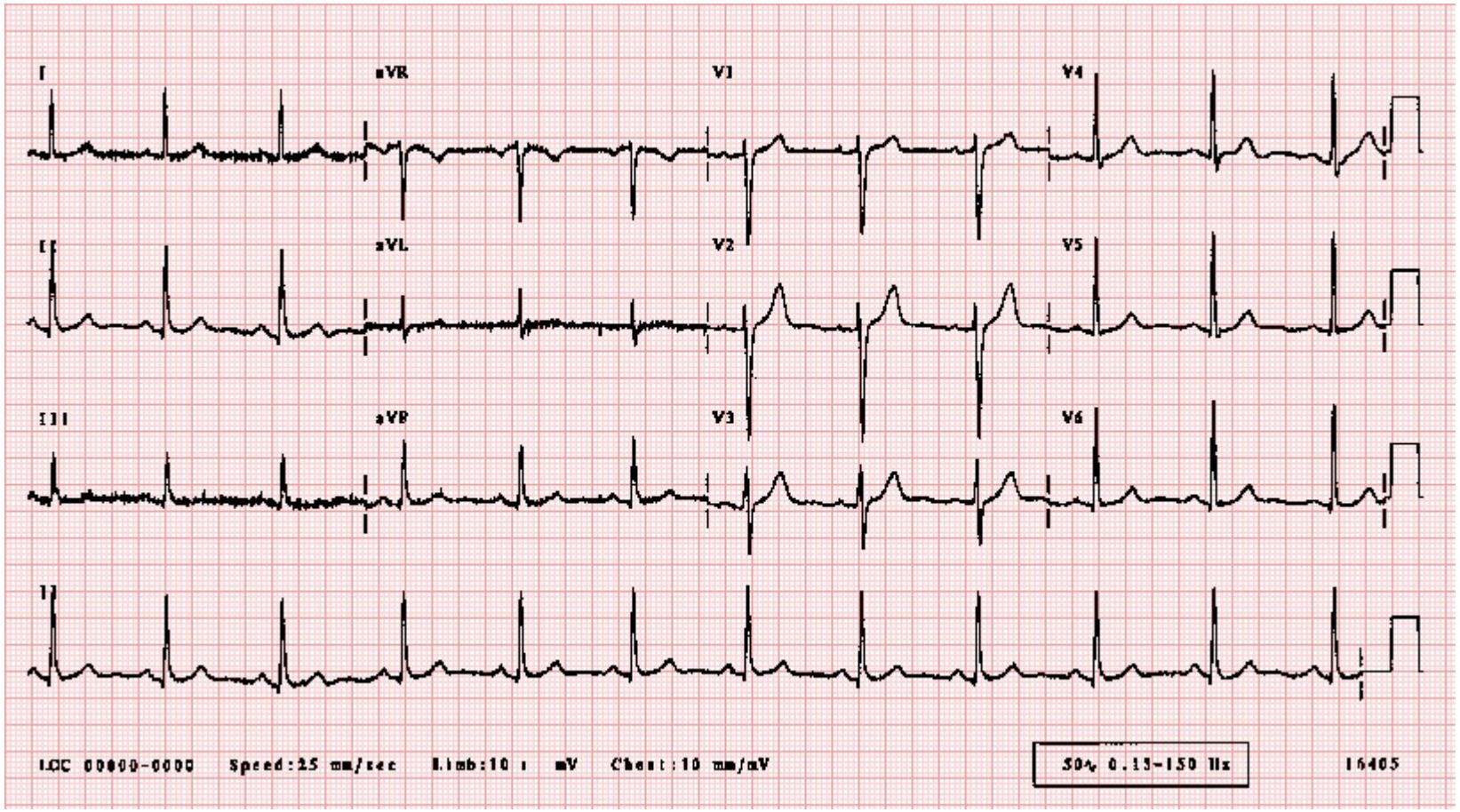
Penetrating Cardiac Trauma (PCT)

Both of these can also result in aortic injury !!!

Cardiac Trauma

- 75 years old female patient
- Sudden brake while driving her car because of a child running on the street
- Despite safety beld, important impact of the steering wheel on the chest
- Patient is hemodynamically stable
- **How you will manage this patient ?**

- 75 years old female patient

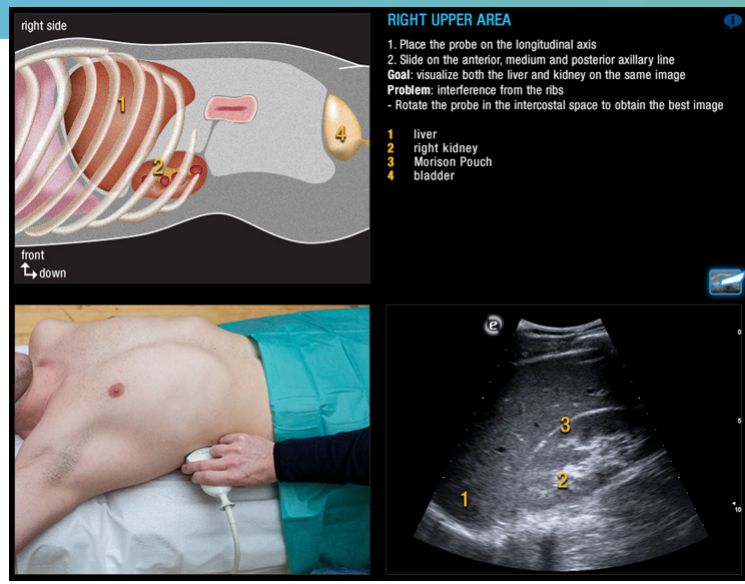


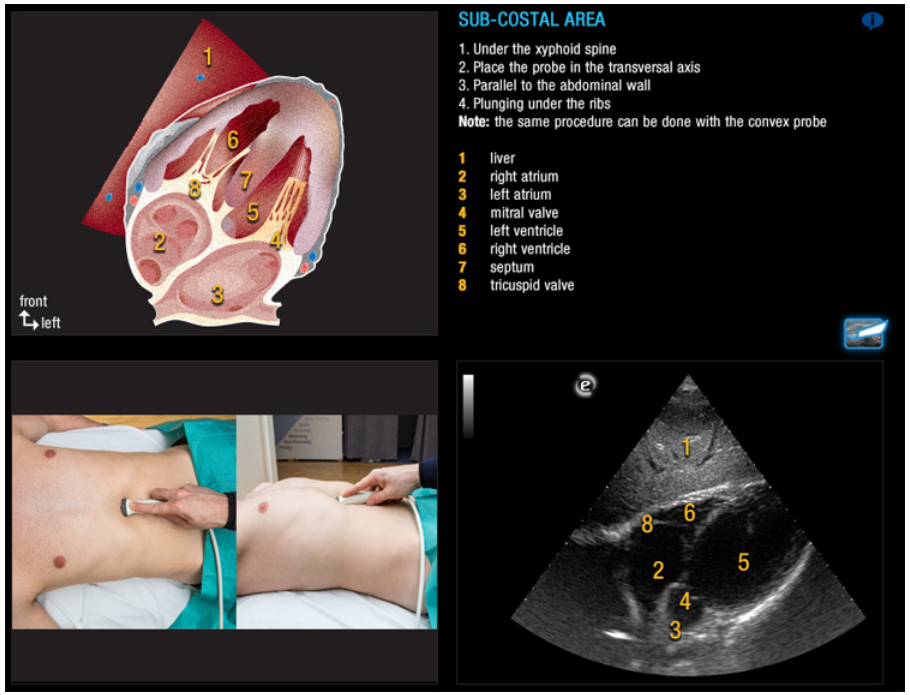
- TroponinT ultra sensible – 10 ng/l

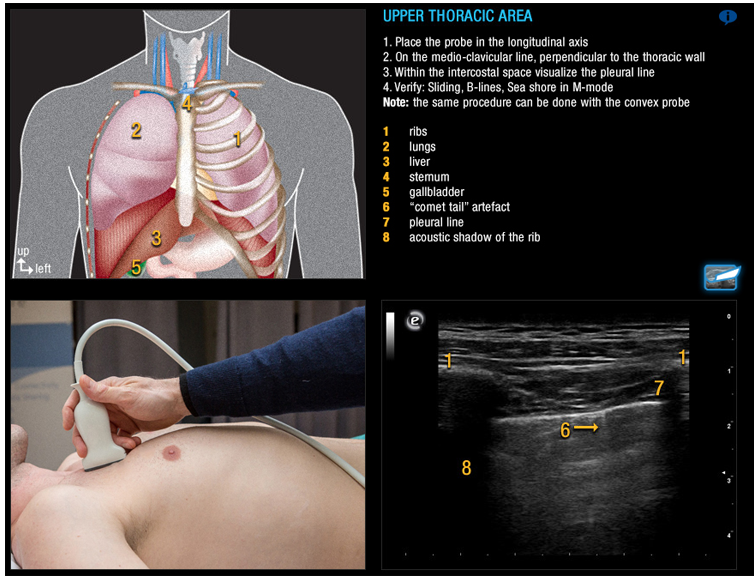
- 75 years old female patient

Cardiac Trauma

- 75 years old female patient
- **FAST**(**F**ocused **A**ssessment with **S**onography for **T**rauma) or
- **FOCUS** (**Fo**cused **C**ardiac **U**ltra**S**ound- echocardiography)





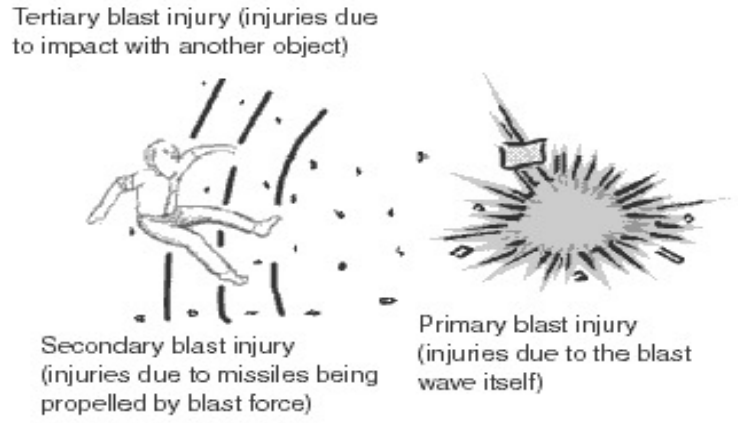


Blunt Cardiac Trauma (BCT)

- **Definition:** any form of blunt trauma resulting in an injury to the heart
- **Mechanism:** abrupt deceleration or impact- crush to the thoracic cavity

-- motor vehicle or motorcycle accidents
-- high fall
-- industrial accidents

-- pedestrian struck
-- sport accidents
-- explosion- blast exposure

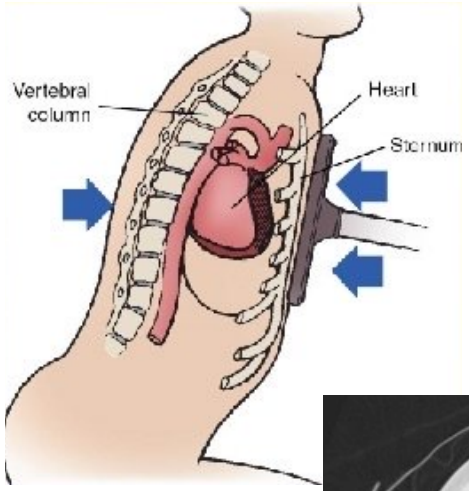


kinetic energy generated during deceleration –
when the body in motion strikes a fixed object. The internal organs, due to inertia of motion, remain in motion and get compressed between the sternum and the spine

dynamic energy generated during a direct or indirect trauma –
fix body receives hit by pressure wave or moving object (i.e. blast exposure to the chest wall)

Blunt Cardiac Trauma (BCT)

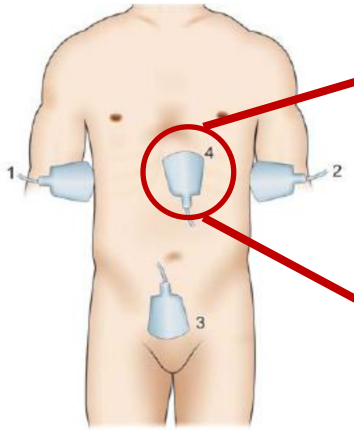
- BCT covers a spectrum of injuries ranging from
  - silent- minor, asymptomatic myocardial contusion, sternal fractures
  - myocardial necrosis and hemorrhage with elevated cardiac enzymes
  - deadly ventricular rupture, traumatic aortic dissections or tear.
- True incidence is unknown but reported rates range between 8 and 71%.
  - autopsy reports show BCI involved in 20% of all motor vehicle deaths.
- Right ventricle and atrium injuries are more common then left sided chamber, septal, coronary artery and valvular injuries
- Pericardial injury results from direct high-energy impact or secondary to a significant increase in intra-abdominal pressure.
  - tearing involves either the pleuro-pericardium or diaphragmatic pericardium.
  - cardiac evisceration or herniation is one of the serious complications and it can lead to torsion of the great vessels along with strangulation of the heart and impaired cardiac output.

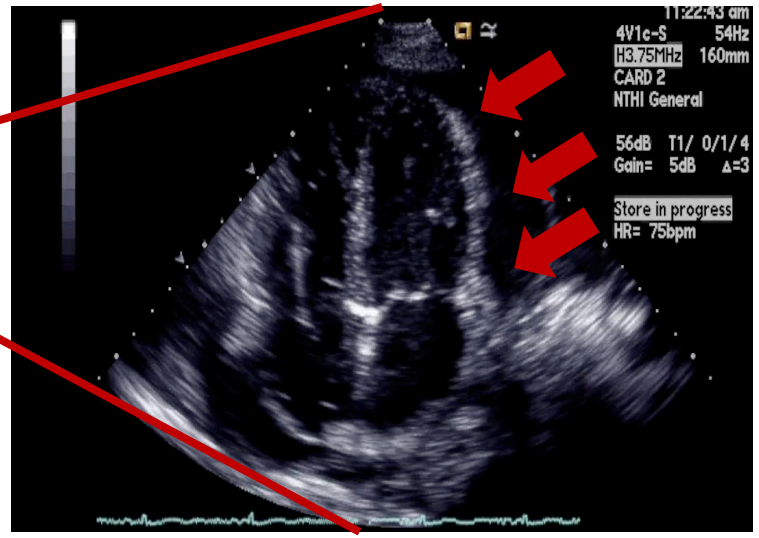


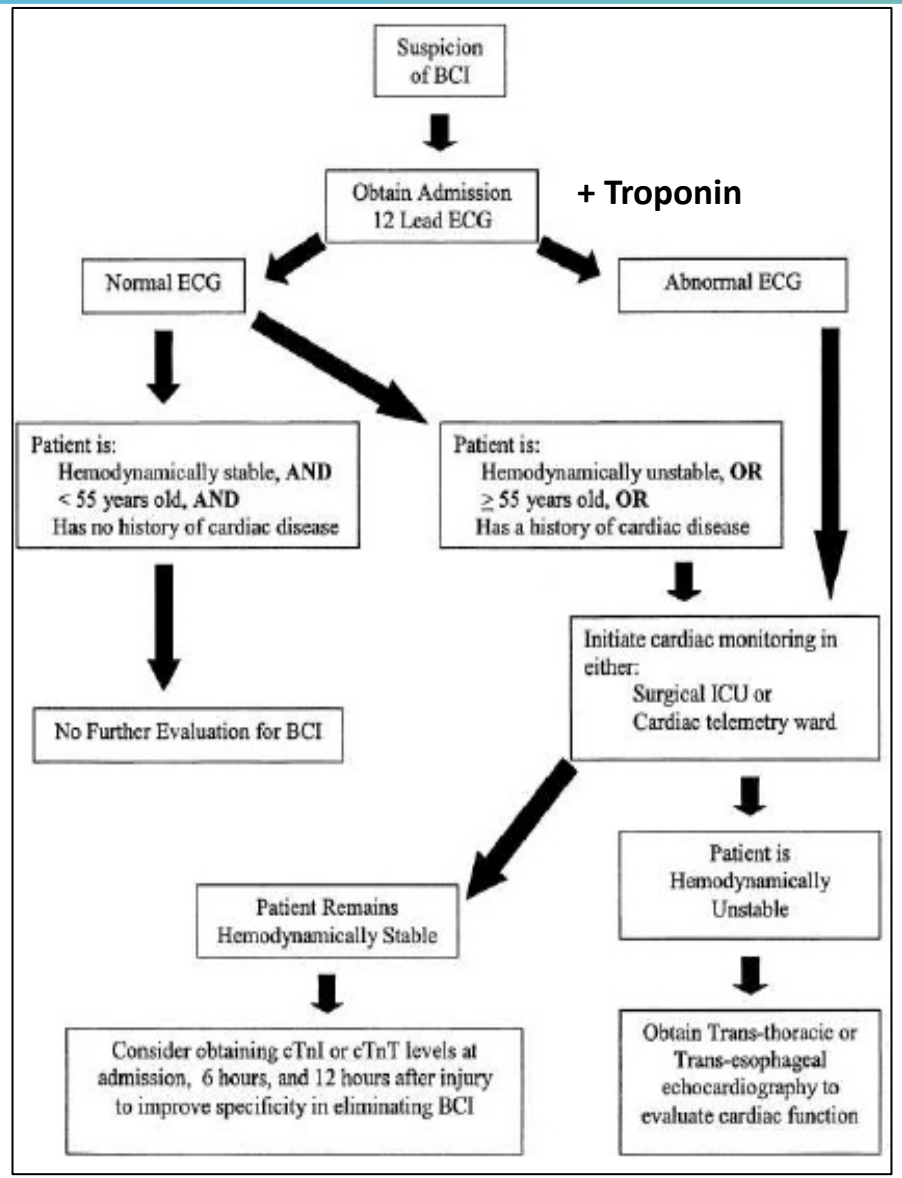
Screening for stable BCT patient

- Obtain an ECG and Troponin on any patient suspected of having BCT
- Normal ECG and normal Troponin (< 1.5 ng/liter) exclude possibility of BCT
- Any ECG abnormality or elevated Troponin should admitted for telemetry
- **FAST**(**F**ocused **A**ssessment with **S**onography for **T**rauma) or **FOCUS** (**Fo**cused **C**ardiac **U**ltra**S**ound- echocardiography) for hemodynamic instability or persistent arrhythmias

1) Right Upper Quad.
2) Left Upper Quad
3) Supra Pubic
4) Subxiphoid







Algorithm for treatment of suspected BCT

Cardiac Trauma

- 75 years old female patient
- Sudden brake while driving her car because of a child running on the street
- Despite safety beld, important impact of the steering wheel on the chest
- Patient is hemodynamically stable
- **How you will manage this patient ?**
- **12 hours clinical, ECG, troponin follow-up**
- **Return to home**

ECG Abnormalities Associated with BCT

Nonspecific abnormalities

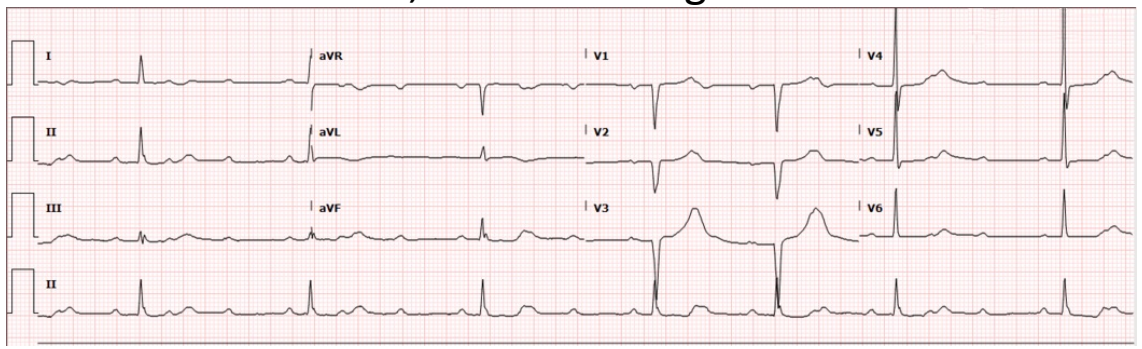
- Pericarditis-like ST elevation or depression
- Prolonged QT interval

Myocardial Injury

- New Q wave
- ST-T segment elevation or depression

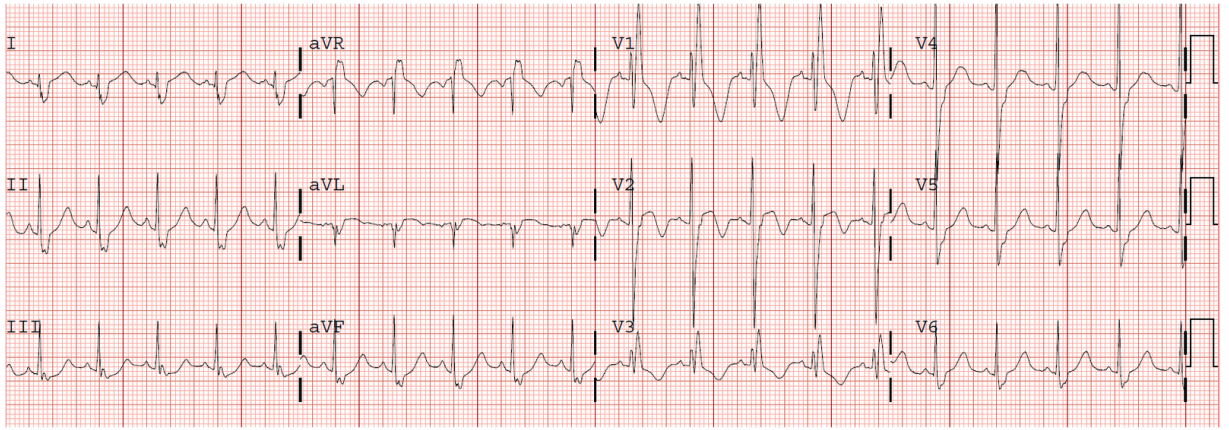
Conduction Disorders

- Right BBB
- Fasicular block
- AV nodal conduction disorder
  - 1st, 2nd and 3rd degree AV block



Arrhythmias

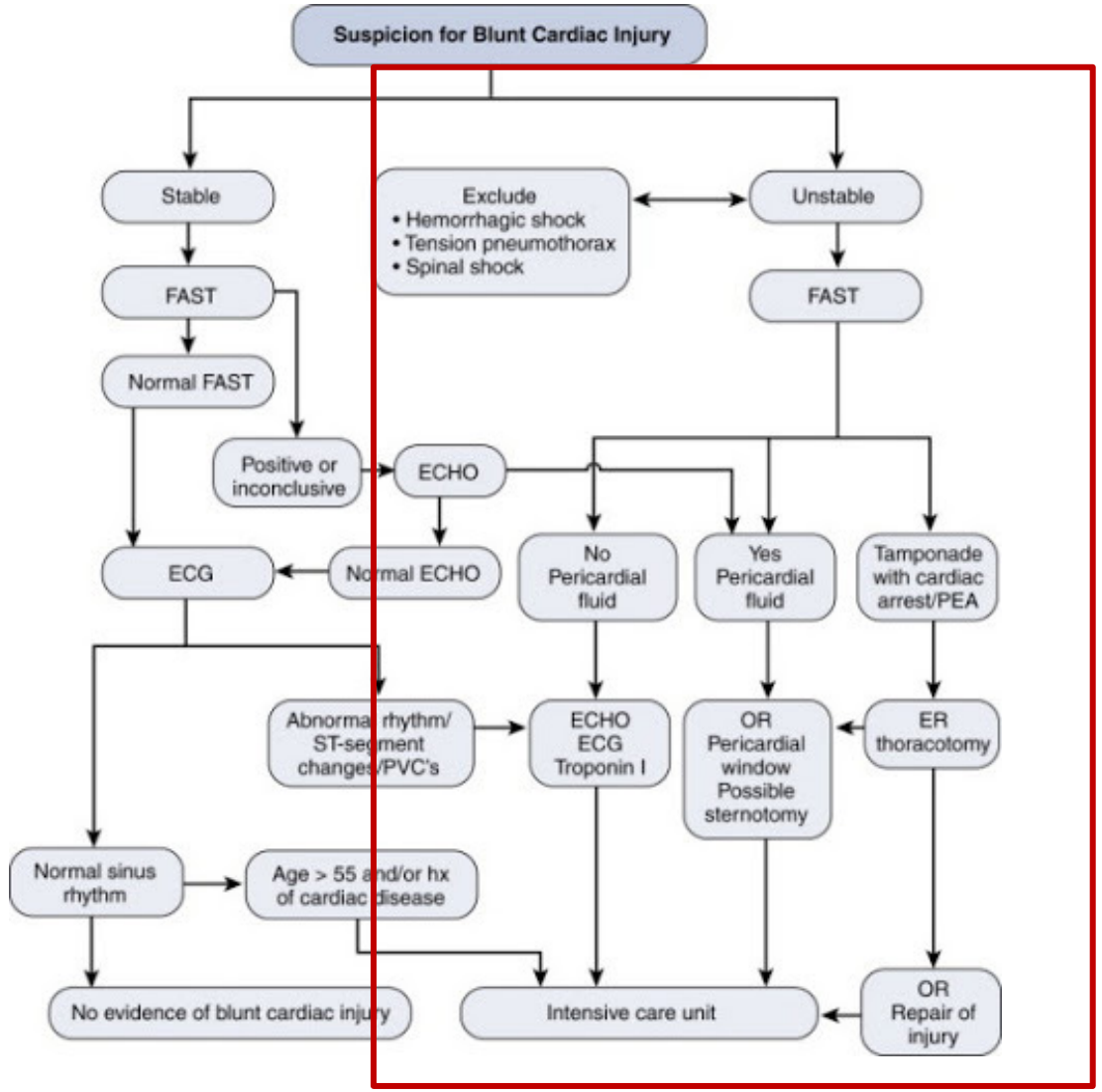
- Sinus tachycardia
- Atrial and ventricular extrasystoles
- Atrial fibrilation
- Ventricular tachycardia
- Sinus bradycardia
- Atrial tachycardia



Screening for unstable BCT patient *

* **Systolic arterial pressure < 90 mmHg**
Oxygene saturation < 90 %

- Significant BCT is defined if the patient present
  - **Cardiogenic shock**
  - **Arrhythmias requiring treatment**
  - **Post-traumatic structural defects**
  - **Unexplained hypotension**
- Investigation of shock (hemorrhagic or cardiogenic) by FAST and chest- pelvic X-ray
  - Chest X-ray-HTX/PTX
  - FAST-abdominal hemorrhage, PTX, pericardial effusion
  - Pelvic X-ray- pelvic fracture could be source of major bleed
  - Orthopedic injury
  - External bleed
  - Sources of hemorrhage are more common and than BCI.



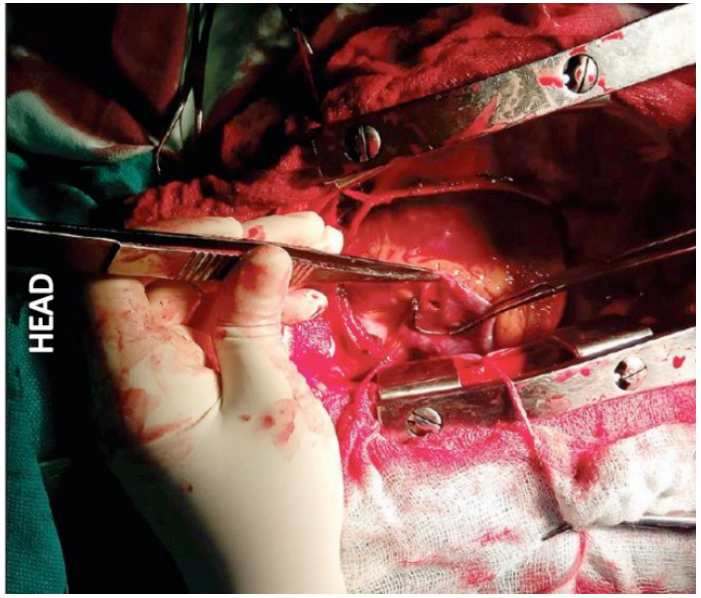
Algorithm for unstable BCT patient

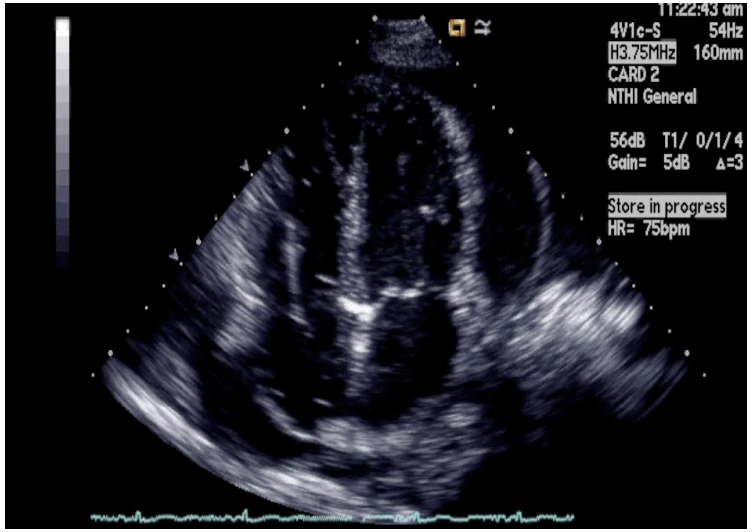
Emergency intervention on unstable BCT patient

- Distended neck veins
- Pericardial epanchement- tamponade on FAST- echo
- Pulseless electrical activity (electro-mechanical dissosiation)
- Cardiac arrest

EMERGENCY THORACOTOMY

- Sub-xyphoid drainage
- Left antero-lateral thoractomy
- Clamshell incision
- Median sternotomy



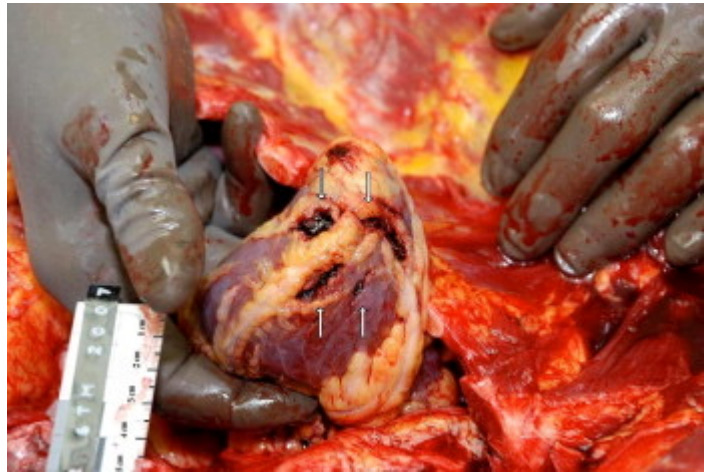


Blunt Cardiac Rupture (BCR)

BCR is a life threatening injury. **Majority of patients do not reach the hospital and in those who reach the emergency department, timely diagnosis and treatment is a challenge.** The case is about a patient with multiple **blunt** injuries who presented in shock.

Mechanisms of Blunt Cardiac Rupture

- Direct precordial impact
- Hydraulic effect significant blunt force to **abdomen** and **lower extremities** reflected through the venous system up into the right side of the heart
- Compression between sternum and vertebral column
- Acceleration or deceleration forces
- Blast effect
- Sternal or rib penetration



Pericardium is not perforated; the LV sustained numerous lacerations from the blast forces upon discharge of the weapon, resulting in a hemopericardium.

Blunt Cardiac Rupture (BCR)

ORIGINAL ARTICLE

Blunt Cardiac Rupture: A 5-Year NTDB Analysis

Pedro G. R. Teixeira, MD, Kenji Inaba, MD, Didem Oncel, MD, Joseph DuBose, MD, Linda Chan, PhD, Peter Rhee, MD, MPH, Ali Salim, MD, Timothy Browder, MD, Carlos Brown, MD, and Demetrios Demetriades, MD

TABLE 2. Continuous Variables of Risk Factors for Hospital Mortality in Patients Surviving to Hospital

Characteristic	Total	Survived	Died	*P*
Age	45 ± 20	39 ± 18	46 ± 20	0.04
GCS	7.1 ± 5.2	10.5 ± 5.3	6.1 ± 4.7	<0.0001
ISS	54 ± 20	47 ± 23	56 ± 19	0.02

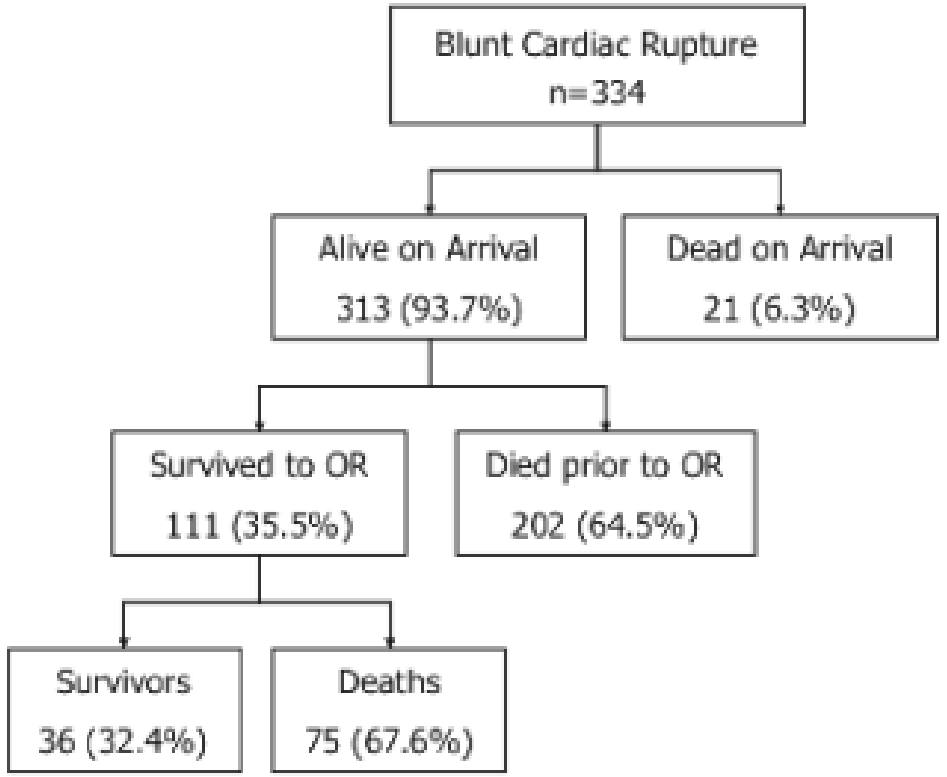


Figure 1. Blunt cardiac injury: outcome stratified by location.

J Trauma. 2009; 67: 788-91.

Overall survival 11.5% if vital signs present

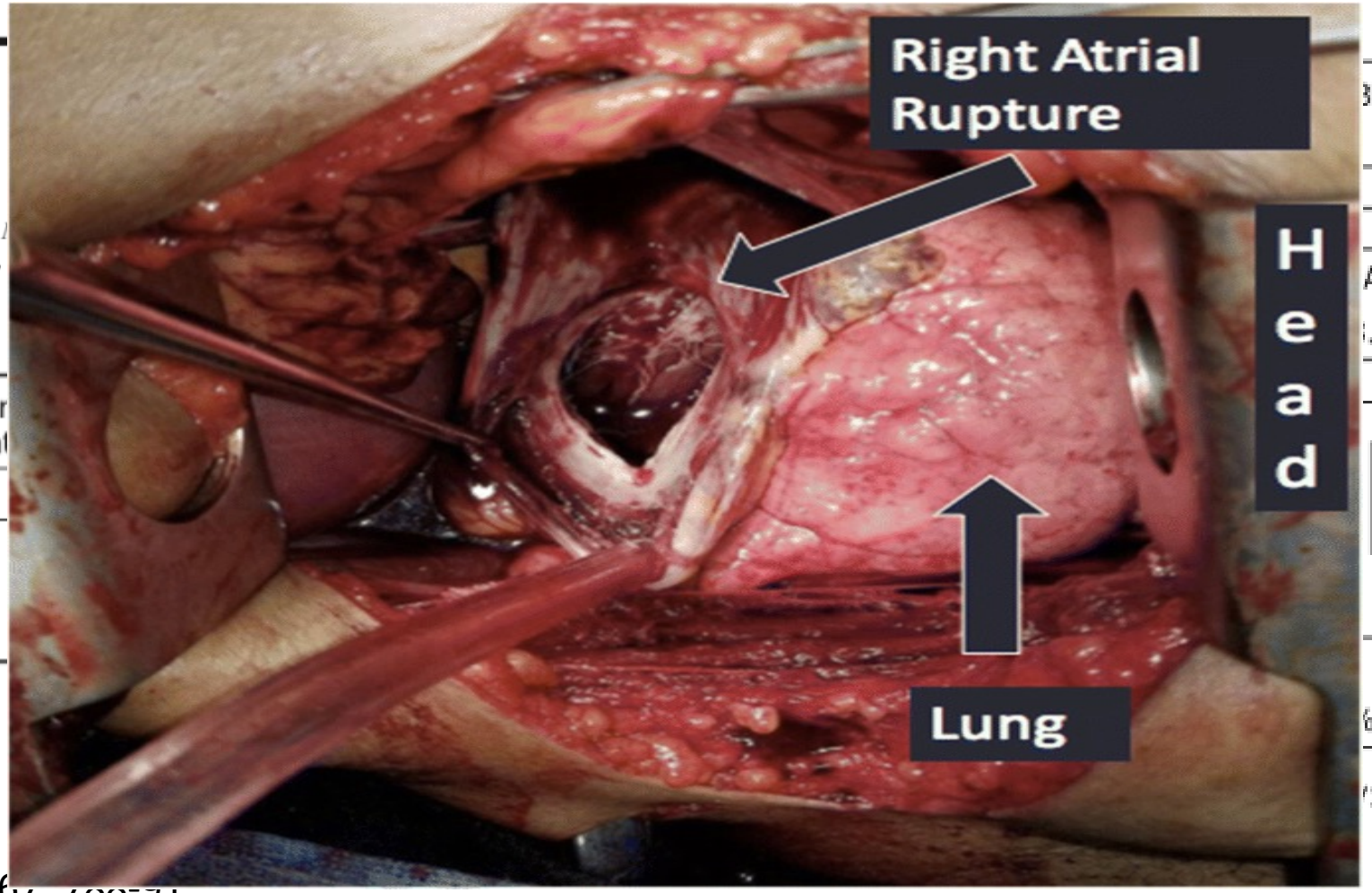
Blunt Cardiac Rupture (BCR)

Blunt

Pedro G. R. Teixeira,
Peter Rhee,

TABLE 2. Cor
Mortality in Pat

Characteristic
Age
GCS
ISS



Blunt Cardiac Rupture
n=334

Arrival
.7%)

Dead on Arrival
21 (6.3%)

Died prior to OR
202 (64.5%)

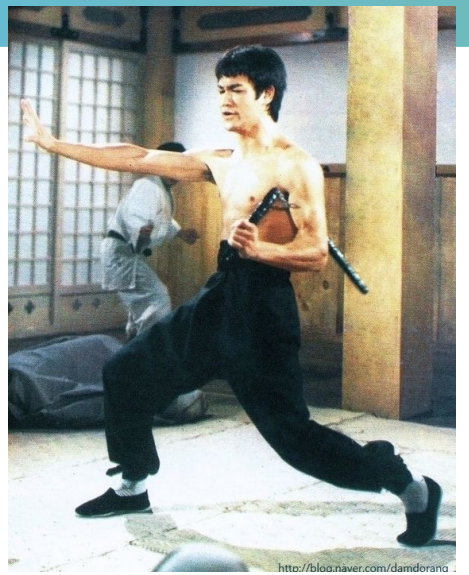
6)

: outcome stratified by location.

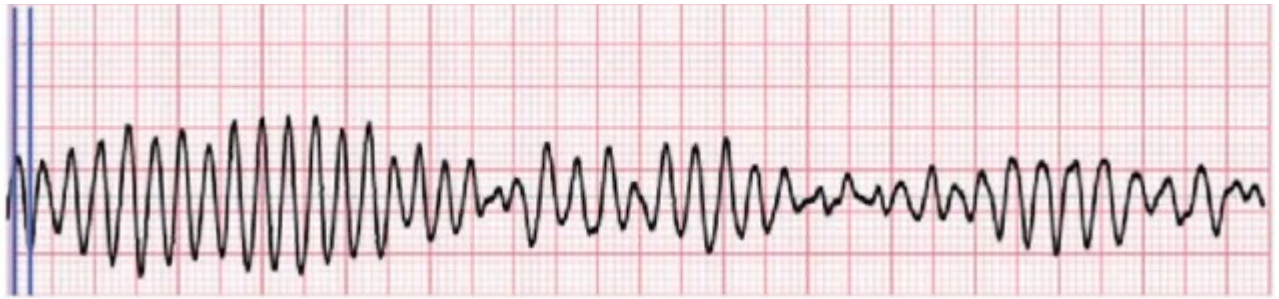
J Trauma. 2009; 67: 788-91.

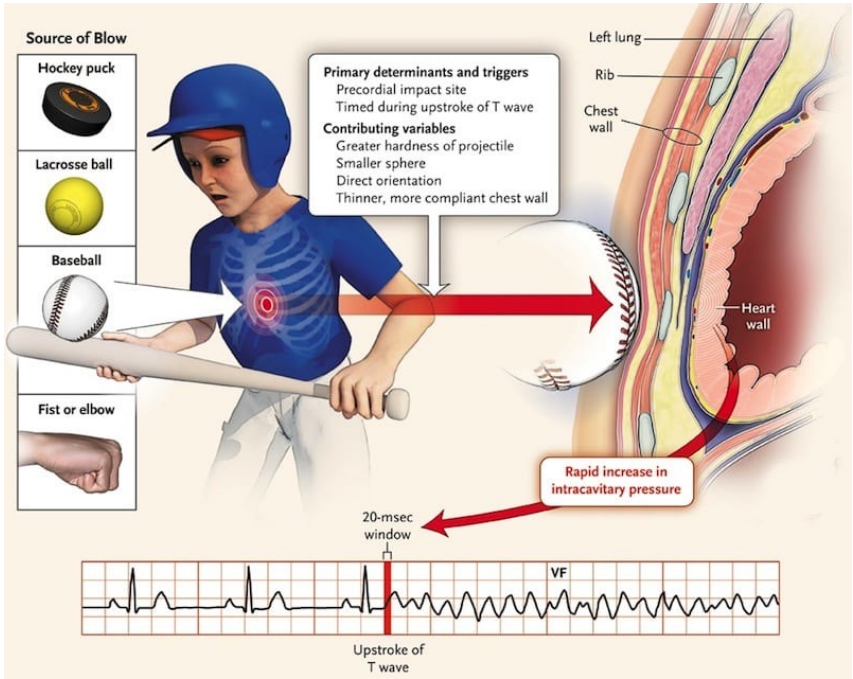
Overall survival 11.5% if vital signs present

Comotio Cordis



- Sudden direct blow to the chest in young athlete resulting in V-fib
- Occurs with impact directly over left ventricle
- Vulnerable period on the up-stroke of the T-wave
- Primarily an electrical conduction phenomenon not ischemic event
- 10 to 20 cases reported annually
- Mortality has declined from 90% in the 1970's to 40% currently
- Typically occurs in white males 10- 18 years old





Penetrating Cardiac Trauma (PCT)

◂ Messages

tdg.ch — Private

Agressions au quai Wilson: la police cherche des témoins

Samedi dernier à 1 heure du matin, trois personnes ont été blessées au couteau à la fête foraine. Les forces de l'ordre recherchent des gens possédant des images des faits.

Aurélie Toninato
Mis à jour: 29.07.2021, 15h45

Plusieurs agressions à l'arme blanche ont eu lieu samedi 24 juillet à 1 heure du matin au quai Wilson, là où se déroule en ce moment la fête foraine, révèle 20minutes.ch ↗. Celui-ci indique qu'elles sont le fait d'un seul homme, «alors que de nombreux témoins étaient présents. Les trois victimes, toutes des hommes, ont été attaquées sur une centaine de mètres. Elles ont subi d'importantes blessures mais sont en vie.» Toujours selon le média gratuit, l'un des assauts aurait eu lieu «dans un cadre que l'on pourrait qualifier d'altercation». Samedi, aucune interpellation n'avait encore eu lieu.

140

- 24 years old male patient
- Stab wound on the left hemithorax
- Patient is concious, hemodynamically stable
- **How you will manage this patient ?**

Penetrating Cardiac Trauma (PCT)

◂ Messages

tdg.ch — Private

Agressions au quai Wilson: la police cherche des témoins

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140

- 24 years old male patient

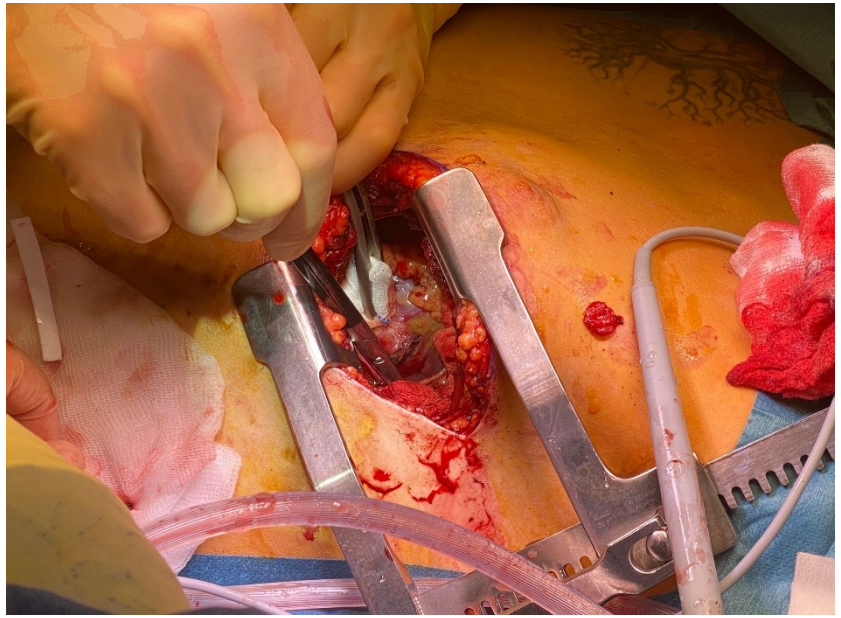
- FAST- left pleural effusion
- FOCUS- Synthèse ETT limitée à quelques coupes, en urgence, chez patient en décubitus dorsal (vue non conventionnelle) ne permettant que les conclusions suivantes. Présence de liquide évoquant un épanchement pleural gauche et sur certaines coupes d'un épanchement péricardique discret.

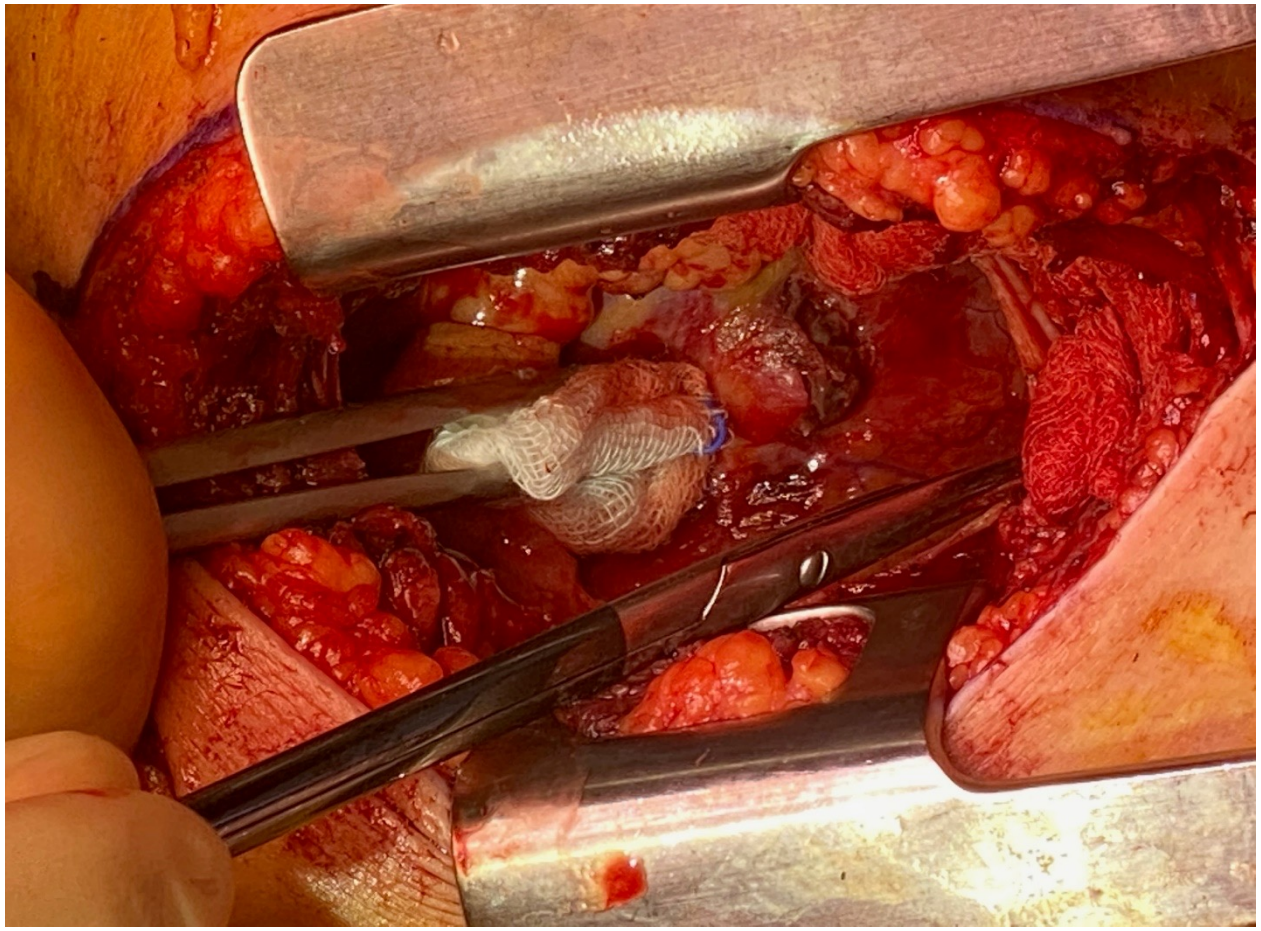
Penetrating Cardiac Trauma (PCT)

- 24 years old male patient

INTERVENTION CHIRURGICALE

- Thoracotomie antérieure gauche exploratrice pour drainage péricardique et thoracique et exploration cardiaque.
- Réparation des lésions myocardiques par des points séparés en U au Prolène 4-0 supportés par des bandelettes de Téflon
- Hémostase de saignement active d'une petite artère intercostale





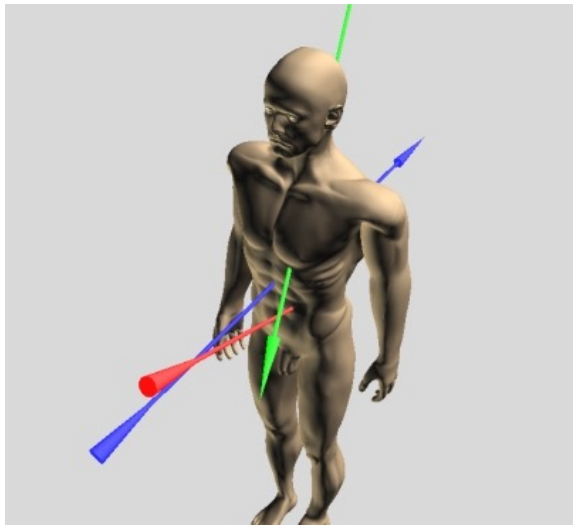
Penetrating Cardiac Trauma (PCT)

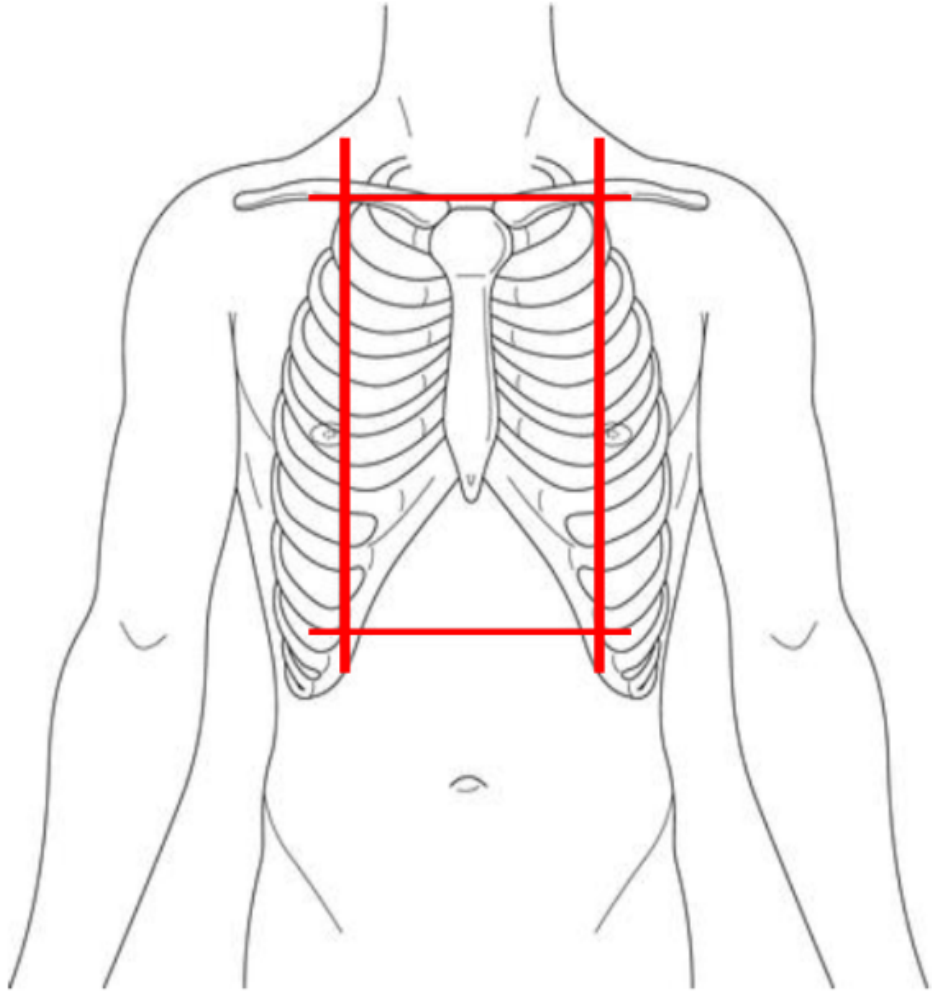
- **Definition:** **PCT** occurs when a foreign object pierces the skin and enter the body creating a wound. In **BCT** the skin is not necessarily broken. In **PCT**, the object remains in the tissue or passes through the tissues and exits the body.
- Certain injury patterns place patients at risk
- May present relatively stable or in extremis
- Physiologic status determines type of evaluation or intervention
  - FAST exam
  - Chest CT
  - Emergency Department Thoracotomy (EDT)
- EDT most aggressive approach and appropriately trained individual may open the chest in the ED

Penetrating Cardiac Trauma (PCT)

- Penetrating trauma to the heart most frequently occur with trauma to the anterior chest, **but should also be suspected with wounds to the upper abdomen, lateral chest, back, and neck.**

- Of the patients that do present to the hospital, the majority of the injuries are to the low pressure, anteriorly located right side of the heart.
  - right ventricle 43%
  - left ventricle 33%
  - right atrium 14%
  - left atrium 6%
  - coronary arteries 4%



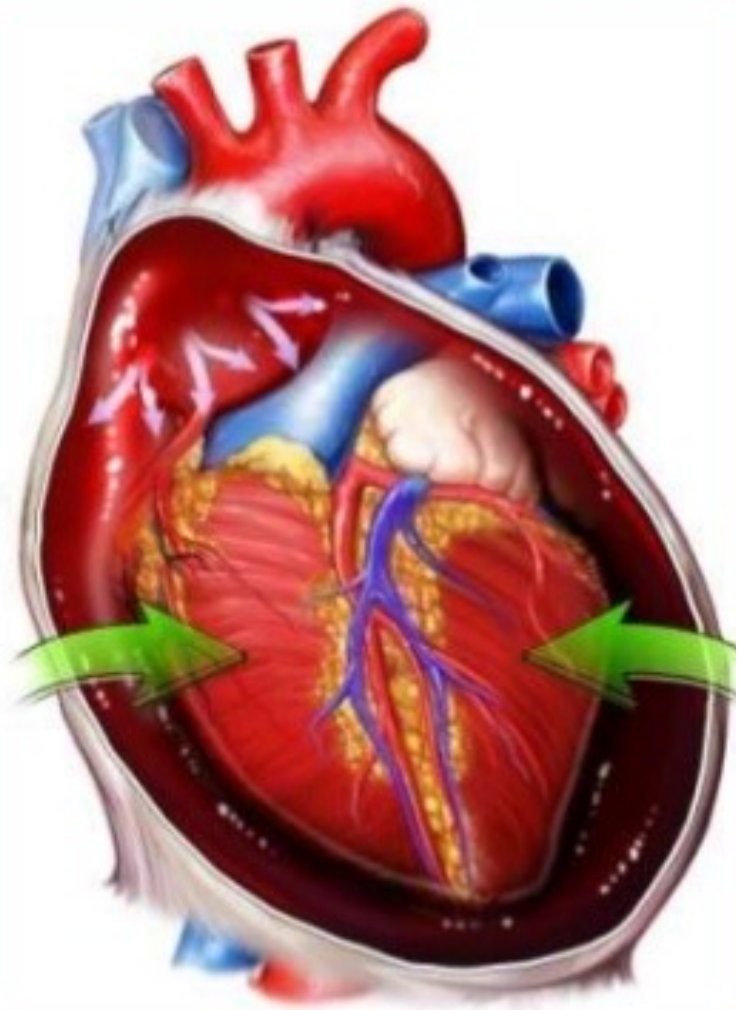


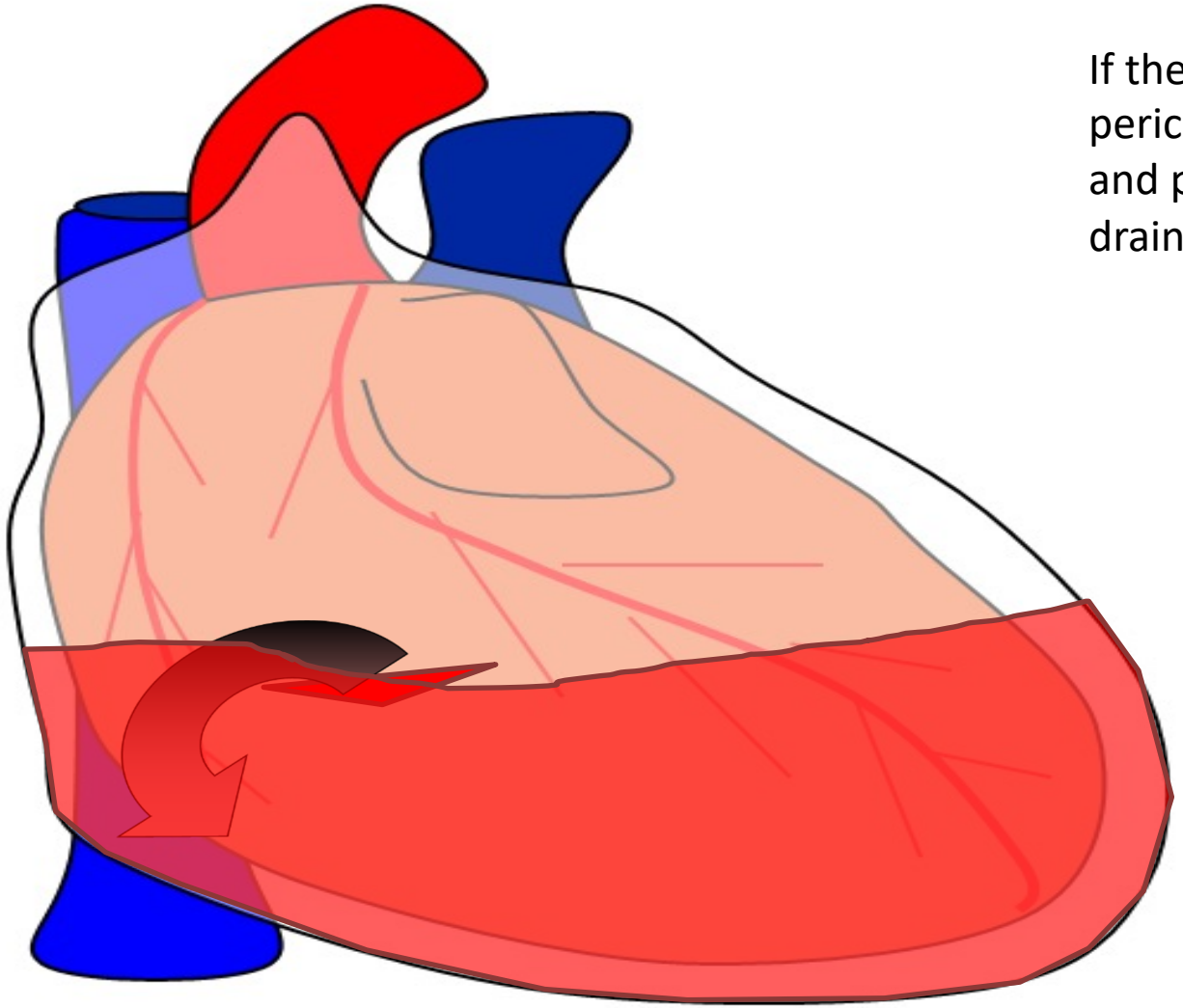
“Cardiac Box”

Trauma to this anatomic area of the anterior chest should raise suspicion for a cardiac injury. Box is bordered by the clavicles, the costal margin inferiorly, and the midclavicular line laterally

Penetrating Cardiac Trauma (PCT)

- Survival following penetrating trauma is often dependent on the state of the pericardial wound.
  - If the blood is retained in the pericardial space, cardiac tamponade and physiology will ensue if not drained immediately.
  - If the pericardial wound is open and blood is able to flow freely into the pleural space, the patient can often be supported with fluid resuscitation and chest tube thoracostomy.
  - Persistent drainage from the thoracostomy tube should warn of possible cardiac injury and surgical exploration is indicated.





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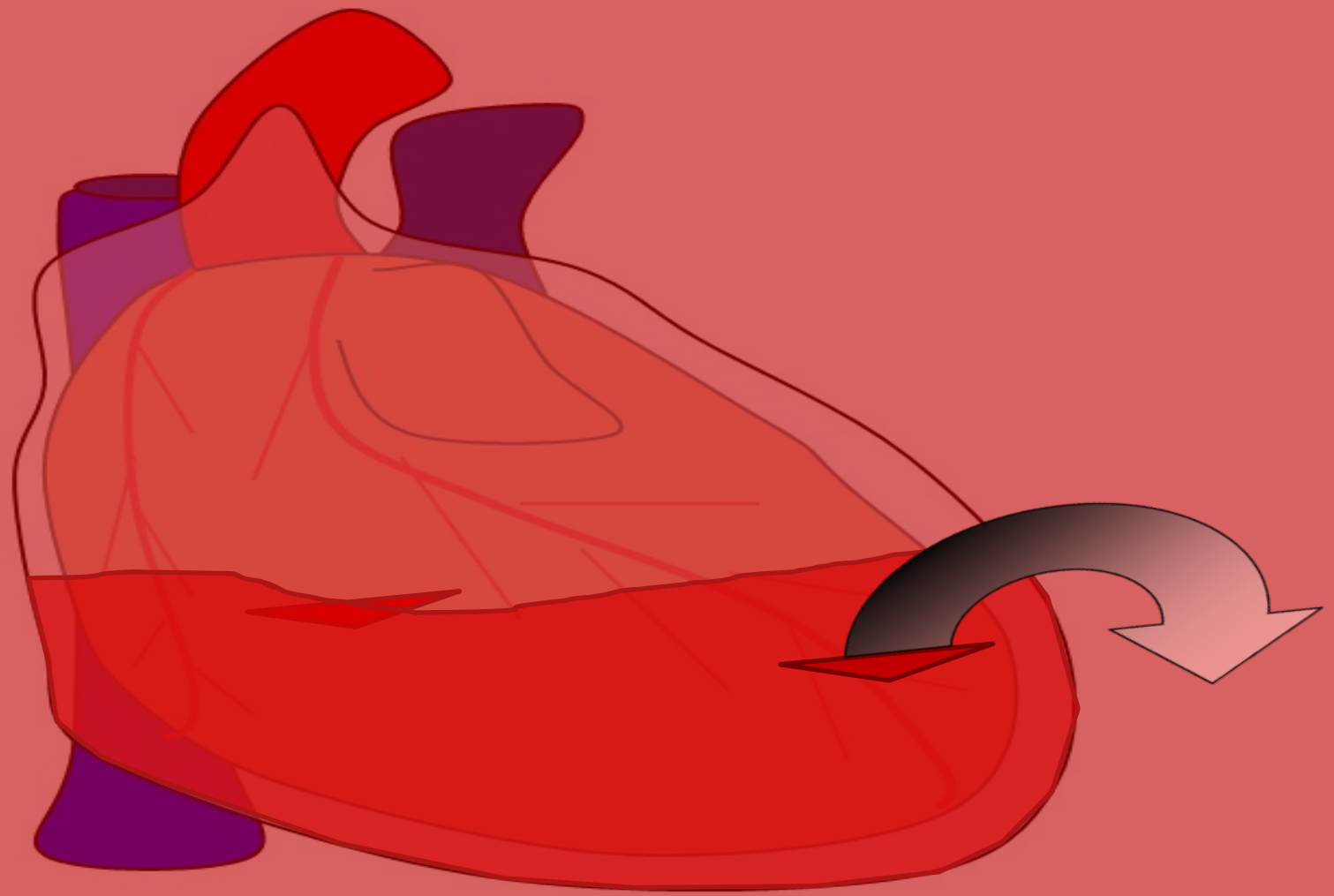

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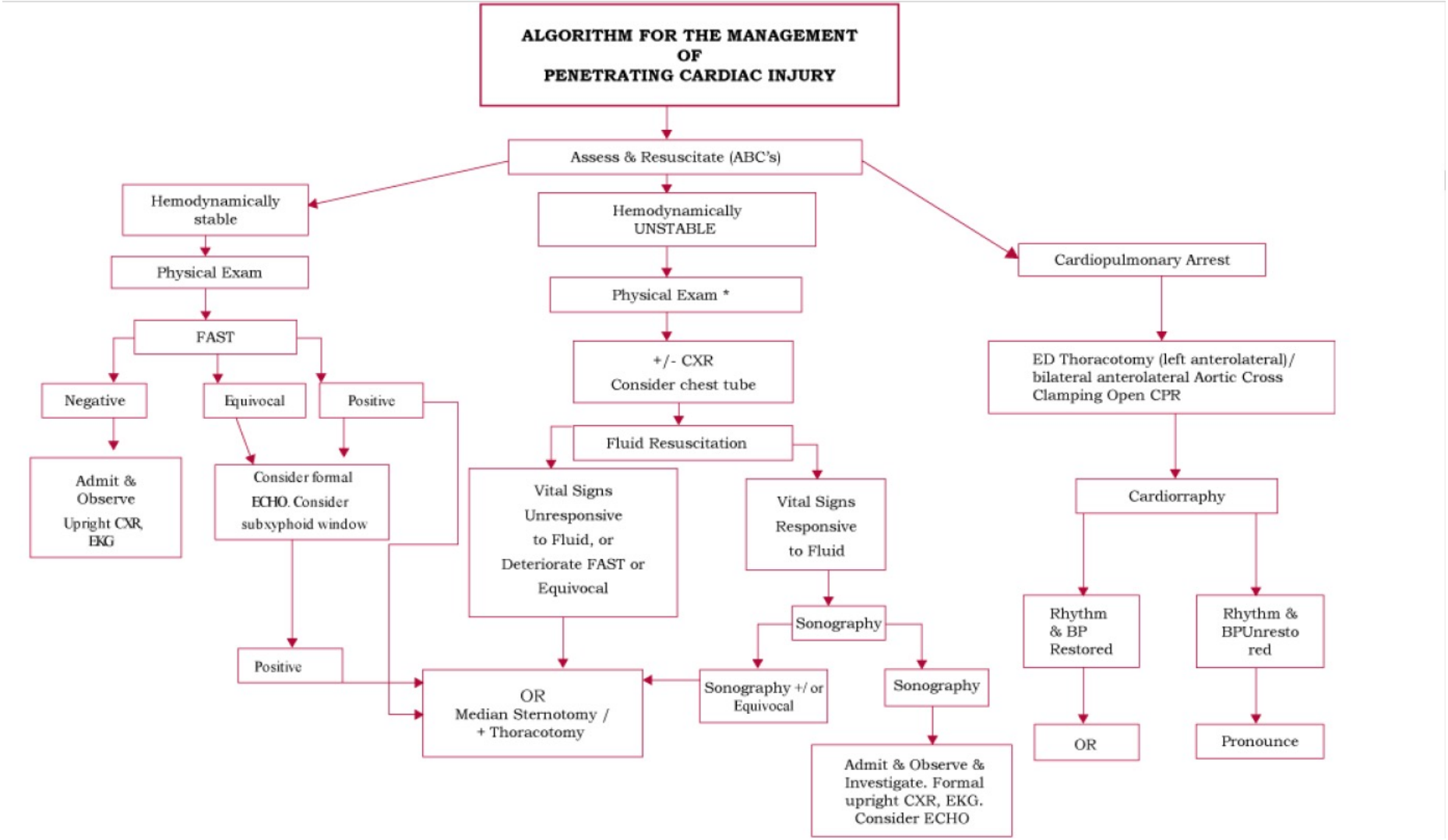
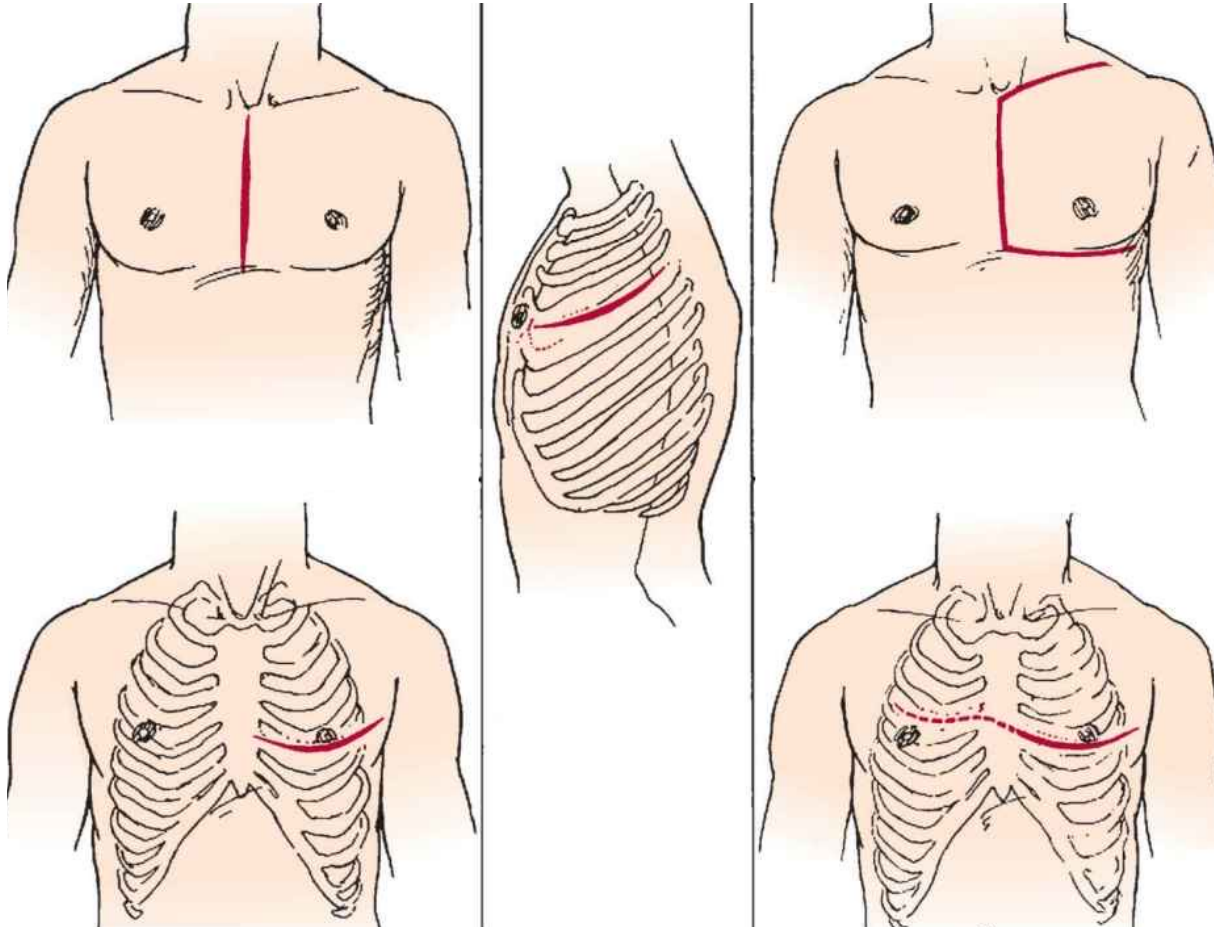
Penetrating Cardiac Trauma (PCT)

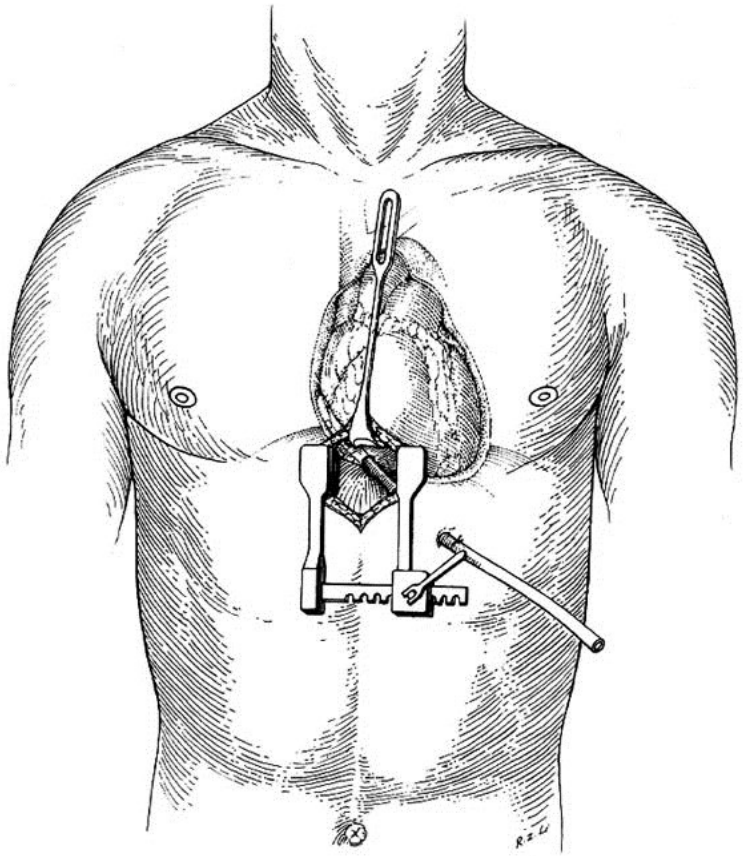


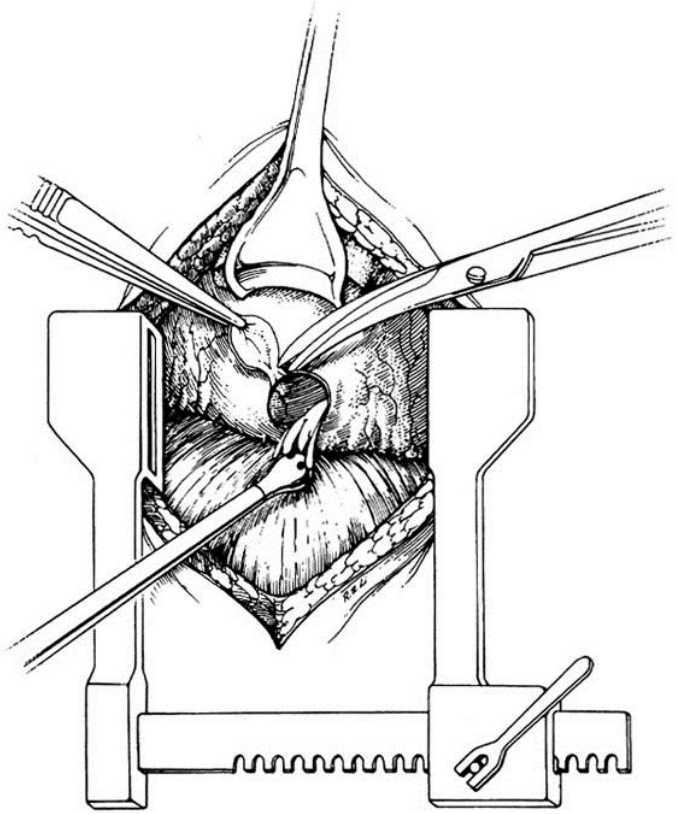
Penetrating Cardiac Trauma (PCT)

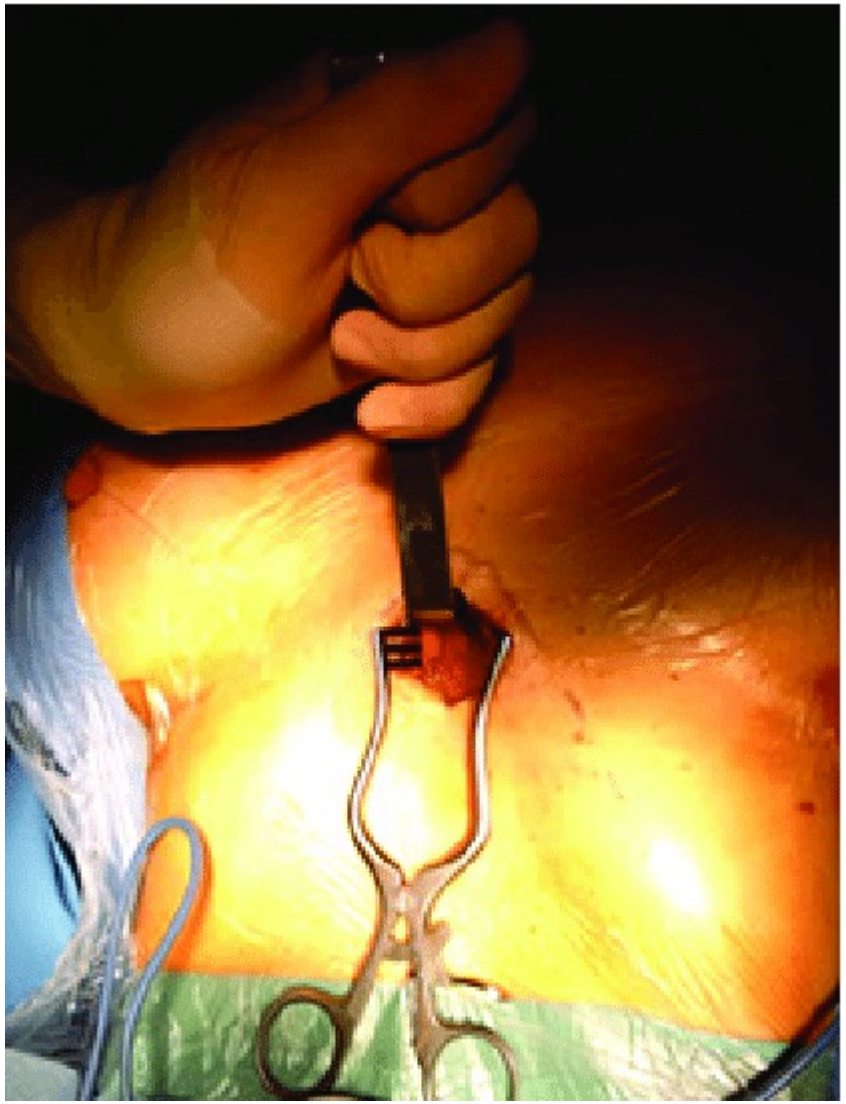
- **Surgical access:**
  - Left antero-lateral thoracotomy
  - Clamshell thoracotomy
  - Median sternotomy
  - Left posterolateral thoracotomy
  - Right antero-lateral thoracotomy
  - Trap-door incisions
  - Sub-xyphoid pericardial drainage



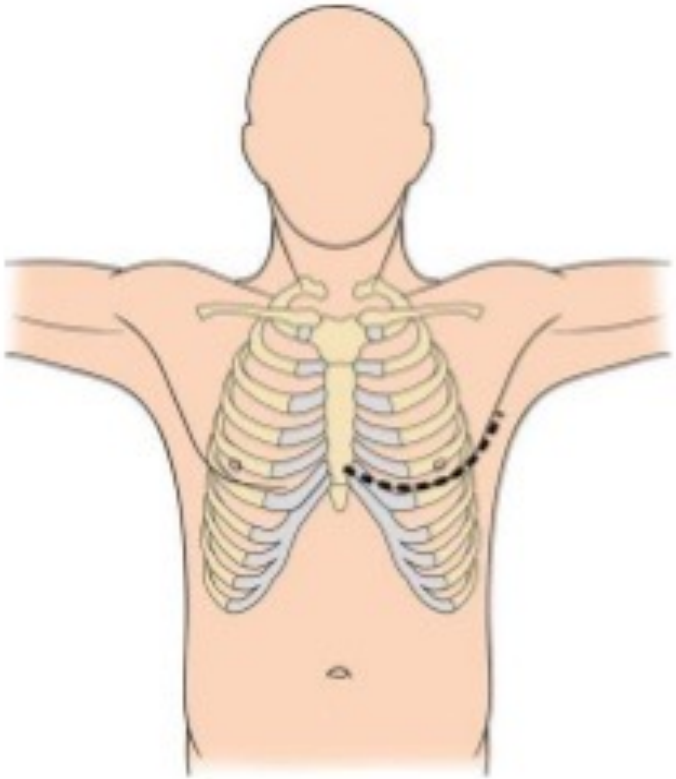
Sub-xyphoid pericardial drainage





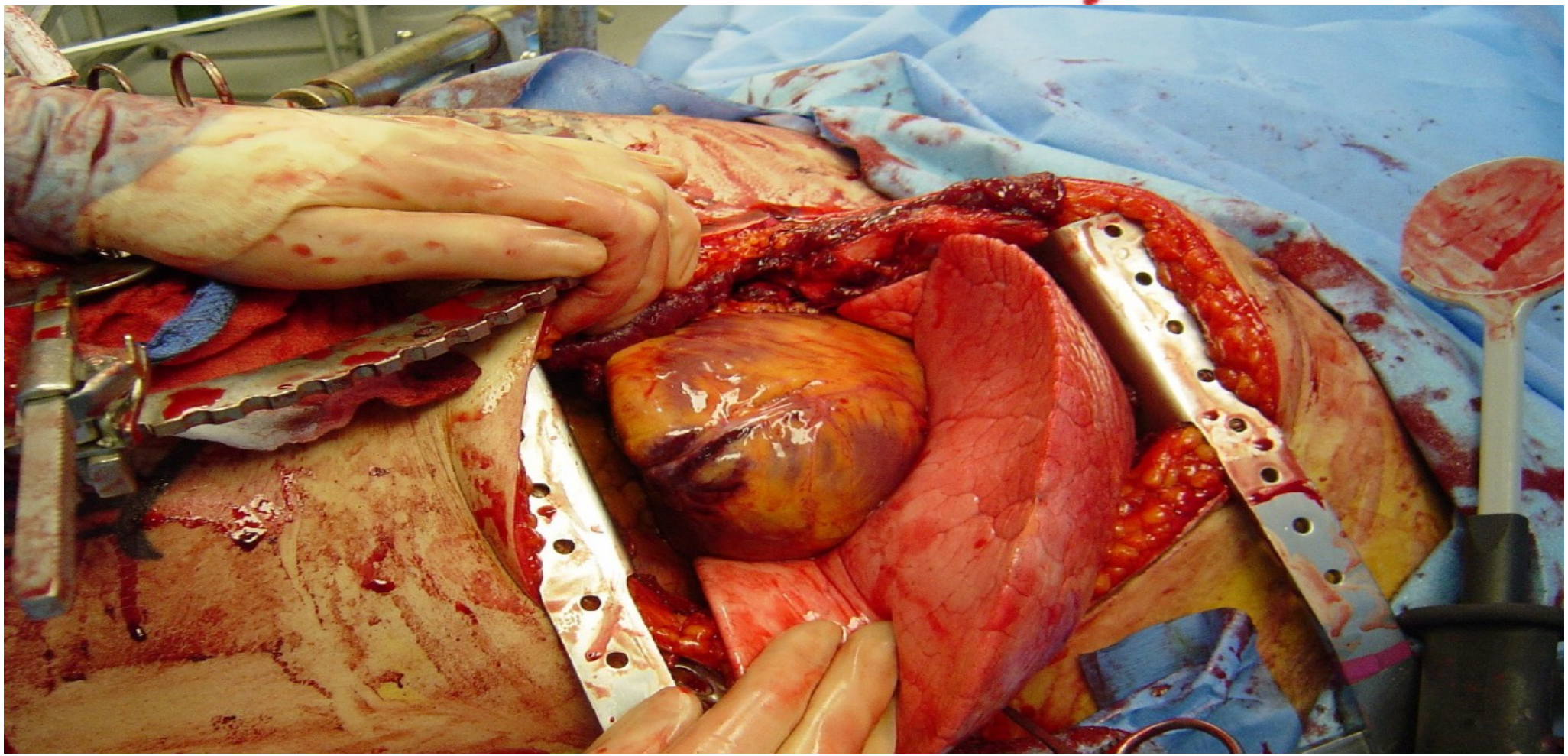


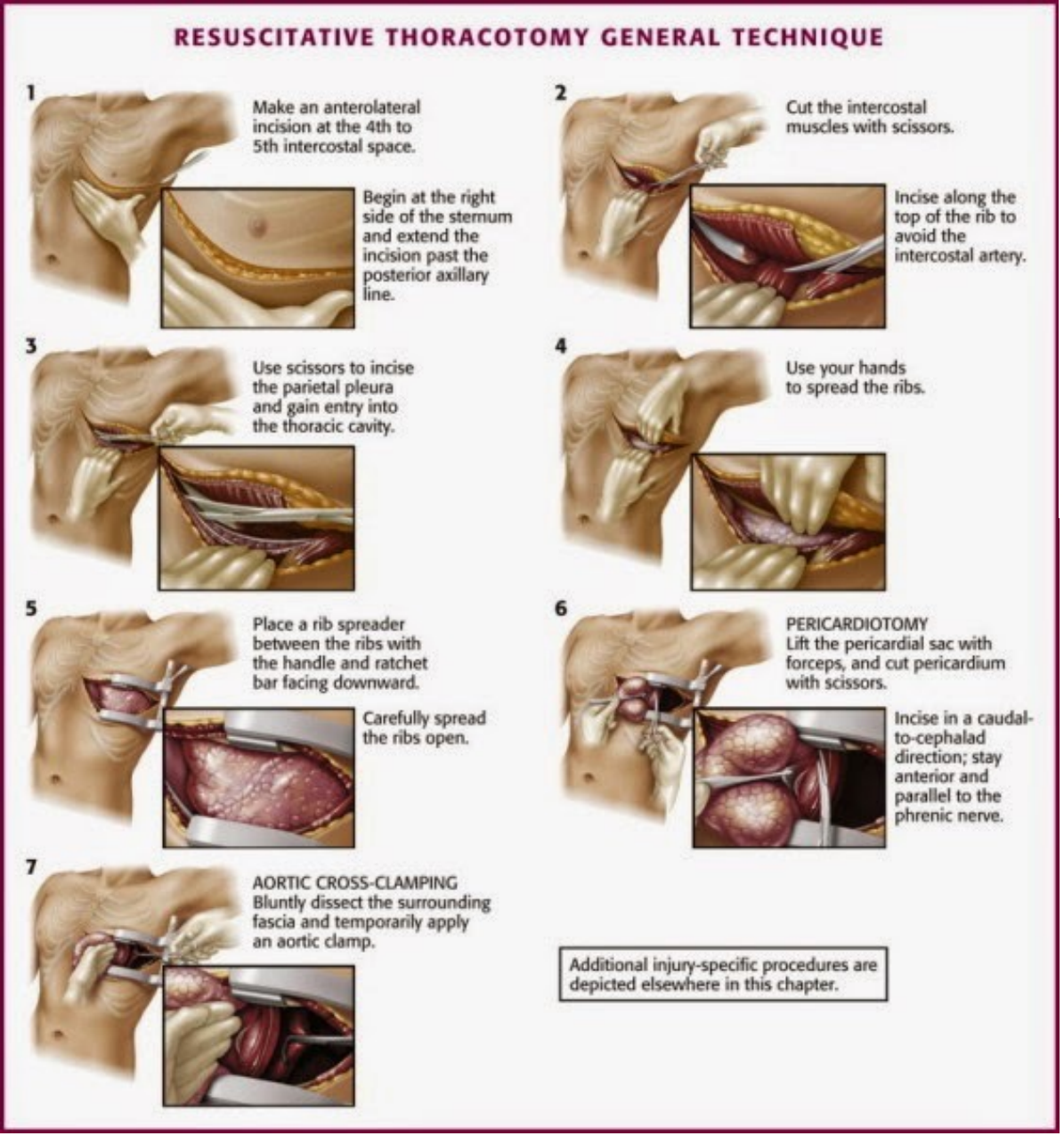
Left Anterolateral thoracotomy

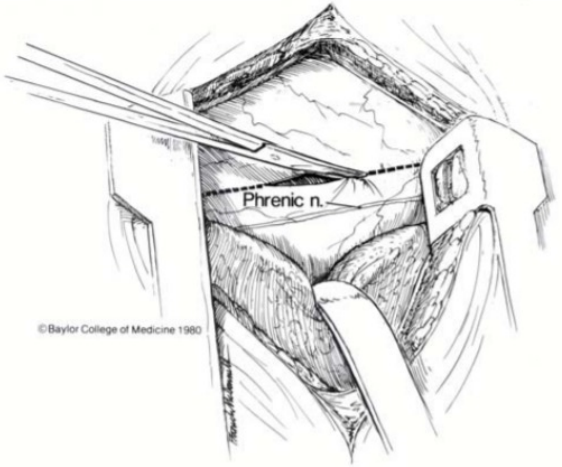


- **Utility emergency thoracotomy- for unstable patient**
- It is made from the sternal edge, under the mammary fold, and in a curvilinear fashion toward the axilla, staying in close proximity to the fourth or fifth intercostal space.
- This incision should not be a straight line incision nor be carried through the female breast
- Provides exposure – Heart, Aorta and Left Lung with hilum and any time can be extended to other side.

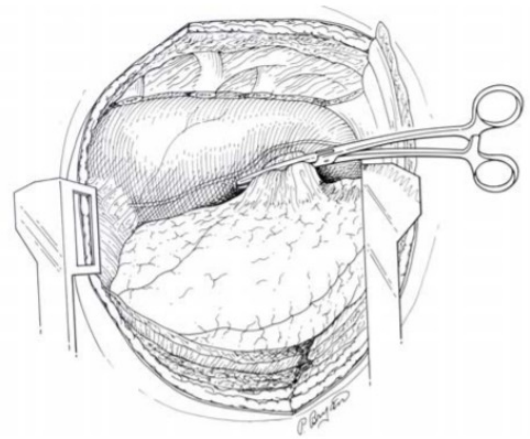
Left Anterolateral thoracotomy



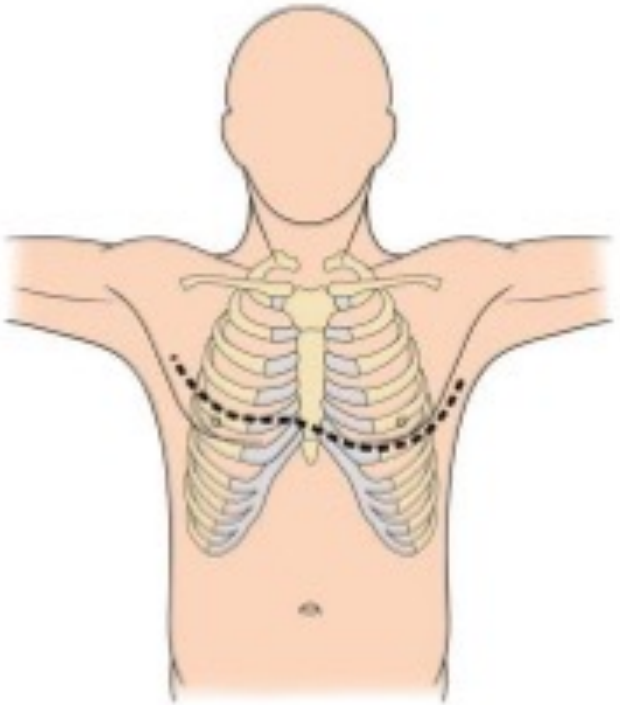




Pericardiotomy above left phrenic nerve

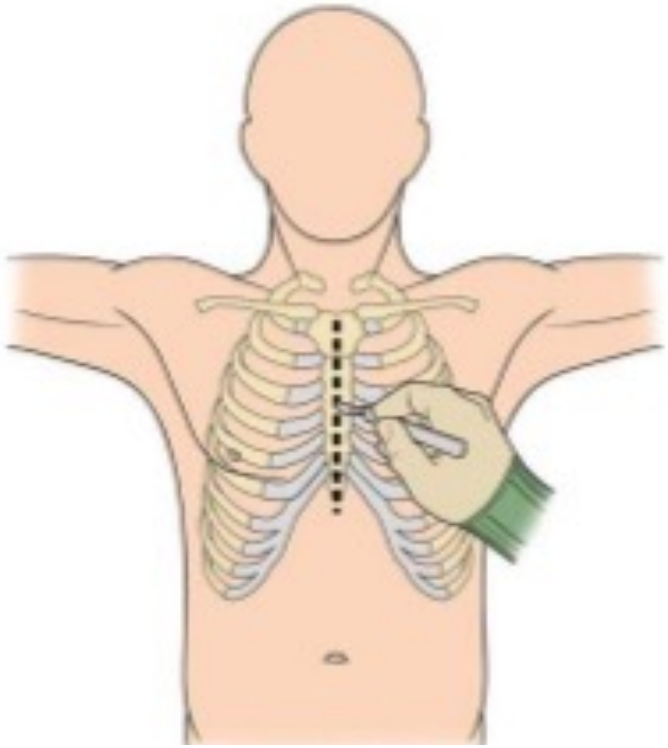


Clamshell thoracotomy

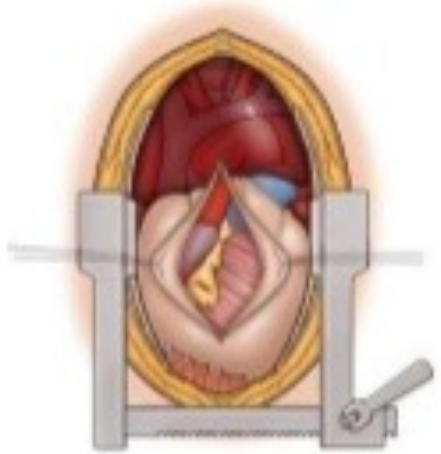


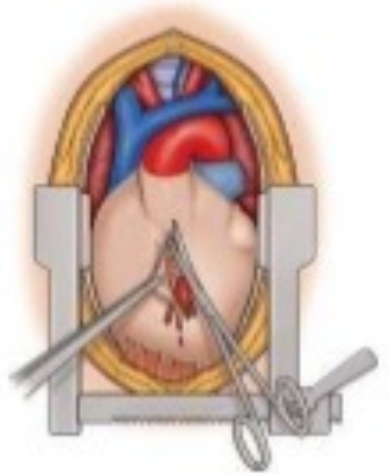
- Most of the time its extended from Left AL thoracotomy
- Provides better exposure to Both side lung with hilum, heart and descending aorta.
- Not good for Superior mediastinum, trachea, other great vessels.
- Avoid to cut breast tissue in female patient.

Median sternotomy



- Its time taking procedure over Anterolateral thoracotomy
- Preferred in superior mediastinum hematoma, precordial stab, to take proximal control for other bleeding vessels
- May be part of neck exploration, thoraco-laparotomy.



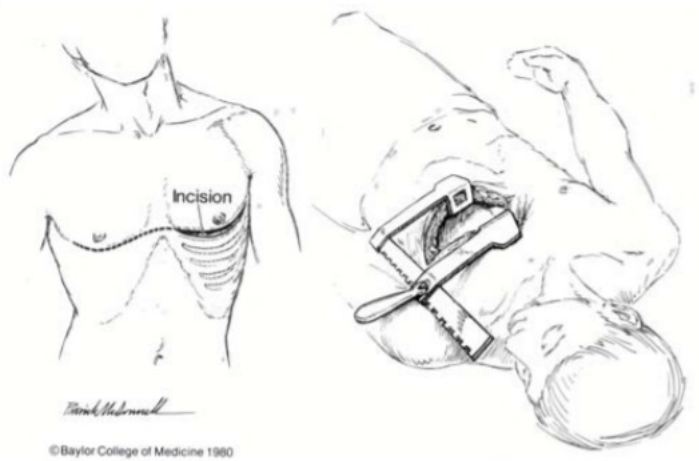


Posterolateral thoracotomy

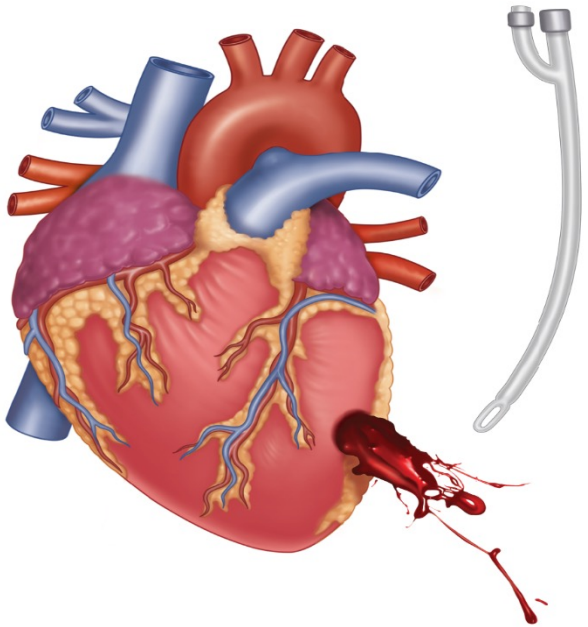
- Provides better exposure to posterior mediastinum
- Most preferred – stable patient for exposure esophagus, trachea, retained hemothorax

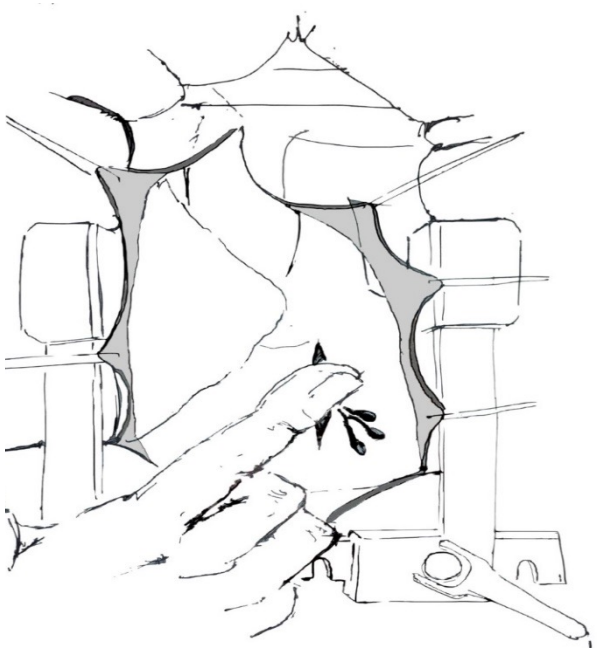
Cardiac Trauma

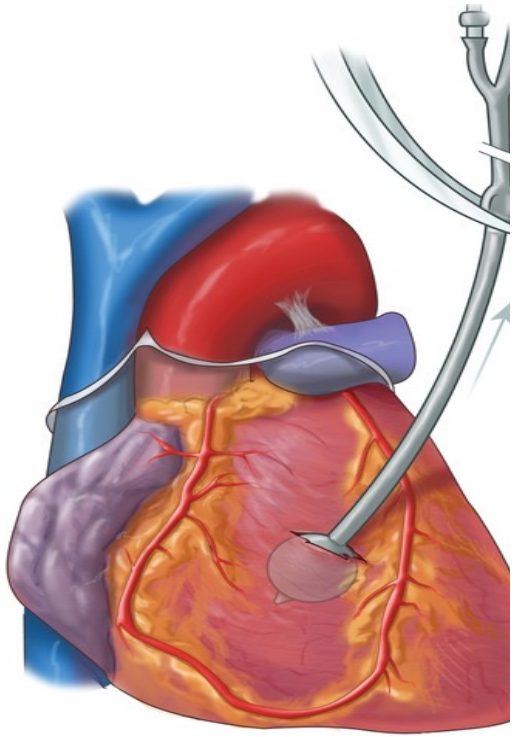
Incision	Left anterolateral	Clamshell	Median sternotomy
	• ED thoracotomy (crashing, bedside thoracotomy)	• EDT (mostly extended from Left ALT)	• Very selected cases
Indication	• All in-Extremis patient. • Cardiac stab/GSW • Cross clamping of aorta • Left lung penetrating injury	• Both lung penetrating injury • Associated cardiac injury	• Cardiac stab-low velocity • Sup mediastinal hematoma.



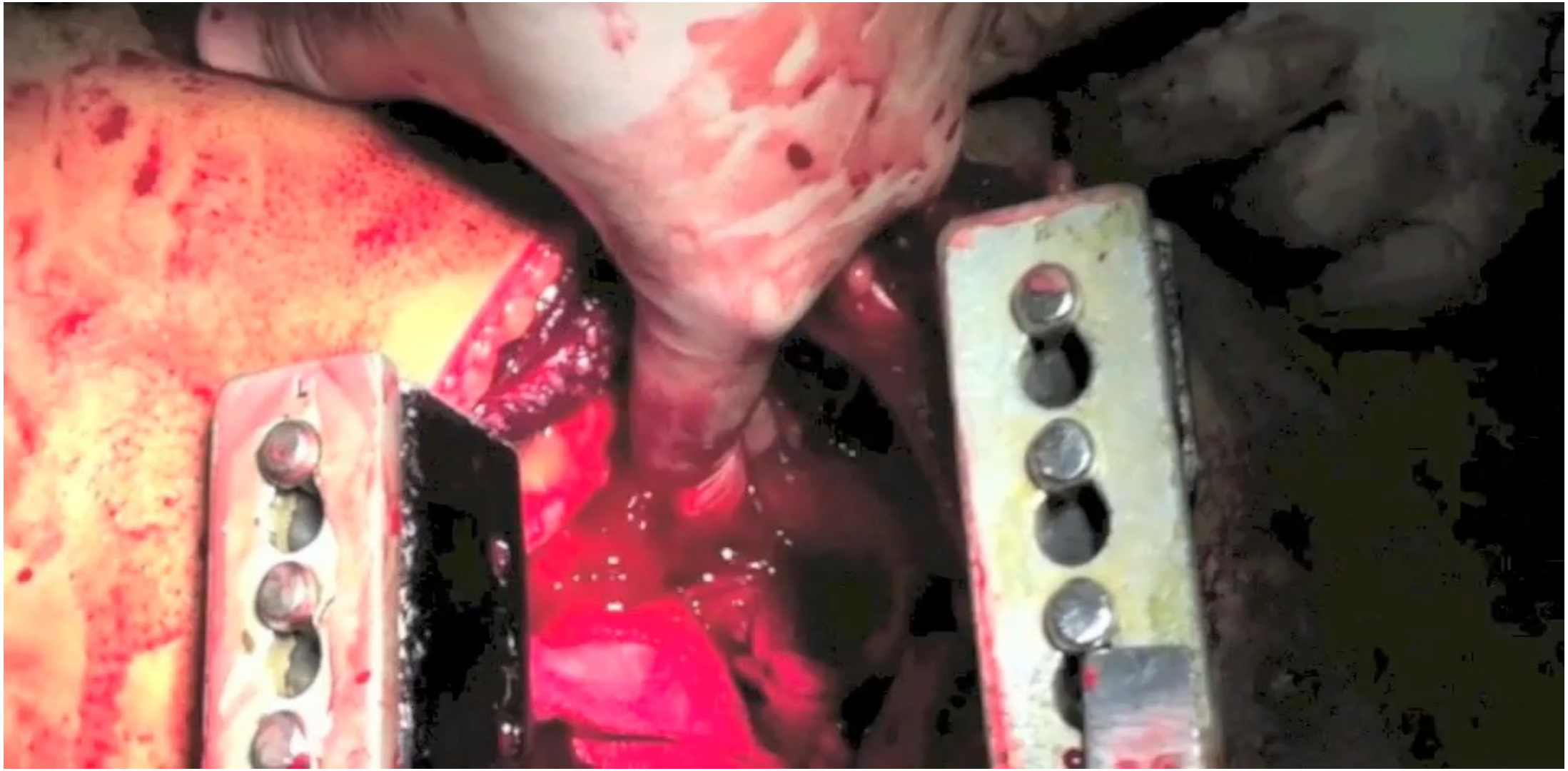
A simple Foley catheter may save the life !



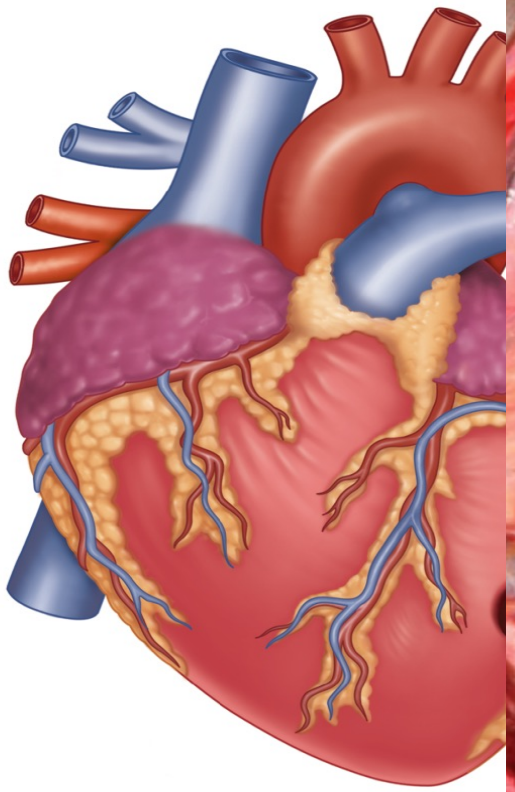


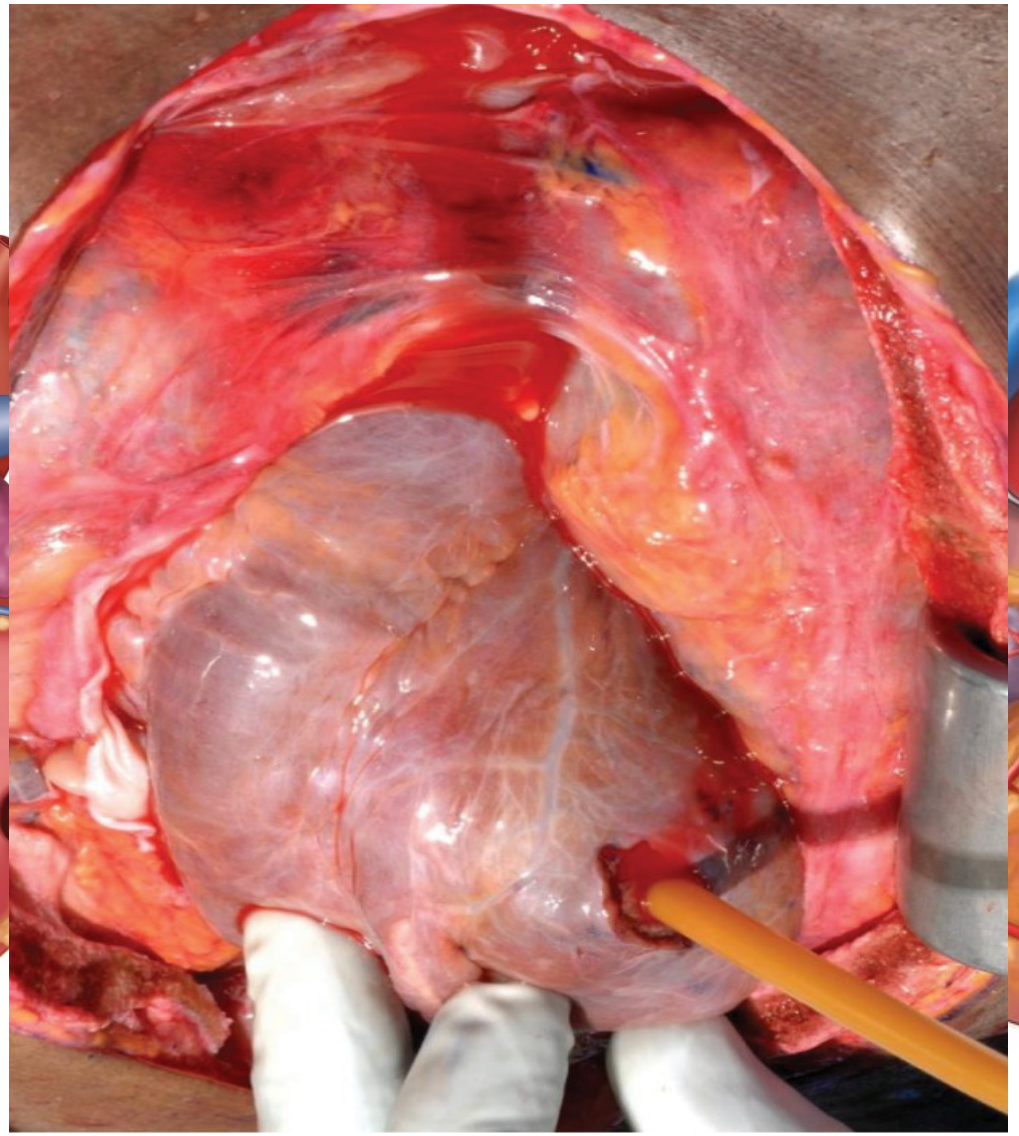


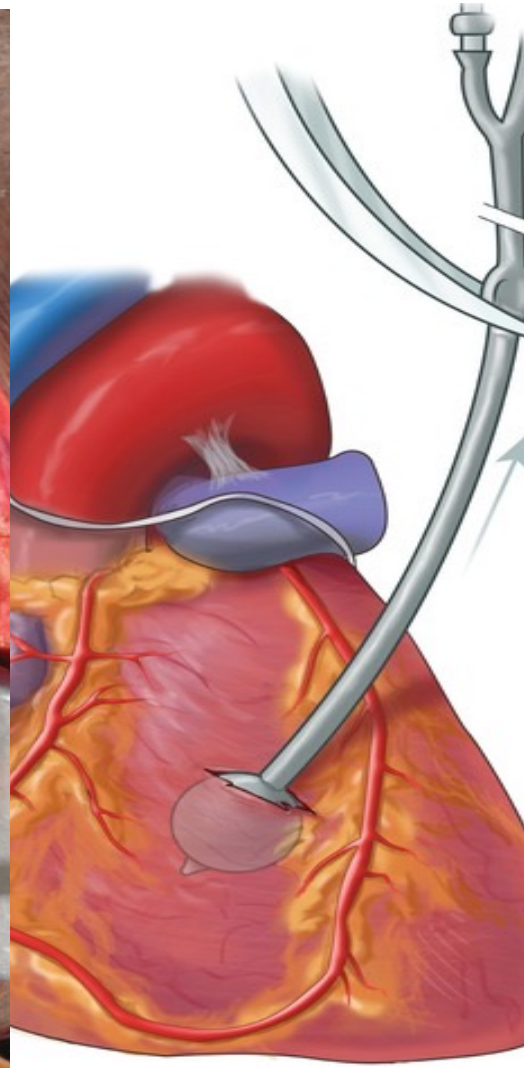
Cardiac Trauma



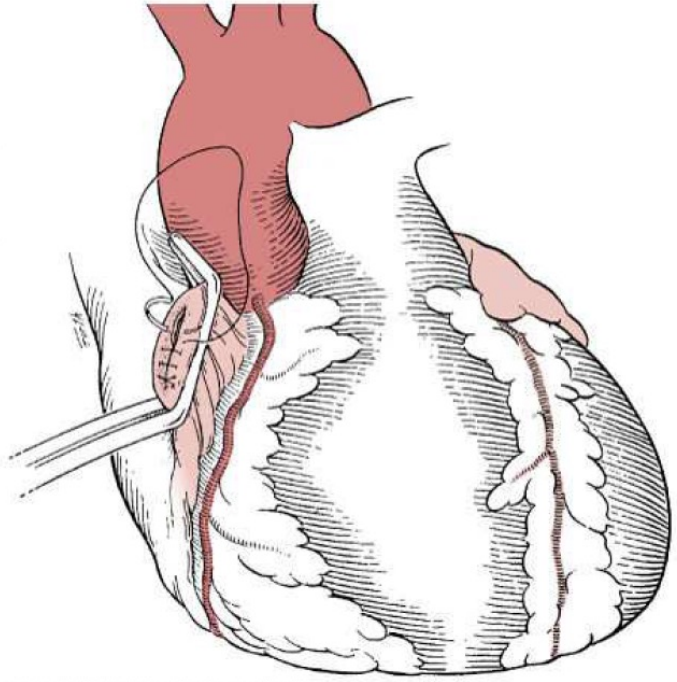
Cardiac Trauma

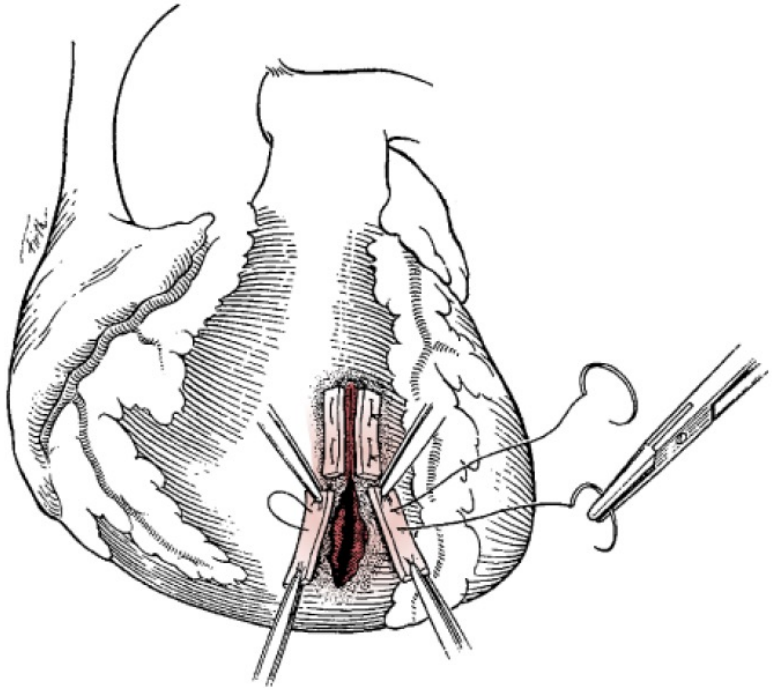


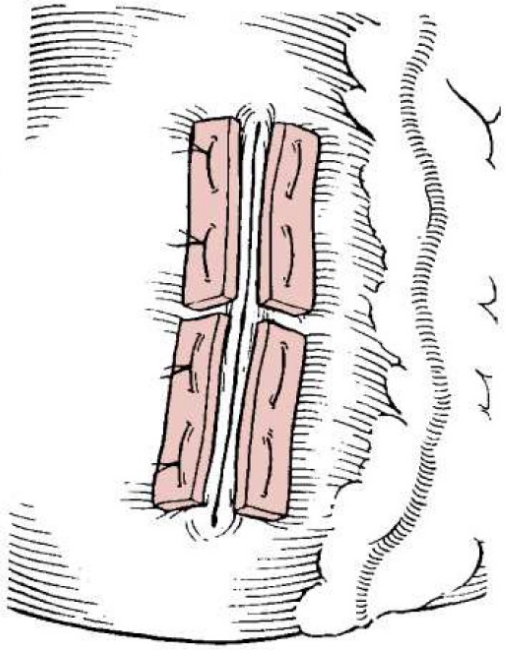




Penetrating Cardiac Trauma (PCT)

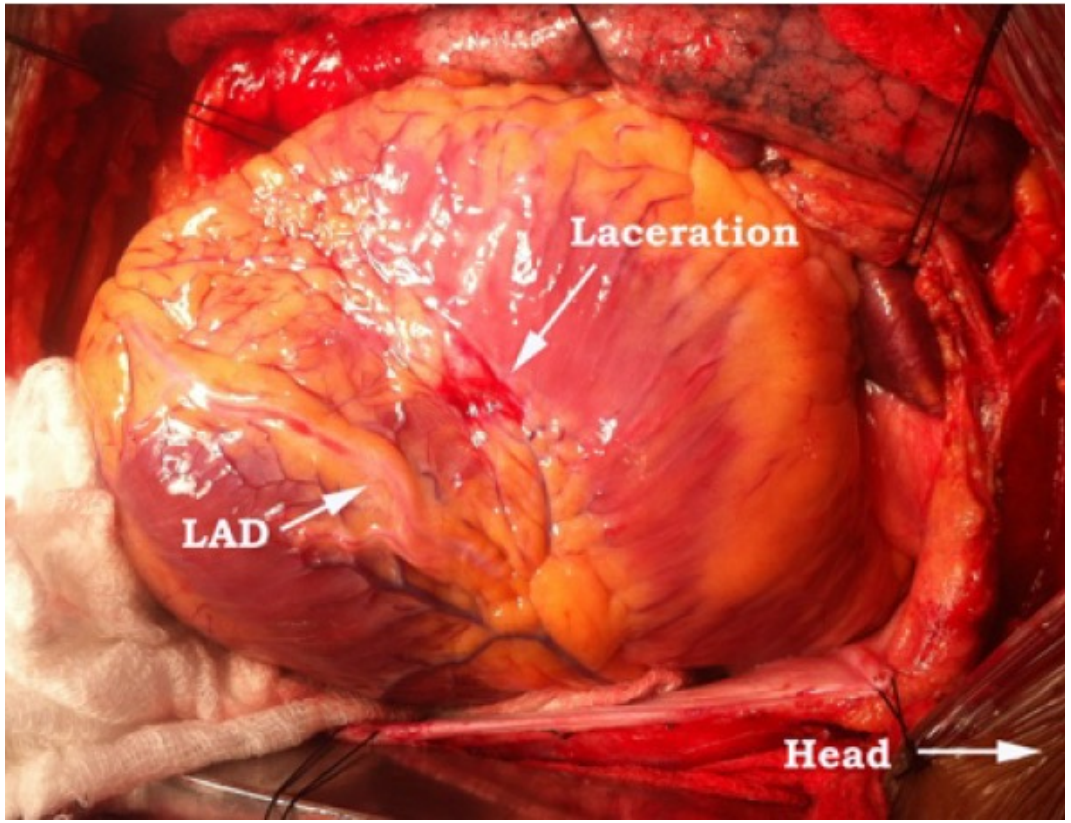


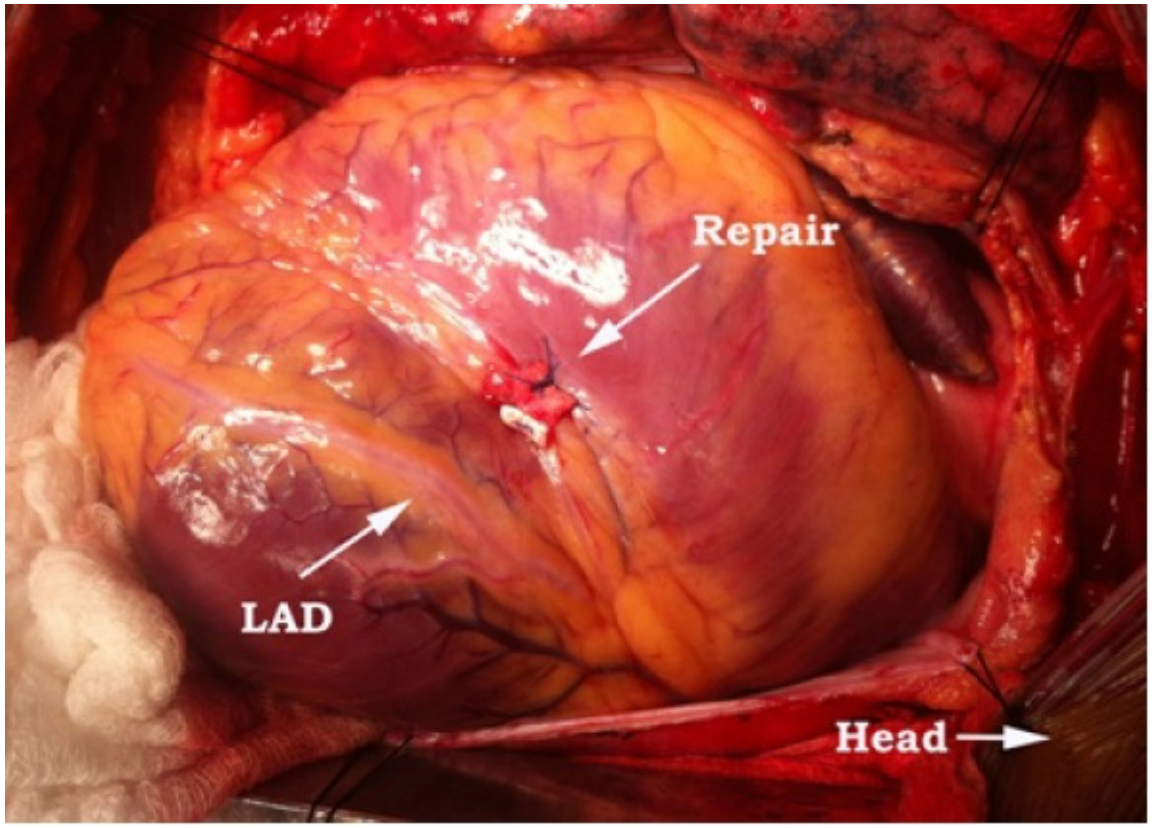




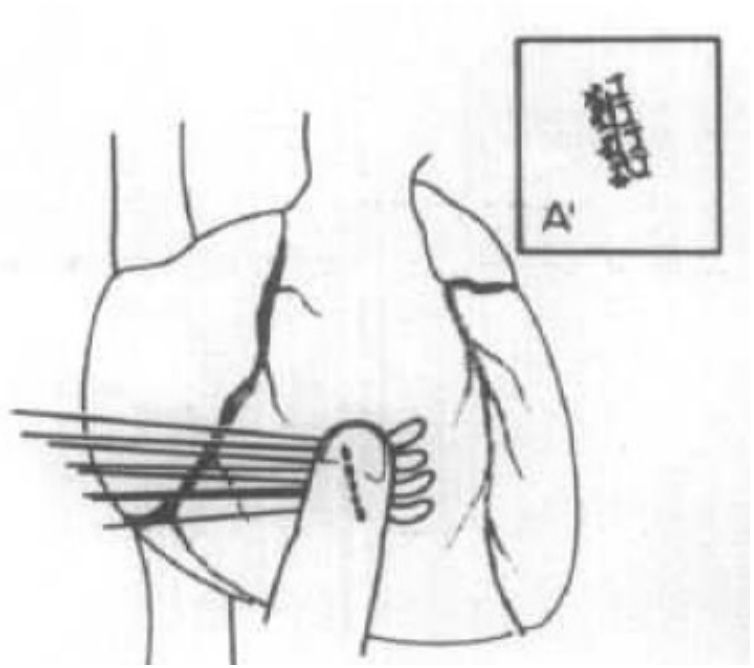
Needle ◉ - 2,3 or 4/0 –Prolène® …

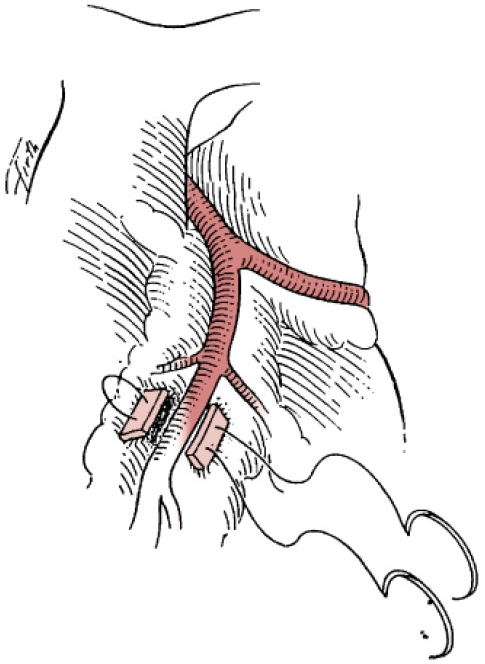
Cardiac Trauma

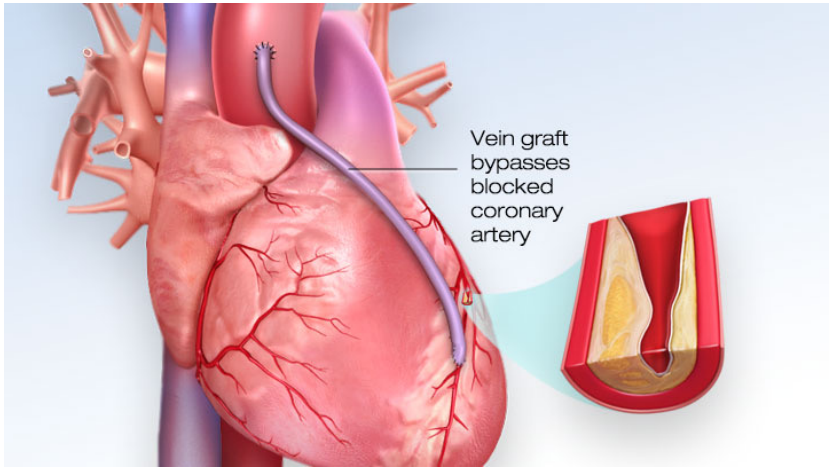




Penetrating Cardiac Trauma (PCT)

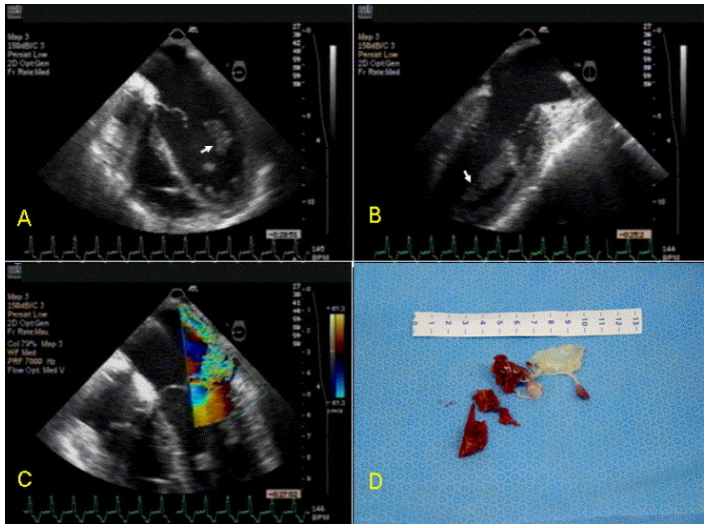




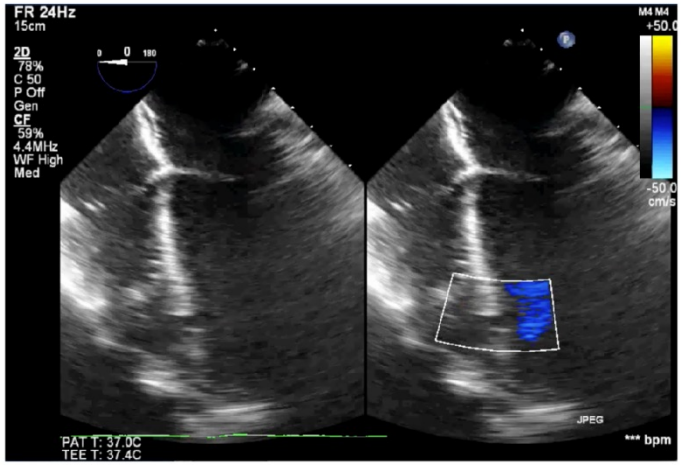


Cardiac Trauma

Aortic leaflet rupture secondary to BCT

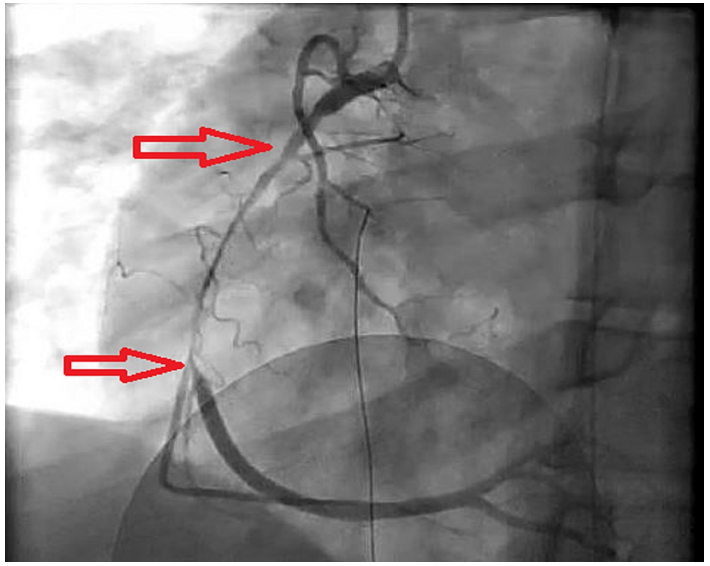


Papillary muscle rupture and acute MR secondary to PCT



operative TOE images demonstrating absence of colour doppler flow across region of VSD after direct su

Ventricular septal defect secondary to PCT



Right coronary artery dissection secondary to BCT

Cardio-pulmonary bypass - Open heart surgery

Chirurgie Cardio Vasculaire

HUG

UNIVERSITÉ DE GENÈVE

Survival Following Emergency Thoracotomy

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

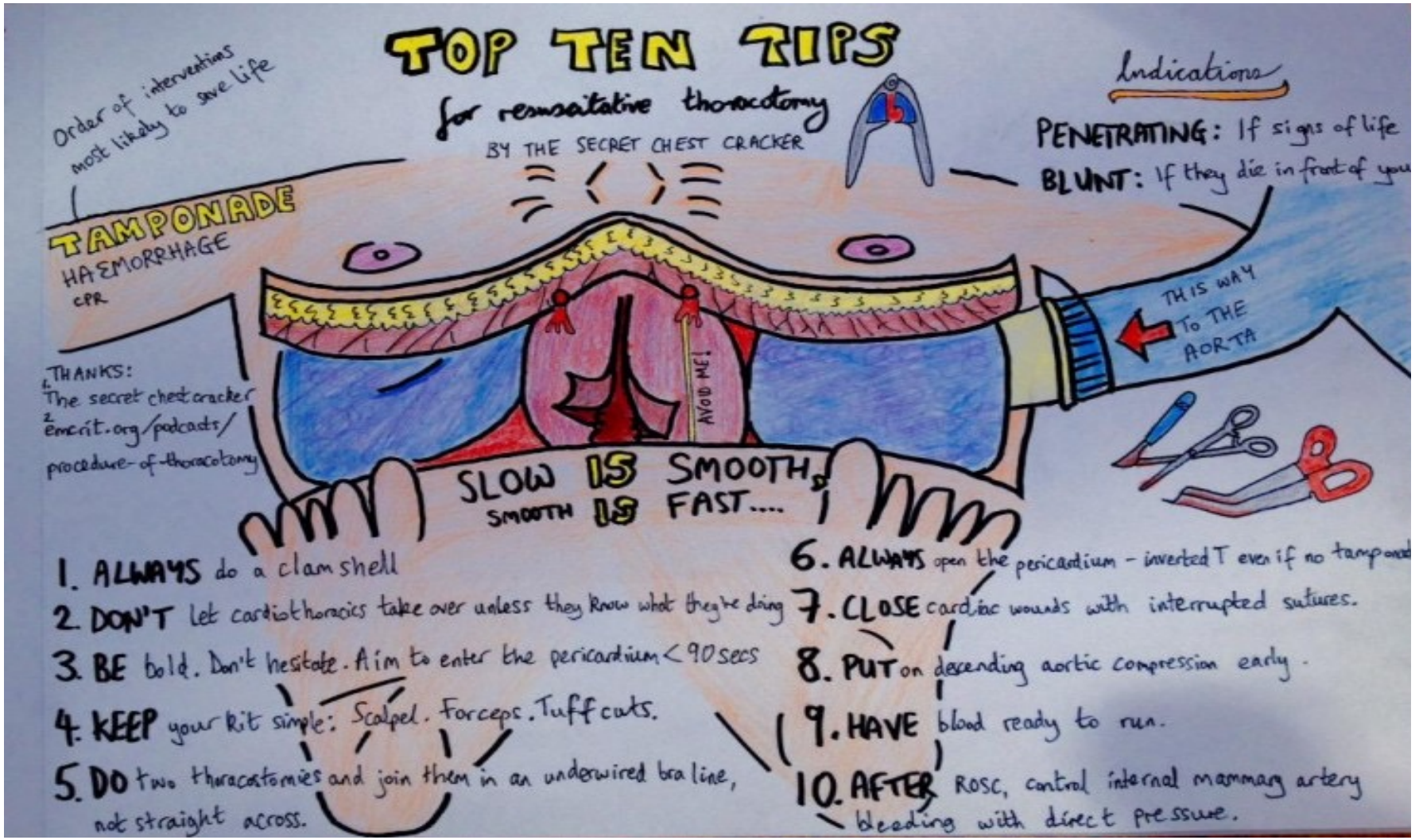
++- strong recommendation
+- conditional recommendation
NR- Not Recommended

Signs of Life

- Palpable pulse
- Respiratory effort
- Movement
- Pupillary response

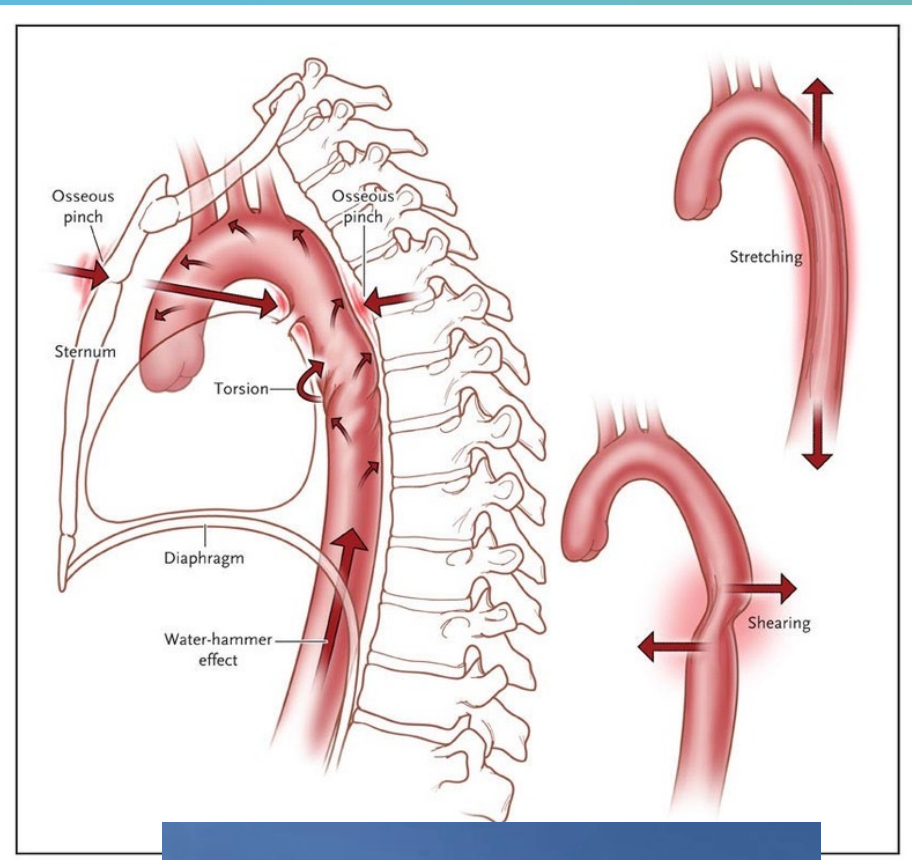
J Trauma. 2015; 79: 159-173.

Emergency Thoracotomy



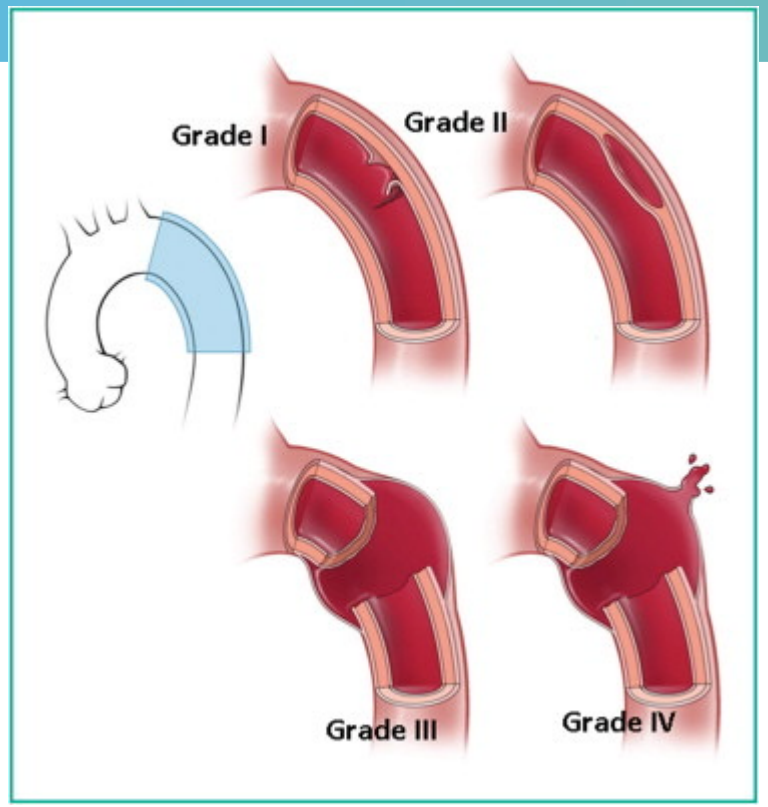
Thoracic aorta- traumatic injuries

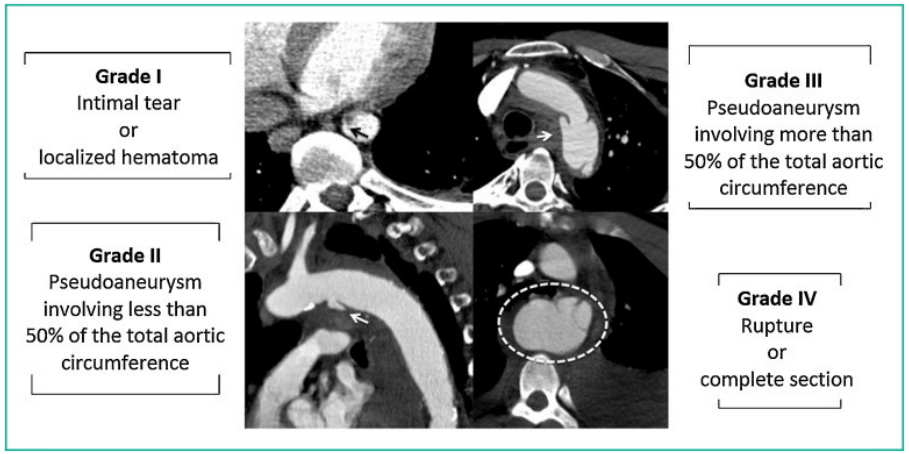
- Most of the aortic injuries occur due to blunt trauma secondary to “head-on motor vehicle crash or fall from height” (72%), followed by “side impact” (24%) and then by “rear impact” (4%).
- Typically deceleration injuries are seen. Aortic trauma may also occur from stab wounds or gunshot injuries.
- Trauma to the aorta occurs most commonly at the isthmus, nearly 90% of the time. This portion of the aorta has attachment with the ligamentum arteriosum.
- With deceleration injuries, shearing forces and luminal compression against this fixed portion of the aorta lead to a tear and transection of the aorta.



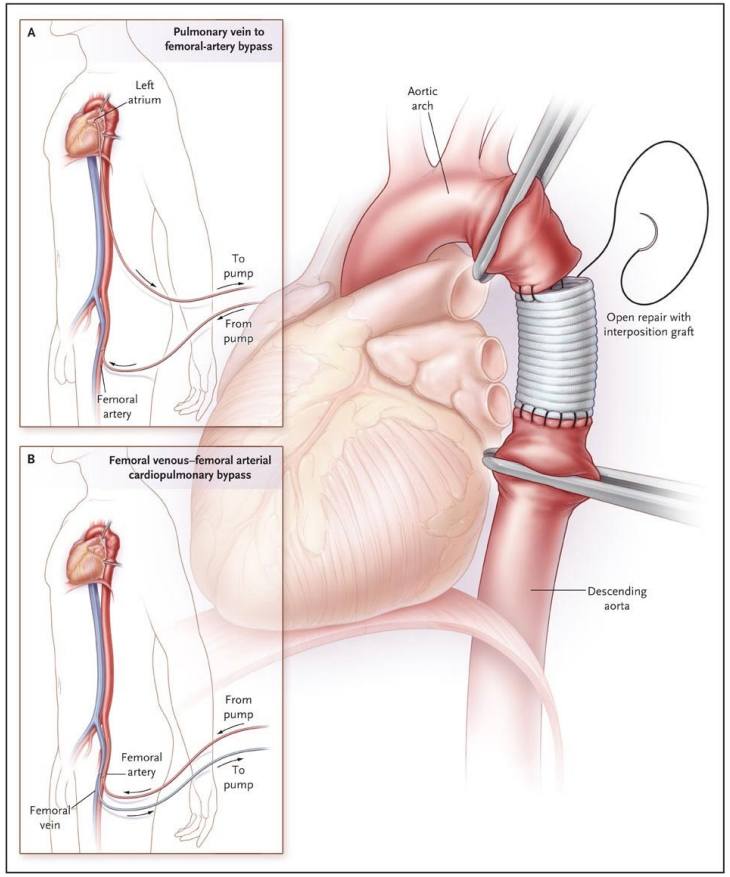
Thoracic aorta- traumatic injuries

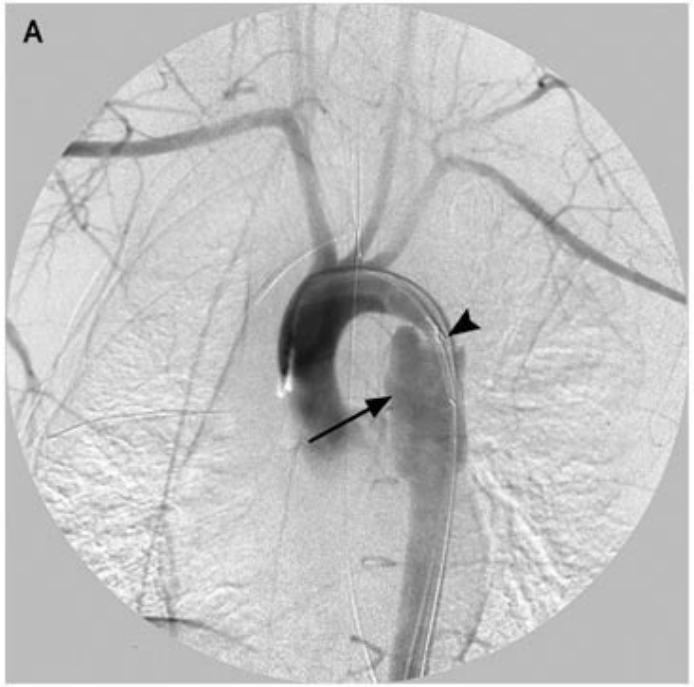
- Trauma to the aorta may result in
  - aortic intimal laceration,
  - aortic intramural hematoma,
  - aortic pseudo-aneurysm (aortic rupture is contained by the adventitia or periaortic tissue)
  - aortic transection where the injury traverses through three layers of the vessel wall.
- Aortic dissection, which is a longitudinal tear in the aortic wall, occurs secondary to trauma.
- Penetrating aortic injuries secondary to either stab wound or gunshot wound has a very high mortality rate despite the improvement in trauma care in recent years.

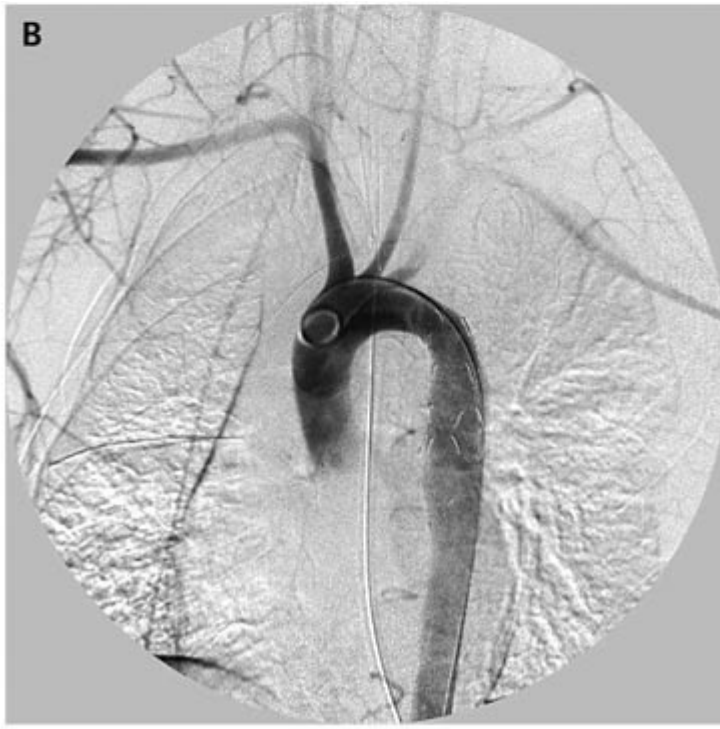




Thoracic aorta- traumatic injuries







Thoracic aorta- traumatic injuries

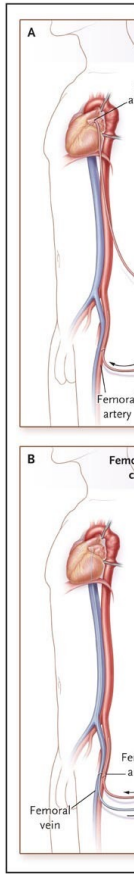


Table 1. Comparison of Operative Approaches to Blunt Aortic Injury.

Variable	Relative Degree of Risk*		
	Clamp and Sew	Shunt–Bypass	Endovascular Repair
Complication			
Operative stress	High	Medium	Low
Blood loss	Medium	Medium	Low
Operative time	Medium	High	Low
Paraplegia	High	Medium	Low
Clinical scenario			
Patient with high surgical risk	High	Medium	Low
Patient with severe lung injury	High	Medium	Low
Patient with severe head injury	High	High	Low
Patient with challenging anatomy	Medium	Low	High

* Relative degree of risk refers to a general comparison among the three operative procedures.

The initial care of the patient with cardiac injuries

- The initial care of the trauma patient with cardiac injuries does not vary from standard **Advanced Trauma Life Support (ATLS)** protocols.

- The primary priority is **ensuring the patency of the airway and establishing adequate oxygenation and ventilation**. This may include tube thoracostomy for drainage of hemothorax from the pleural space to allow re-expansion of the lung.

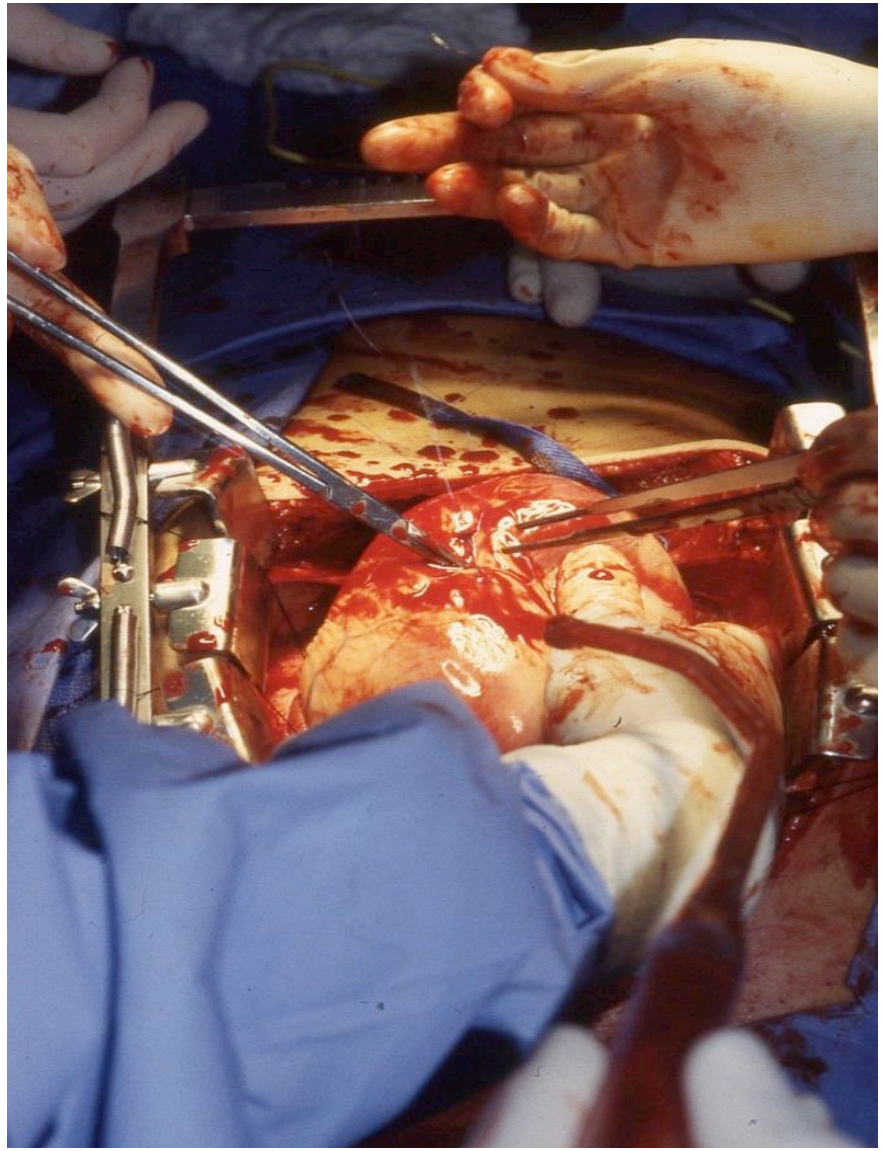
- Subsequently, **the circulatory system** is assessed. Priority is given to establishing intravenous access for the **administration of crystalloid and/or blood products**. If **cardiac tamponade** is suspected, this should be confirmed with sonographic confirmation of hemopericardium and/or right ventricular collapse during diastole.

- If tamponade physiology is present, treatment for **immediate drainage of the pericardial space** should be initiated. This can be accomplished by via open sub-xyphoid pericardial approach.

- The treatment algorithm for cardiac injured patients branches at this point depending on the mechanism of injury and hemodynamic status.

Take Home Messages

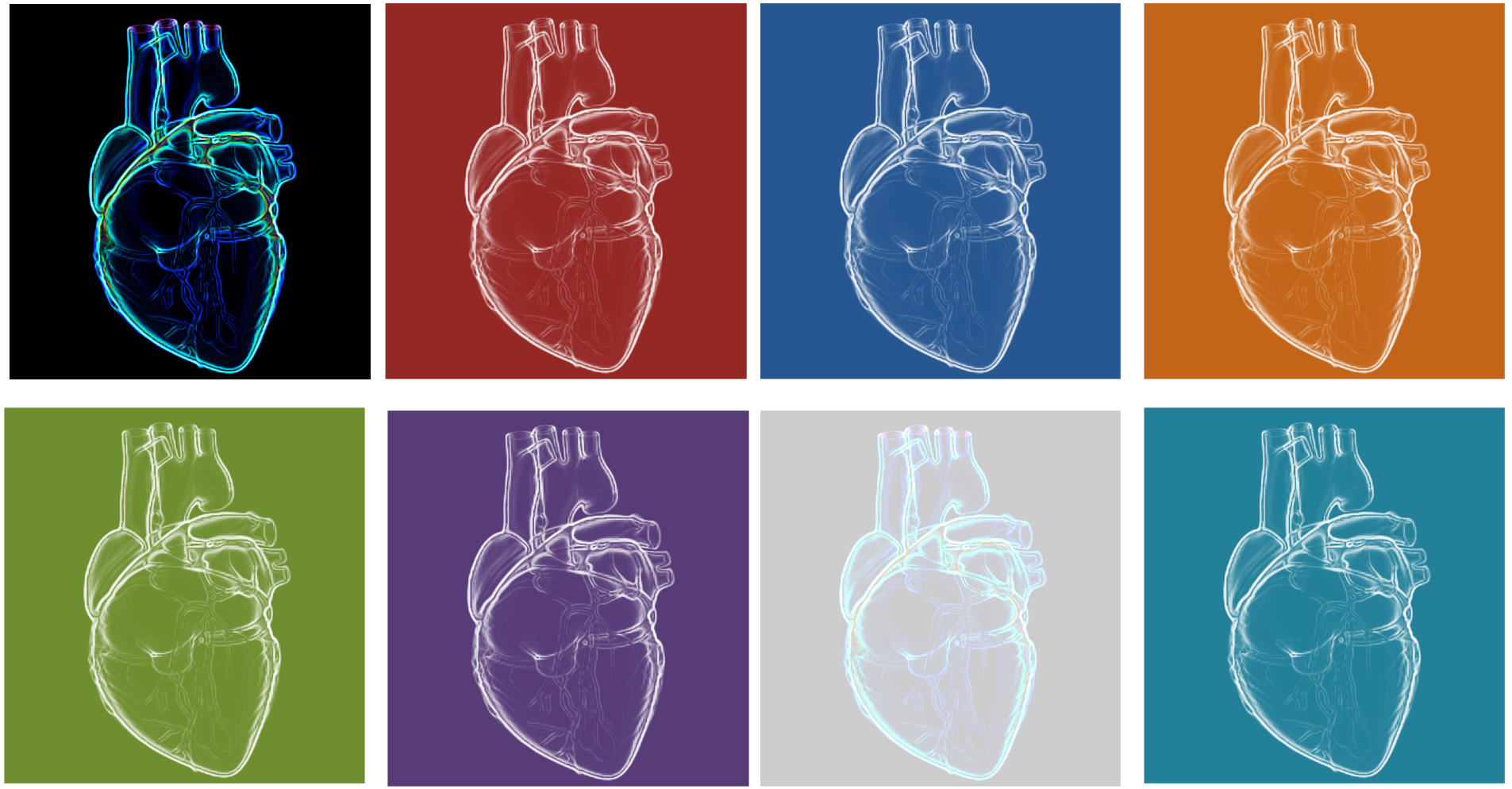
- «**High index of suspicion**» saves lifes.
- «**Team Work**» (as in every field in medicine, today) is essential for diagnosis and treatment of complex trauma patients.
- «**Practicing**» on different scenarios and models may do your practice easier before «D» day arrives.
- Heart and vessels are **fragile structures** then other tissues you practice in routine- use support materials in order to prevent further injuries secondary to your intervention.
- «**Asking help, getting second opinion**» - do not make you weak ! It just helps you and helps to your patient by «**getting out of the tunnel vision**».



Cardiac Trauma

- **Cardiac Trauma and the Cardiac Box-**
  Robert Maxell, MD, FACS
- **Cardiac Trauma-**
  Sucheta Gosavi, Alan H. Tyroch, Debabrata Mukherjee.
- **Cardiac Trauma-**
  Daniel Eiferman, R. Nathan Cotterman and Michael Firstenberg-
- **Traumatismes Thoraciques-**
  Henri de Lesquen- Cours Suisse de Chirurgie de Guerre et de Catastrophe, Genève, le 19 septembre 2019
- **Blunt Aortic Injury-**
  David G. Neschis, Thomas M. Scalea, William R. Flinn, Bartley P. Griffith

Cardiac Trauma



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