

Case Report

- 39yM stabbed in the left upper chest by wife with kitchen knife. Intubated in the field. Loss of vitals on arrival to hospital while in ambulance.
- In ED, (-) palpable pulse and (+) organized electrical cardiac activity
- On exam, stab wound to the left chest, third intercostal space, midclavicular line

ED Thoracotomy

- Left chest opened and extended across sternum with 1000mL blood drained
- Pericardium opened with 100mL blood drained
- 1cm laceration in the pulmonary artery controlled with digital pressure then Satinsky clamp
- Thoracic aorta clamped after NGT placement
- Return of palpable carotid pulse after direct cardiac massage

OR #1

- Injury to pulmonary artery over-sewed with two 2-0 prolene figure-of-eight stitches
- Through-and-through injury to left upper lobe lung resected with EndoGIA stapler
- Internal mammary arteries ligated
- Oozing from area of aortic dissection over-sewed with 2-0 prolene

OR #1 (continued)

- Unable to remove aortic clamp without immediate hypotension and desaturation
- No additional sources of bleeding identified
- After approximately 1h with multiple rounds of blood products, decision made to remove aortic clamp
- Gradual bradycardia resulted which responded to cardiac massage and epinephrine drip
- Hypothermia, acidosis and coagulopathy demanded transfer to SICU
- Oozing from area of aortic dissection packed with surgicel and two lap pads
- Three chest tubes placed and skin closed

SICU

- EBL 5L, 13U RBC, 5U FFP, 2U platelets
- ABG pH 6.7, pCO₂ 55, pO₂ 65, BE -23
- CBC 3.6/5.2/16.8/49
- Unstable on full dose epinephrine and norepinephrine
- Continuously receiving RBC, FFP, cryoprecipitate and platelets as well as factor VII
- Persistent chest tube output (\approx 2L/h)

OR #2

- Chest reopened and 2L blood evacuated
- Bleeding from PA repair controlled with pledgeted 4-0 prolene figure-of-eight
- Posterior mediastinum unpacked
- Bleeding from below the heart
- Laceration of right atrium at atriocaval junction identified extending from inferior surface of right atrium along anterior surface of supradiaphragmatic IVC

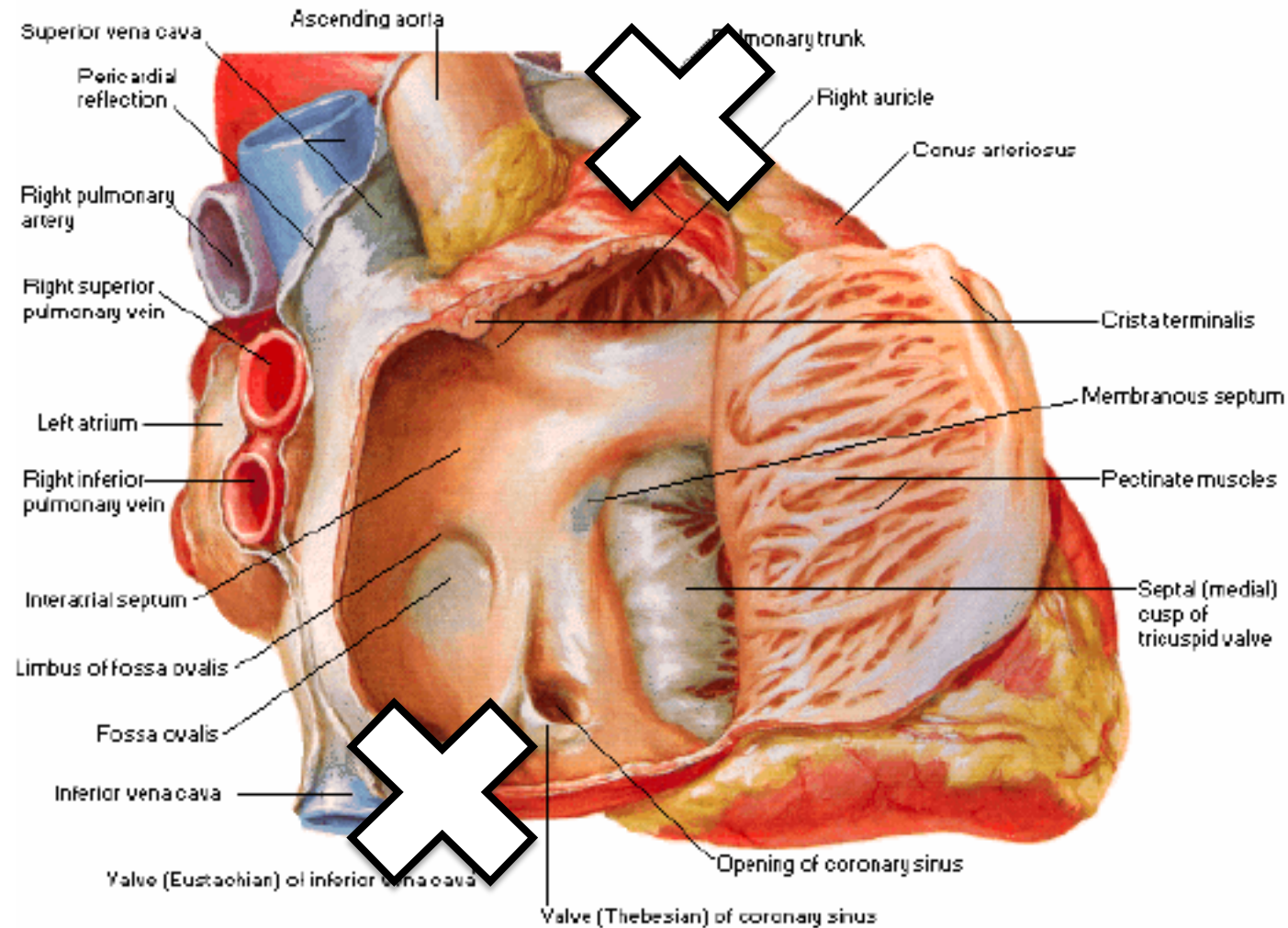
OR #2

- Injury site clamped
- Asystole requiring open massage and defibrillation
- Abdomen tense and diaphragm elevated prompting midline decompressive laparotomy
- Repair of laceration attempted with running 3-0 prolene
- Unable to control bleeding
- Asystole again unresponsive to cardiac massage

Autopsy

- Laceration to pulmonary artery
- Laceration to atriocaval junction
- No intracardiac injury to suggest that both injuries caused by stab wound

Right Lateral View



ED Thoracotomy

Christopher Turner

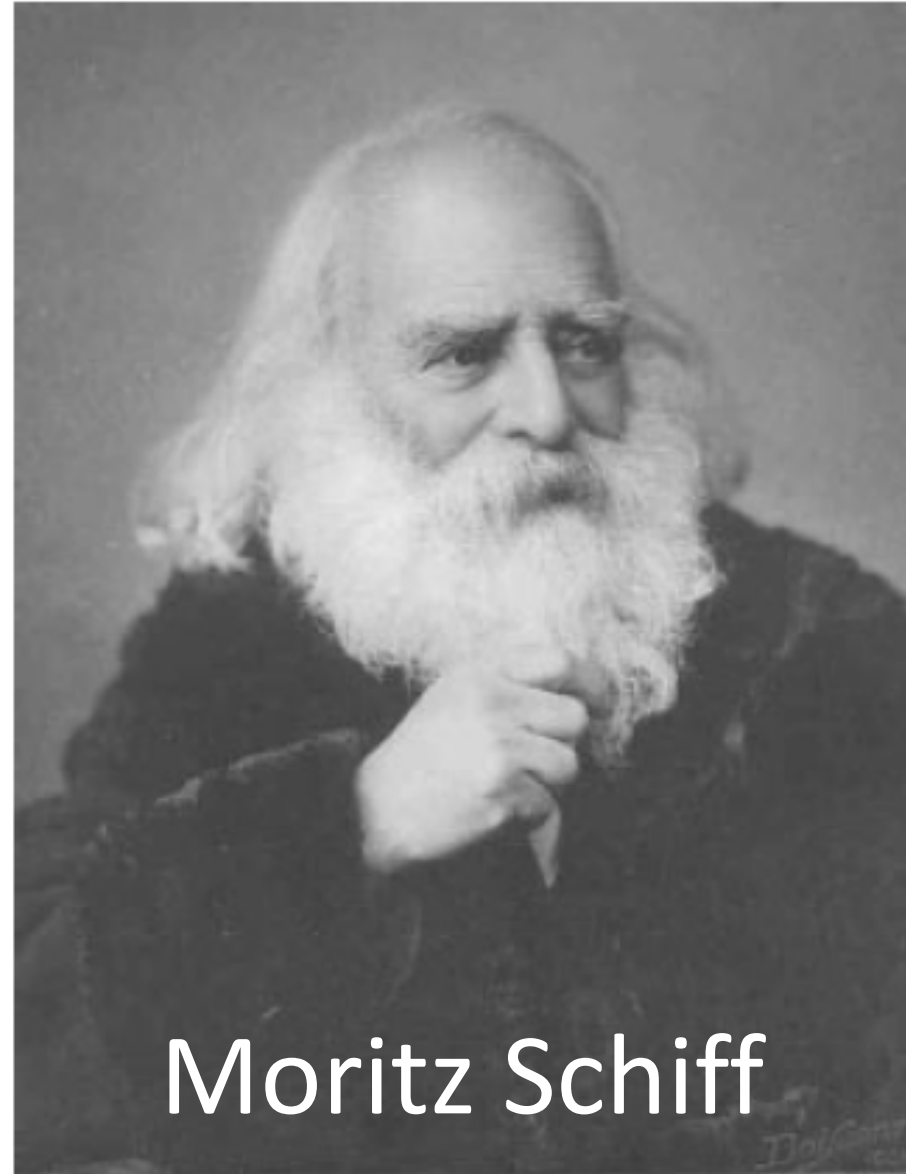
October 24, 2013

Outline

- History
- Definitions
- Physiologic Rationale
- Clinical Results
- Indications
- Technical Details
- Complications

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History: Animal models

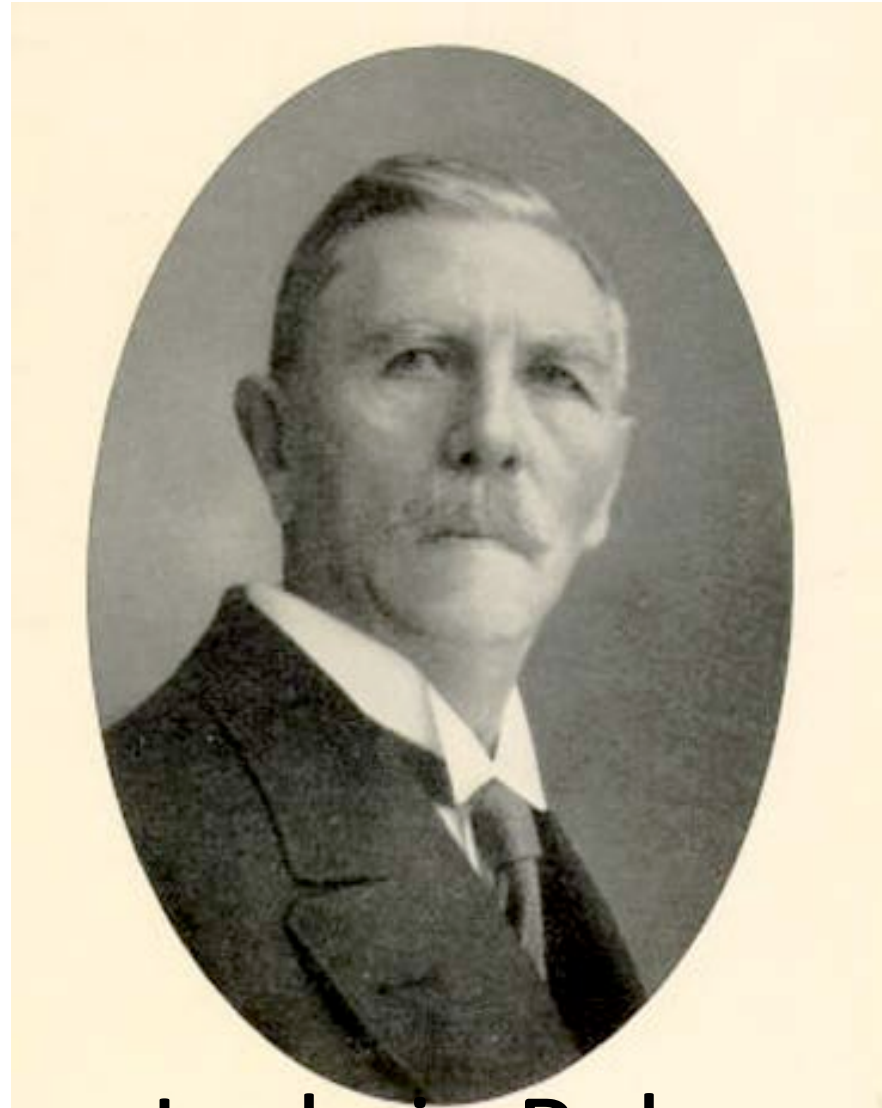
- 1874
- “He lays open the thoracic cavity, and, compressing the passive heart with his fingers, imitates in it the periodic movement of the organ.”



Moritz Schiff

History: First Successful Cardiac Repair

- 1897
- “In the desperate case of a stab wound of the right ventricle, I was forced to operate ... The sight of the heart beating in the opened pericardial sac was extraordinary ... I passed the needle quickly during the diastolic phase.”



Ludwig Rehn

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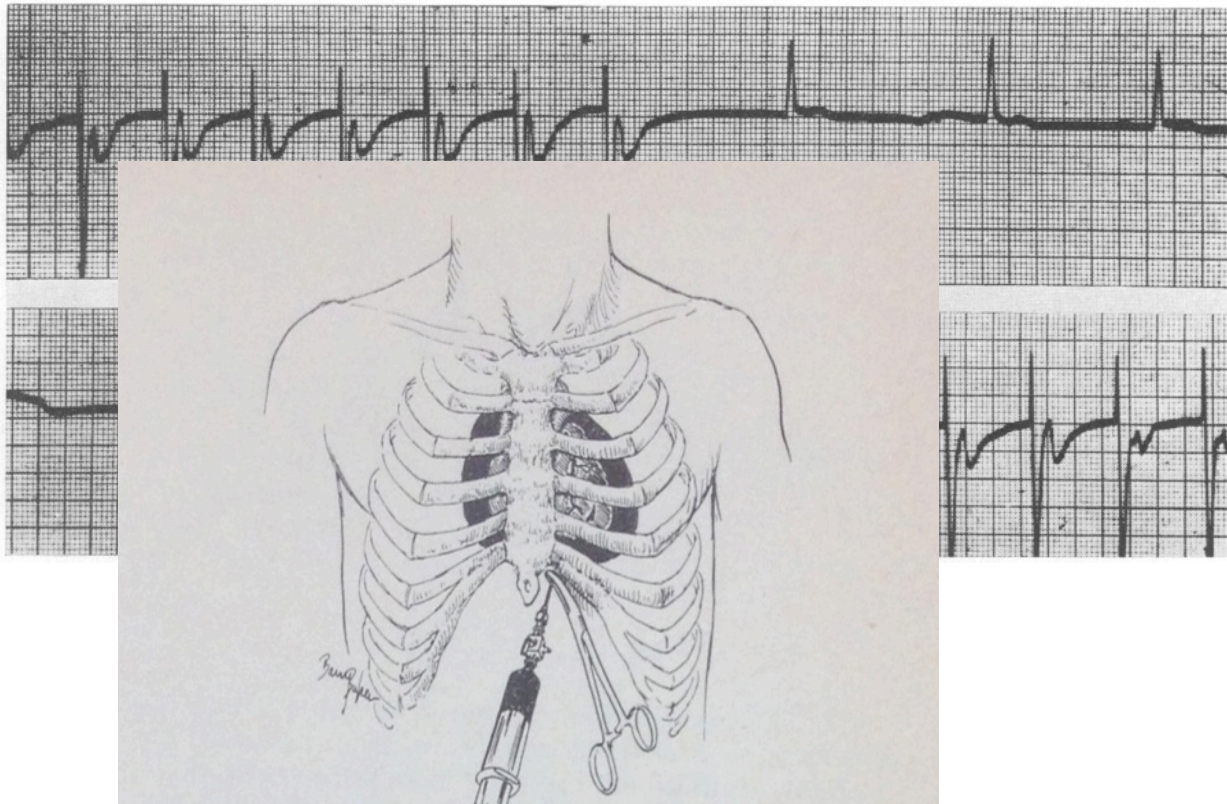
History: Medical Men

- Closed chest compression, Kouwenhoven, JAMA 1960
- External defibrillation, Zoll, NEJM 1956
- Pericardiocentesis, Green and Ravitch.

Sur

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History: Return of the Surgeons

Surgical Management of Penetrating Cardiac Injuries

American Journal of Surgery. 1966

Beall, Diethrich, Crawford, Cooley, DeBakey

Houston, Texas

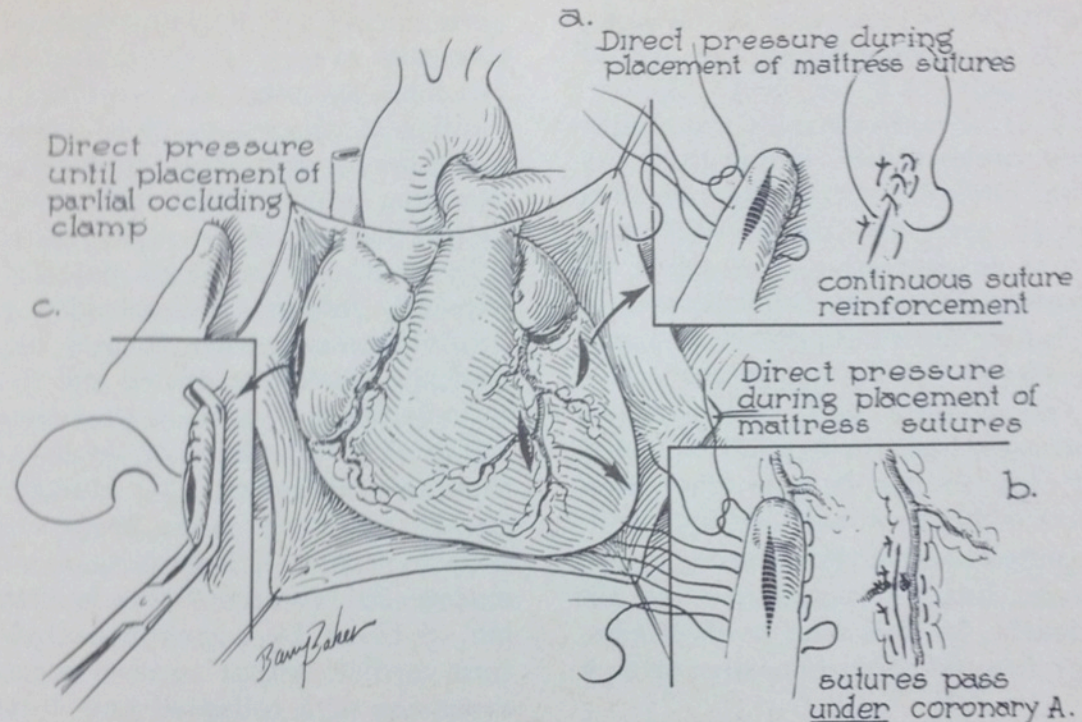
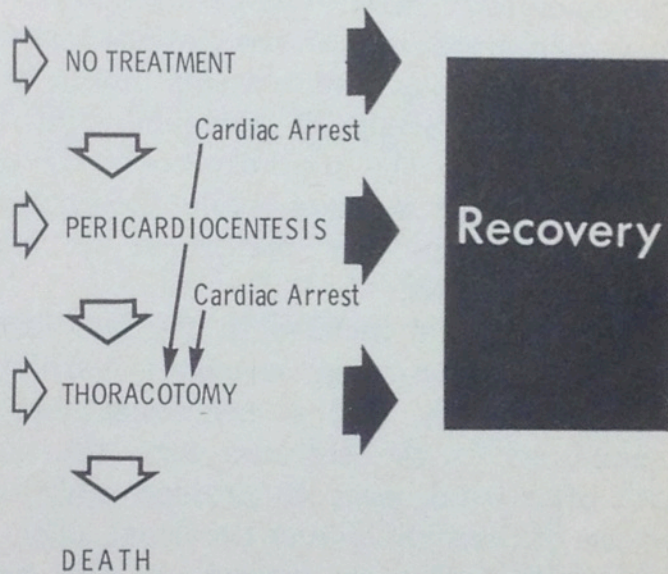


FIG. 2. The plan of treatment. Regardless of method of therapy in progress, any patient experiencing cardiac arrest immediately undergoes thoracotomy.

Definitions

- ED thoracotomy = thoracotomy performed in the ED for patients arriving *in extremis*
- Vital signs = palpable pulse, measurable blood pressure, spontaneous respiratory activity
- Signs of life = respiratory or motor effort, cardiac electrical activity, pupillary activity

Physiologic Rationale

- A. Release pericardial tamponade and control cardiac hemorrhage
- B. Control intra-thoracic hemorrhage
- C. Perform open cardiac massage
- D. Achieve thoracic aortic cross-clamping
- E. Evacuate bronchovenous air embolism

Clinical Results

Critical Analysis of Two Decades of Experience with Postinjury Emergency Department Thoracotomy in a Regional Trauma Center

www.downstatesurgery.org

Scott W. Branney, MD, Ernest E. Moore, MD, Kim M. Feldhaus, MD, and Richard E. Wolfe, MD

Journal of Trauma 1998

Denver Health Medical Center

- Retrospective review of 950 EDTs at a single center over 23 years
- Blunt 45%, GSW 38%, SW 17%
- 78% dead in ED, 15% dead in OR, 3% dead in SICU
- Overall survival 4.4%, Intact survival 3.9%
- 72% without vital signs in field
- 82% without vital signs in ED

TABLE 3. Neurologically intact survival based on site and mechanism of injury

Mechanism and Site	Total No.	Survivors	
		n	%
Stab wounds			
Chest	109	20 ^a	18
Abdomen	17	1	5
Head injury	1	0	
Other	5	0	
Gunshot wounds			
Chest	229	5	2
Abdomen	56	7	13
Head injury	11	0	
Other	19	0	
Blunt injuries			
Chest	119	2 ^b	2
Abdomen	51	1	2
Pelvis	3	1 ^c	33
Head injury	119	3 ^c	3
Other	83	1	1

TABLE 2. Neurologically intact survival based on the presence or absence of vital signs in the field or emergency department

Mechanism	With Vital Signs			Without Vital Signs		
	Total No.	Survivors		Total No.	Survivors	
		n	%		n	%
Field						
Overall	243	23	10	624	12	2
Blunt	126	4	3	269	0	0
Penetrating	116	19	16	355	12	3
GSW	73	9	12	255	3	1
SW	4	10	23	100	9	9
Emergency department						
Overall	160	21	13	708	14	2
Blunt	86	3	4	311	1	0.3
Penetrating	74	18	24	397	13	3
GSW	42	6	14	286	5	2
SW	32	12	38	111	8	7

TABLE 4. Patient survival after EDY based on anatomic structure injured and mechanism

Mechanism and Anatomic Injury	Total No.	Survivors		Sig ^a
		n	%	
Stab wounds				
Cardiac tamponade	28	8 ^b	29	6.56 × 10 ⁻⁵ 0.01
Penetrating cardiac	41	6 ^c	15	
Great vessel	21	0		0.04
Hilar	13	2	15	
Lung	5	1	20	
Chest wall	10	3	33	
Abdomen	18	1	5	
Head injury	1	0		
Other	6	0		
Gunshot wounds				
Cardiac tamponade	14	0		0.009
Penetrating cardiac	112	2	2	
Great vessel	52	1	2	
Hilar	29	1	3	
Lung/chest	29	1	3	
Diaphragm	1	0		
Abdomen	58	7	12	
Head injury	12	0		
Other	19	0		

Conclusions

- Chance of survival
 - SW > GSW > Blunt
 - ED vitals > Field vitals > No vitals
 - Chest > Abdomen
 - Cardiac > Non-cardiac
- Clinical algorithm involving mechanism, presence of vitals, and location of wound

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Defining the Limits of Resuscitative Emergency Department
Thoracotomy: A Contemporary Western Trauma Association
Perspective

Journal of Trauma 2011
WTA Study Group

- Prospective review of 18 institutions over 6 years
- 56 patients survived to hospital discharge
- Mean age 31.3 years
- 93% male
- SW 54%, GSW 38%, Blunt 9%
- Total number of thoracotomies not requested

www.downstatesurgery.org
Defining the Limits of Resuscitative Thoracotomy: A Contemporary Western Trauma Association
Perspective

Journal of Trauma 2011
WTA Study Group

- #1 injury SW to ventricle (30%)
- #2 injury GSW to lung (16%)
- 34% had prehospital CPR
- 18% had moderate to severe anoxic cerebral injury
- 7 survived with asystole at ED arrival, but only 3 of these had functional neurologic recovery

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Defining the Limits of Resuscitative Emergency Department
Thoracotomy: A Contemporary Western Trauma Association
Perspective

Journal of Trauma 2011
WTA Study Group

- Prehospital CPR for SW
 - 2-10min
 - Survivor at 10min had ventricular wound
- Prehospital CPR for GSW
 - 1-15min
 - Survivor at 15min had ventricular wound
- Prehospital CPR for blunt
 - 3-9min
 - Survivor at 9min had atrial rupture

Conclusions

- Limits of ED thoracotomy
 - Prehospital CPR >10min after blunt trauma
 - Prehospital CPR >15min after penetrating trauma
 - Asystole is presenting rhythm and no pericardial tamponade

Practice Management Guidelines JACS 2001

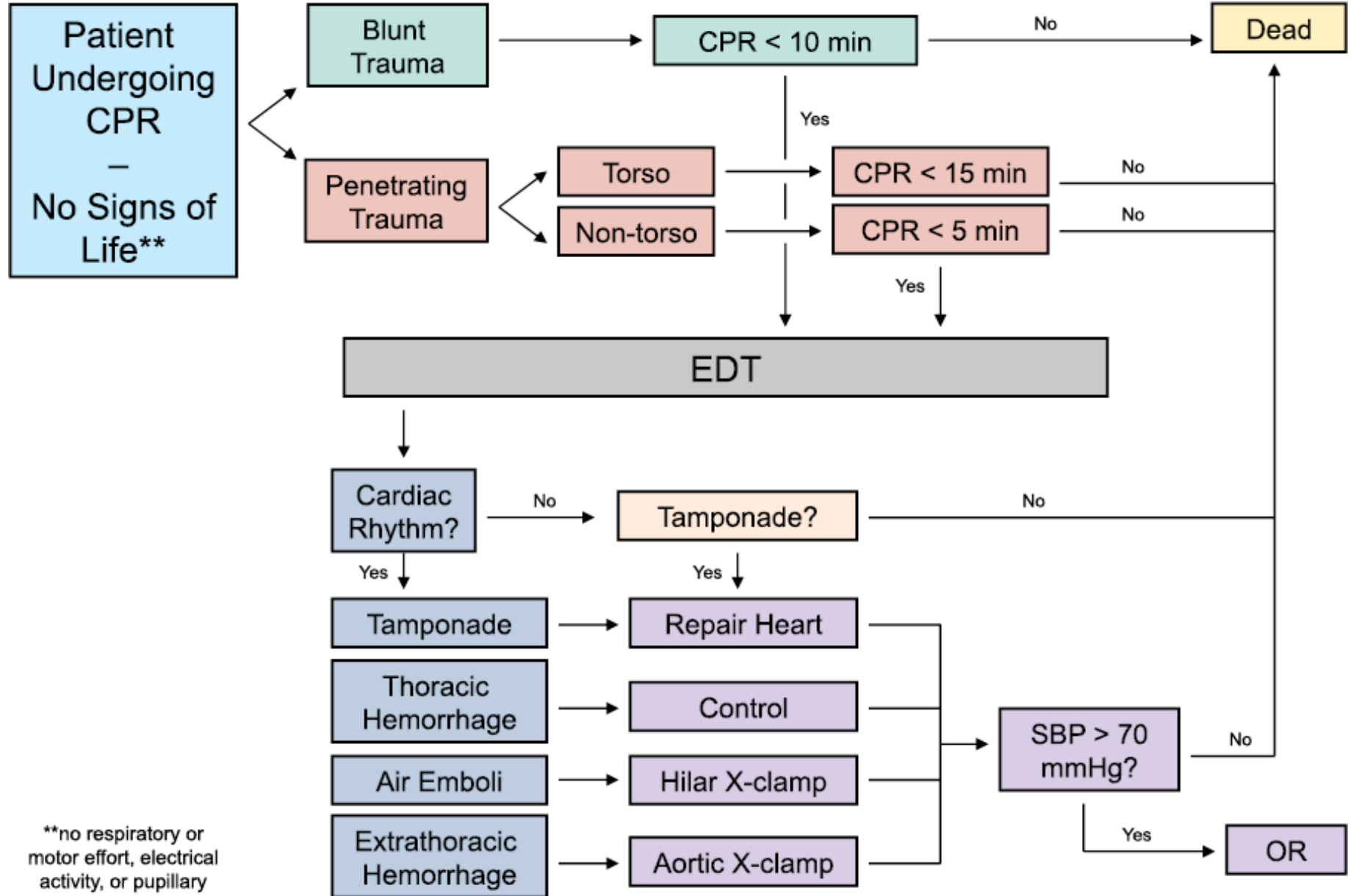
Indication

- Penetrating thoracic injuries with short scene/transport times and signs of life (respiratory or motor effort, cardiac electrical activity, pupillary activity)

Possible Indication

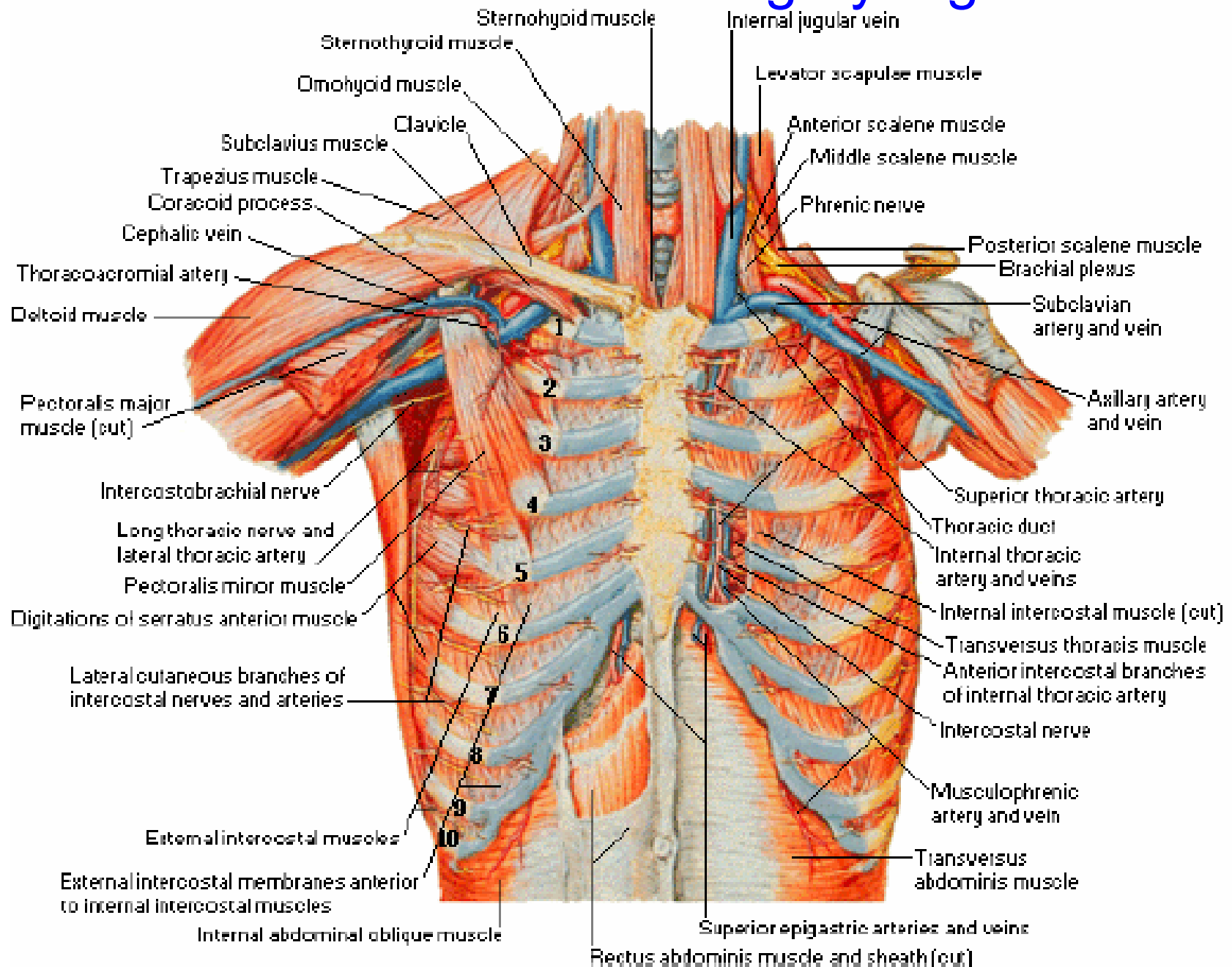
- Penetrating abdominal injuries as an adjunct to definitive repair
- Blunt trauma patients who arrive with vital signs at the trauma center and experience a witnessed cardiopulmonary arrest

Algorithm Directing the Use of EDT

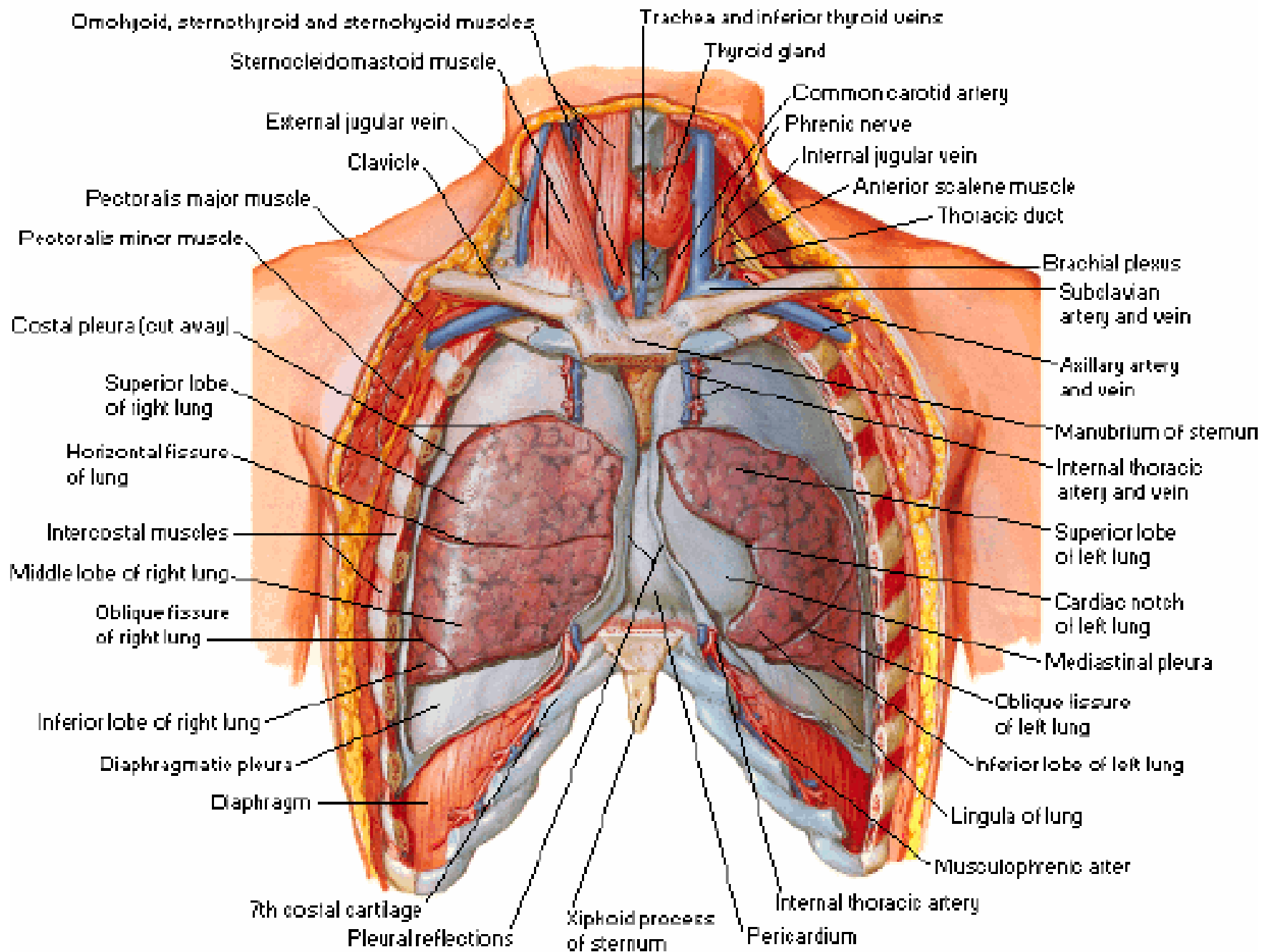


**no respiratory or motor effort, electrical activity, or pupillary activity

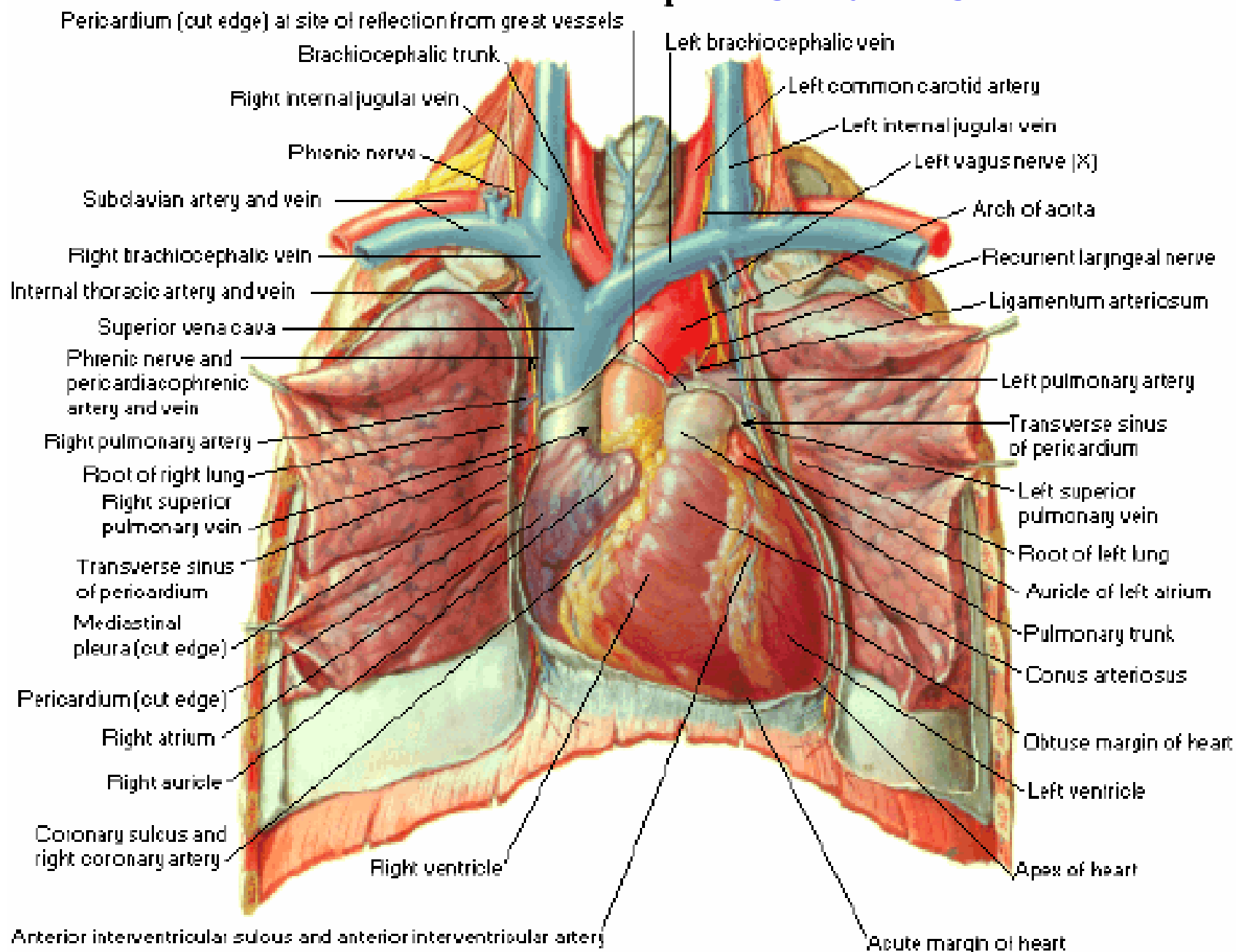
Anatomy

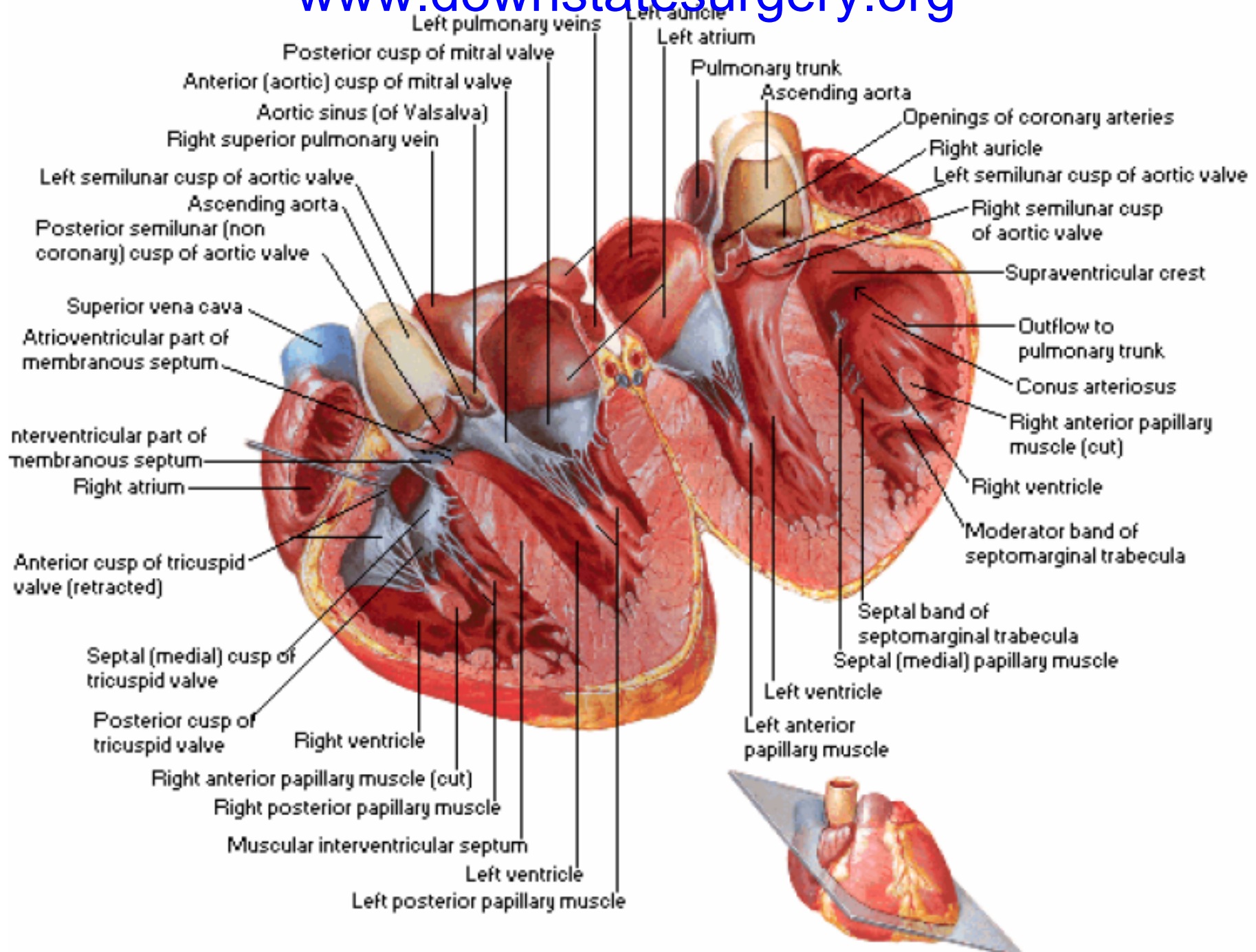


Anterior view



Anterior Exposure





Instruments

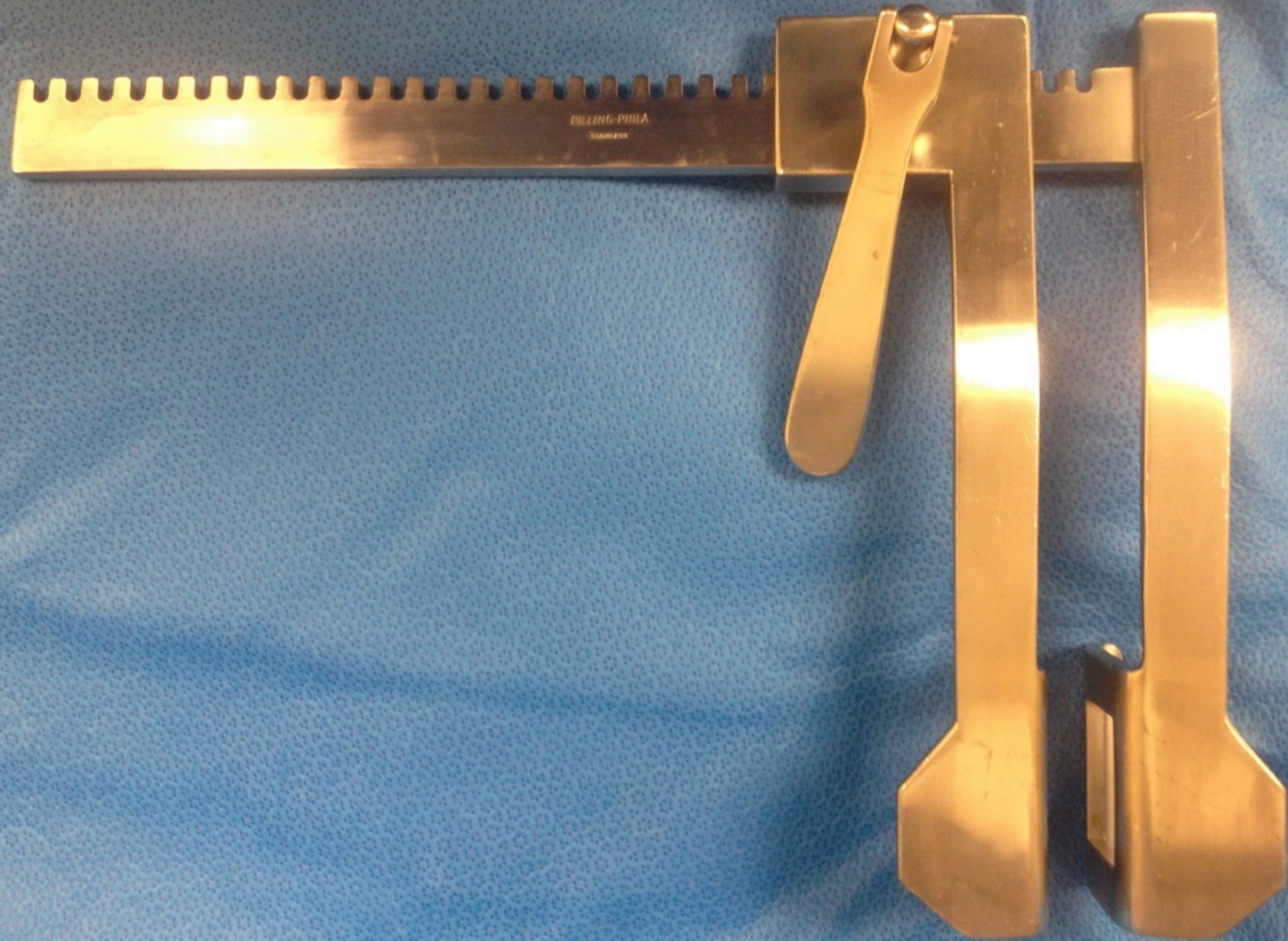
Cardiac Tray



#20 Blade



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Finochietto Retractor

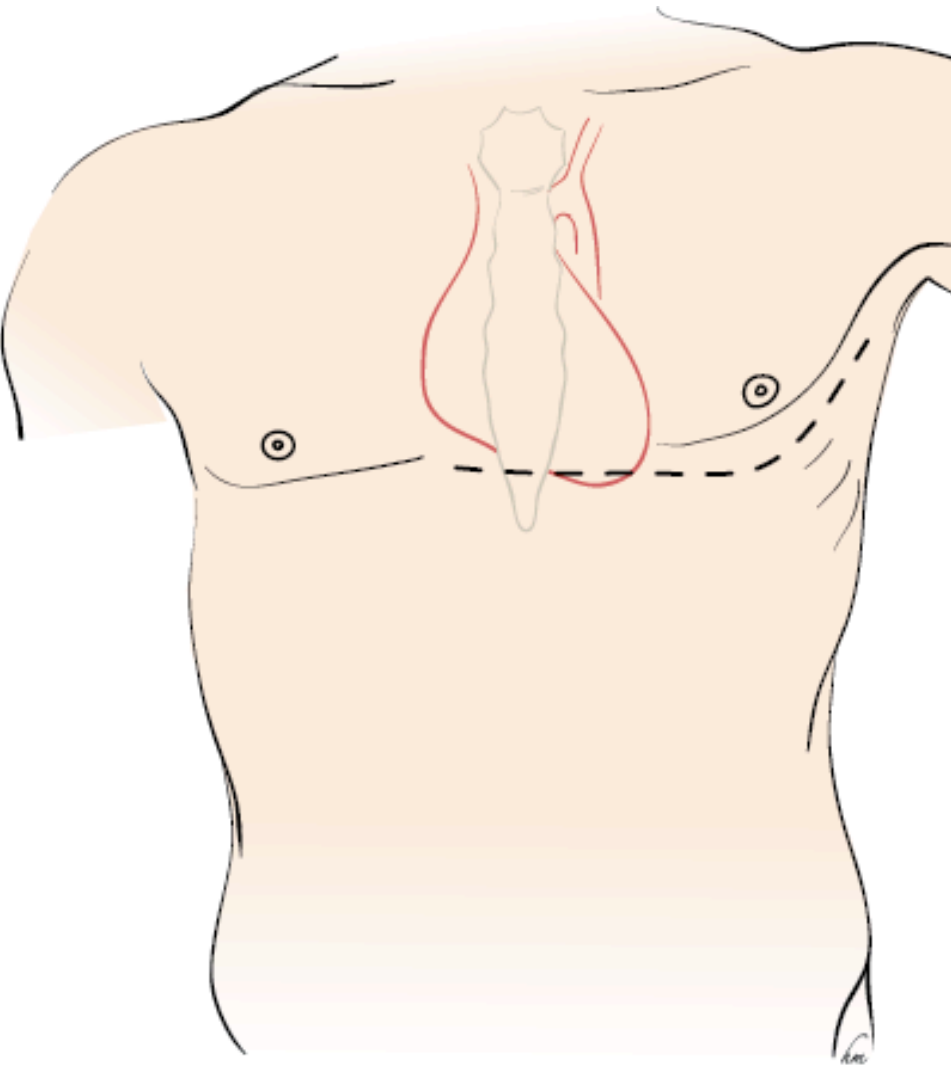


Lebsche Sternum Knife and Mallet



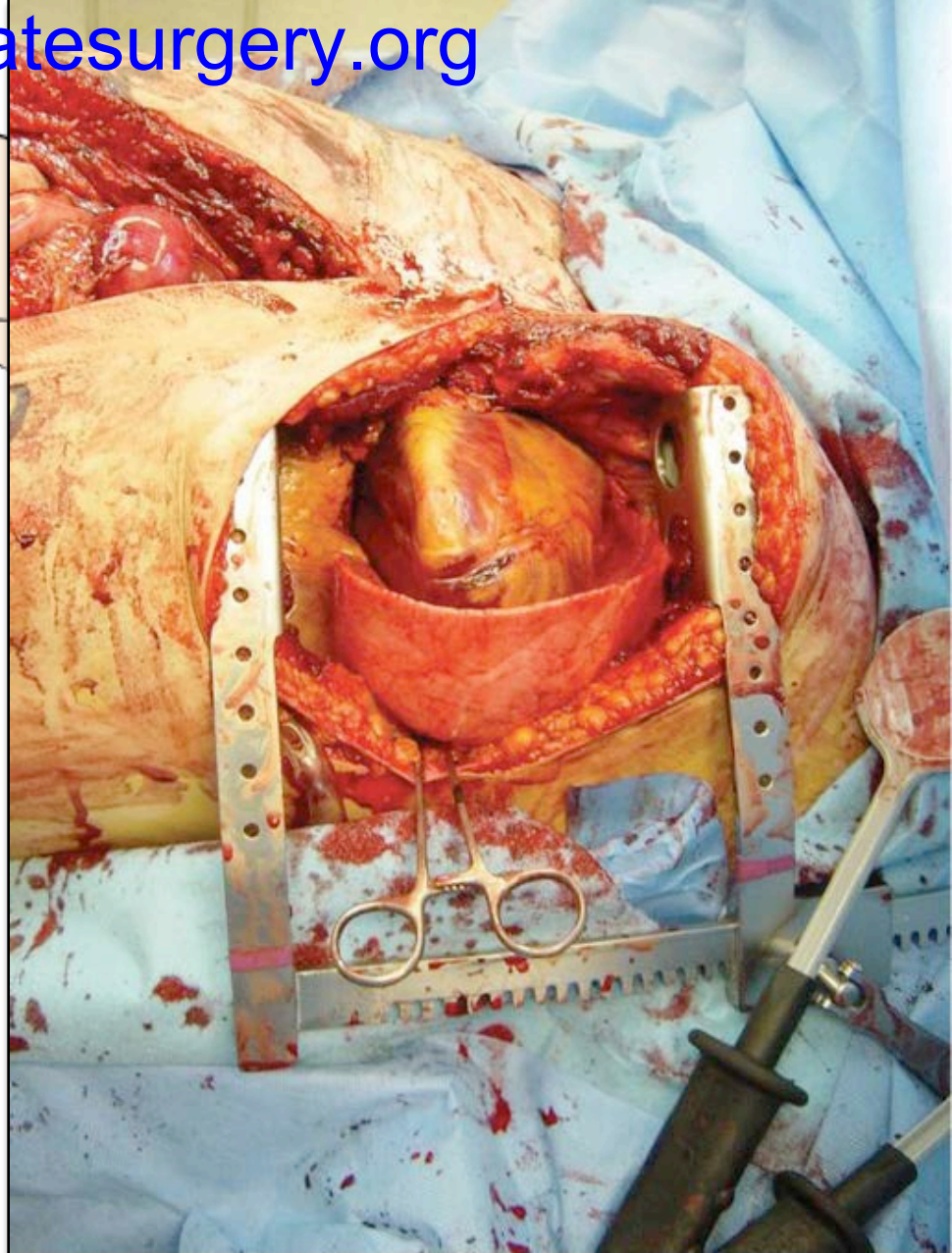


Technical Details



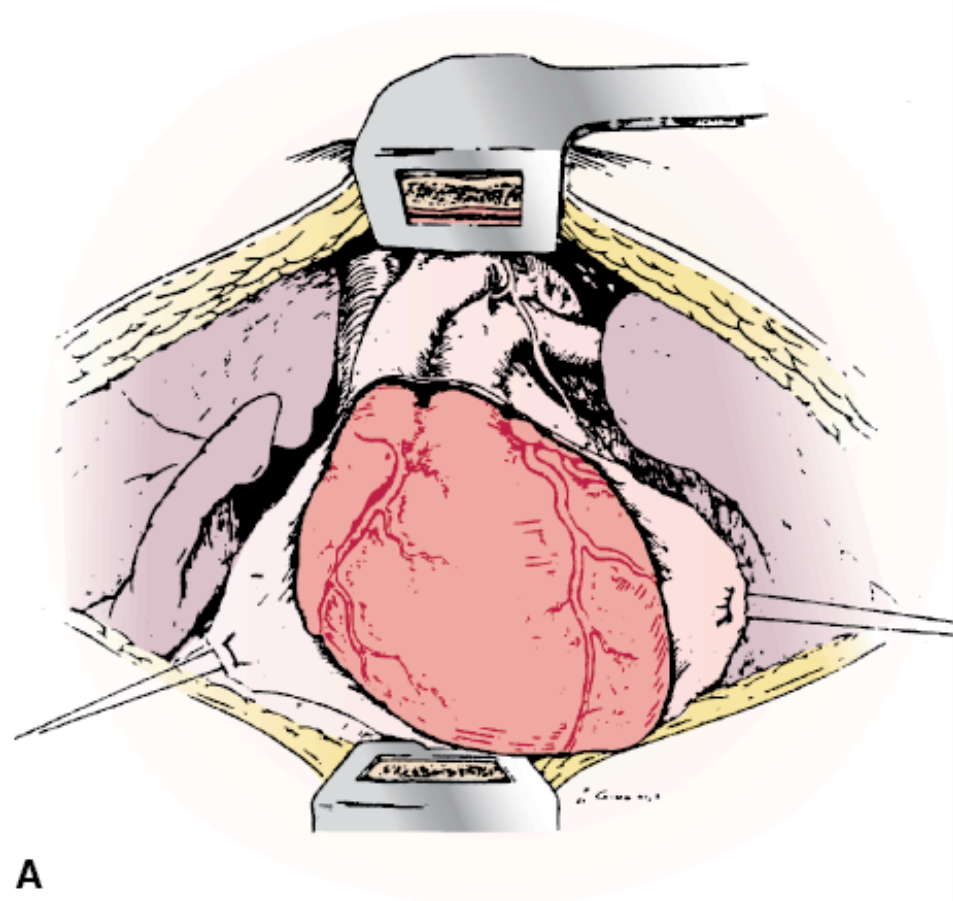
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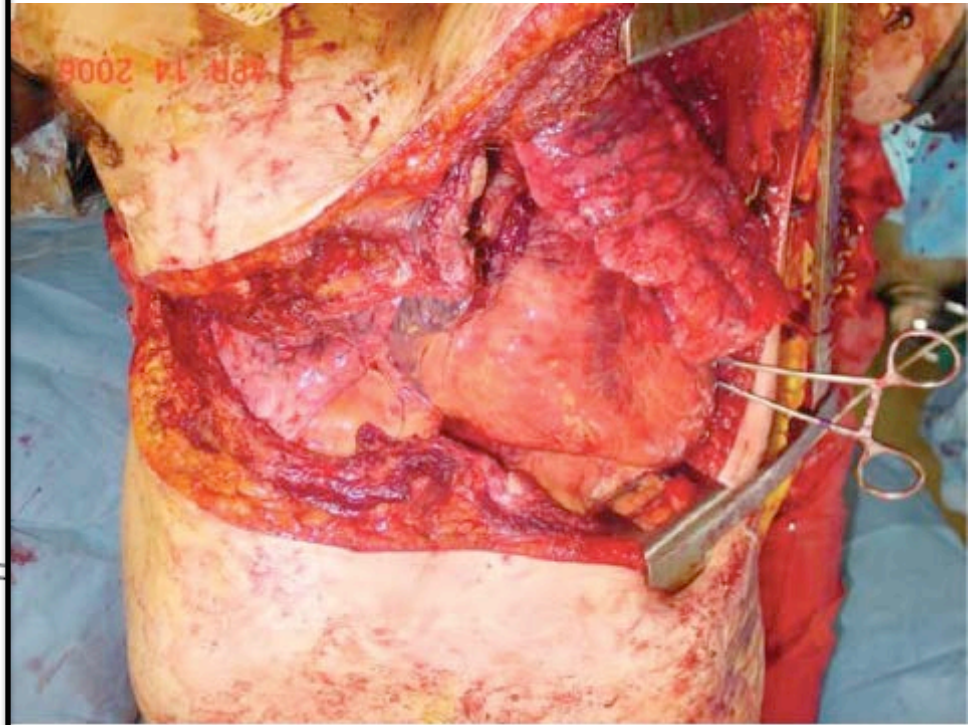


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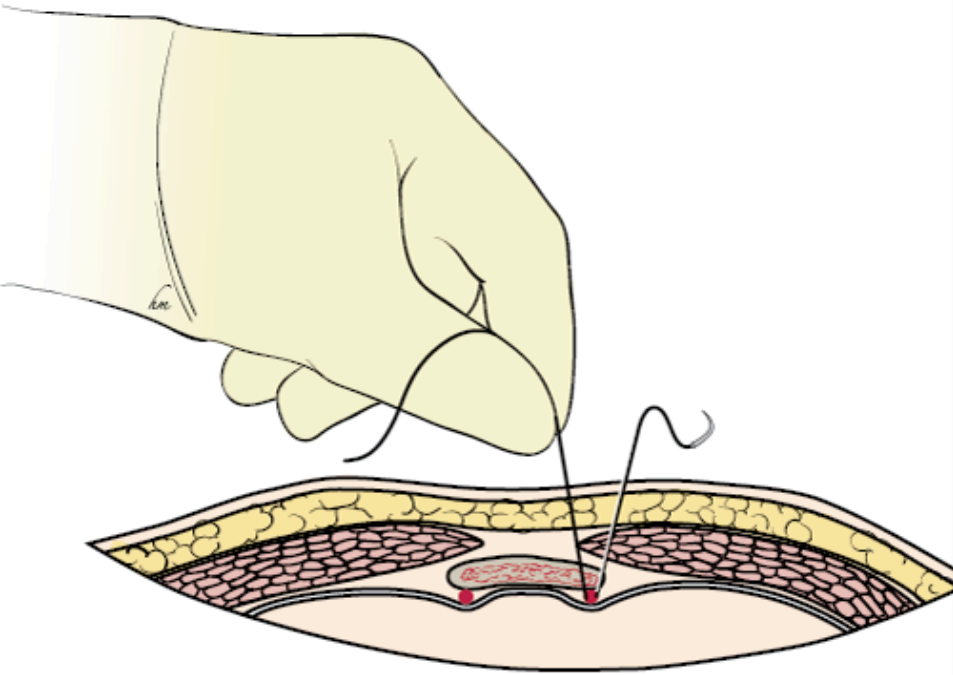
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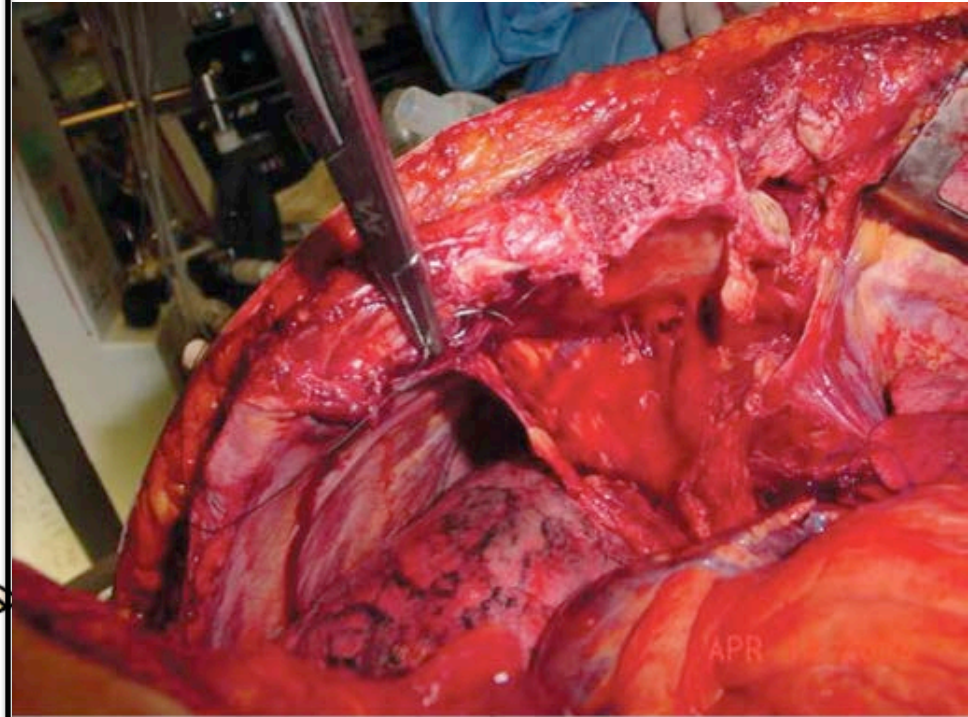


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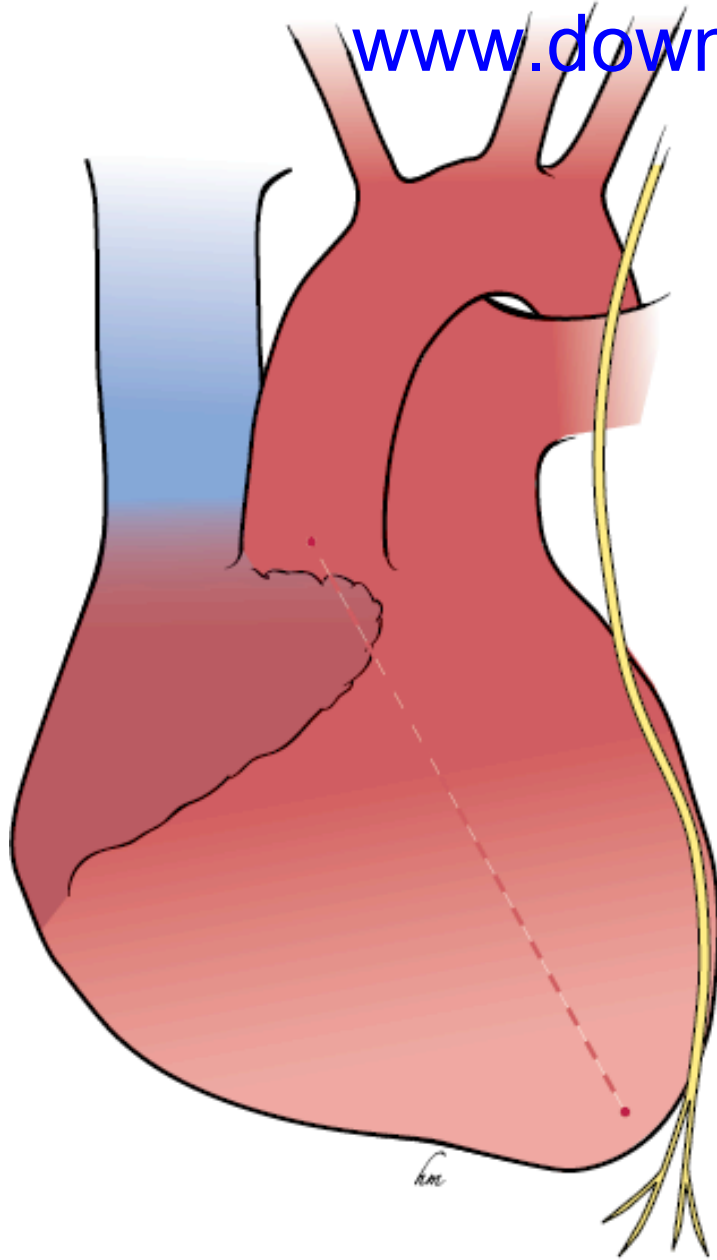
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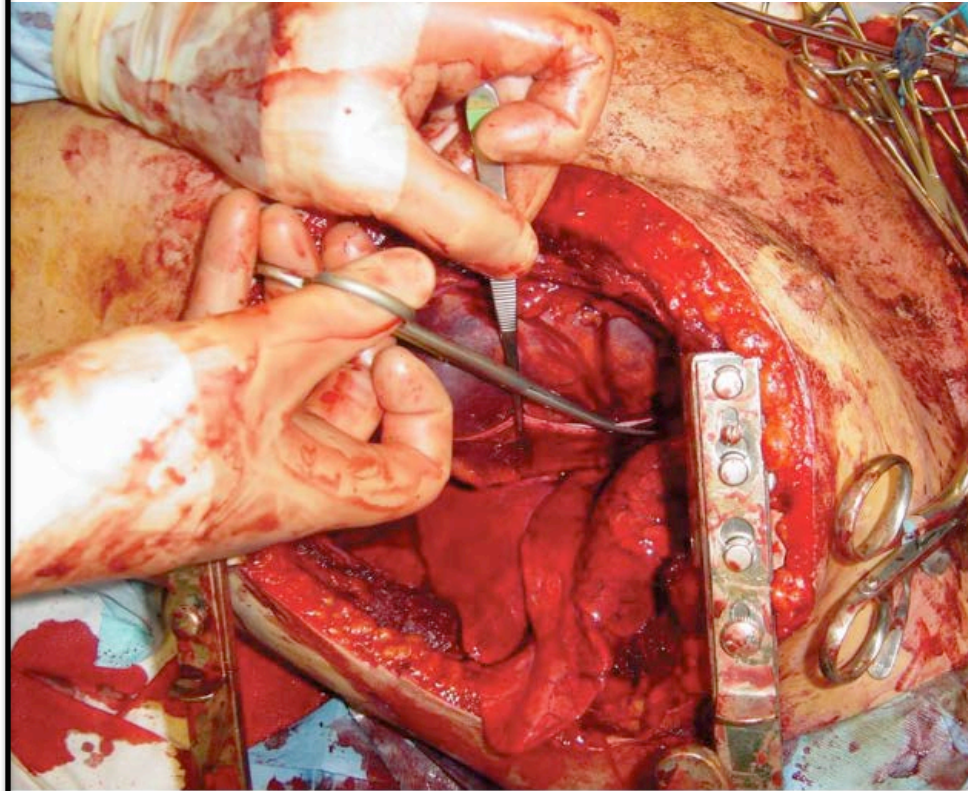
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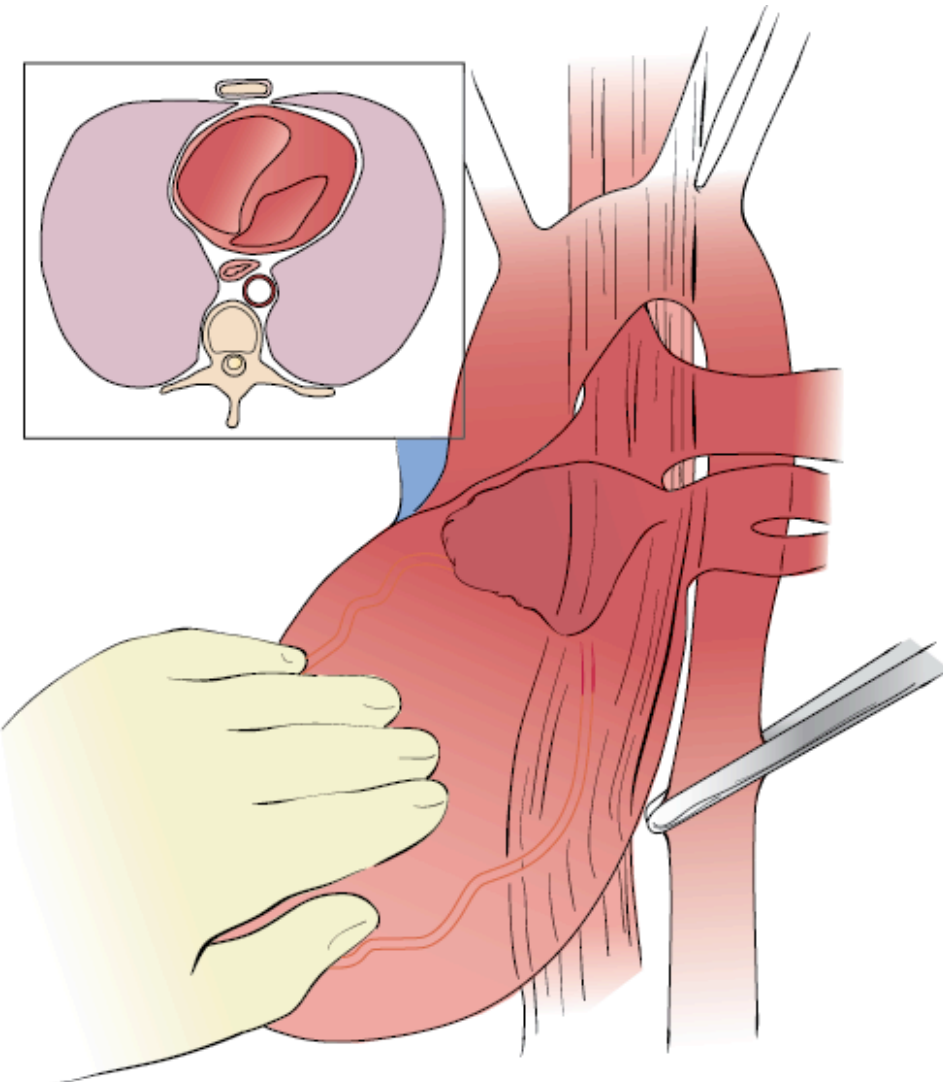
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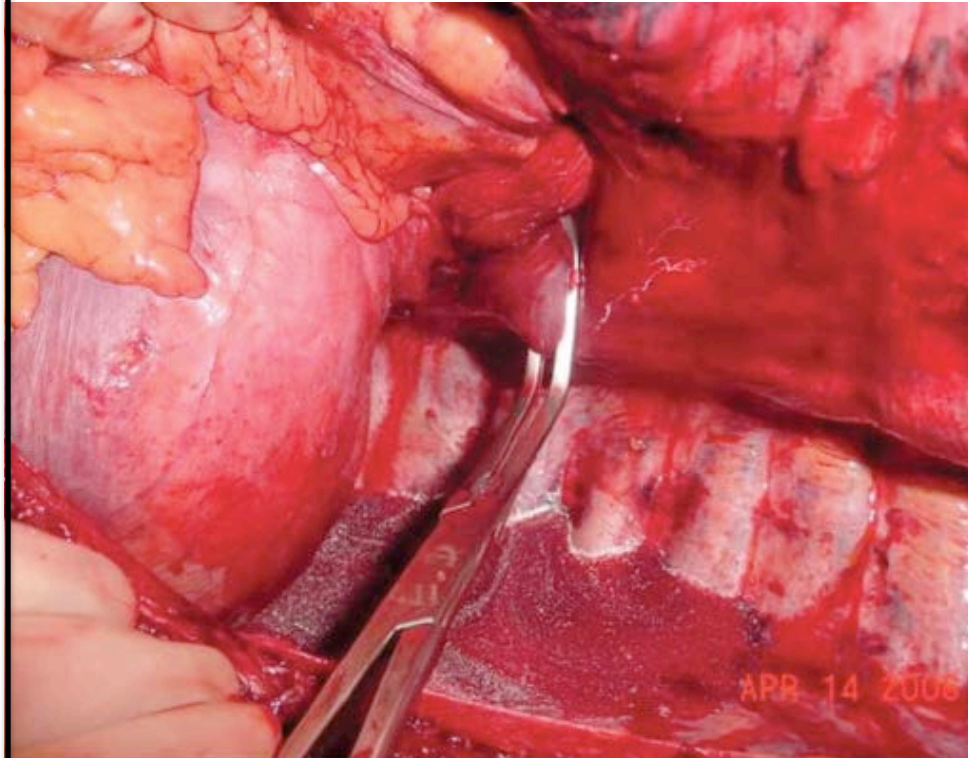
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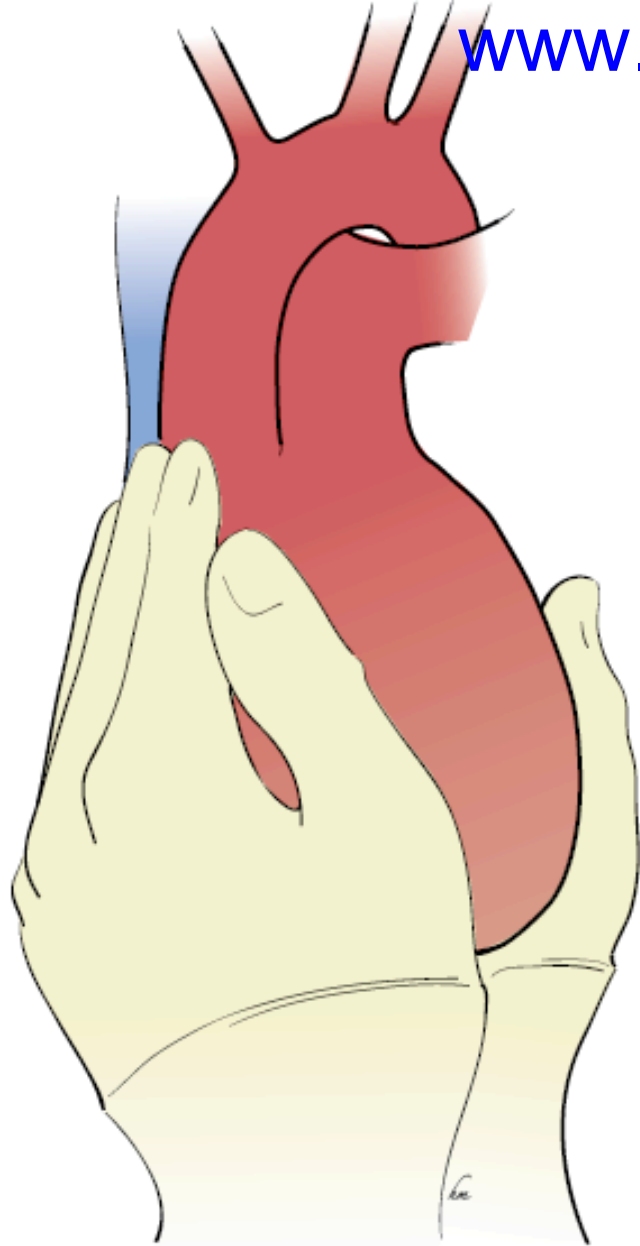
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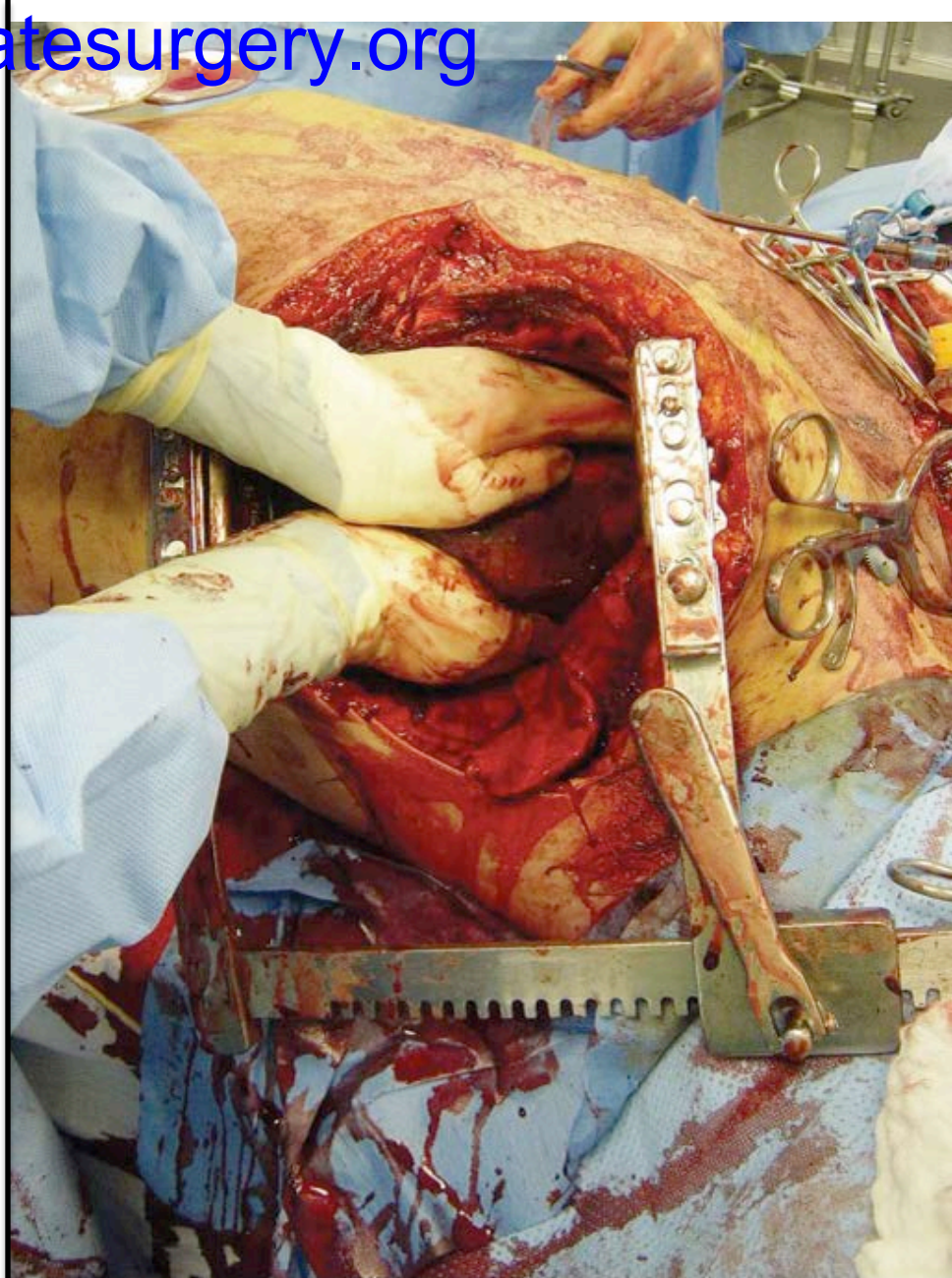
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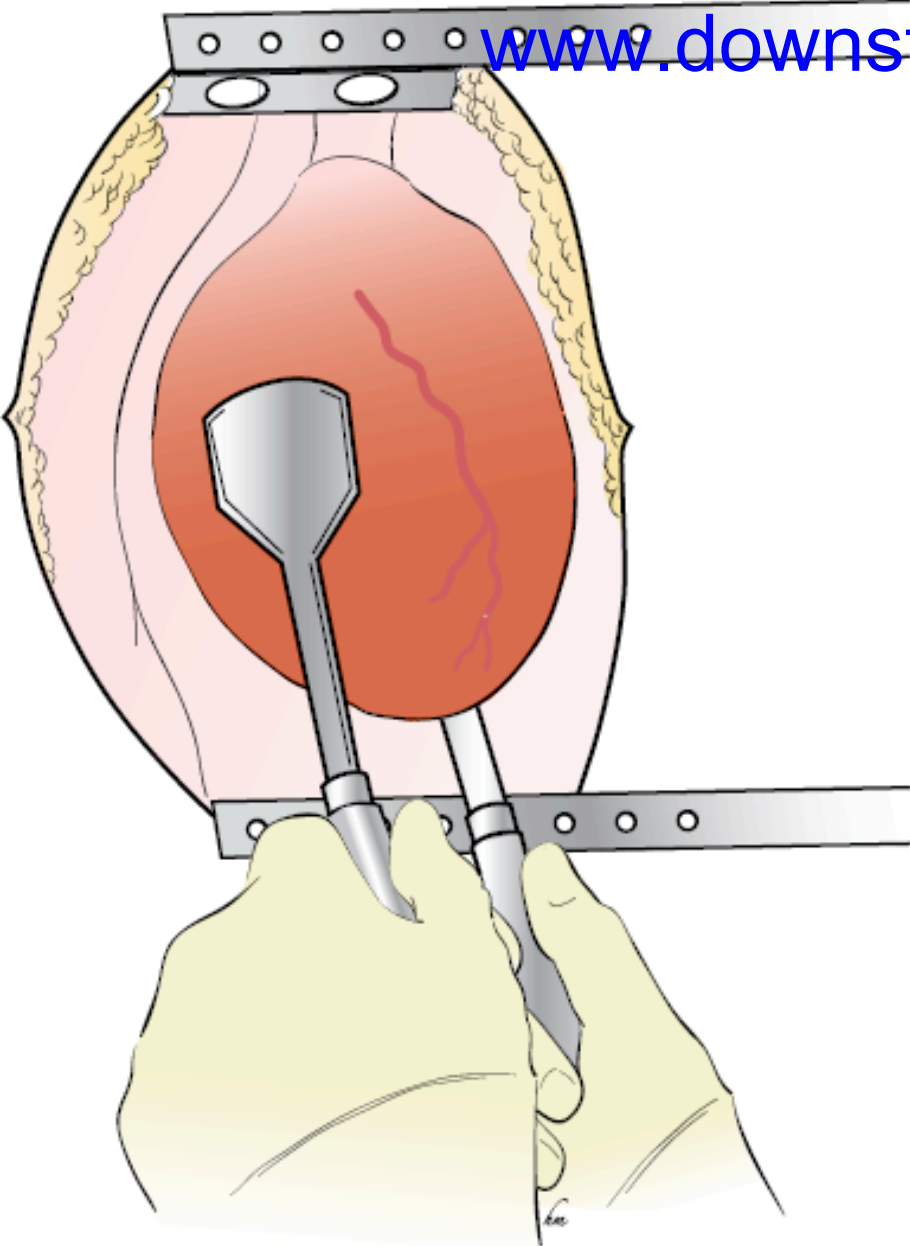
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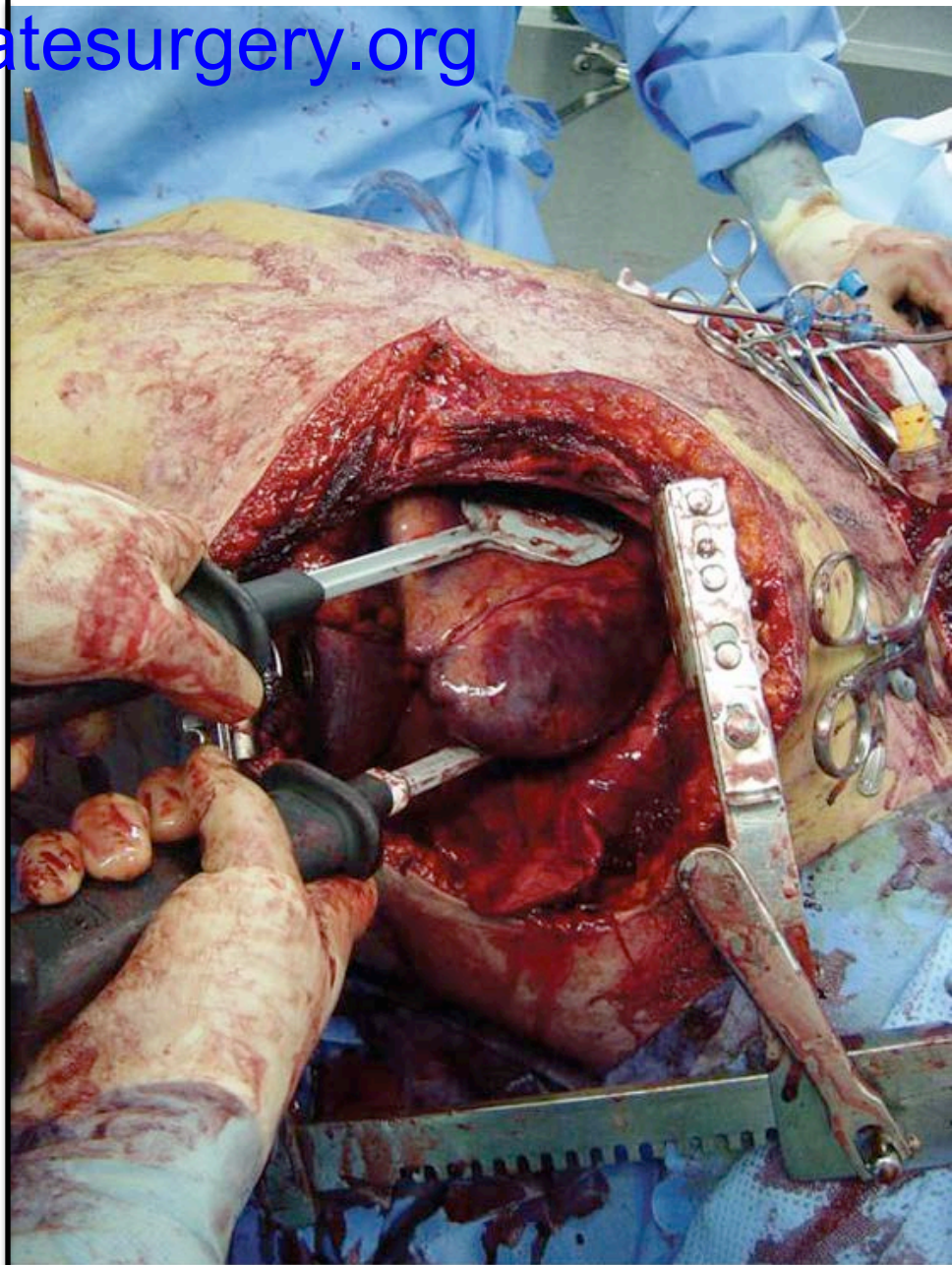
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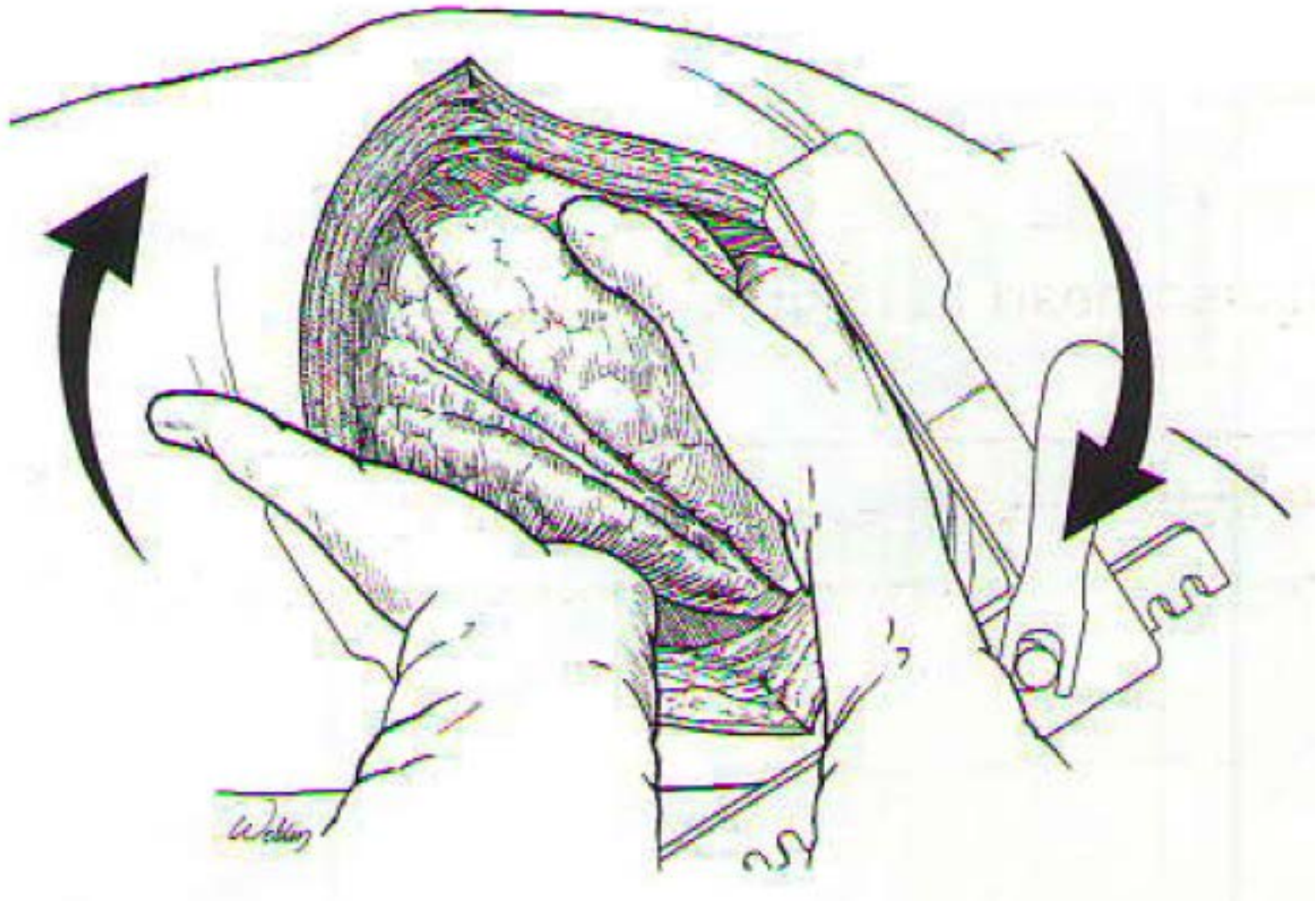


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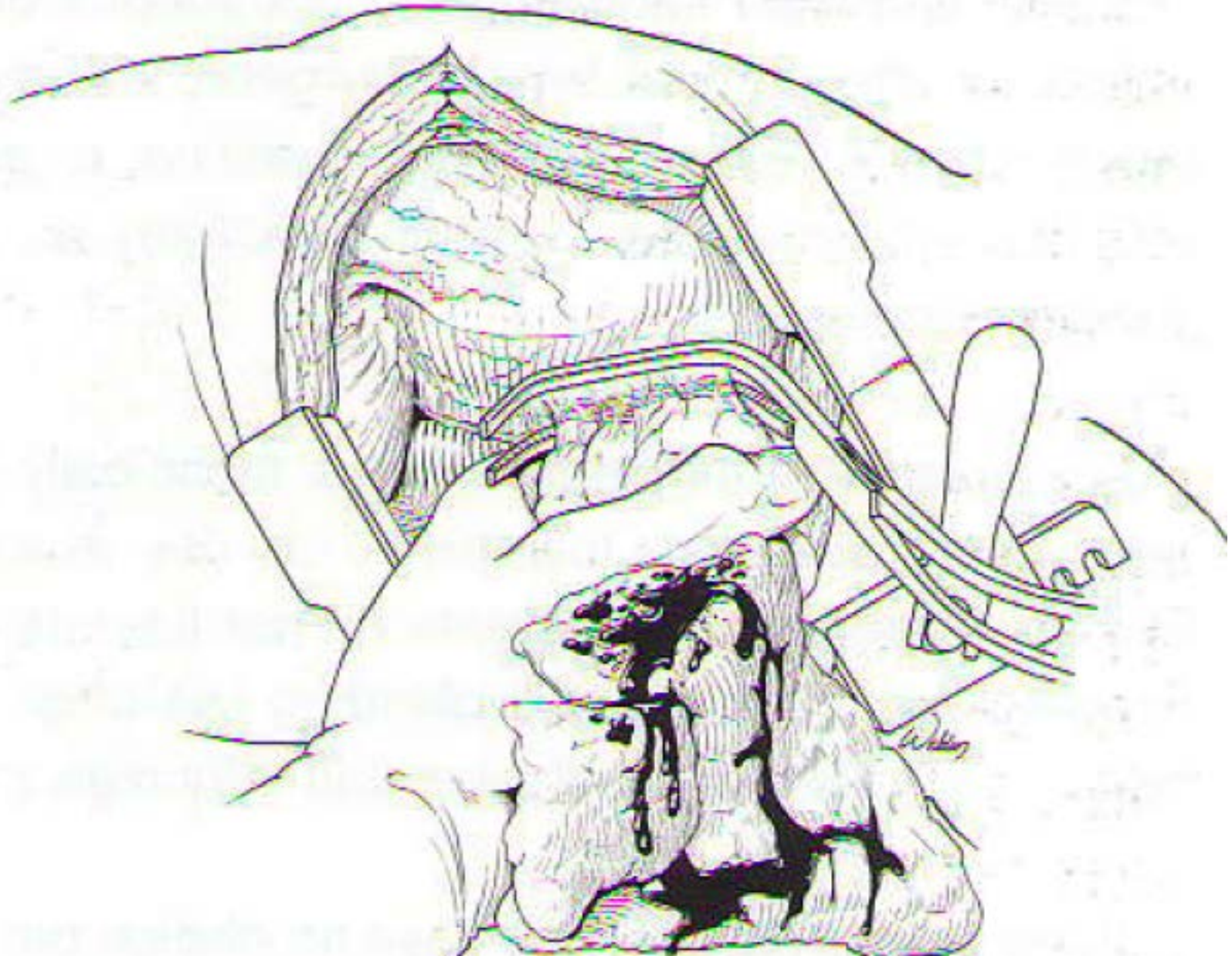
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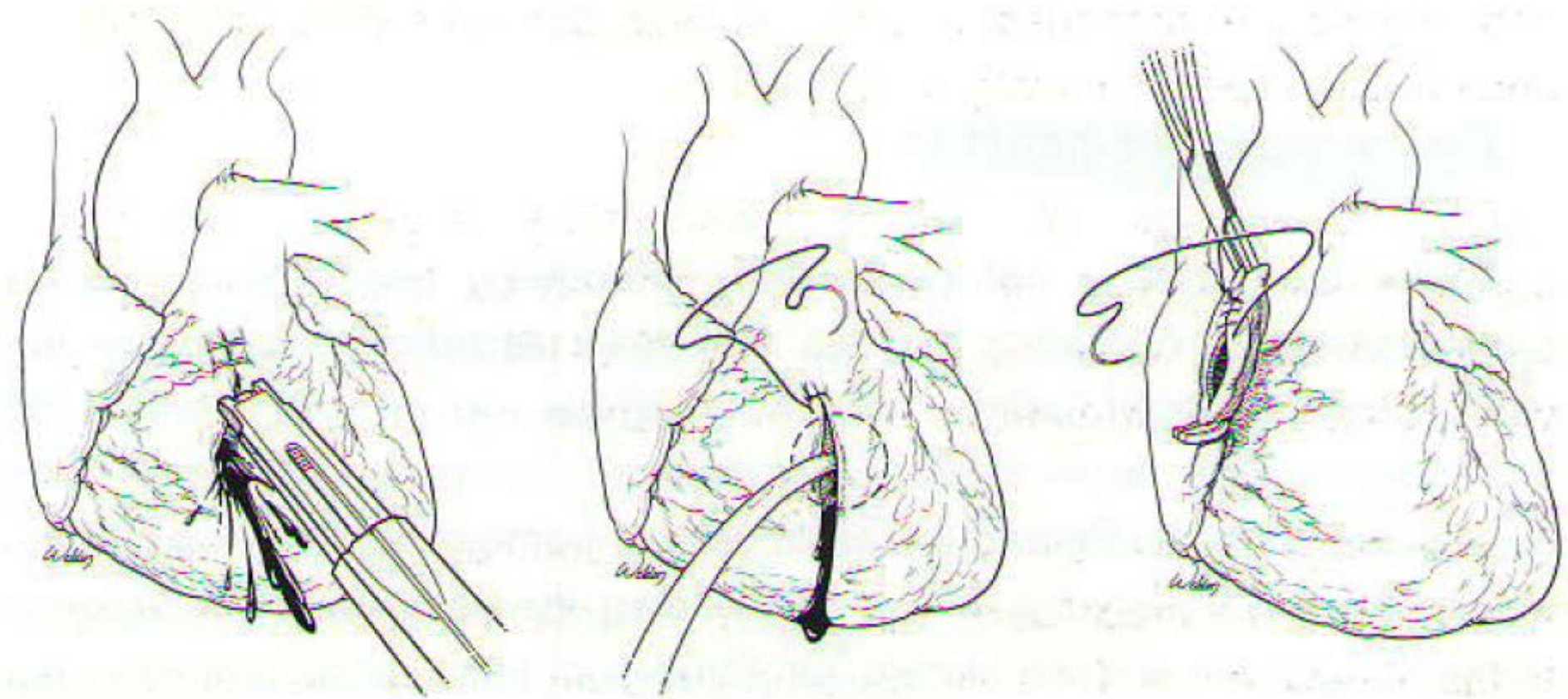
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Bleeding from the Lung



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Bleeding from the Lung

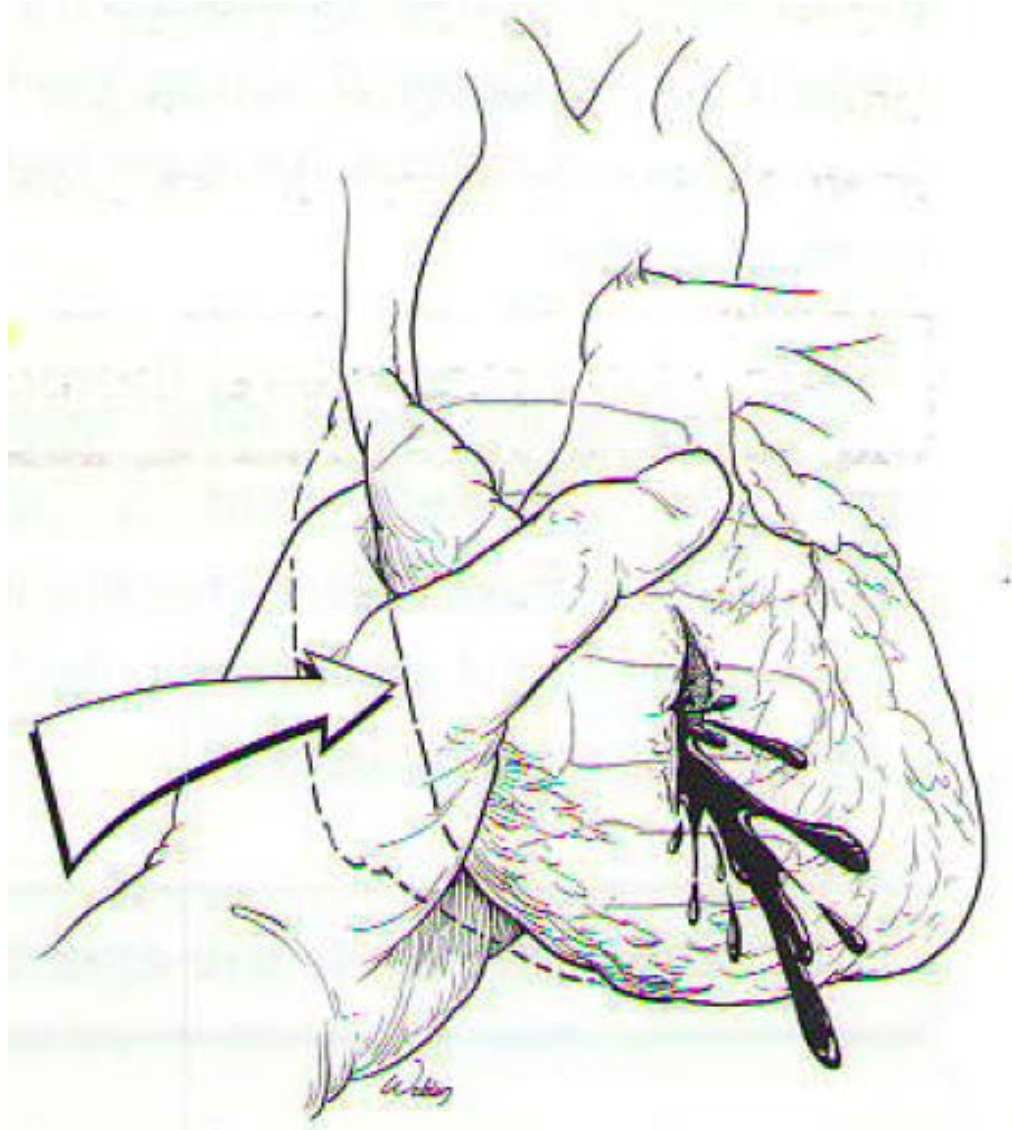


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Bleeding from the Heart

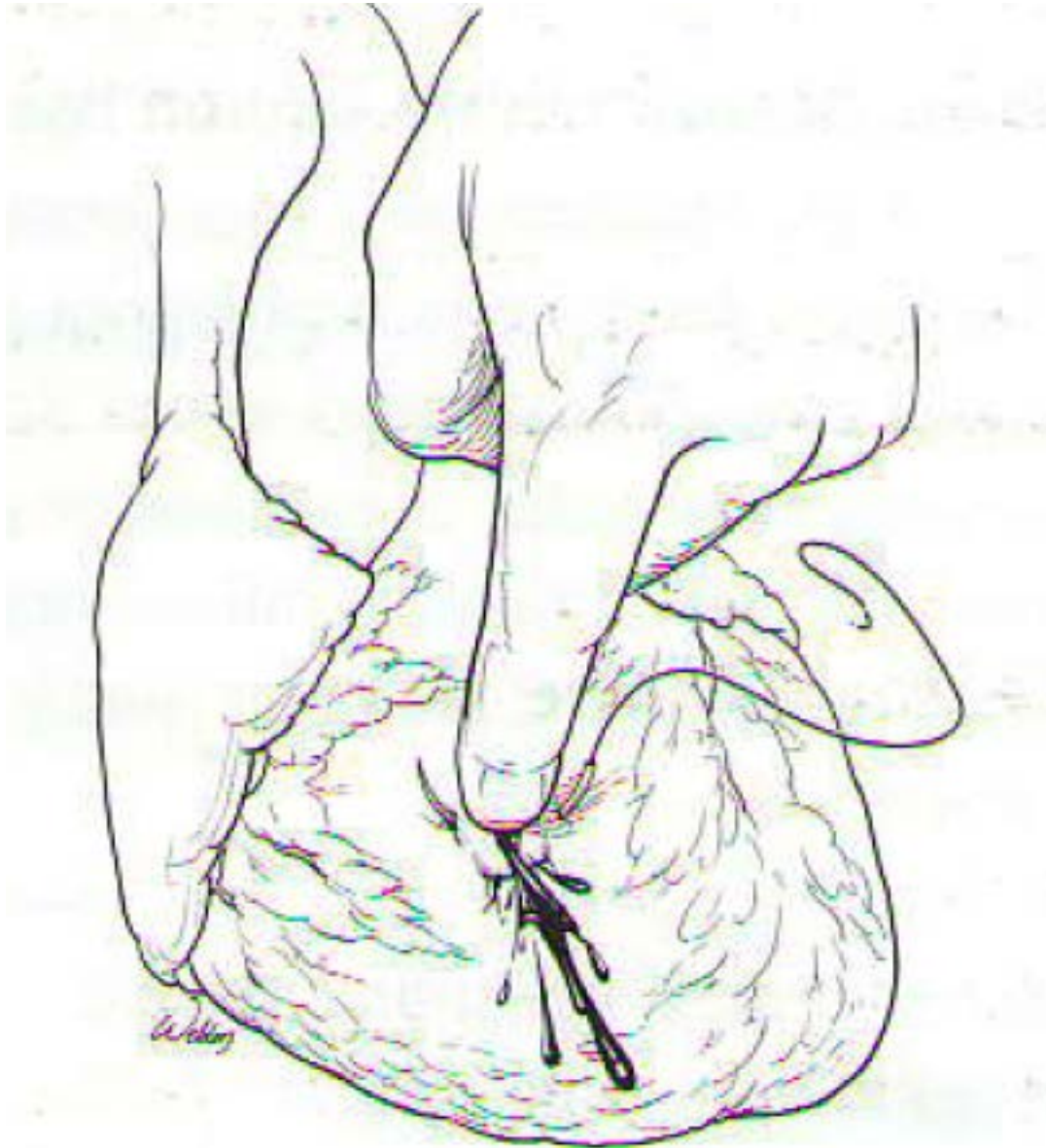


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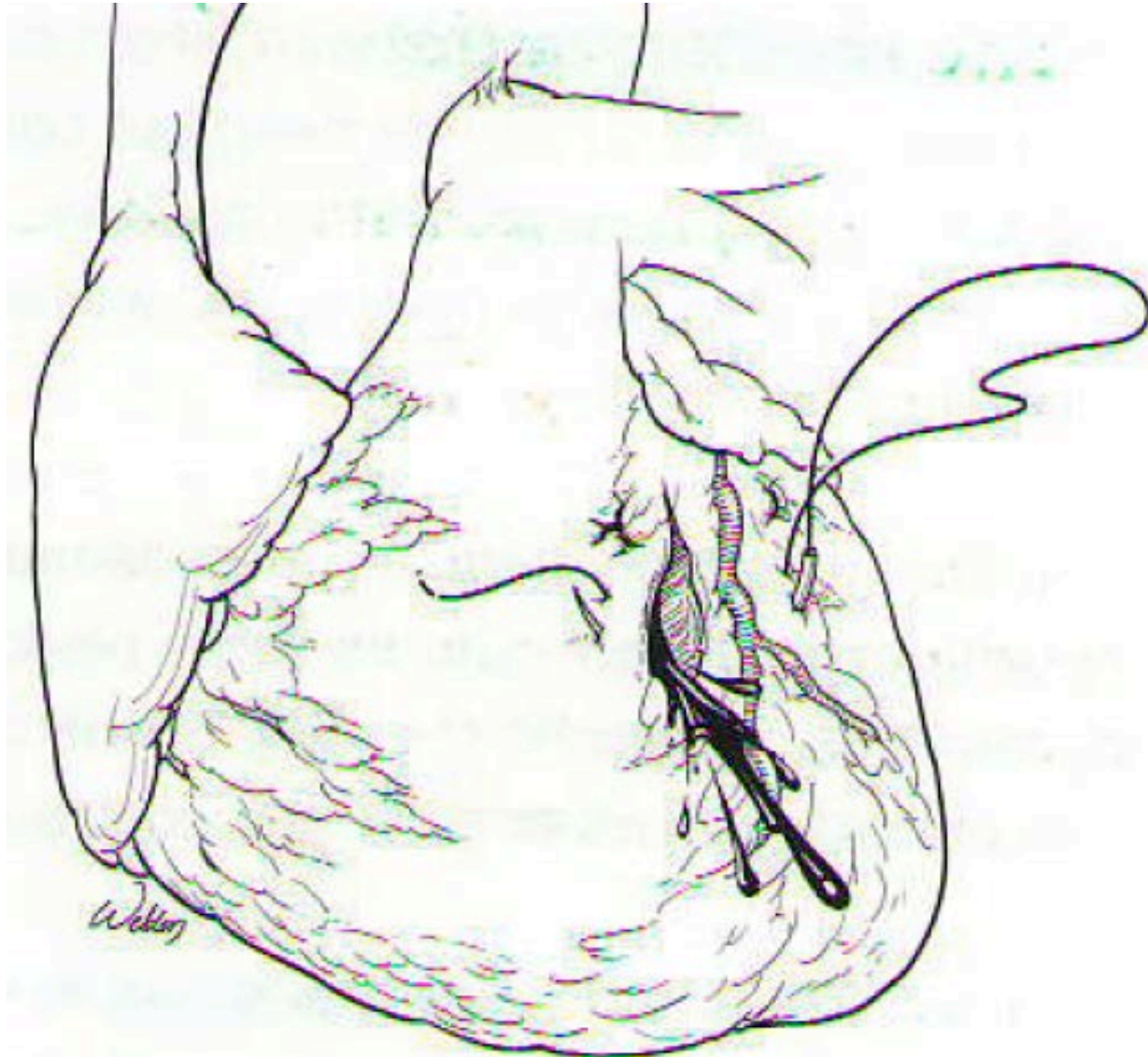
Bleeding from the Heart



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Video #1

Video #2

Procedural Complications

- Technical complications involve virtually every intrathoracic structure
- Risk to health care providers
 - 26% of acutely injured patients had evidence of exposure to HIV (4%), HepB (20%), HepC (14%)

Consequences of Aortic Cross-Clamping

- Placement of clamp
 - Causes tissue acidoses and increased oxygen debt
 - Hypoxia of distal organs, WBC and endothelium induces inflammatory mediators
 - Intestinal tolerance to normothermic ischemia is 30-45min
- Removal of clamp
 - Return of large volume of blood with low pH, high lactate and other mediators may be cardiodepressant
 - Impaired LV function, systemic oxygen utilization, coronary perfusion

Future Considerations

- Defining nonsalvageability
- Temporary physiologic hibernation
- Temporary mechanical cardiac support

Summary

- Best indicated to repair a simple injury in the thoracic cavity that is causing a serious physiologic insult
 - Penetrating trauma with CPR <15min
 - Blunt trauma with CPR <10min
- Key moves: release of pericardial tamponade, control of intrathoracic vascular or cardiac hemorrhage, open cardiac massage, temporary occlusion of the descending thoracic aorta

Questions

“Trauma code to CCT ...”

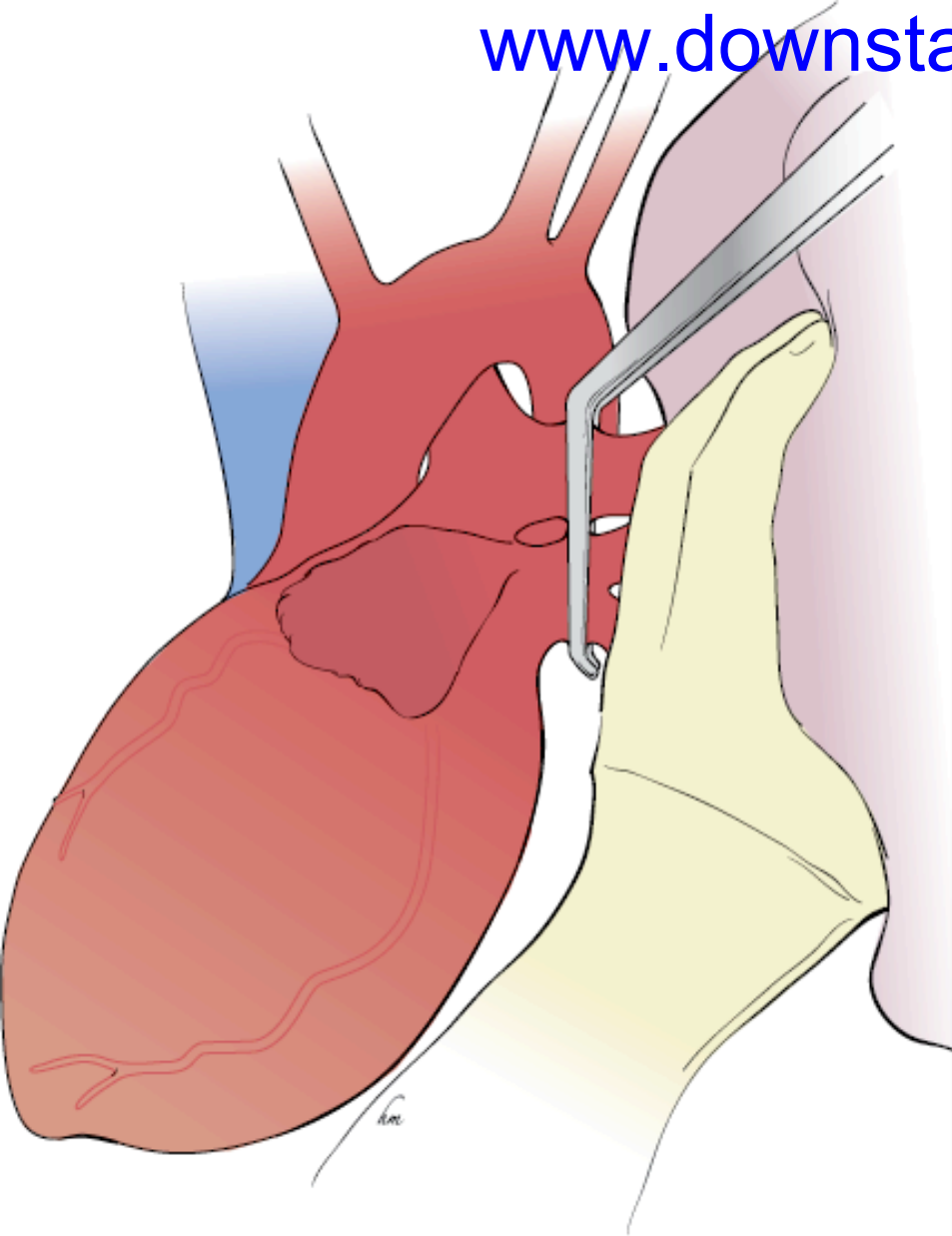
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Indications

- Salvageable postinjury cardiac arrest
 - Penetrating thoracic trauma with <15m of prehospital CPR
 - Penetrating nonthoracic trauma with <5m of prehospital CPR
 - Blunt trauma with <10m of prehospital CPR
- Persistent severe post-injury hypotension (SBP<60mmHg) due to:
 - Cardiac tamponade
 - Hemorrhage
 - Air embolism

Contra-Indications

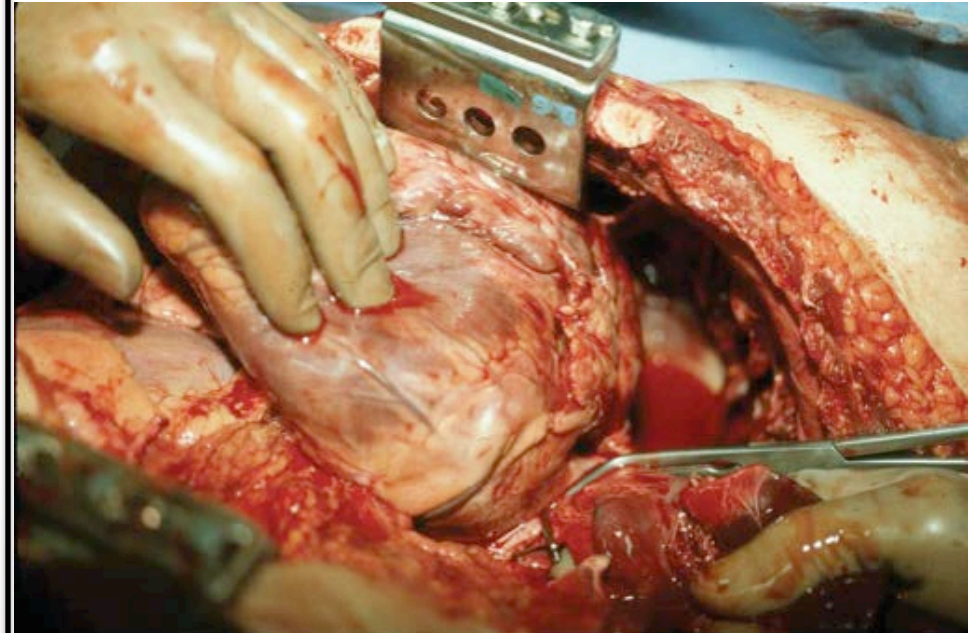
- CPR >15m following penetrating injury and no signs of life
- CPR >10m following blunt injury and no signs of life
- Signs of life = pupillary response, respiratory effort, or motor activity



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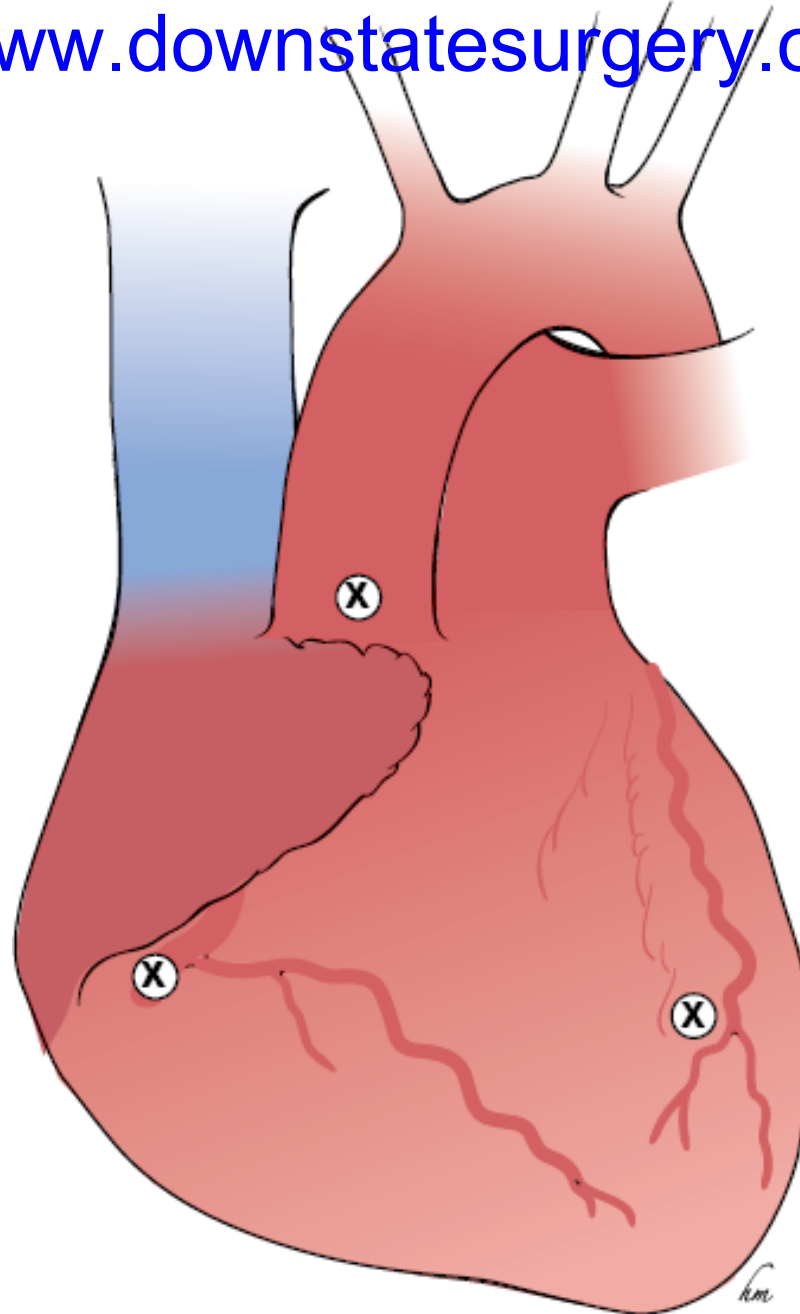
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