

# Management of Surgical Complications of Trauma Victims

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THE BUSOGA HEALTH FORUM

FEBRUARY 10 2023

# Outline

- The physiology of trauma
- A review of the ATLS principles
- Specific Organ system trauma management
- Trauma in unique populations
- Damage control resuscitation and Damage Control Surgery
- Massive Transfusion and Protocols
- The lethal triad

# The physiology of major trauma- shock

- Ultimately, all trauma leads to **decreased organ perfusion, cellular ischemia, and a cascade of edema and inflammation.**
- Once begun, inflammation becomes a disease process independent of its origin, and can lead to multiple organ failure and death even after a patient has been completely resuscitated

# Classification of Shock

- Hypovolemic:
  - Hemorrhagic
  - Non-hemorrhagic
- Cardiogenic
- Obstructive
  - Flow obstructive
  - Increased intrathoracic pressure
- Distributive:
  - Septic
  - Anaphylactic
  - Neurogenic

### Class of haemorrhagic shock

	I	II	III	IV
Blood loss (mL)	Up to 750	750–1500	1500–2000	> 2000
Blood loss (% blood volume)	Up to 15	15–30	30–40	> 40
Pulse rate (per minute)	< 100	100–120	120–140	> 140
Blood pressure	Normal	Normal	Decreased	Decreased
Pulse pressure (mm Hg)	Normal or increased	Decreased	Decreased	Decreased
Respiratory rate (per minute)	14–20	20–30	30–40	> 35
Urine output (mL/hour)	> 30	20–30	5–15	Negligible
Central nervous system/ Mental status	Slightly anxious	Mildly anxious	Anxious, confused	Confused, lethargic

# ATLS APPROACH

- Preparation and Triage
- Primary survey(ABCDEs) and resuscitation
- Adjuncts to Primary survey
- Consider need for patient transfer

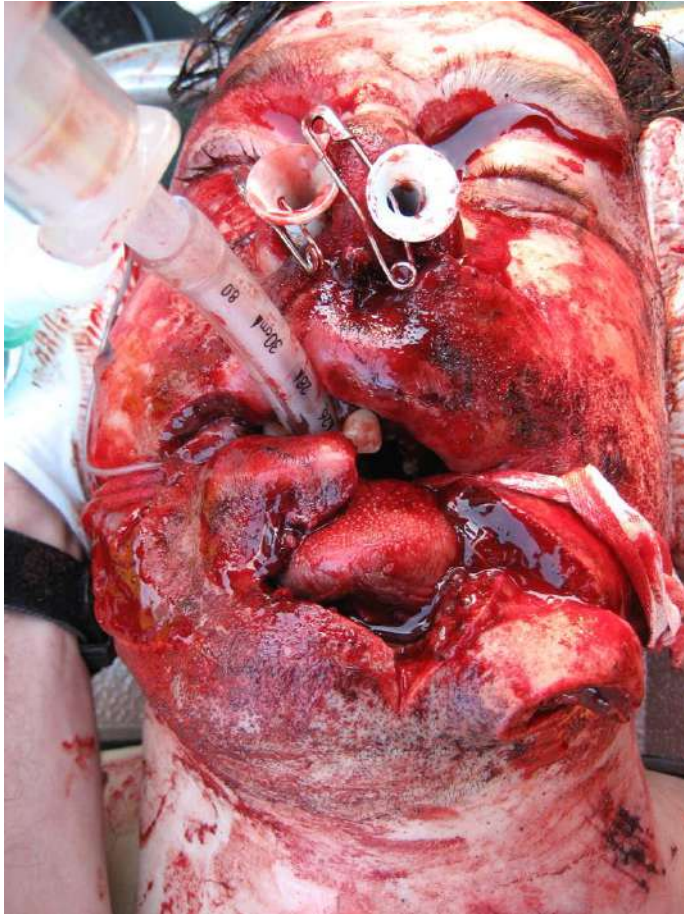
# ATLS APPROACH CONTD...

- Secondary Survey (AMPLE & Head to toe analysis +logroll)
- Adjuncts to the secondary survey
- Reassessment/Reevaluation
- Definitive care

# Definitive Care-surgical teams

- ABCDE Critical surgical interventions

# Airway



- The difficult airway- FBs, Secretions, Blood, hematomas, edema, facial bone fractures
- Facial trauma and the quick definitive airway (ETT/Trach)
- Surgical cricothyroidotomy

## SURGICAL CRICOTHYROTOMY: RAPID FOUR-STEP TECHNIQUE

1



If possible, extend the neck to better expose the trachea. Palpate the depression over the cricothyroid membrane with your nondominant hand.

2



Make a 1.5-cm single horizontal stab incision through the skin, subcutaneous tissue, and cricothyroid membrane.

3



Using the scalpel blade as a guide, pick up the cricoid cartilage with the tracheal hook and provide traction in the caudal direction to stabilize the trachea.

4



Place a No. 4 cuffed tracheostomy tube or a 6.0 cuffed endotracheal tube through the opening.

# Airway

- Pitfalls: - dislodge, deflated balloons

Management: Reassessment

- Uniquely fatal: Tracheobronchial tree injuries

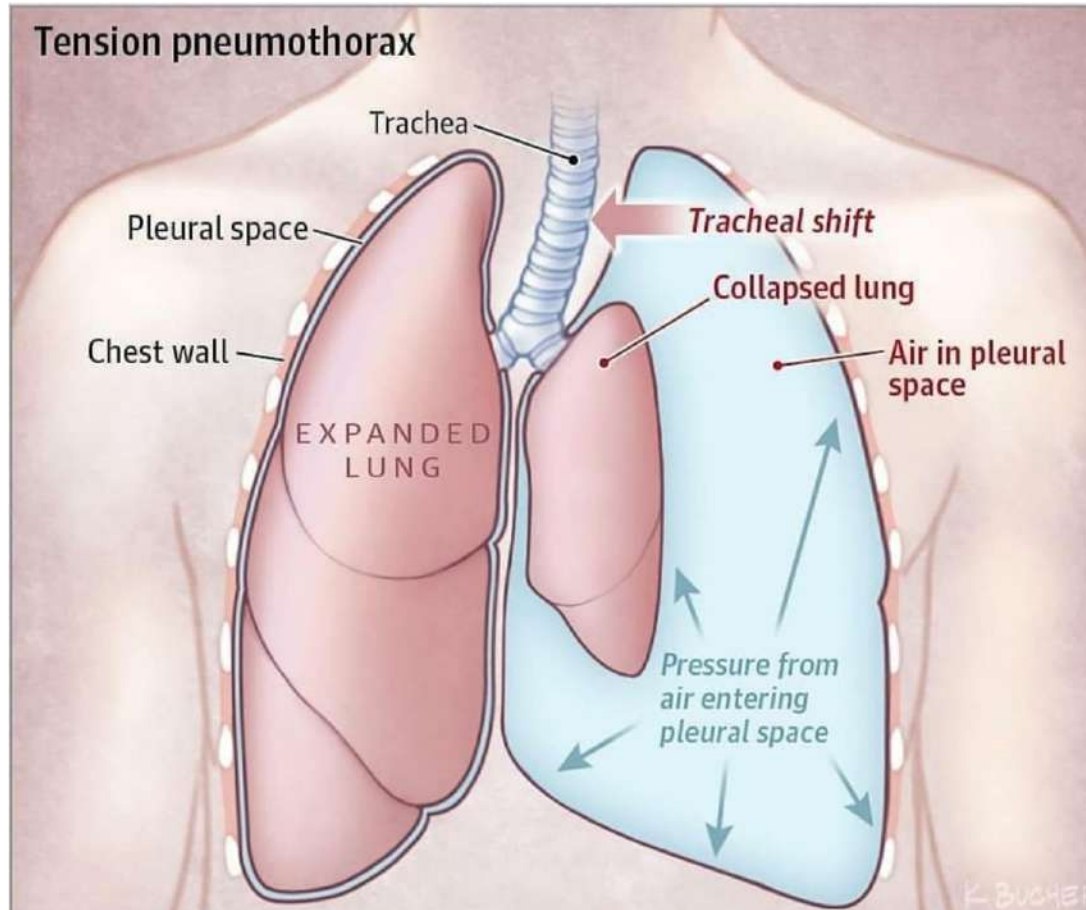
# chest trauma-what can go wrong?

- common chest trauma injuries including:
  - Pneumothorax (simple, tension, open)
  - Hemothorax
  - Flail Chest & Pulmonary contusion
  - Cardiac Tamponade
  - Tracheobronchial tree injury
  - Aortic Disruption
  - Diaphragmatic injury
  - Esophageal injury

# Chest trauma- pathophysiology

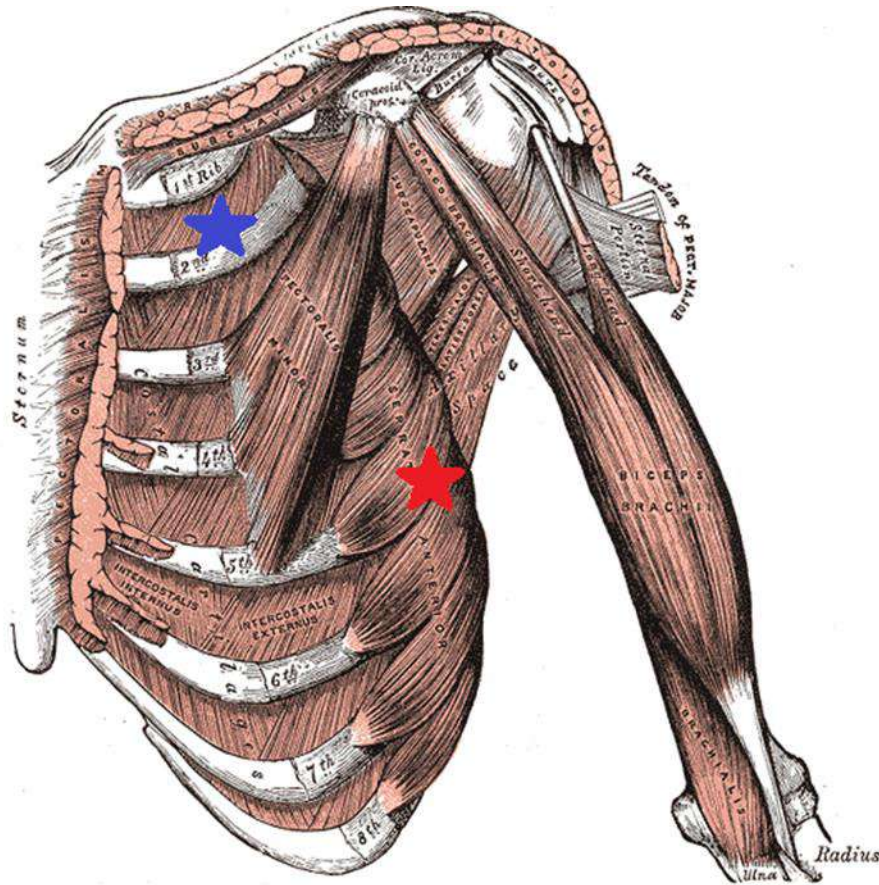
- Chest injuries often result in hypoxia, hypercarbia, and acidosis.
- Hypovolemia (blood loss), pulmonary ventilation/perfusion mismatch (contusion, hematoma), and changes in intrathoracic pressure (tension pneumothorax) can cause tissue hypoxia which leads to metabolic acidosis.
- Hypercarbia can lead to respiratory acidosis following inadequate ventilation due to changes in intrathoracic pressure relationships, poor ventilation (pain due to rib fractures) and depressed level of consciousness

# Tension Pneumothorax



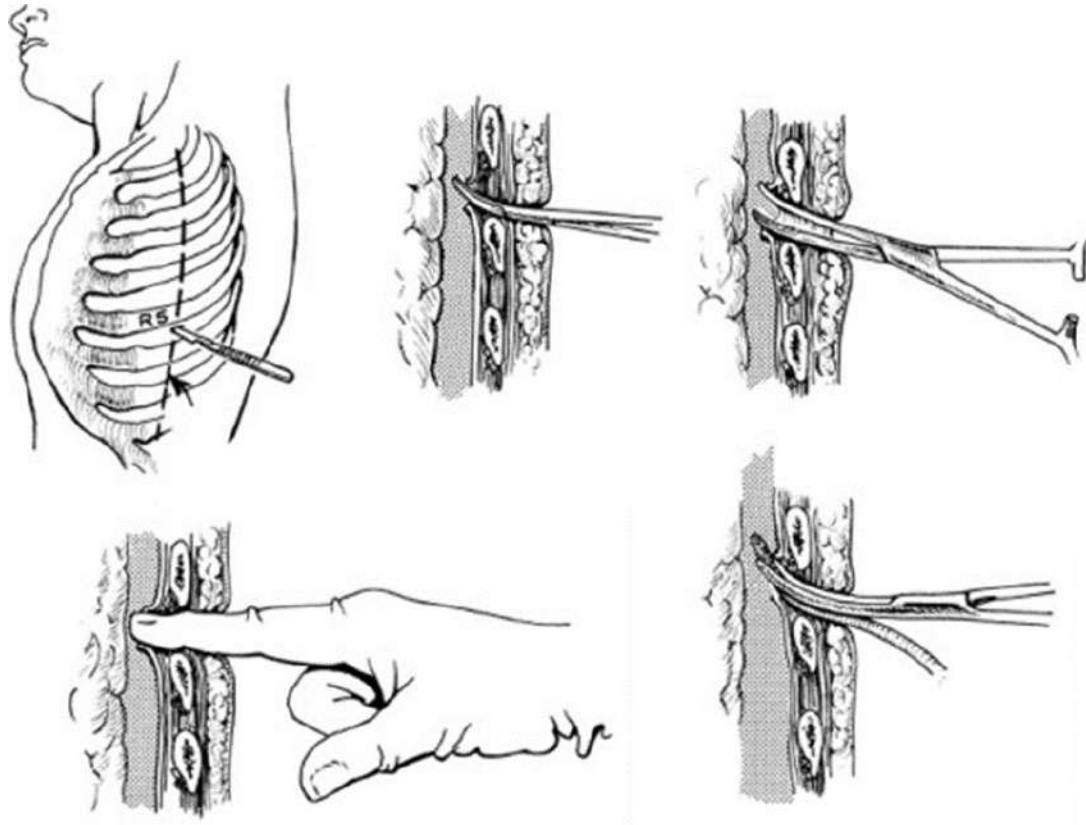
- Chest pain
- Respiratory distress/ Air hunger
- Tracheal deviation away from side of injury
- Distended neck veins
- Hyperresonant percussion
- Unilateral breath sounds
- Shock physiology: tachycardia, hypotension
- Cyanosis (late)

# Management- Most chest injuries chest tube



- 2<sup>nd</sup> or 5<sup>th</sup> intercostal space- large bore cannula
- Chest tube in 5<sup>th</sup> ICS space just anterior to midaxillary line

# Chest Tube



- Make incision  $\frac{1}{2}$  to 1 interspace level below entry site to angle tube placement
- Tunnel through subcutaneous tissue and muscle with curved clamp
- Bluntly puncture through parietal pleural in a controlled fashion
- Insert finger and palpate lung parenchyma

# Open Pneumothorax Treatment:

Close defect with sterile occlusive dressing

- Any occlusive dressing (ex: petroleum gauze, plastic wrap) can be used as a temporary measure

Dressing should be taped securely on three sides

- The open end allows air to escape from the pleural space – do NOT tape on all edges or air can accumulate in the thoracic cavity causing a tension pneumothorax

Place a chest tube in a different

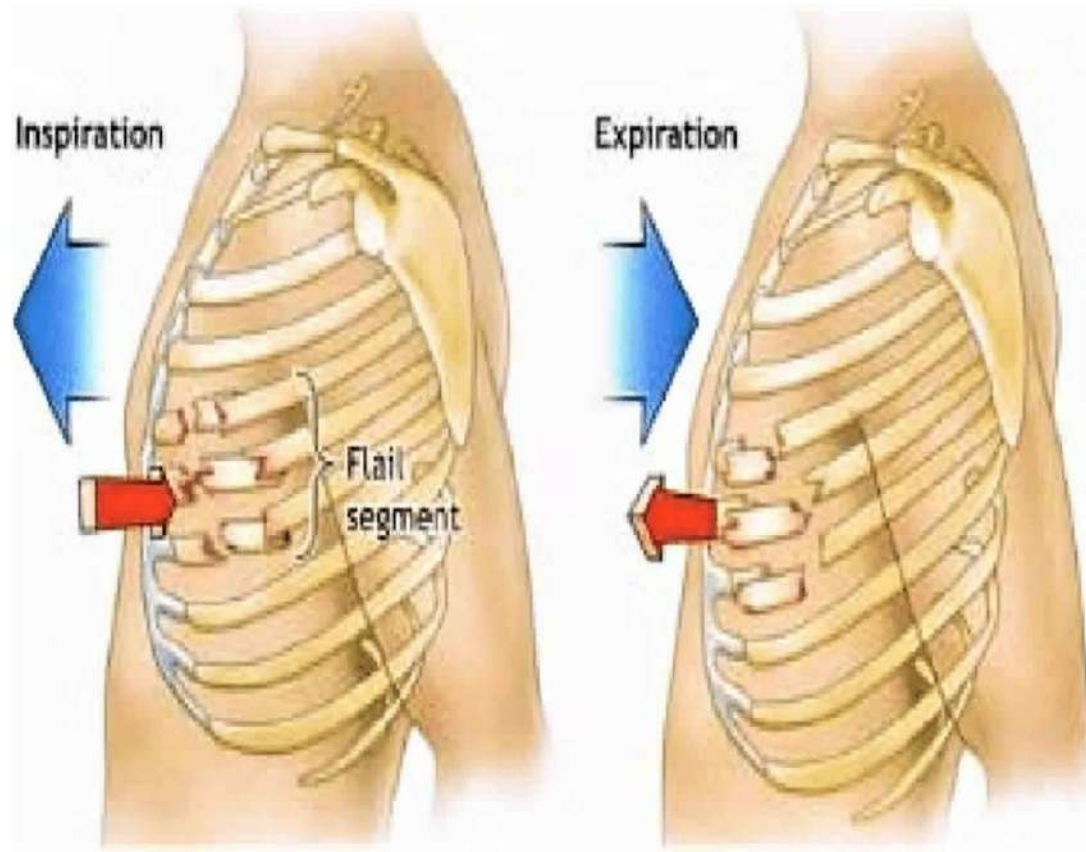
location than the wound as soon as possible

Patient may need intubation and ventilation

Surgery consult for closure of wound



# Flail chest- the sucking chest wound



- Ensure adequate oxygenation
- Judicious fluid administration
- Pain control to improve ventilation
- Oral analgesia
- Intercostal nerve blocks
- Intrapleural, extrapleural, epidural anesthesia
- Short term intubation and ventilation may be necessary if respiratory compromise

# Massive Hemothorax

- Rapid Accumulation of >1500mL of blood in chest cavity
- Clinical Findings
  - Dullness to percussion
  - No breath sounds on affected side
  - Decrease chest movements
  - Hypotension and shock with severe blood loss
  - Hypoxia, arrhythmias, accompanying thoracic injuries
- Most commonly occurs with penetrating chest wound but can also result from blunt trauma
- Management- chest tube
- Consider need for exploratory thoracotomy by CTS if:
  - >1500 mL blood immediately
  - >200 ml/hr for 2-4 hours
  - Persistent need for blood transfusions due to ongoing bleeding

# Cardiac tamponade

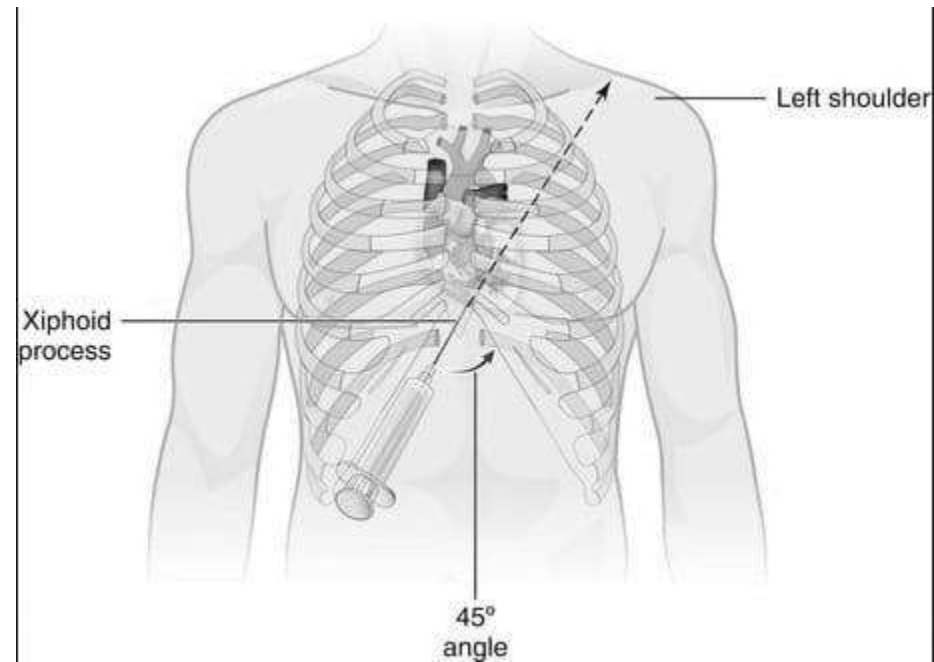
- blood accumulates in the pericardial space
- Can develop rapidly or slowly
- Clinical features
- Beck's Triad: hypotension, jugular venous distension, muffled heart sounds
- Kussmaul's sign: rise in venous pressure with inspiration
- Can result in PEA
- Can have similar signs to tension pneumothorax

EFAST

Surgery

- Pericardiocentesis
- Pericardial window

# Tamponade



# Other lethal injuries

- Tracheobronchial tree injuries- hemoptysis, ephysemas
- Traumatic aortic disruptions-survivors with haematoma
- Esophageal rupture- endoscopy dx
- Diaphragmatic rupture- esp left side: herniation, strangulation
- Lower rib fractures and associated Abdominal injuries

# Abdominal Injuries

Organ Injury	Frequency of Occurance (%)
Spleen	30
Liver	25
Kidney	20
Small Bowel	6
Diaphragm	4
Bladder	4
Colon	3
Abdominal Vessels	2
Other	6

# Stereotypical Patterns of Injury

Mechanism of Injury	Pattern of Injury
Seat Belt – lap and sash belts	Jejunal Perforation
Seat Belt – lap belt only	Duodenal or Pancreatic Injury
Side Impact	Hepatic or Splenic Injury
Sporting Injury	Splenic Laceration
Bicycle Handle Bar Injury	Pancreatic Injury
Animal (Cow/ Horse) Kick	Small Bowel Perforation



# Penetrating Abdominal Injury

- Stab wounds:
  - Injury generally confined to the tract of the weapon at wounding however
- Gunshot wounds:
  - Injury dependent on type of weapon (pistol vs. shotgun), size of projectile, distance from assailant
  - High energy rifles (i.e. military weapons) produce cavitation resulting in wide tract of destruction and contamination

# Assessment-C

- Inspection
- Expose patient from lower chest to upper thighs
- Inspect back (bullet wound pictured)



# Abdominal Assessment

## Palpation/Percussion

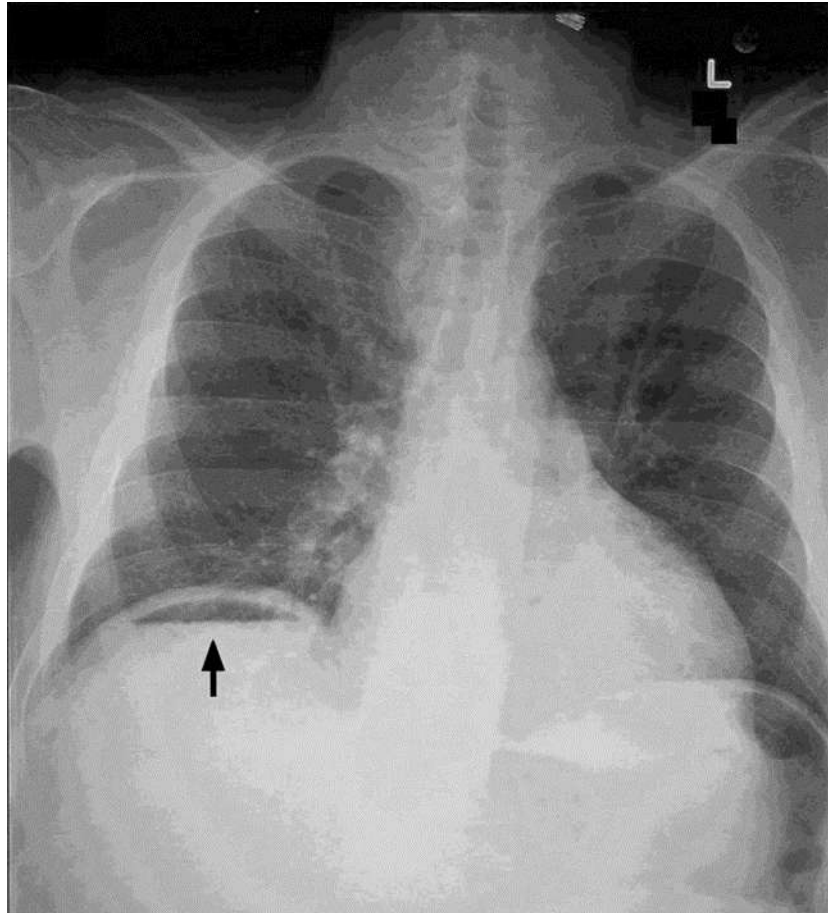
- Guarding – voluntary (normal reaction) vs. involuntary (peritoneal irritation)
- Superficial, deep or rebound tenderness
- Look for increased tympany (pneumoperitoneum)
- Useful to detect an enlarged solid viscus or a distended bladder

## Auscultation

- Rarely helpful in trauma assessment

PELVIC SPRING TEST- Open book pelvic fracture

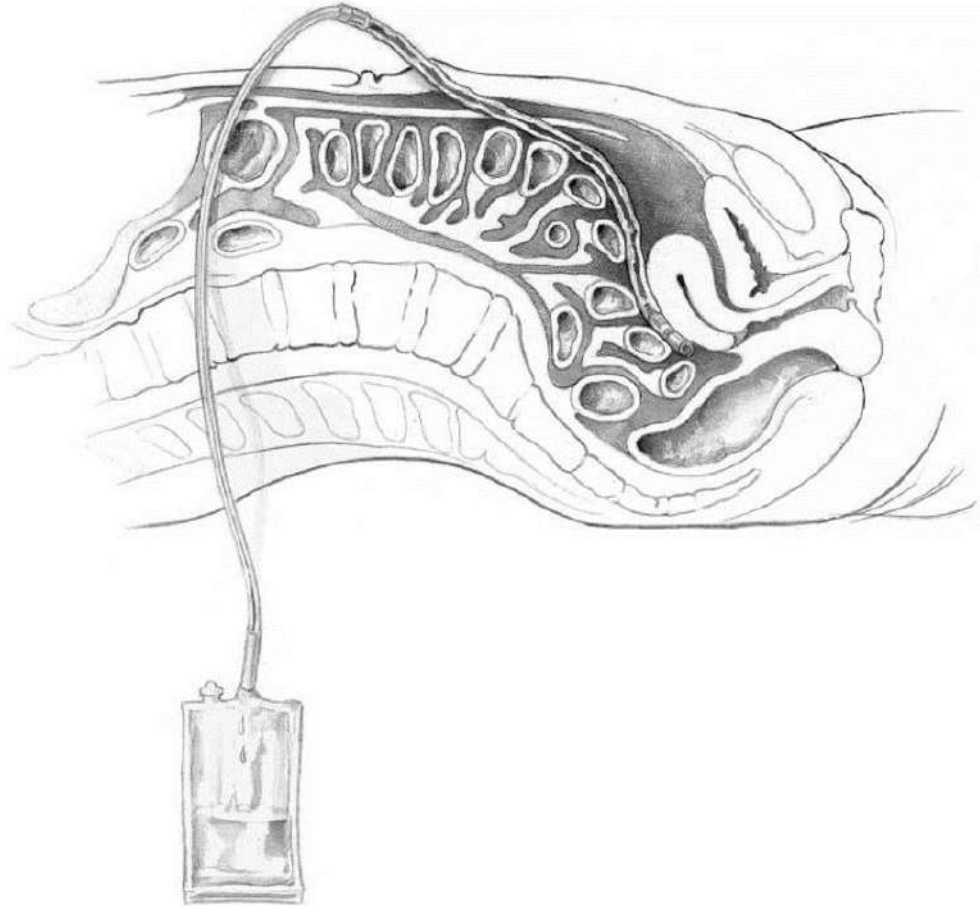
# Useful adjuncts



## Focused Assessment with Sonography for Trauma (FAST)



# Useful adjuncts



# Abdominal injuries- laparotomy

- Diaphragmatic rupture
- Solid organ injuries- spleen, liver, kidneys, pancreas
- Haemoperitoneum
- Hollow organ injuries
- Mesenteric injuries
- The expanding retroperitoneal haematoma
- Intraperitoneal bladder rupture
- Pelvic fracture

# Damage control surgery (DCS)

- Very sick rapidly deteriorating patient
- The non responder
- Damage control surgery (DCS) is a concept of abbreviated laparotomy, designed to prioritize short-term physiological recovery over anatomical reconstruction in the seriously injured and compromised patient.

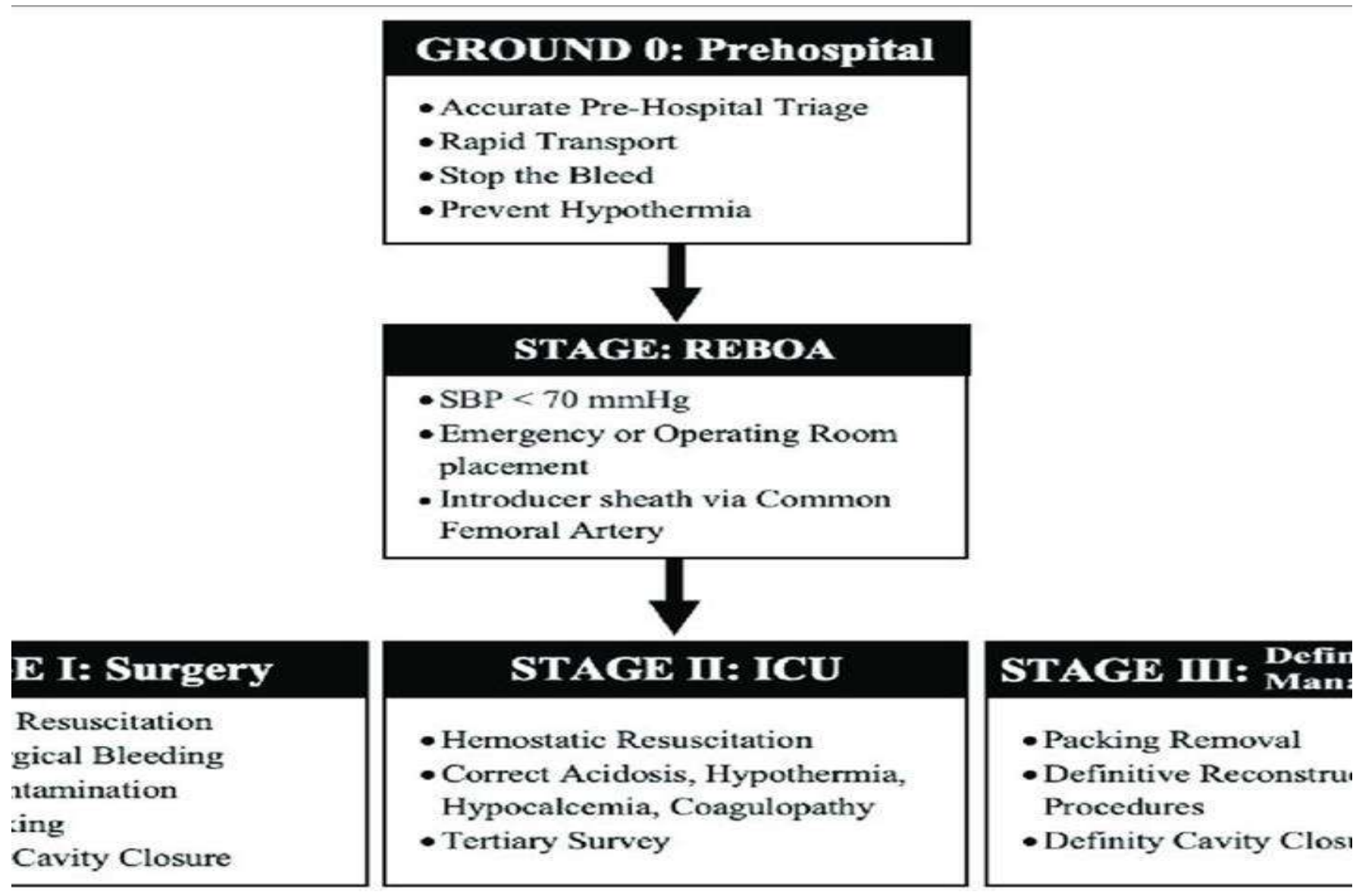
# DCS

## **Thoracic trauma**

- Penetrating thoracic wound and systolic blood pressure  $<90$  mm Hg
- Pericardial fluid on surgeon-performed ultrasound after blunt or penetrating thoracic trauma
- S/p emergency department thoracotomy for penetrating thoracic wound

## **Abdominal or pelvic trauma**

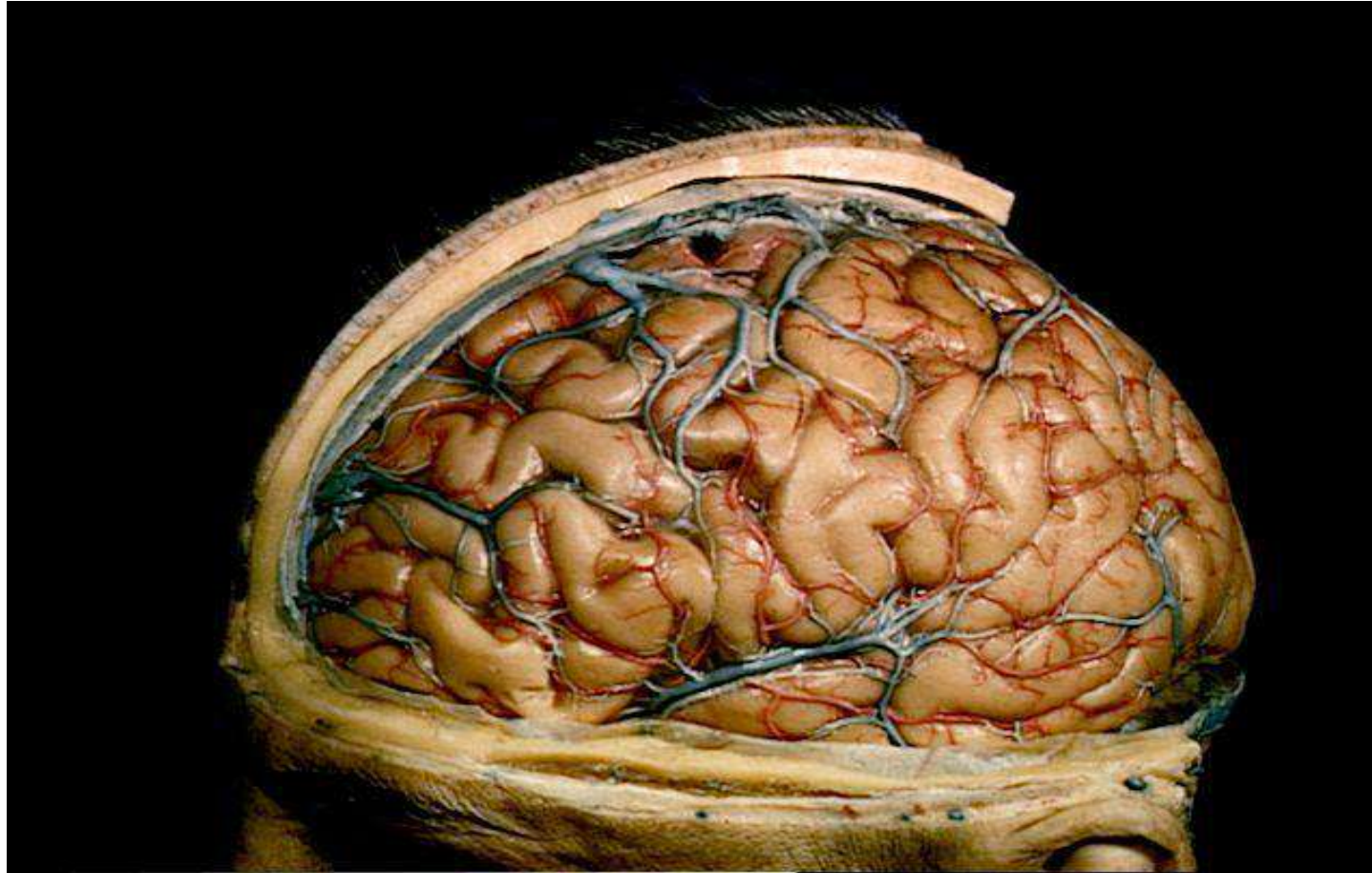
- Penetrating abdominal wound and systolic blood pressure  $<90$  mm Hg
- Blunt abdominal trauma, systolic blood pressure  $<90$  mm Hg, and peritoneal fluid on surgeon-performed ultrasound or gross blood on diagnostic peritoneal tap
- Closed pelvic fracture, systolic blood pressure  $<90$  mm Hg, and peritoneal fluid on surgeon-performed ultrasound or gross blood on diagnostic peritoneal tap
- Open pelvic fracture



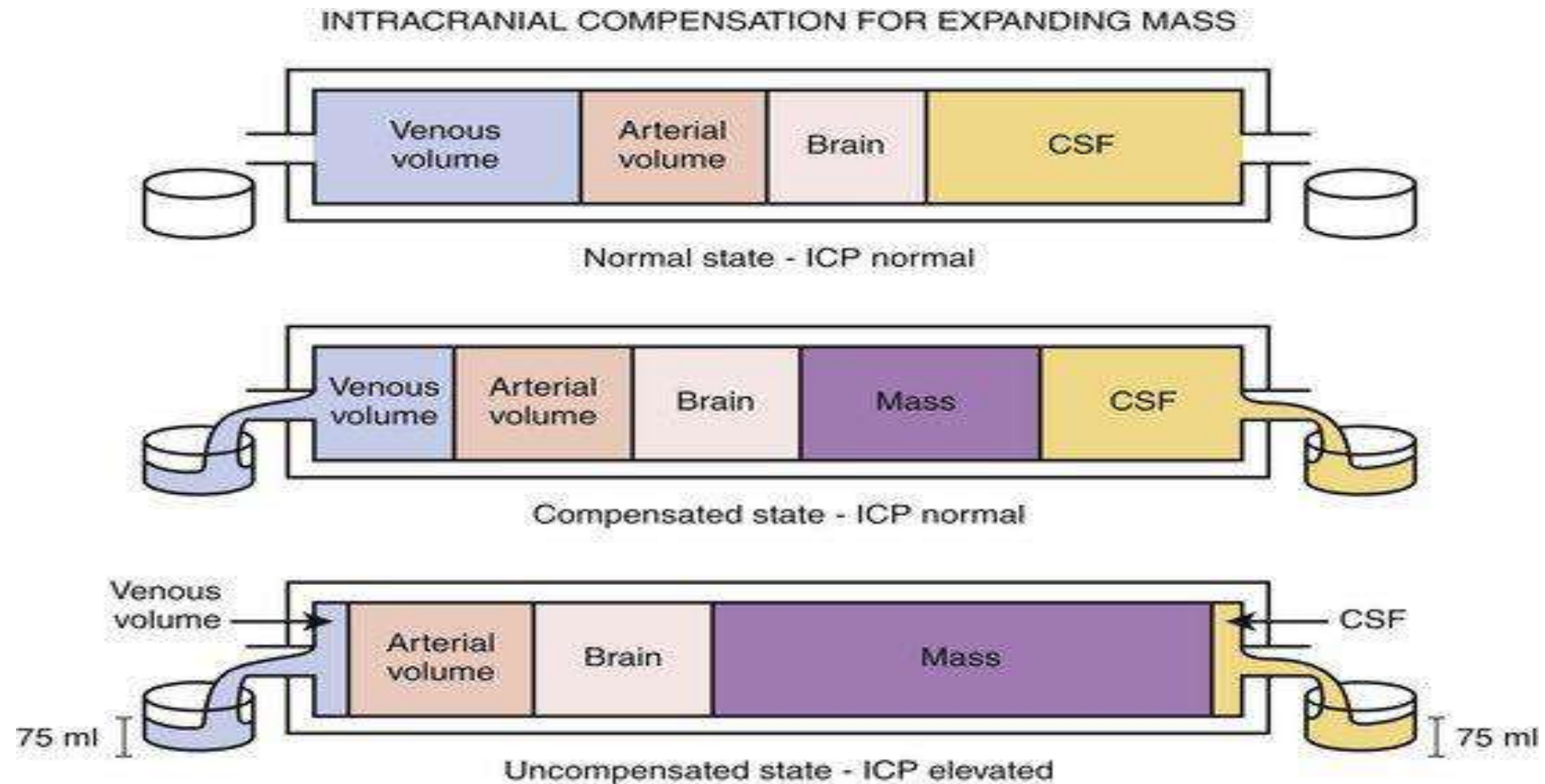
# DCS

- Abdomen: Quadrant packing, soiling control, Pringle maeuvre
- Pelvic Peritoneal packing

# Head Trauma- Anatomy



# Pathophysiology- Monroe Kellie



Pathophysiology- cerebral perfusion pressure

$$\text{CPP} = \text{MAP} - \text{ICP}$$

# Injuries

- Scalp: lacerations
- Skull: depressed skull fractures, cranium, skull base
- Meninges: epidural, subdural, SAH
- Brain: DAI, Intracerebral

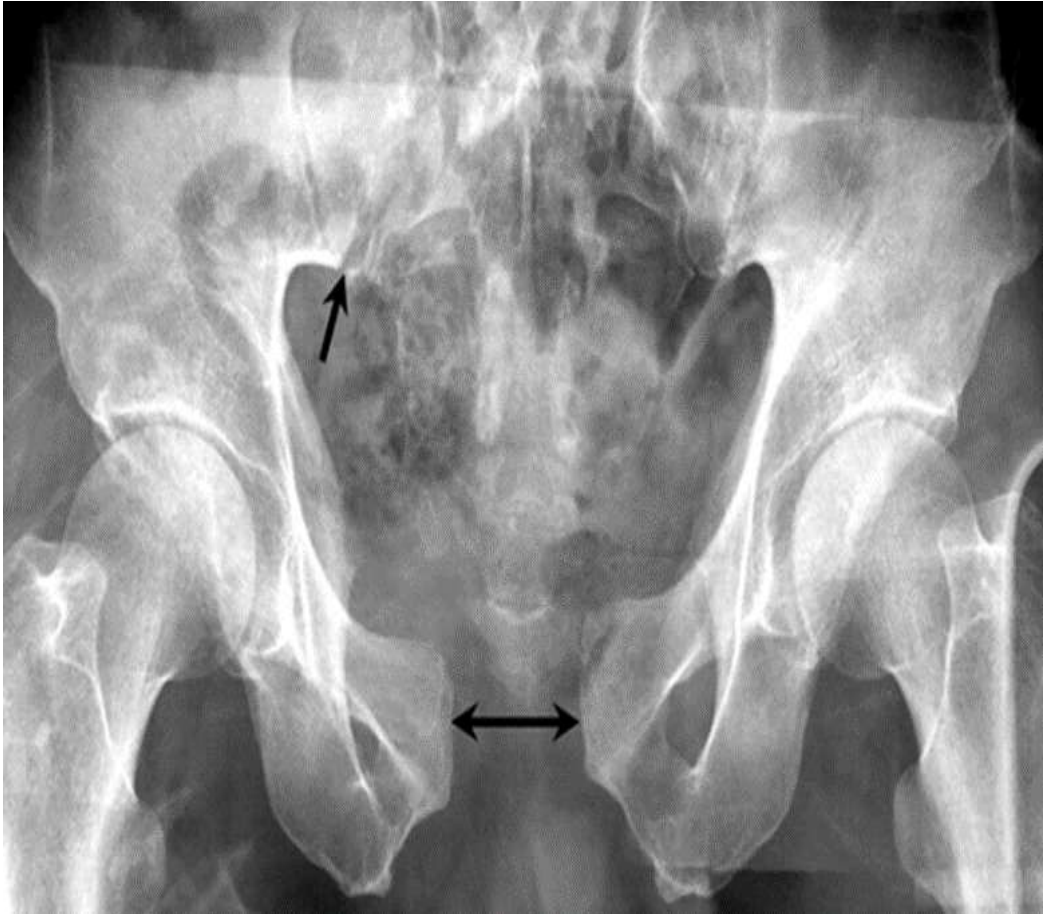
# Haematomas



# Surgical Interventions- Neurosurgeon

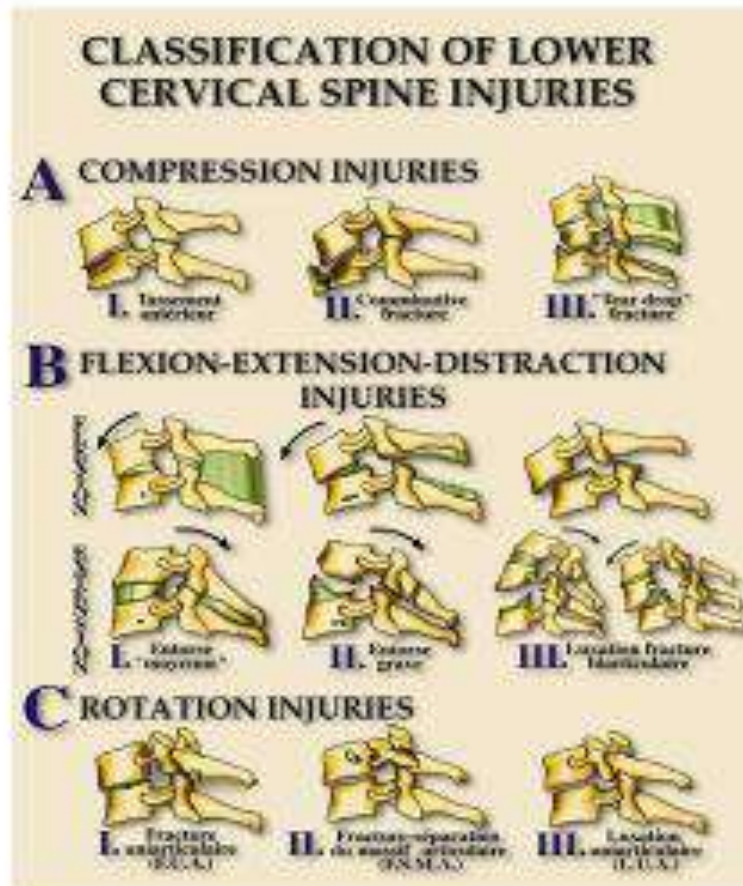
- STS- Major for scalp lacerations
- Skull elevation
- Craniotomy
- Craniectomy
- Achieving haemostasis (pre, intra and post op)
- Other supportive care

# Masculoskeletal Trauma



# Spinal Trauma Mechanisms of Injury

- **Compression**
  - Vertebral body fracture
  - Disc herniation
  - Epidural hematoma
- **Flexion**
  - Tearing and disruption of ligaments
  - Often unstable fractures
- **Extension**
  - Tearing of anterior longitudinal ligament
  - Separation of vertebral bodies
  - Disc rupture, avulsion of vertebral body
- **Rotation**
  - Associated with unilateral facet dislocation



# Life-threatening Extremity Injuries:

- Major arterial hemorrhage
  - Control hemorrhage – careful use of tourniquet may be helpful/ lifesaving
  - Surgical consult
  - Assess and re-assess pulses frequently
  - Direct pressure if open wound
  - Open wounds with fracture ->realign, splint, direct pressure
  - Fluid/ blood resuscitation
- Crush Syndrome (Traumatic Rhabdomyolysis)
  - Direct muscle injury -> muscle ischemia -> cell death -> release of myoglobin -> elevated creatine kinase -> acute renal failure -> DIC
  - Lab tests: myoglobin assay, electrolyte levels, lactate
  - Aggressive fluid repletion: maintain urine output at 100 ml/hr

# Compartment Syndrome

- Pain out of proportion
- Palpable tenseness of compartment
- Pain on passive stretch of the affected muscle
- Asymmetry of muscle compartments
- Absence of palpable distal pulse (late finding)
- Increased intra-compartmental pressure ( $>30$  mmHg)



# BURNS

- Extremes of temperature
- Electrical
- Chemical

## Zones of Burn Injury

Each burned area has three zones of injury. The inner zone or "Zone of Coagulation" is where cellular death occurs and sustains the most damage. The middle area or "Zone of Stasis" has a compromised supply of blood, inflammation, and tissue injury. The outer zone or "Zone of Hyperemia" sustains the least damage.

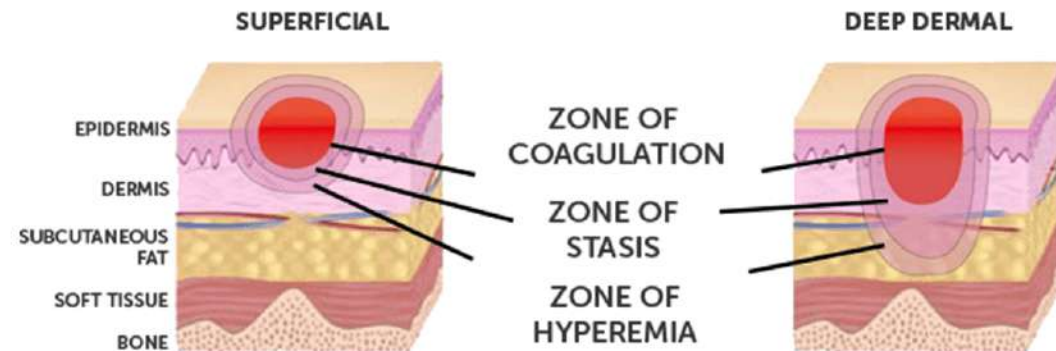


Image via idrps.com

# Burns- Surgical management

- Parkland formula
- Debridement
- Dressings
- Skin grafting

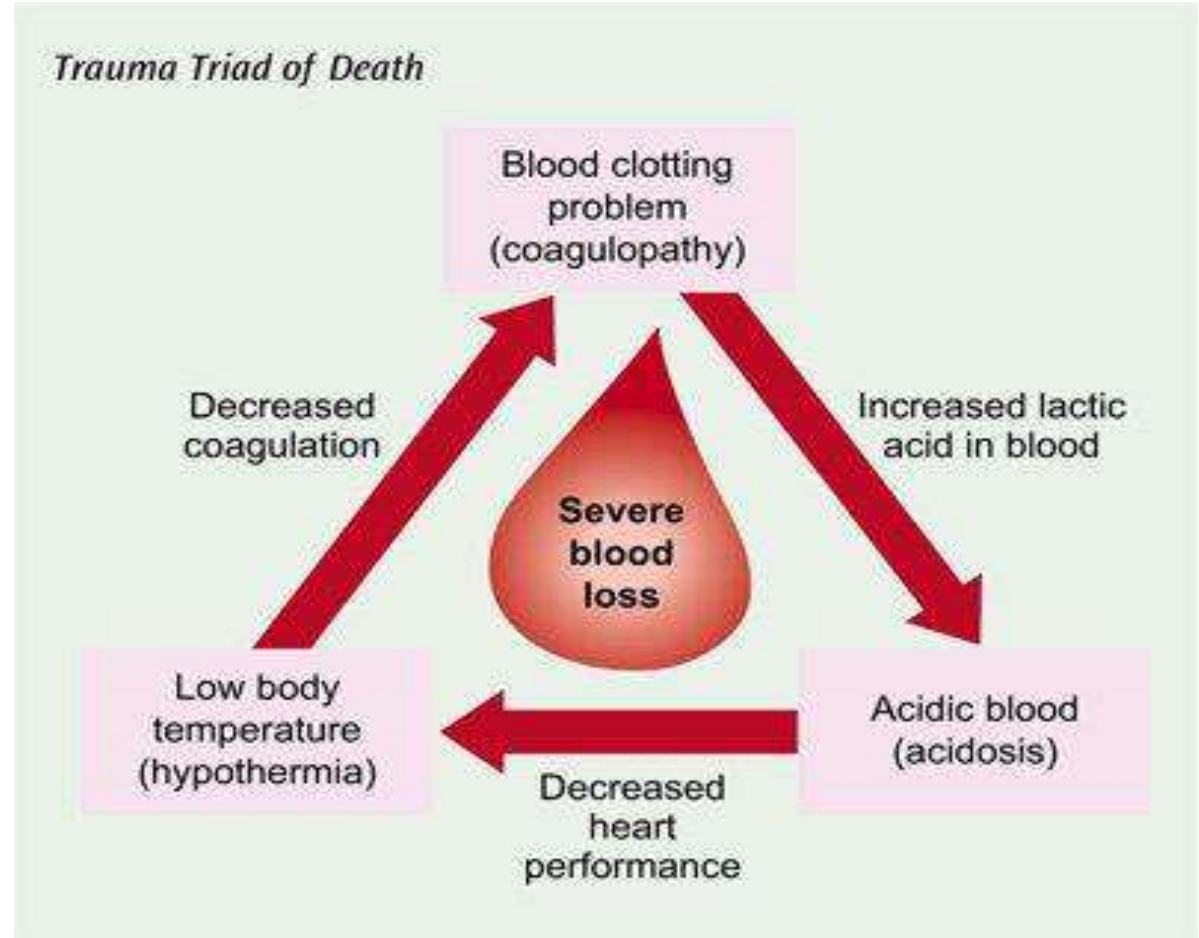


# Special groups- trauma

- Pregnancy
- Geriatric
- Paediatric

# TRAUMA LETHAL TRIAD

- Acidosis
- Coagulopathy
- Hypothermia



# Massive Blood Transfusion

- Replacement of one entire blood volume within 24 h
- Transfusion of >10 units of packed red blood cells (PRBCs) in 24 h
- Transfusion of >20 units of PRBCs in 24 h
- Transfusion of >4 units of PRBCs in 1 h when on-going need is foreseeable
- Replacement of 50% of total blood volume (TBV) within 3 h.



# Complications of Massive Transfusions

## **IMMEDIATE**

- Overzealous resuscitation-circulatory overload, interstitial oedema
- Coagulopathy
- Citrate toxicity
- Hyperkalaemia
- Hypothermia
- Acidosis

## **DELAYED/LATE**

- Transfusion Related Acute Lung Injury
- SIRS
- Sepsis
- Thrombotic complications

# Massive transfusion Protocols

- MTP describes the process of management of blood transfusion requirements in major bleeding episodes, assisting the interactions of the treating clinicians and the blood bank and ensuring judicious use of blood and blood components.
- By developing locally agreed and specific guidelines that include clinical, laboratory, blood bank and logistic responses, clinicians can ensure effective management of massive blood loss and improve outcome.

# References/Resources

- <http://www.kampalatrauma.com/>
- ATLS Students Manual- 10<sup>th</sup> edition
- Patil, V., & Shetmahajan, M. (2014). Massive transfusion and massive transfusion protocol. *Indian journal of anaesthesia*, 58(5), 590.
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