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Musculoskeletal Trauma

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Objectives

At the conclusion of this presentation the participant will be able to:

- Describe the assessment, interventions, and nursing priorities across the continuum of care for patients with musculoskeletal injury
- Discuss the use of Multimodal Analgesia (MMA) and nursing care implications for patients with traumatic musculoskeletal injuries
- Explain indications and strategies for open and closed reduction of fracture/dislocations
- Discuss the prevention, recognition and interventions for compartment syndrome and rhabdomyolysis

Resuscitation

- The primary survey in ATLS/ATCN does not include a thorough assessment of musculoskeletal injuries unless there is gross bleeding, deformity or hemodynamic instability.
- Radiography may/will confirm musculoskeletal injuries.
- Prehospital information can help raise the index of suspicion.

Yurttas, 2009

Mechanism of Injury (MOI)

- Helps team anticipate injuries and care
- Physics of the injury – high energy transfer vs low energy

Mechanism of Injury

- How
- What
- Where
- When

Which Musculoskeletal Injuries Need a Trauma Center?

- Field triage by prehospital providers is the beginning of the process.
- There are national (CDC) plus regional criteria.
- Many patients – especially those with isolated, closed, non-comminuted fractures - can receive quality care in community hospitals.

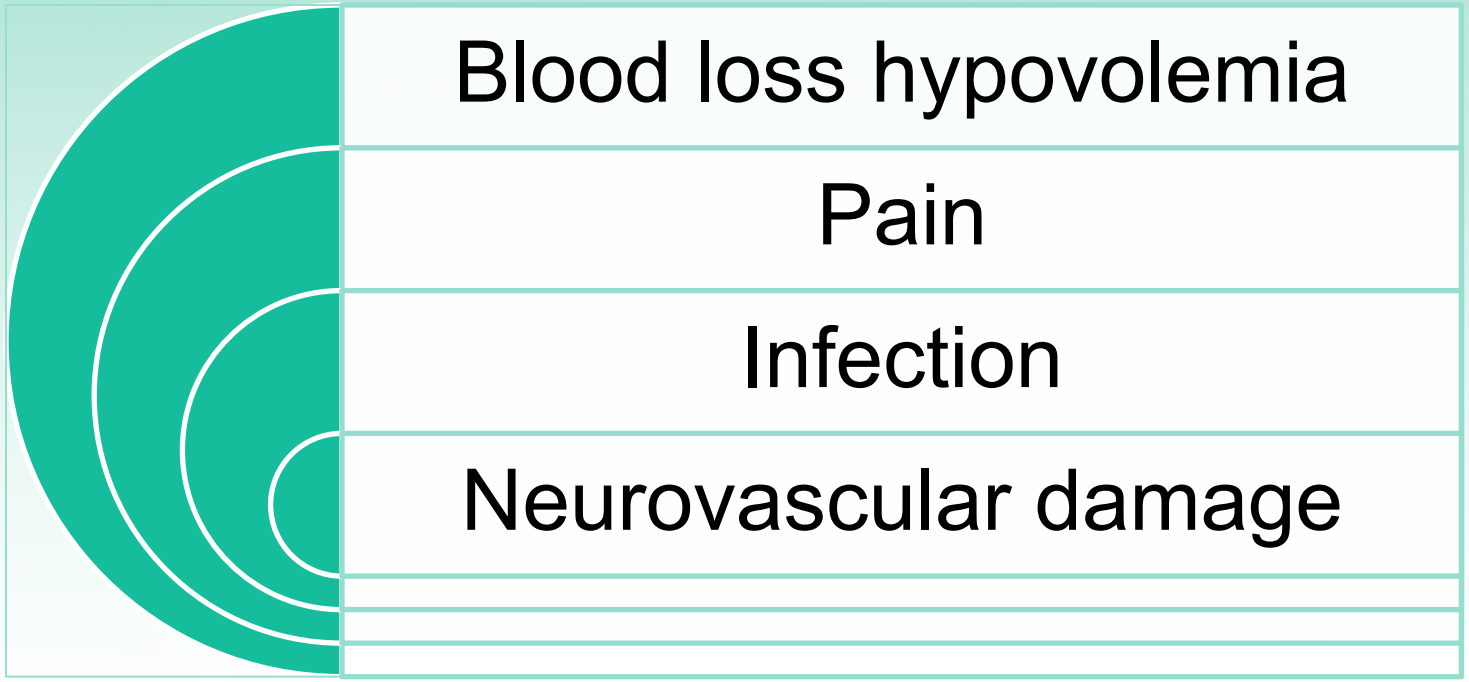
2011 CDC Field Triage Decision Scheme

- Physiologic criteria
- Anatomic criteria relevant to musculoskeletal system:
  - Two or more proximal long-bone fractures
  - Crushed, degloved, mangled, or pulseless extremity
  - Amputation proximal to wrist or ankle
  - Pelvic fractures

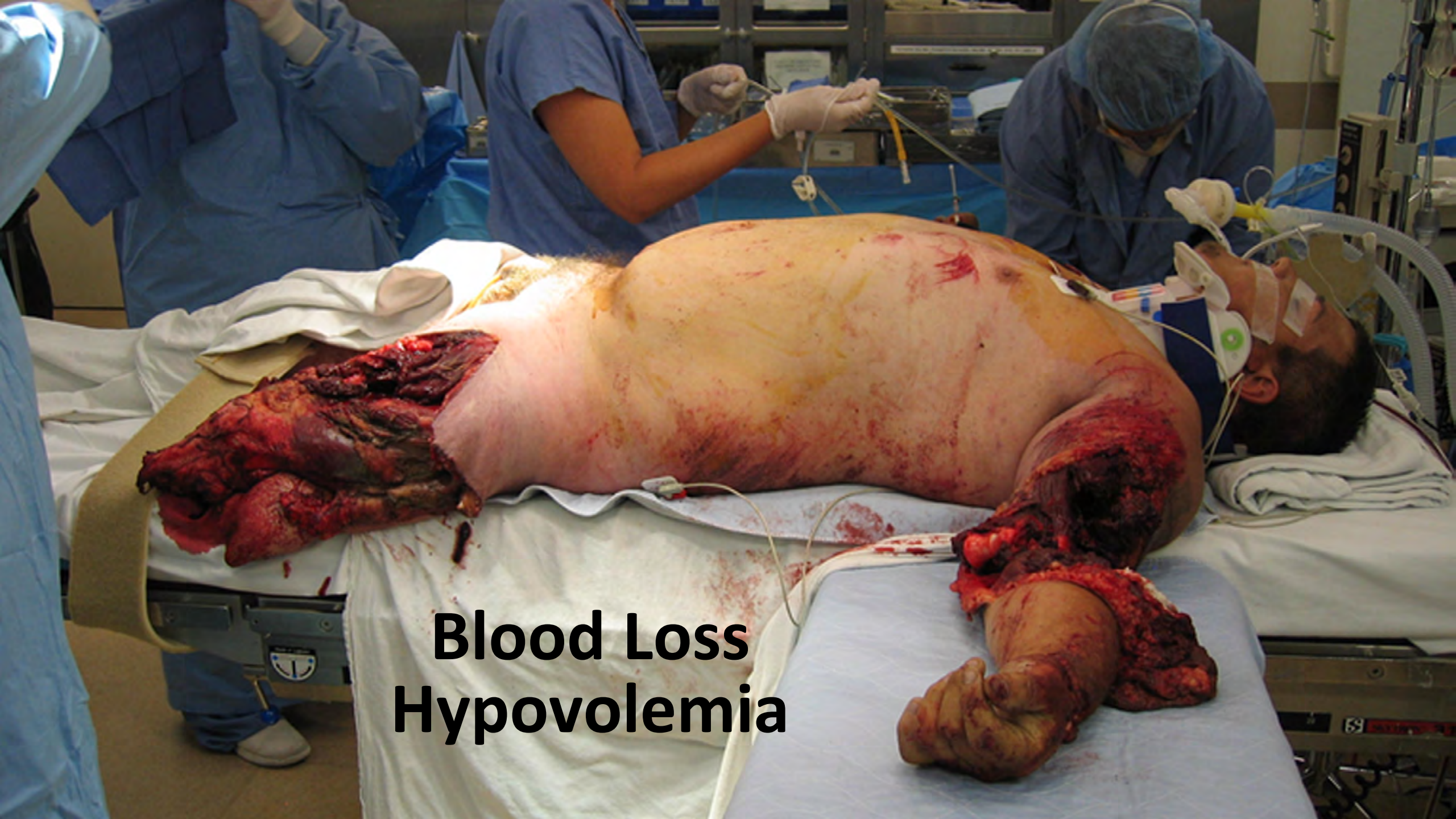
Transfers

- Clear guidelines and processes
- Certain injuries almost always warrant transfer
- Certain patients may warrant transfer
- Transfer agreements

Initial Management of Musculoskeletal Trauma



The Four Priorities of Care


Blood Loss
Hypovolemia

Tourniquets

Petit Tourniquet - Savigny 1798

Combat Application Tourniquet (CAT) – modern day

Bleeding Control

Stop the Bleed began in 2015 following the American College of Surgeons (ACS) Hartford Consensus recommendations. The goal is to teach laypeople life-saving bleeding control techniques – including tourniquet use.

Nursing Care for the Patient with a Tourniquet

- Not intended for long term placement
- Note the time of application – 2 hour goal
- Monitor for bleeding
- Pain management
- Patient reassurance
- **DO NOT REMOVE OR LOOSEN THE TOURNIQUET ONCE IT IS IN PLACE**

Pelvic Binder

Temporary measure – until surgical stabilization

T-POD Pelvic Stabilization Device

Prometheus Russell Pelvic Splint

SAM Pelvic Sling II

Covert Blood Loss

- **Blood Loss Associated with Fracture in Adults**
- Fracture site amount of blood loss in mL
- Radius and ulna 150–250
- Humerus 250
- Tibia and fibula 500
- Femur 1000
- Pelvis 1500–3000

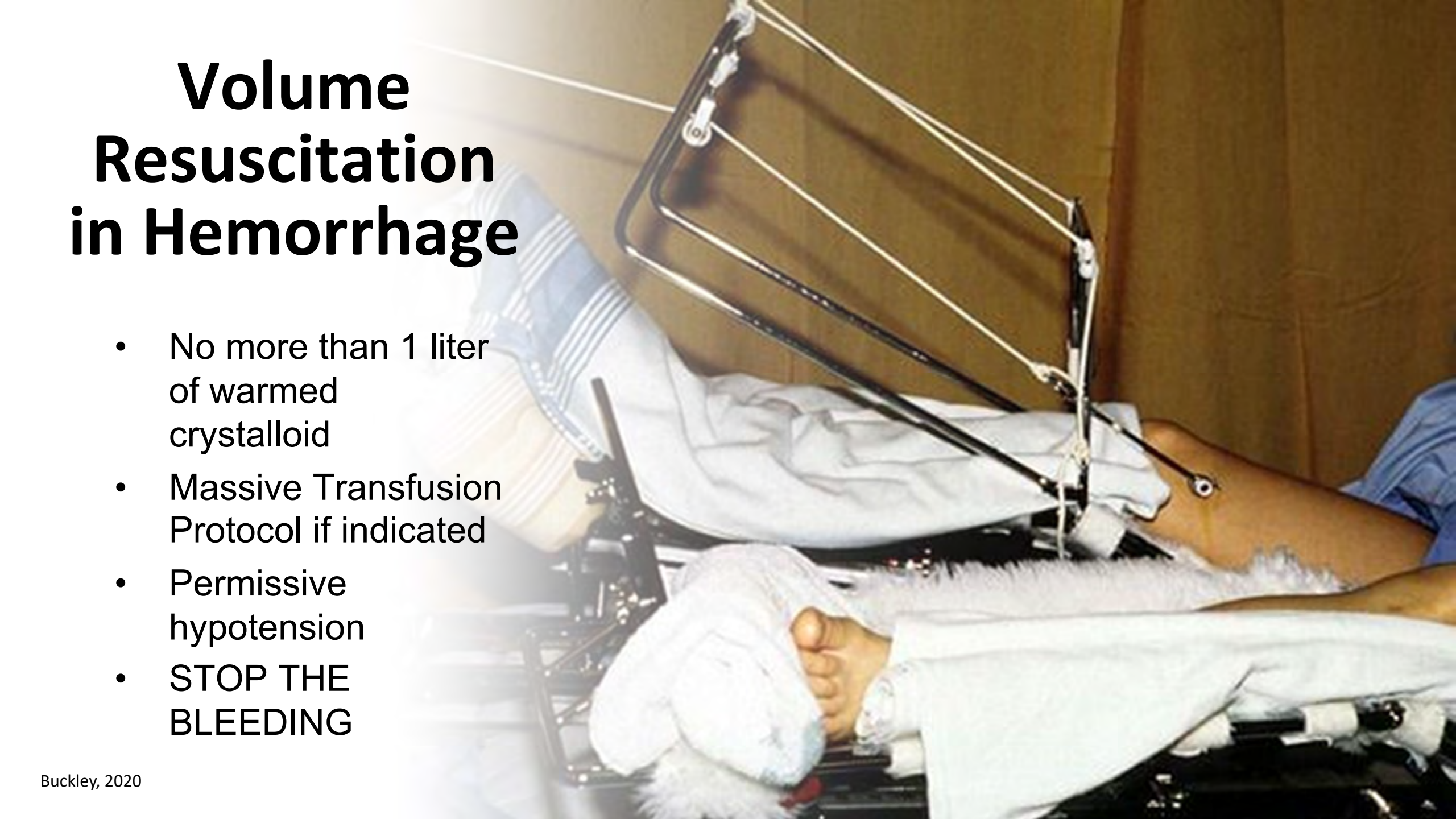
PARAMETER	CLASS I	CLASS II (MILD)	CLASS III (MODERATE)	CLASS IV (SEVERE)
Approximate blood loss	<15%	15–30%	31–40%	>40%
Heart rate	↔	↔/↑	↑	↑/↑↑
Blood pressure	↔	↔	↔/↓	↓
Pulse pressure	↔	↓	↓	↓
Respiratory rate	↔	↔	↔/↑	↑
Urine output	↔	↔	↓	↓↓
Glasgow Coma Scale score	↔	↔	↓	↓
Base deficit[a]	0 to –2 mEq/L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

[a] Base excess is the quantity of base (HCO_3^-, 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.

Mutschler, 2013

Volume Resuscitation in Hemorrhage

- No more than 1 liter of warmed crystalloid
- Massive Transfusion Protocol if indicated
- Permissive hypotension
- STOP THE BLEEDING



Buckley, 2020

MTP

Package	PRBCs	Plasma	Platelets	Cryoprecipitate
Initiation	6 units (UD/TS)	6 units (UD)		
1 (0.5 h)	6 units (UD/TS)	6 units (UD)	1 apheresis§	
2 (1 h)	6 units (UD/TS)	6 units (TS)		20 units
3 (1.5 h)†	6 units (UD/TS)	6 units (TS)	1 apheresis§	
4 (2 h)	6 units (UD/TS)	6 units (TS)		10 units
5 (2.5 h)	6 units (UD/TS)	6 units (TS)	1 apheresis§	
6 (3 h)‡	6 units (UD/TS)	6 units (TS)		10 units

PRBCs = packed red blood cells; TS = type-specific; UD = universal donor.
*PRBCs and plasma can be doubled to 12 units each per cycle by request.
†Recombinant Factor VIIa may be used at attending physician discretion (dose: 3.6 mg, 1 repeat dose as needed in 30 minutes).
‡If MTP is still active, alternate packages identical to packages 5 and 6 until protocol terminated.
§A single apheresis unit of platelets is considered to equal 8–10 standard units.

Ball, 2013

Nursing Care for the Patient Receiving MTP

- Continue administration per order and hospital MTP guidelines
- Blood warmer → Prevent hypothermia
- Prepare patient for definitive care → angiography, OR
- Lab studies → Type and Crossmatch, coagulation studies, Fibrinogen, TEG/ROTEM

Tranexamic Acid (TXA)

- Thromboelastography (TEG) or Rotationalthromboelastometry (ROTEM) laboratory monitoring
- Monitor for thrombotic complications
- TXA dosing
  - Give within 3 hours
  - Load 1 gm over 10 minutes IV
  - Then 1 gm IV over 8 hours
- Follow your agency standards

Splinting

- Prevent further injury
- Pain control
- Management of swelling

Eaton, 2012

https://www.reddit.com/r/pics/comments/iy0ikr/the_homies_at_the_skatepark_made_me_this/

Traction Splints

Indicated for suspected or obvious isolated fracture of the midshaft femur

Kendrick, 1986

Hare, 1960's

Slishman (STS), 2006

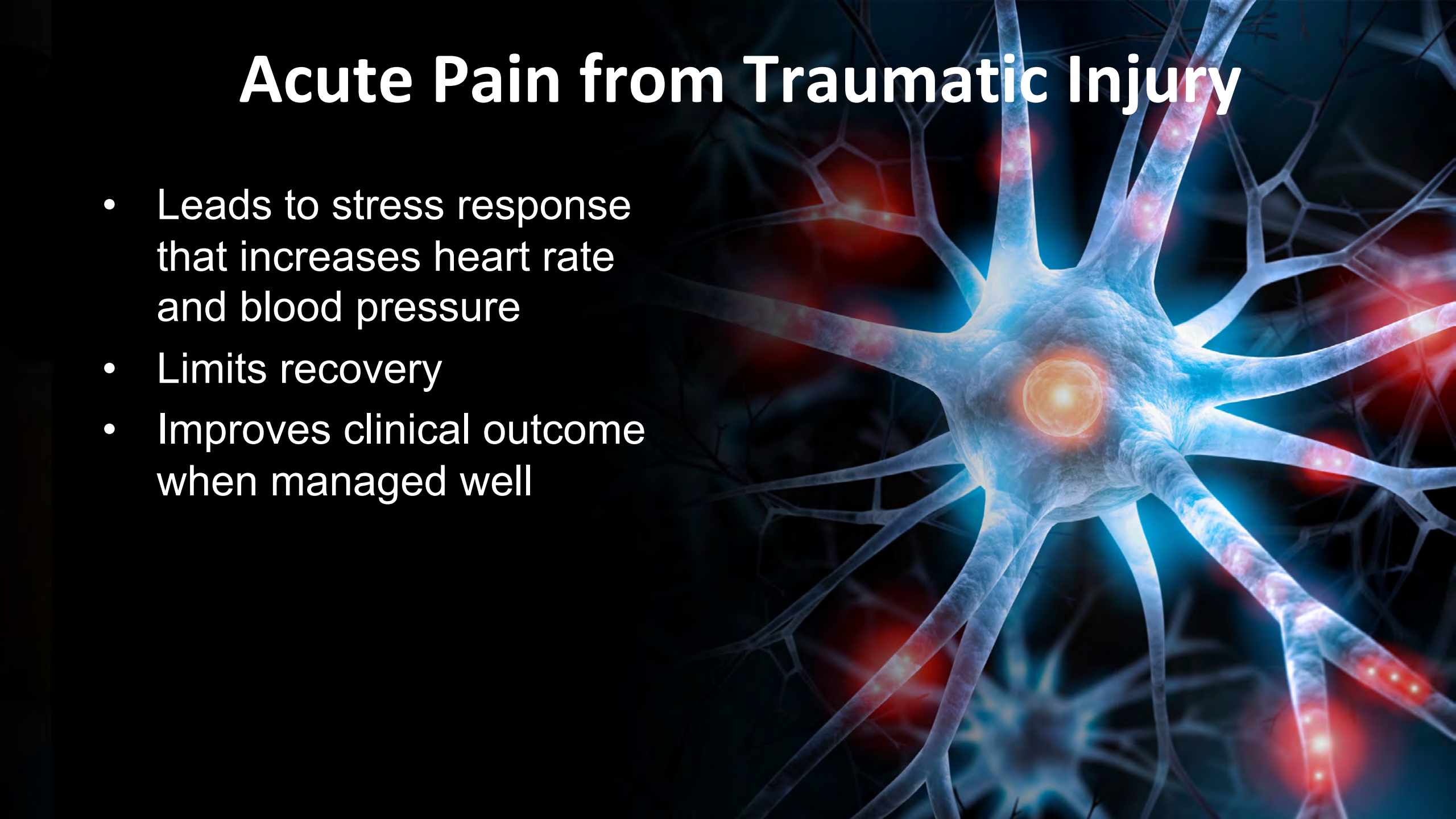
REEL, 1980's

CT-6

Sager, 1970's

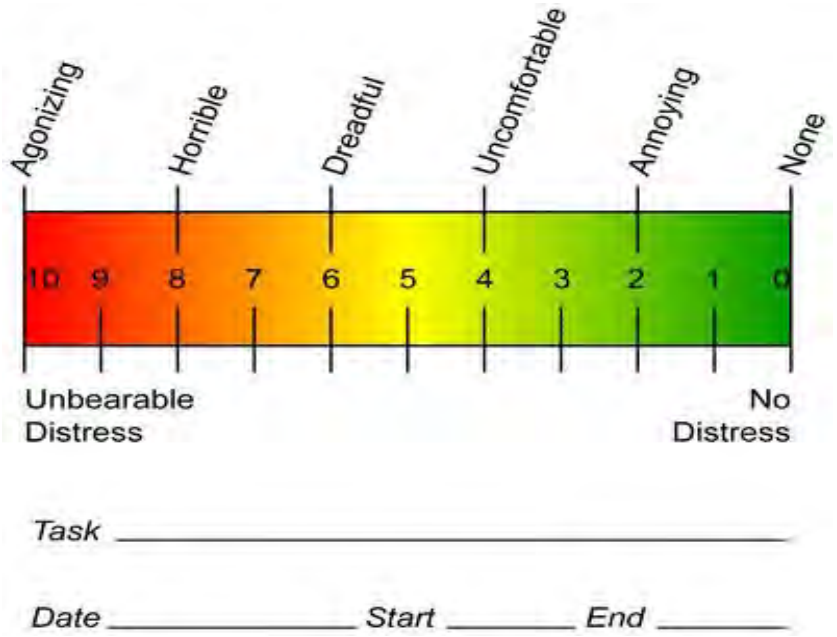
Acute Pain from Traumatic Injury

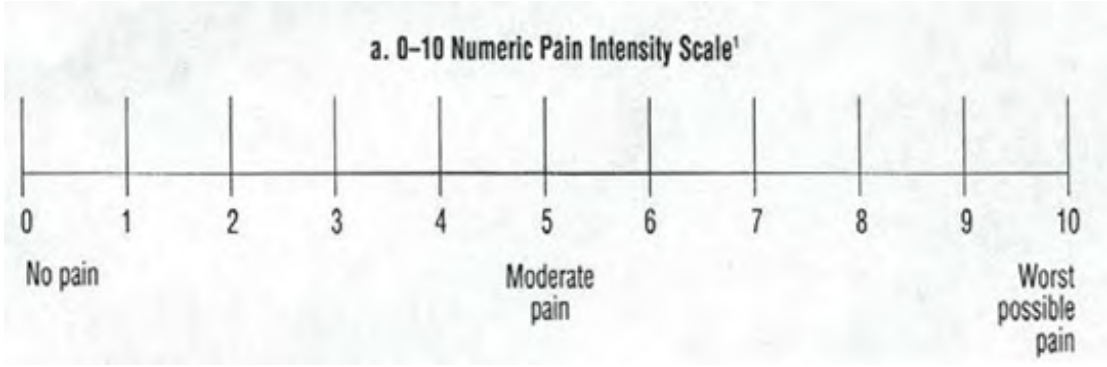
- Leads to stress response that increases heart rate and blood pressure
- Limits recovery
- Improves clinical outcome when managed well



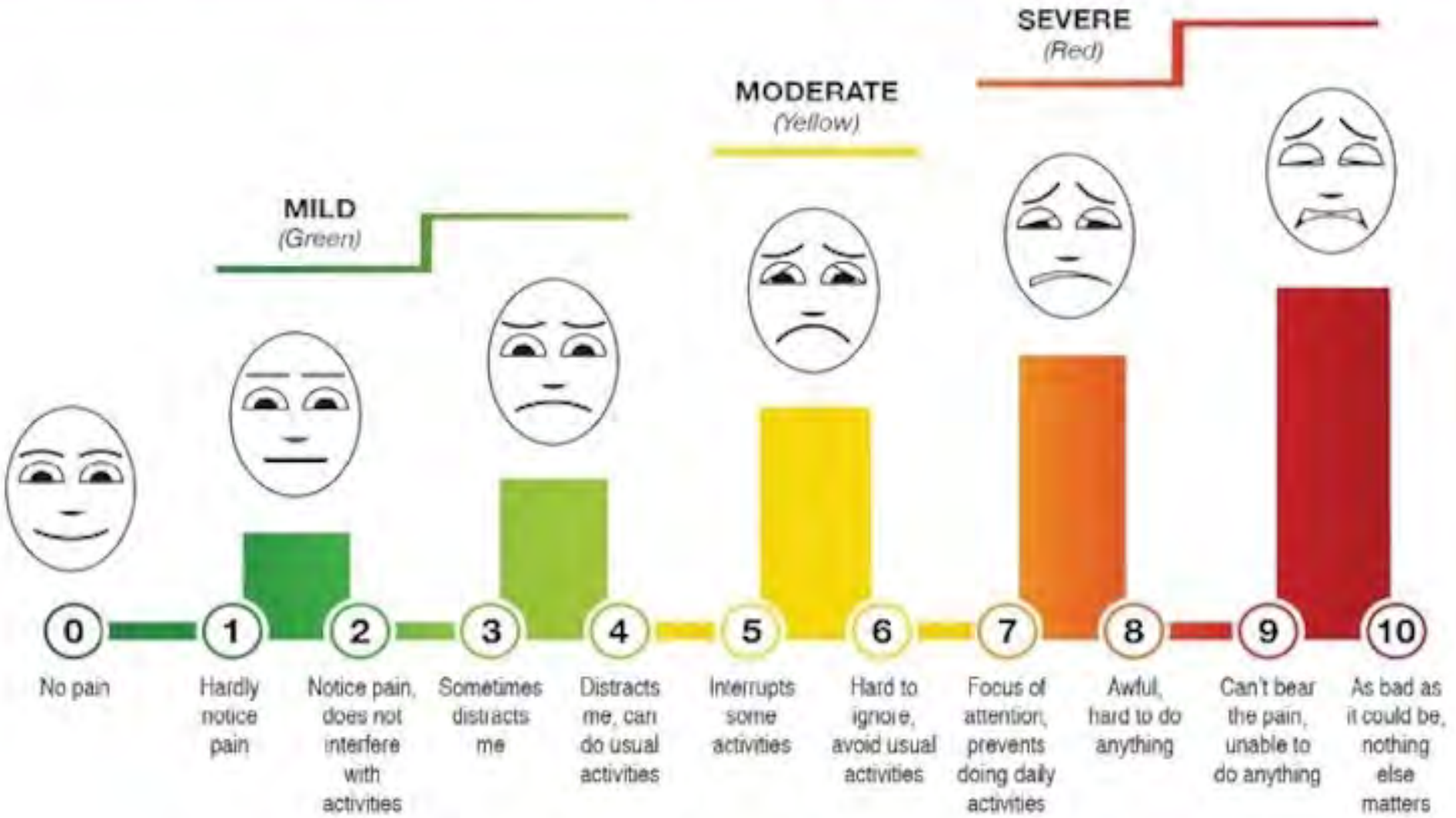
Pain Assessment

- Numeric Scale
- Visual Analogue Scale
- Faces Pain Scale

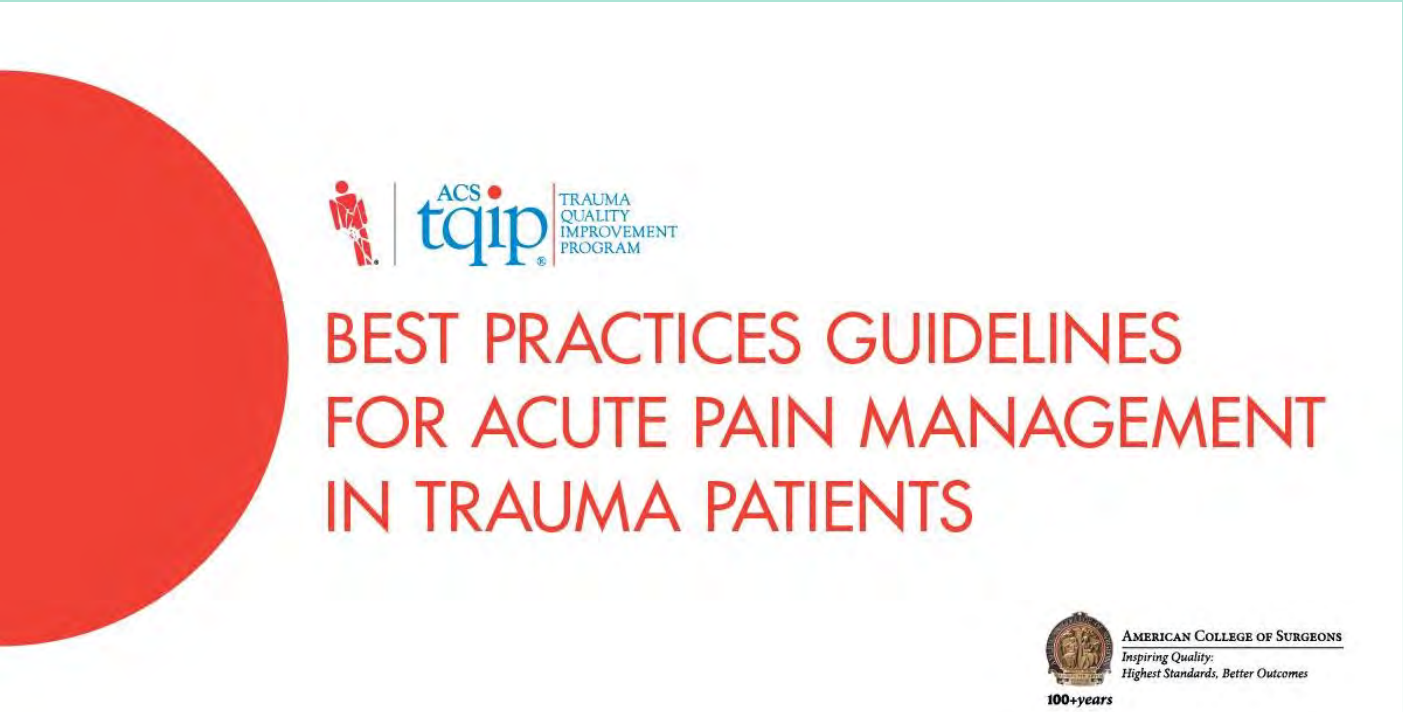




Defense and Veterans Pain Rating Scale



TQIP Guidelines



- Unidimensional Assessment Tools for Cognitively Intact Adults
- Assessment Tools for Adult Patients with Cognitive Impairment
- Functional Pain Assessment Tools
- Pain Assessment in Older Adults
- Pediatric Pain Assessment Tools
- Pain Reassessment

Pain Management with Analgesics

Appropriate route for administration of analgesics

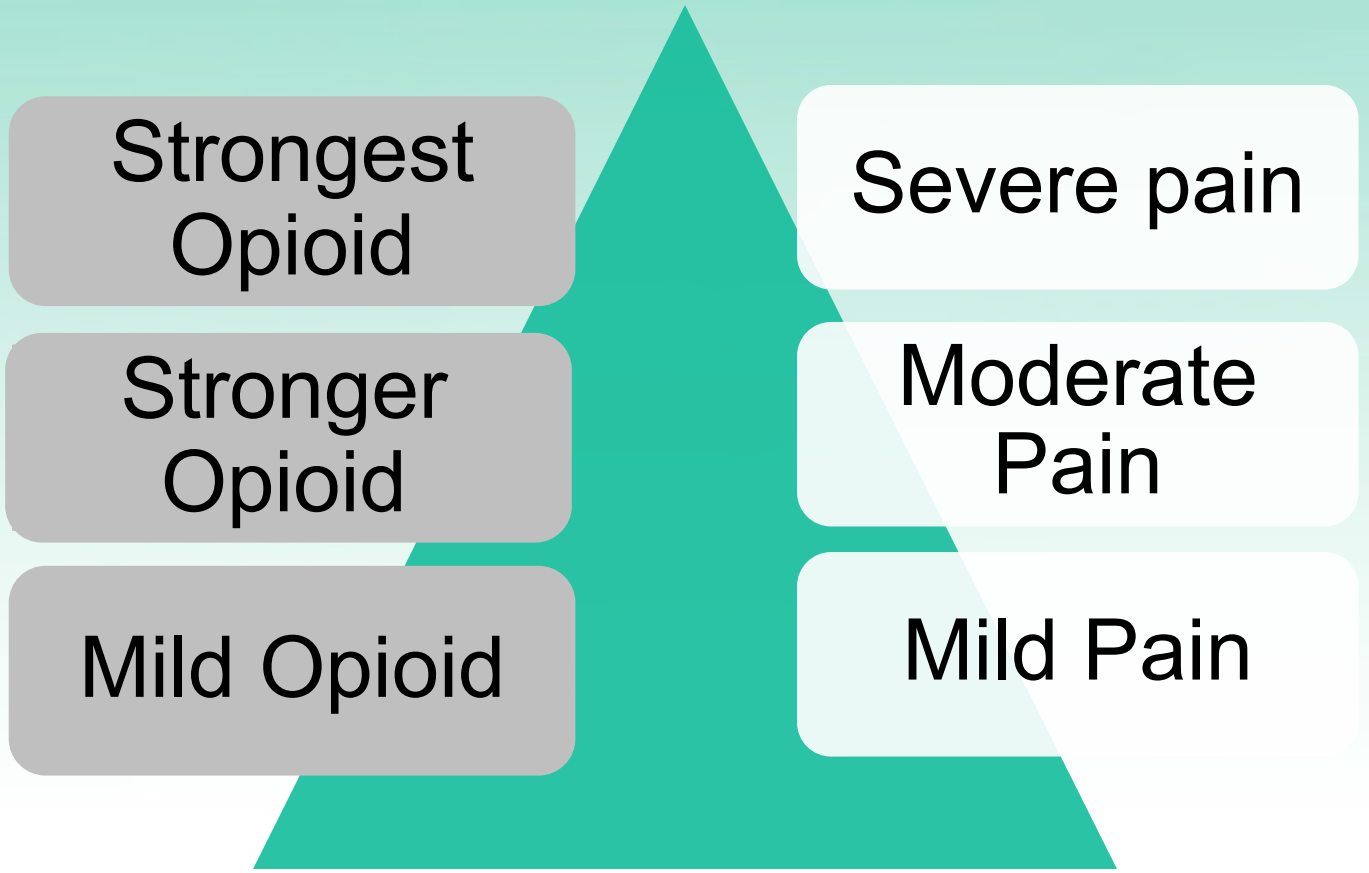
Analgesics should be given at regular intervals

Analgesics should be prescribed according to pain intensity as evaluated by a scale of intensity of pain

Dosing of pain medication should be adapted to the individual

Analgesics should be prescribed with a constant concern for detail

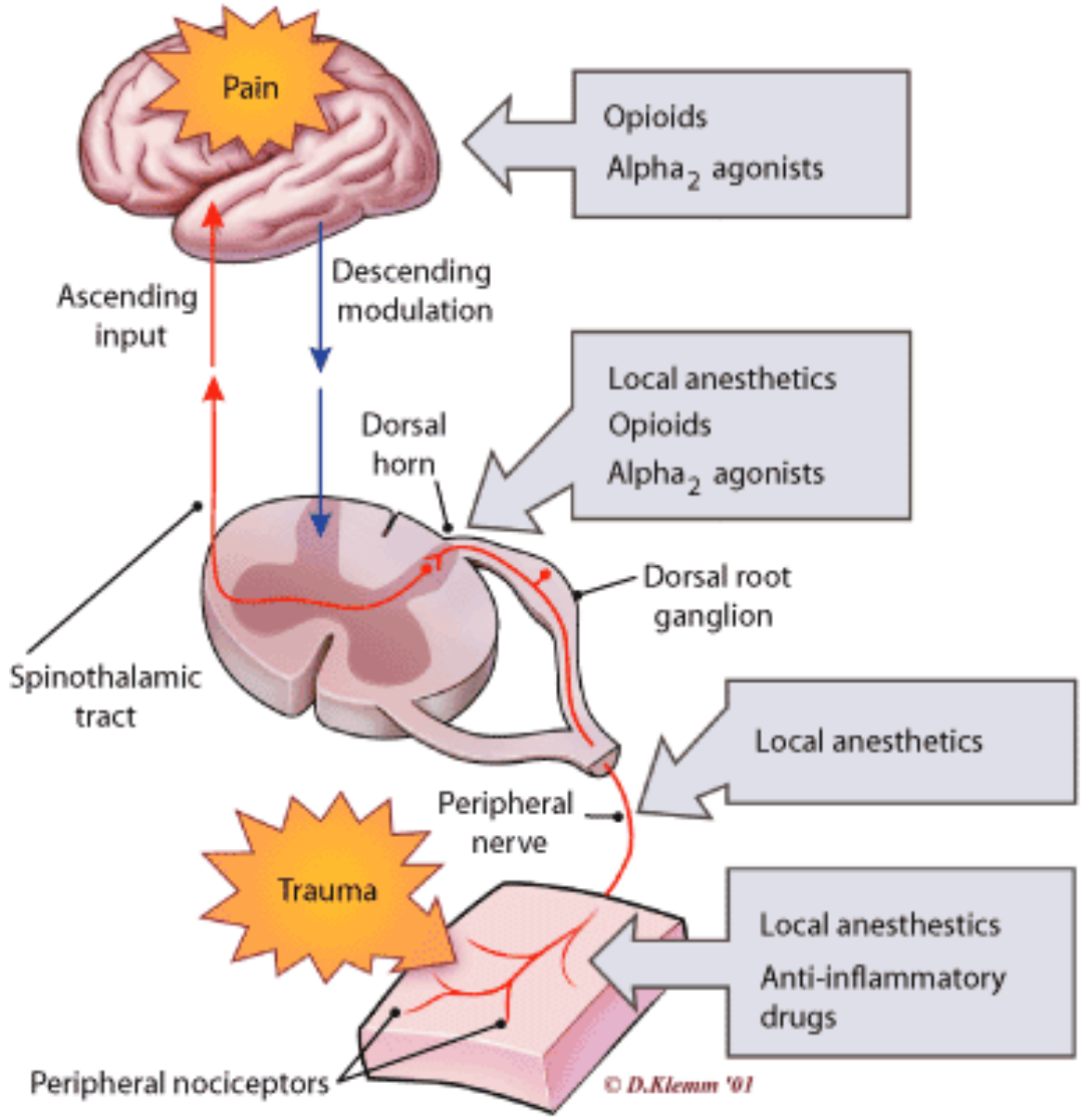
Current Acute Care Practice



Multimodal Analgesia (MMA)

"Multimodal analgesia (MMA) is the use of multiple analgesics, regional analgesia, and nonpharmacologic interventions to affect peripheral and/or central nervous system loci in the pain pathway. The MMA concept may be applied across the care continuum with strategies suited to each phase of care."

The American College of Surgeons (ACS) Trauma Quality Improvement Program (TQIP) Acute Pain Management in Trauma Patients: 2020.



Prehospital

Pain starts at the point of injury (POI) and must be controlled from that initiating event.

Prehospital practitioner has the first and perhaps only opportunity to break the pain cascade.

Early, effective pain control is essential to successful outcomes after traumatic injury.

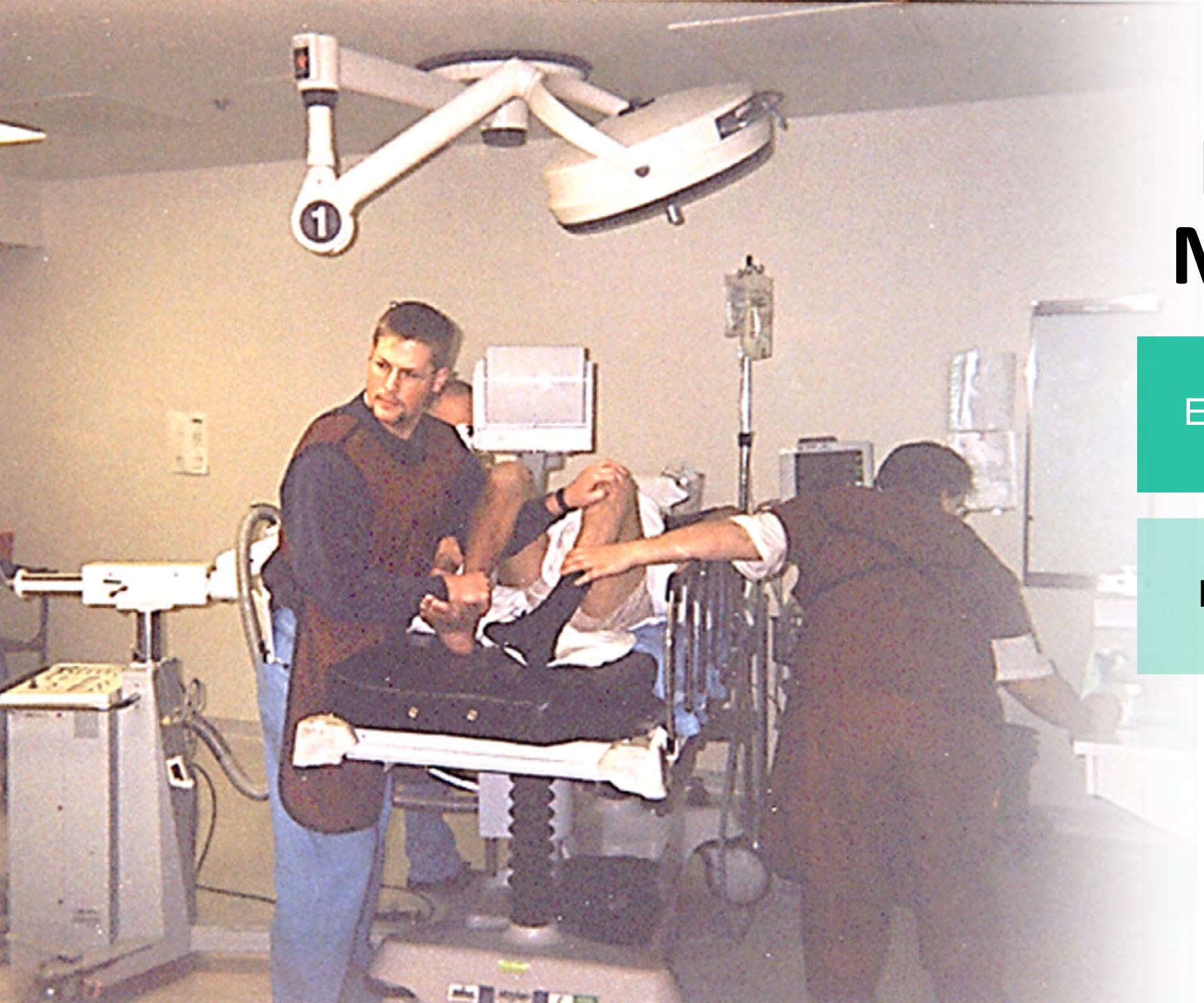
Emergency Department

- Splinting/Reduction
- IV opioids for severe pain
- Local or regional block for localized pain
- NSAIDs and Acetaminophen unless contraindicated
- Oral opioids for breakthrough pain

Post Trauma/Postoperative Pain

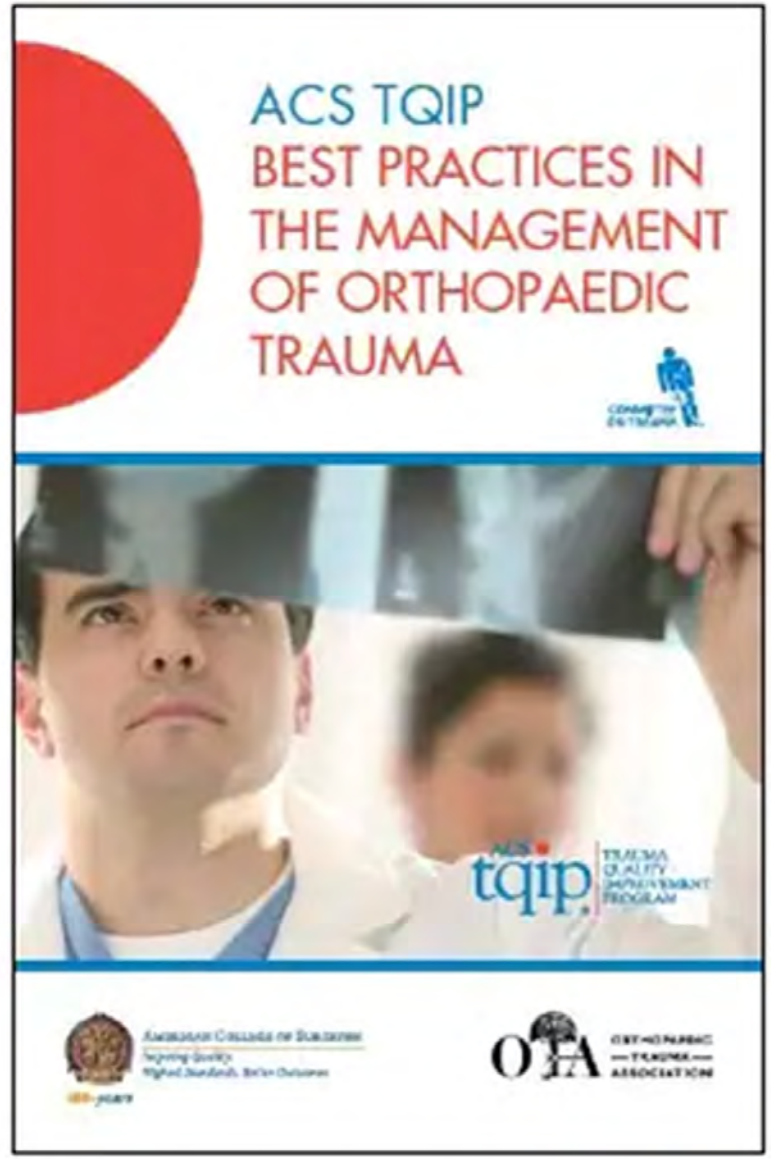
1. Epidural or intrathecal opioids, systemic opioid PCA, and regional techniques

2. Unless contraindicated, patients should receive an around the-clock regimen of NSAIDs, COXIBs, or acetaminophen.



Procedural Medications

- Etomidate
- Midazolam
- Propofol
- Ketamine
- Fentanyl



ACS tqip TRAUMA QUALITY IMPROVEMENT PROGRAM

Prevent Infection

Open fractures occur when the open wound is exposed to contamination from the external environment through disruption of the skin and subcutaneous tissue.

Cite: Open Fracture Management Open fracture of the ankle with exposed fibular present. Gustilo Type 2. Contributed by Mark A. Dreyer, DPM, FACFAS. (http://creativecommons.org/licenses/by/4.0/)

Prevent Infection

Bionixmed.com

ortho.smith-nephew.com

Irrimax.com

Sample of Proprietary Wound Irrigation Systems

Antibiotics

- Should be administered within one hour of presentation to a patient with an open fracture
- Should be administered for no longer than 24 hours after a surgical procedure
- Can be administered for 72 hours if wound is grossly contaminated

Prophylaxis and Surgical Infections

- Staphylococci
- Pseudomonas Aeruginosa
- Klebsiella
- Acinetobacter baumani

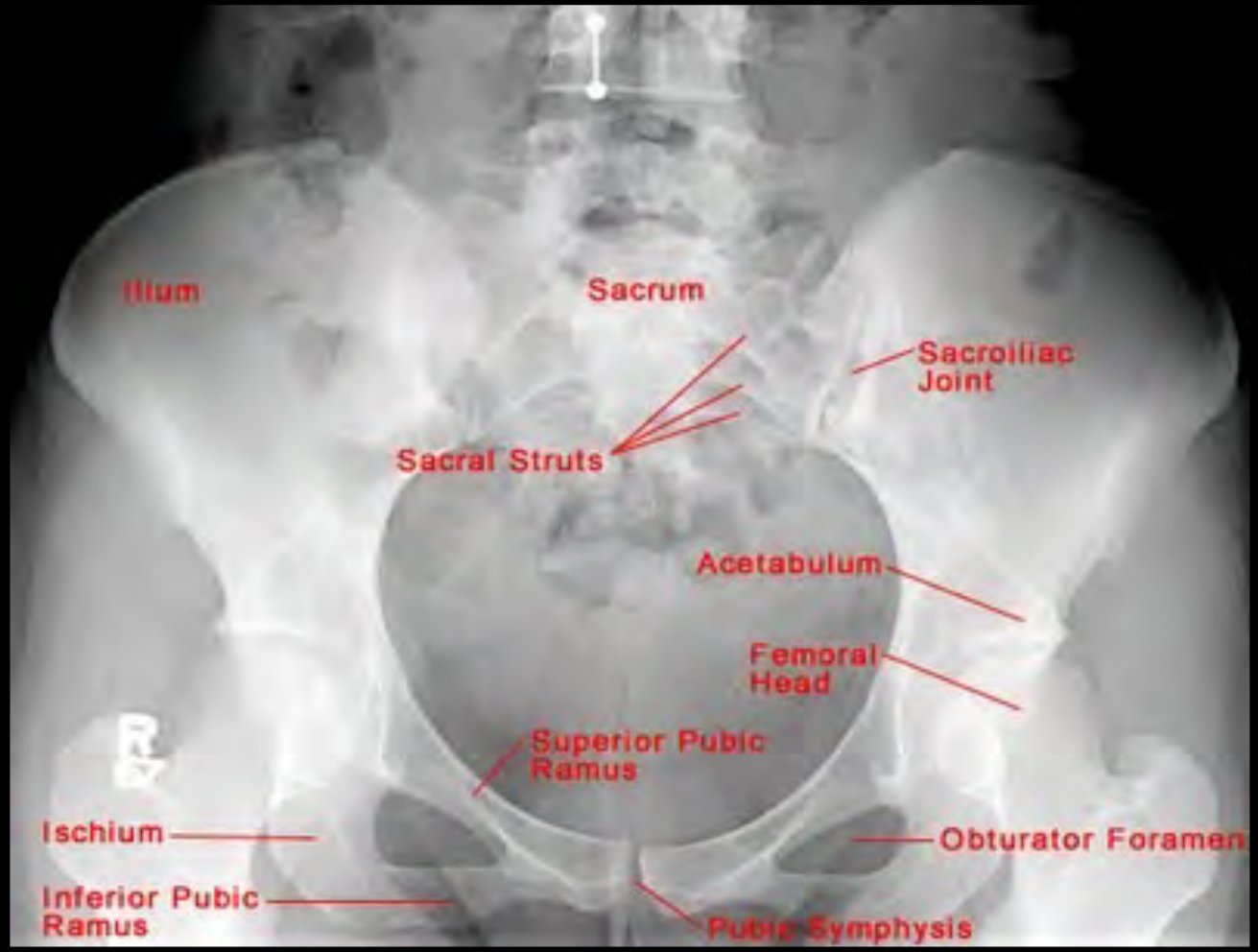
Assessment

- What is baseline status?
- Are splints applied correctly?
- Past Medical History

Diagnostic Studies

- Plain films
- CT, CT angio
- Angiography

Anterior-Posterior (AP) View of the Pelvis



3 Views of the Pelvis

A-P

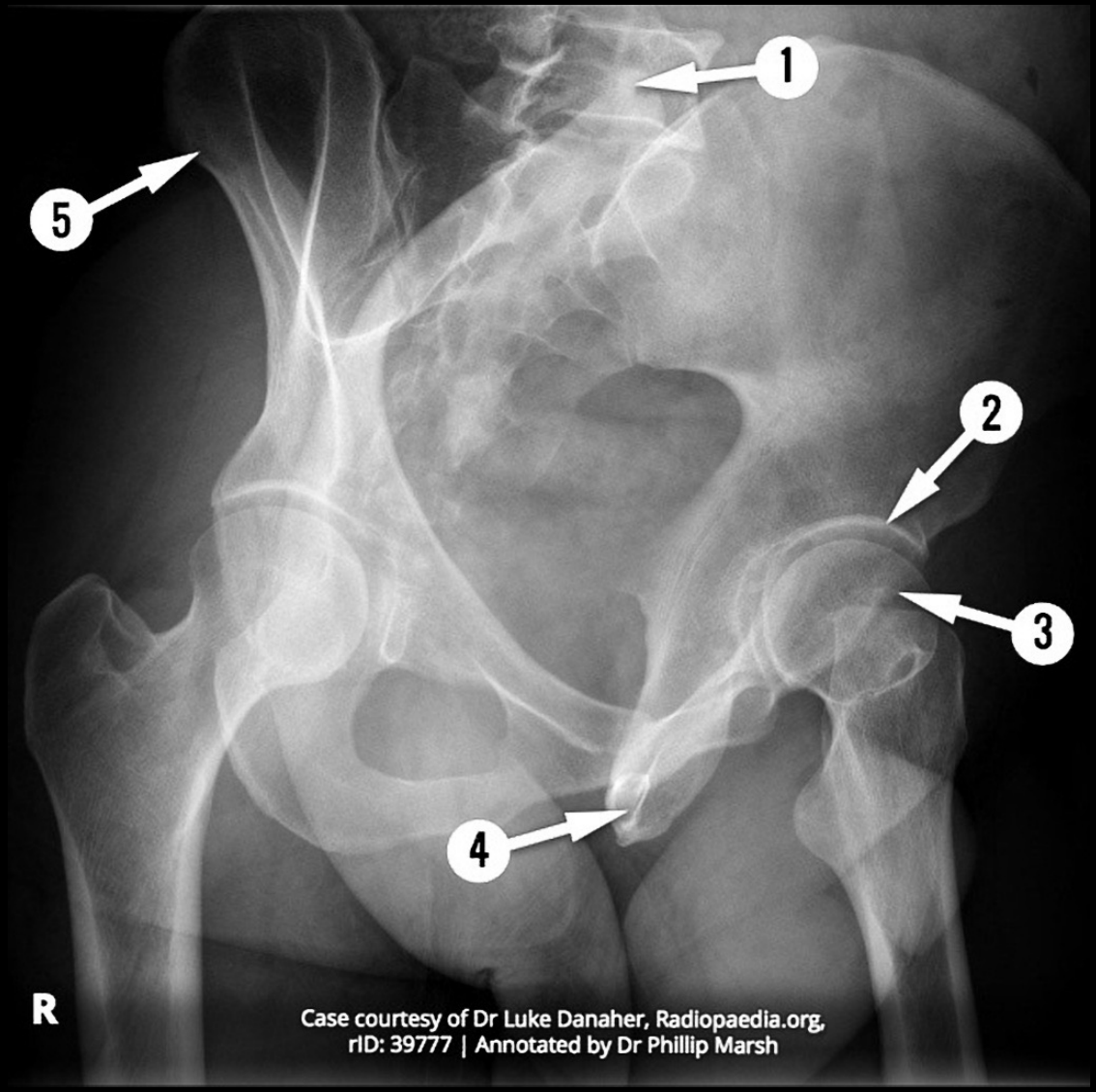
Inlet

Outlet

Murphy, A. Pelvis series. Reference article, Radiopaedia.org. (accessed on 25 Oct 2021) https://doi.org/10.53347/rID-44862

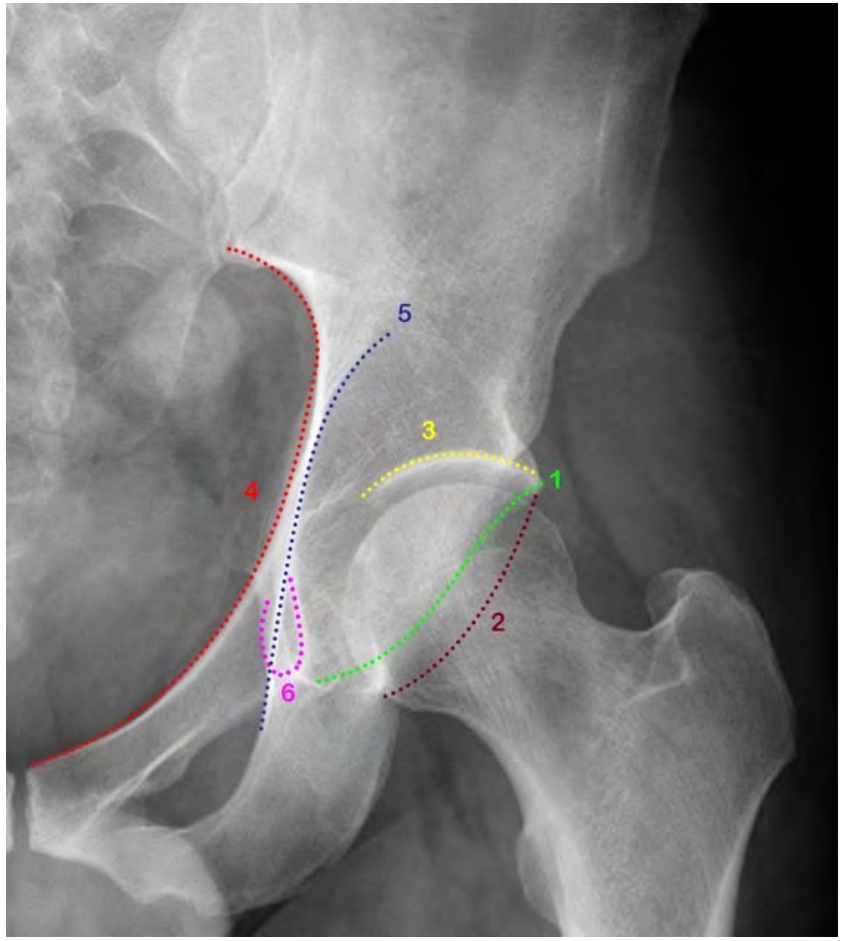
Oblique's "Judet"

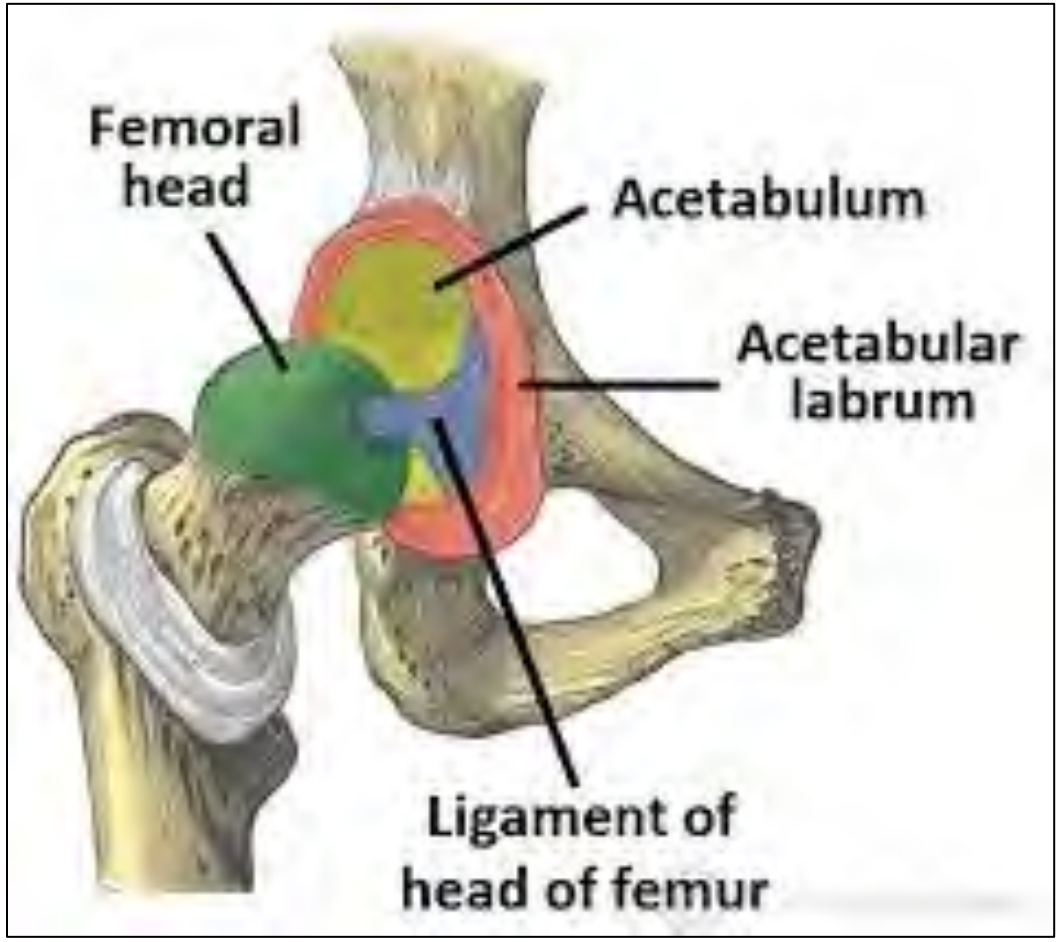
Labels:
1. Vertebral body of L5
2. Left acetabular roof
3. Left anterior acetabular wall
4. Left ischial tuberosity
5. Right ilium



Marsh, P. Pelvis radiograph - right Judet view (anatomy quiz). Case study, Radiopaedia.org. (accessed on 25 Oct 2021) https://doi.org/10.53347/rID-62437

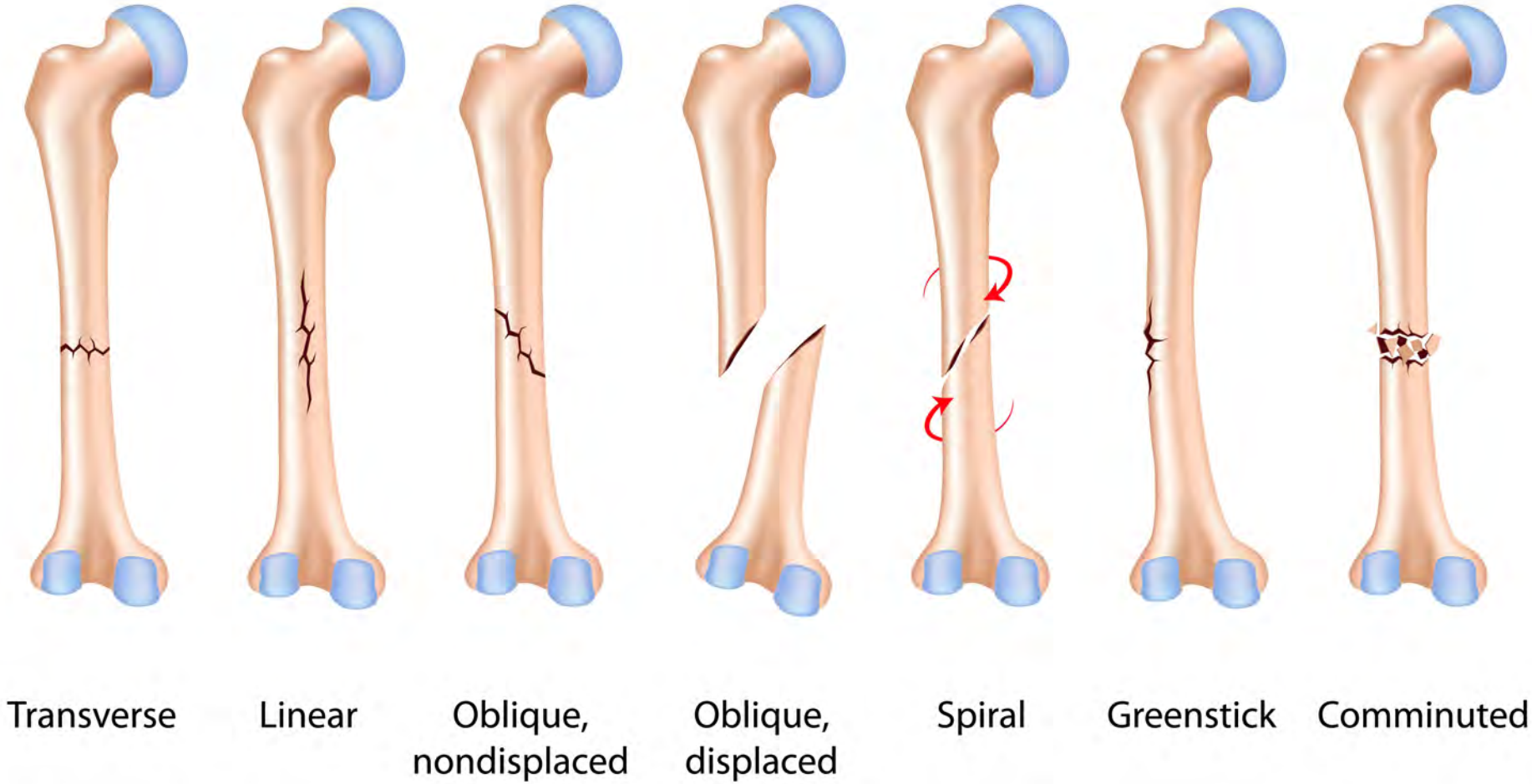
Acetabulum





Benaudina, 2022

Types of Bone Fractures

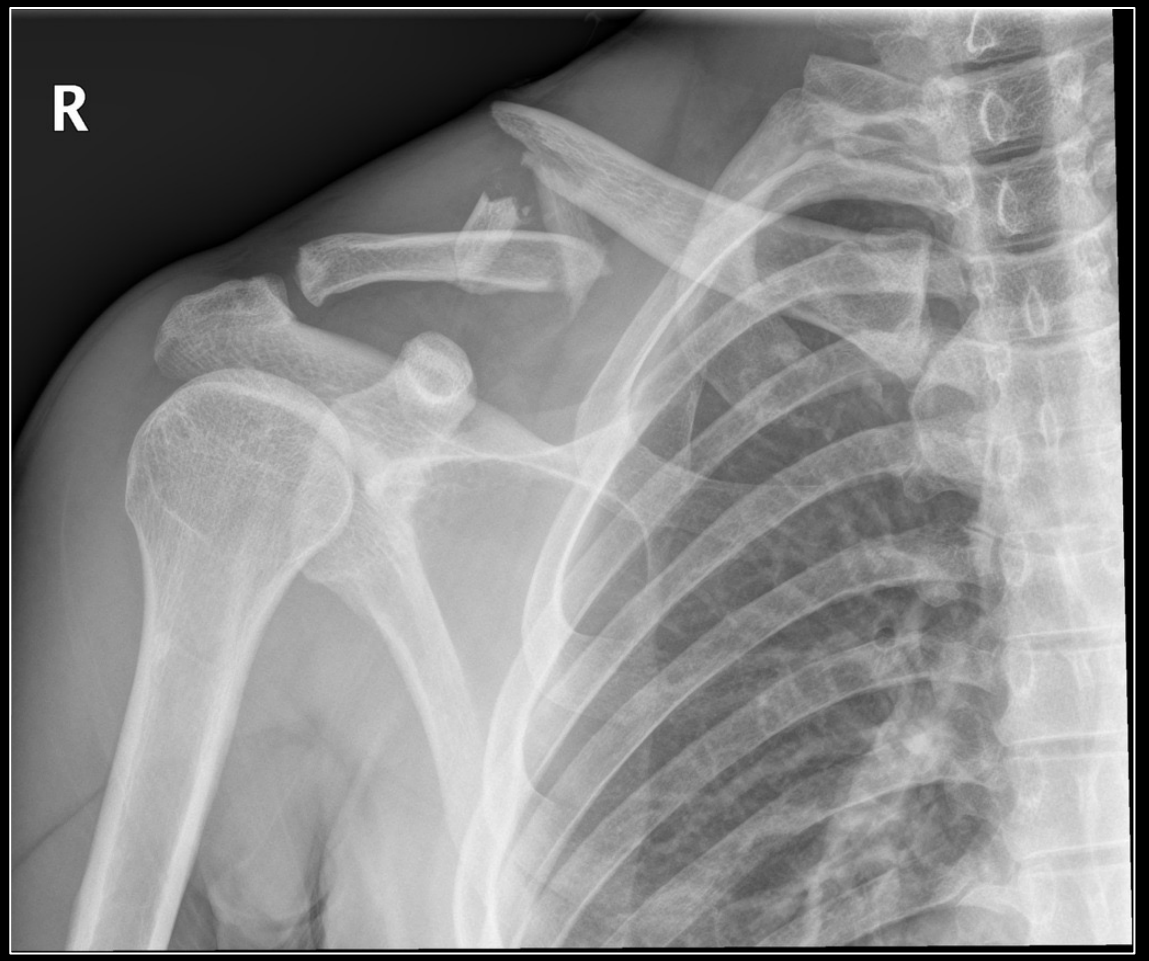


Types of Fractures

Drdavidgeier.com

Farouk, 2022

Types of Fractures



Jones, J. Oblique tibial fracture. Case study, Radiopaedia.org. (accessed on 25 Oct 2021) https://doi.org/10.53347/rID-24274

Di Muzio, B. Comminuted midshaft clavicular fractures. Case study, Radiopaedia.org. (accessed on 25 Oct 2021) https://doi.org/10.53347/rID-44044

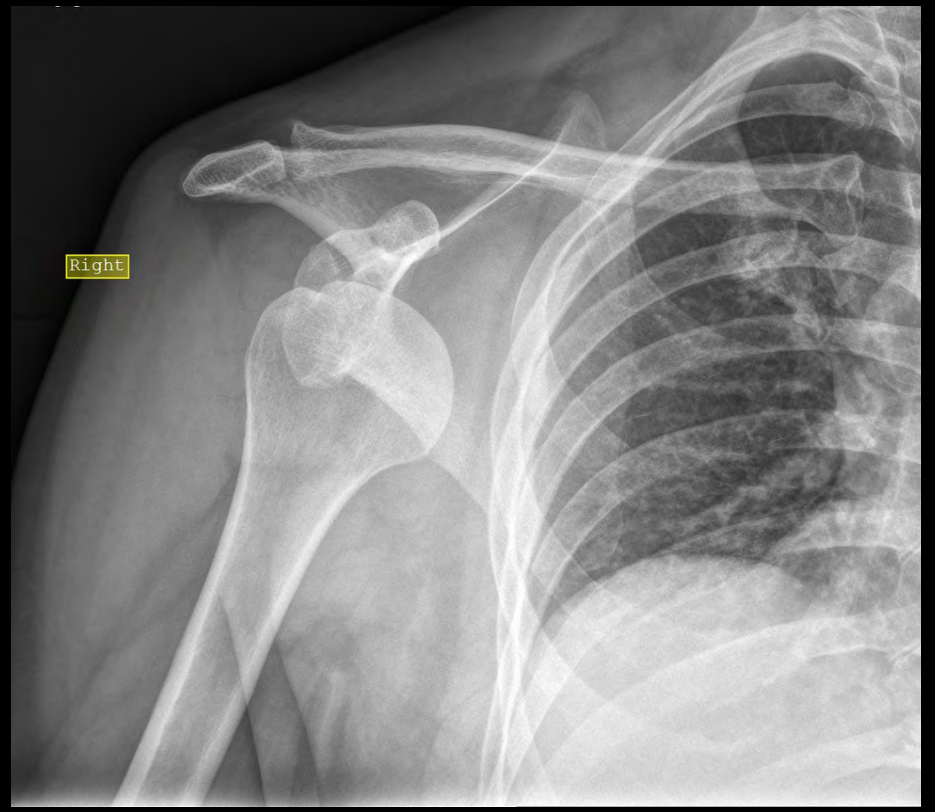
Skeletal Traction

http://brownemblog.com/blog-1/2016/10/28/vho4znj99egy7taz50kdr7t3k23lxw

Reduction

Reduction is a medical procedure to restore a fracture or dislocation to the correct alignment. For the fractured bone to heal without any deformity, the bony fragments must be re-aligned to their normal anatomical position.

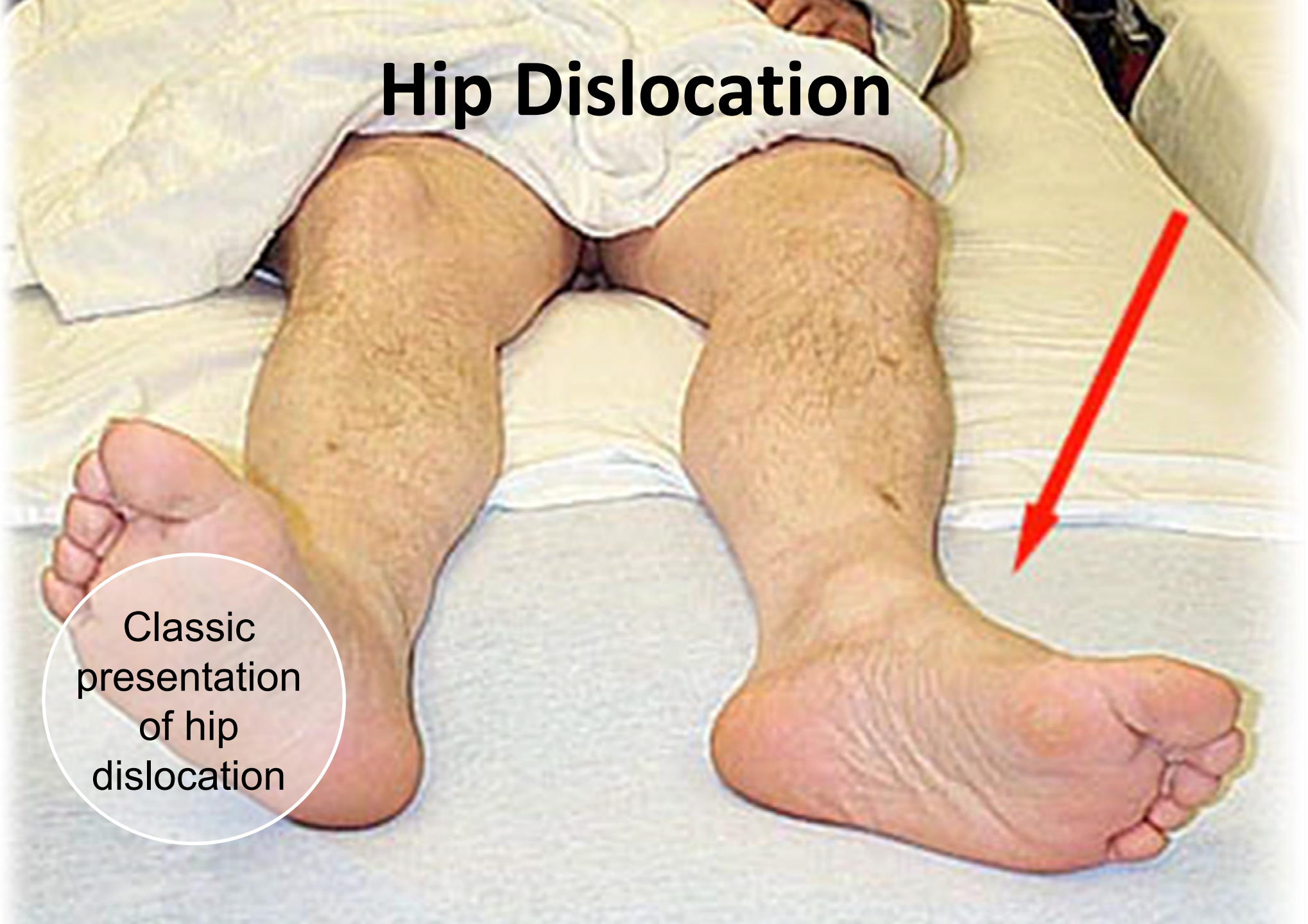
Dislocations



Knipe, H. Hip dislocation. Case study, Radiopaedia.org. (accessed on 25 Oct 2021) https://doi.org/10.53347/rID-49108

Yonso, M. Anterior shoulder dislocation. Case study, Radiopaedia.org. (accessed on 25 Oct 2021) https://doi.org/10.53347/rID-82940

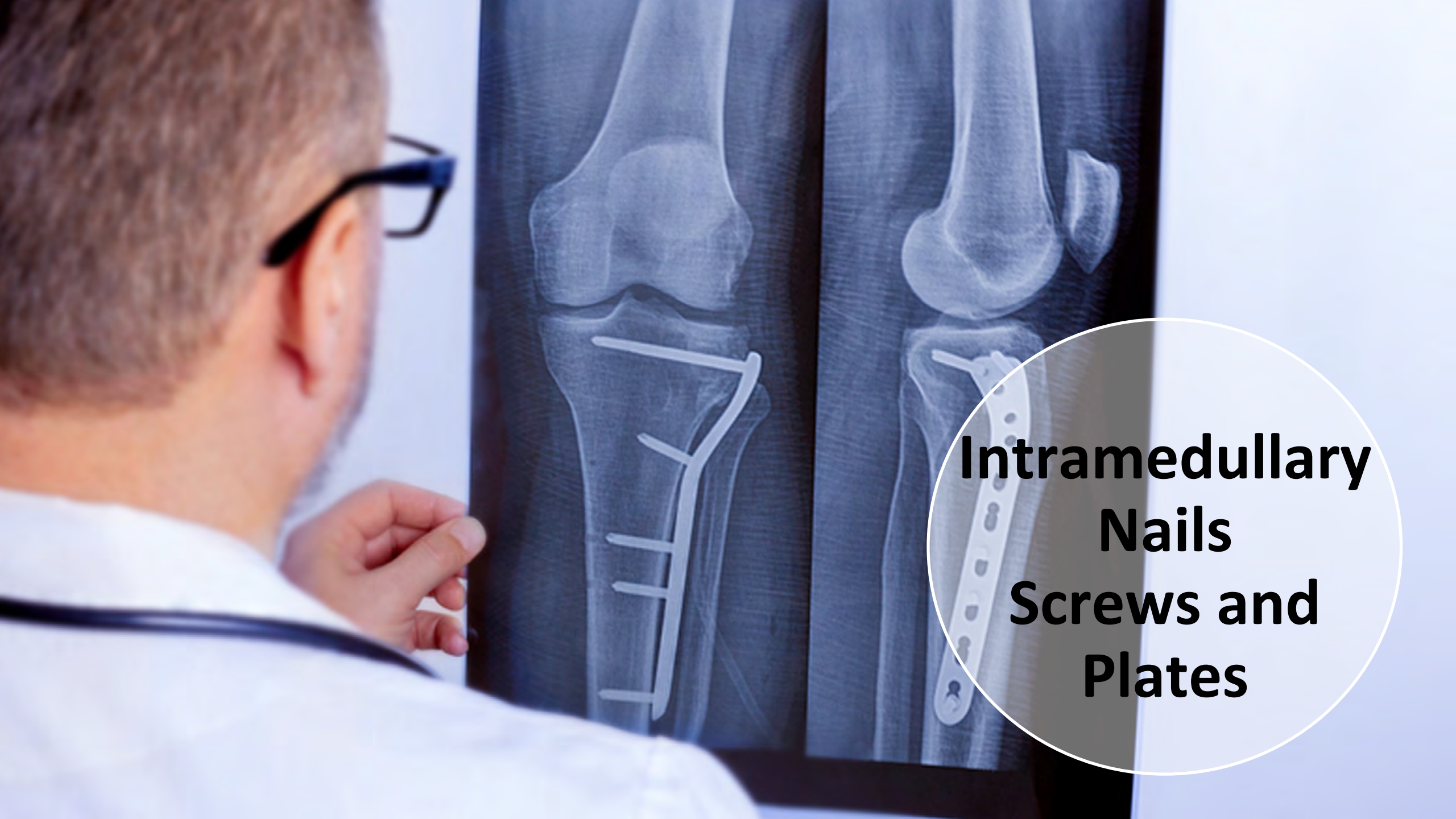
Hip Dislocation



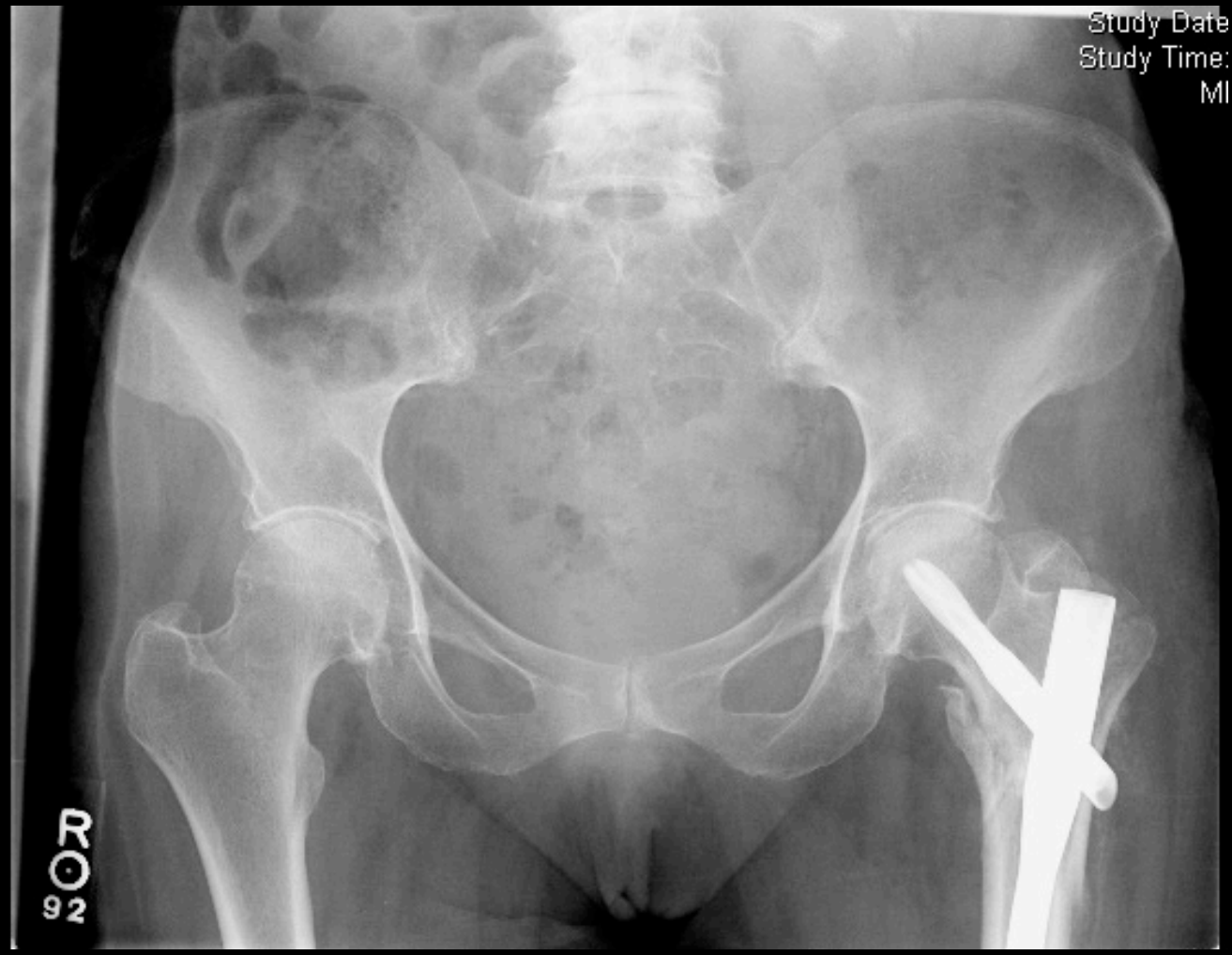
Knee Dislocation

Hacking, 2021

Types of Surgical Treatments for Fractures

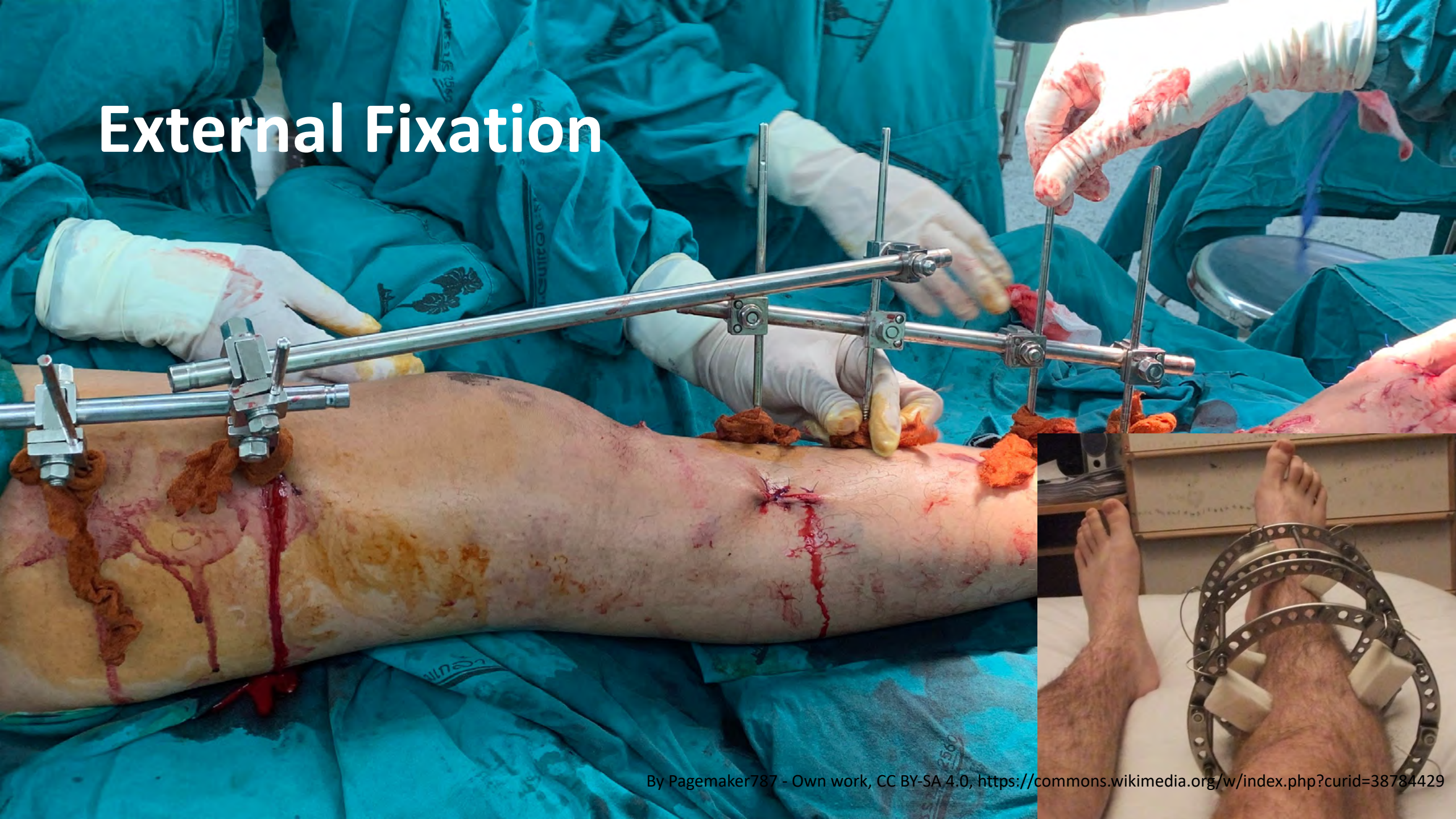

Intramedullary
Nails
Screws and
Plates

Gamma Nail in Femoral Head

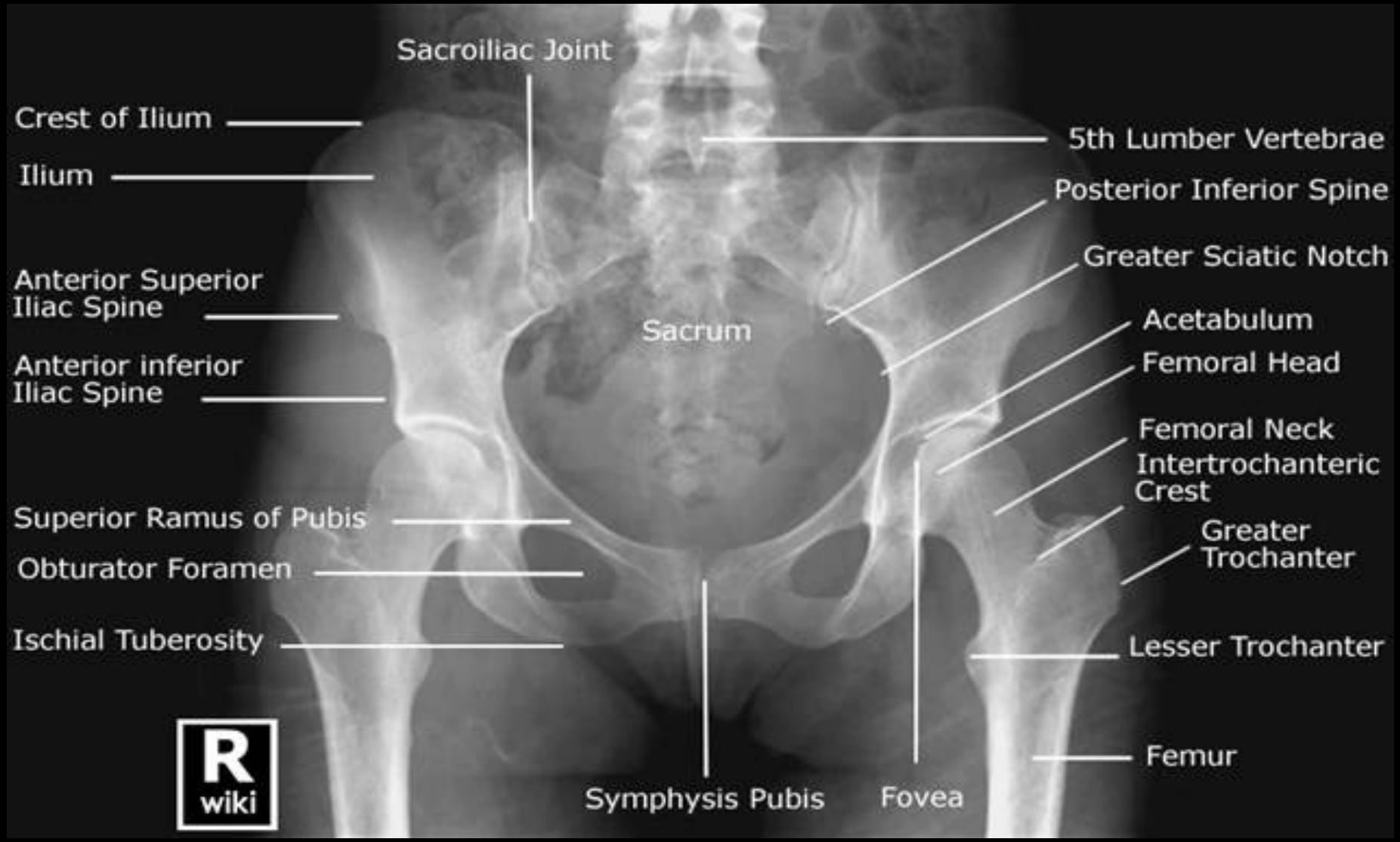


Screw Holds Intramedullary Nail in Place to Avoid Migration

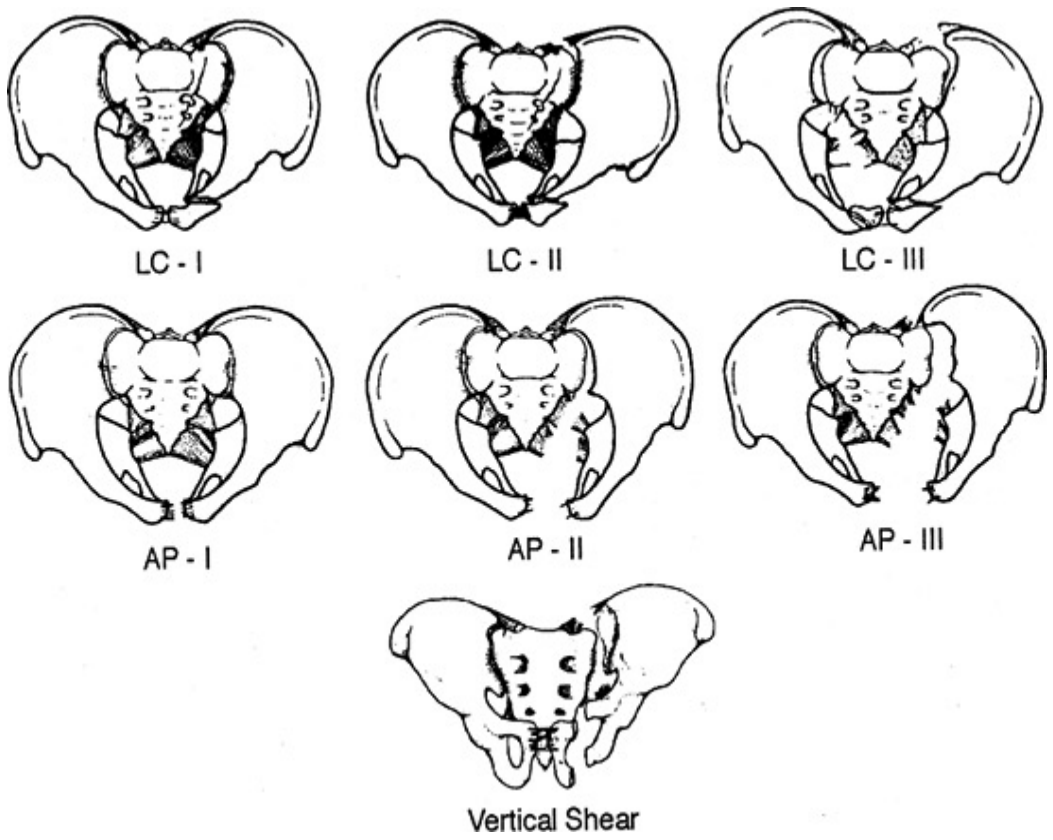
External Fixation

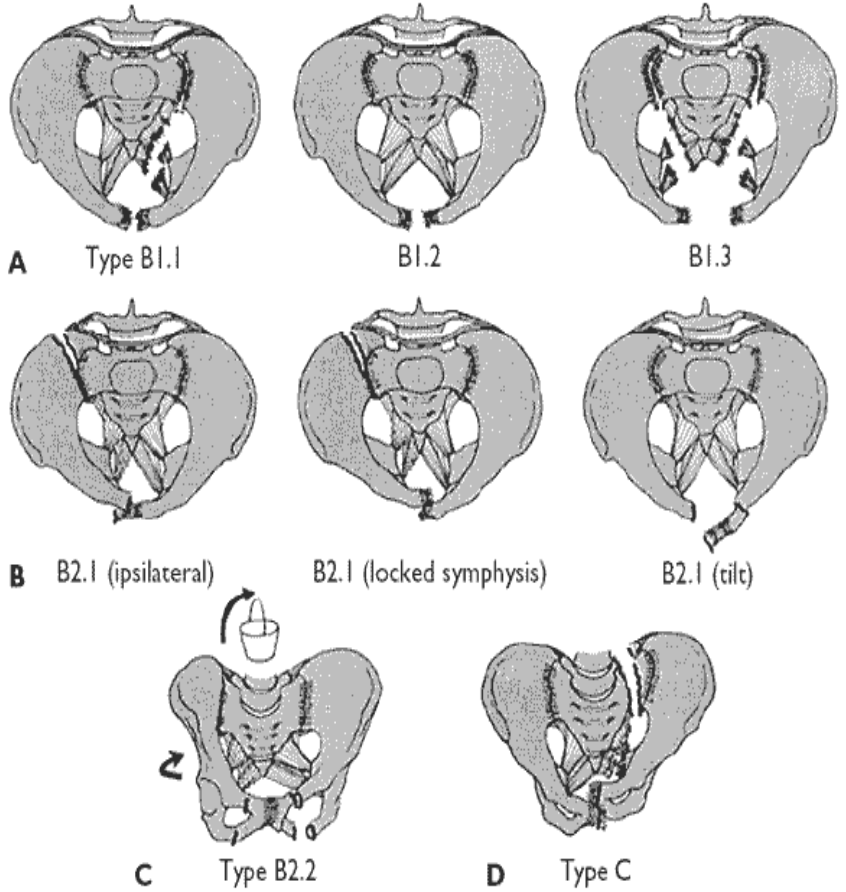


Pelvic Fractures



Classification of Pelvic Fractures: Young vs. Tile





(Young & Resnik, 1990; Tile, 1988)

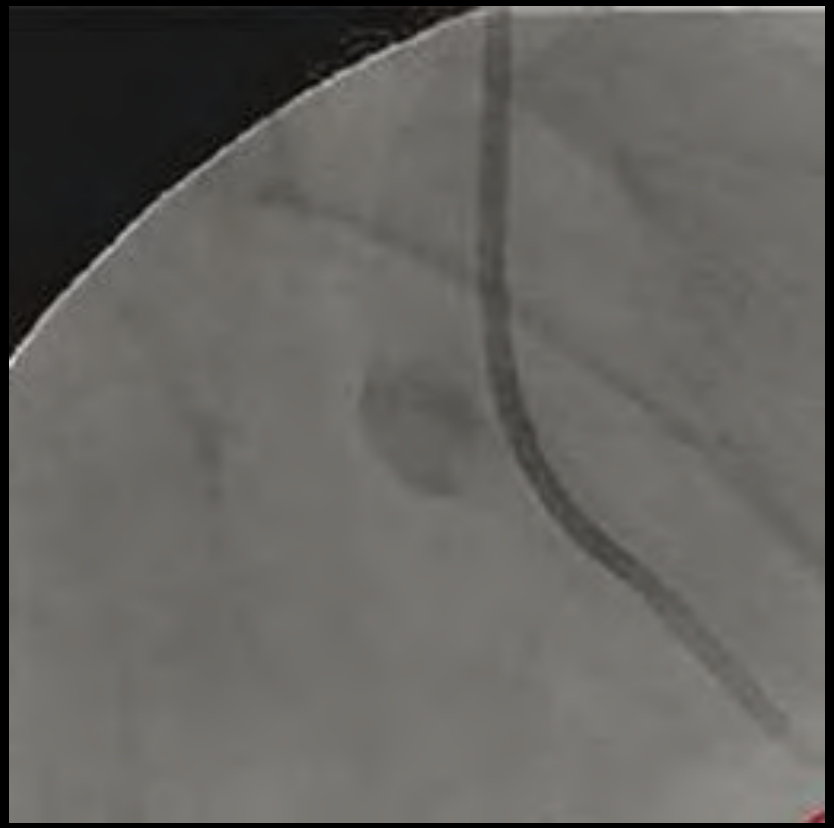
Diastasis Symphysis Pubis

Skandhan, 2022

Associated Injuries in Order of Frequency

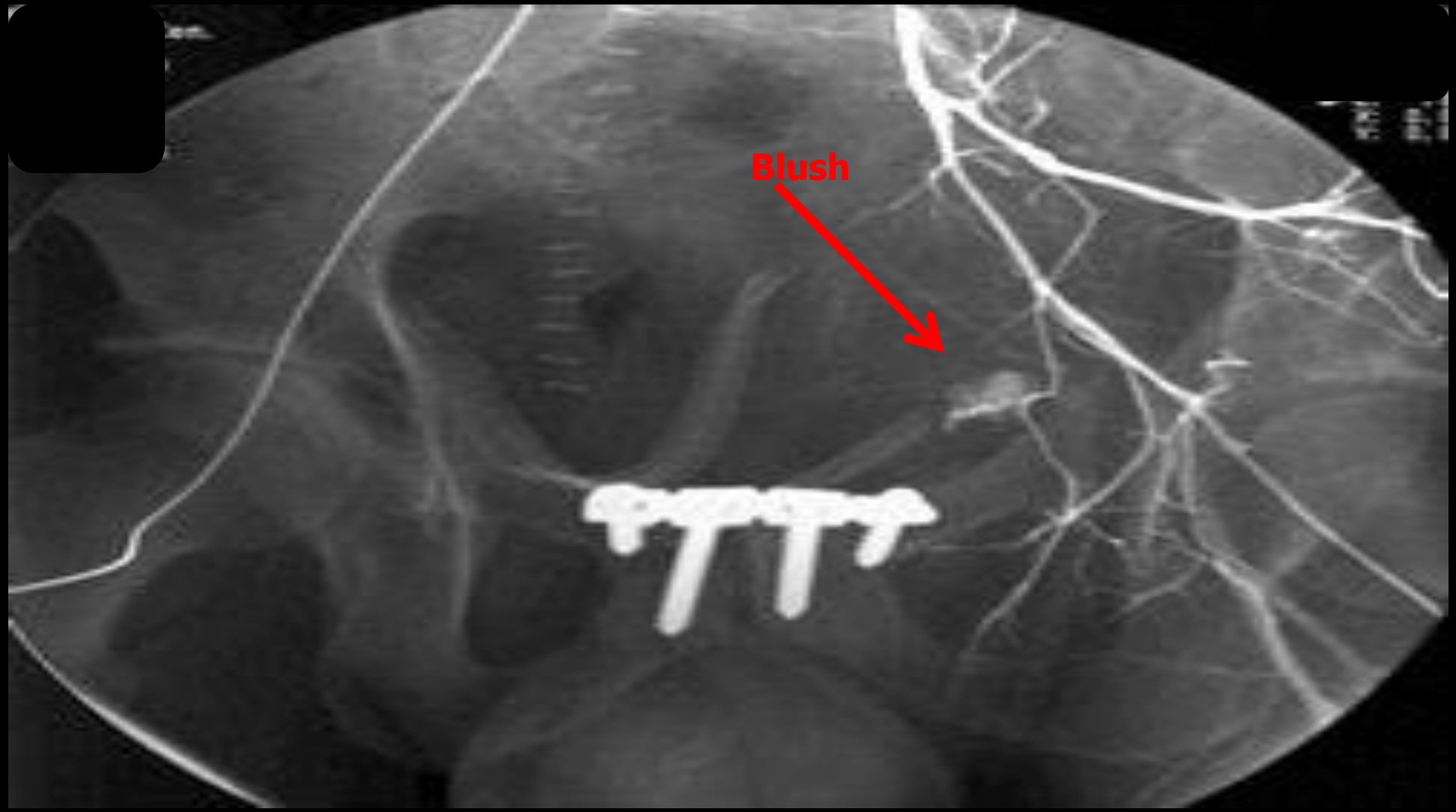
- Closed head injury
- Long bone fractures
- Peripheral nerve injury
- Thoracic injury
- Bladder
- Spleen
- Liver
- GI tract
- Kidney, Urethra, Mesentery, Diaphragm

Role of Angiography



Vaidya, 2018

Angiographic Embolization



REBOA

The rationale for resuscitative endovascular balloon occlusion of the aorta (REBOA) is to control life-threatening subdiaphragmatic bleeding and facilitate damage control resuscitation.


D

Complex Open Fractures

- Gustilo I : <1 cm wound over Fx
- Gustilo II: >1cm wound over Fx
- Gustilo III:
  A) Extensive soft tissue injury
  B) Periosteal stripping
  C) Arterial injury needing repair

Sop, 2021

Gustilo Type 1 & Type 2

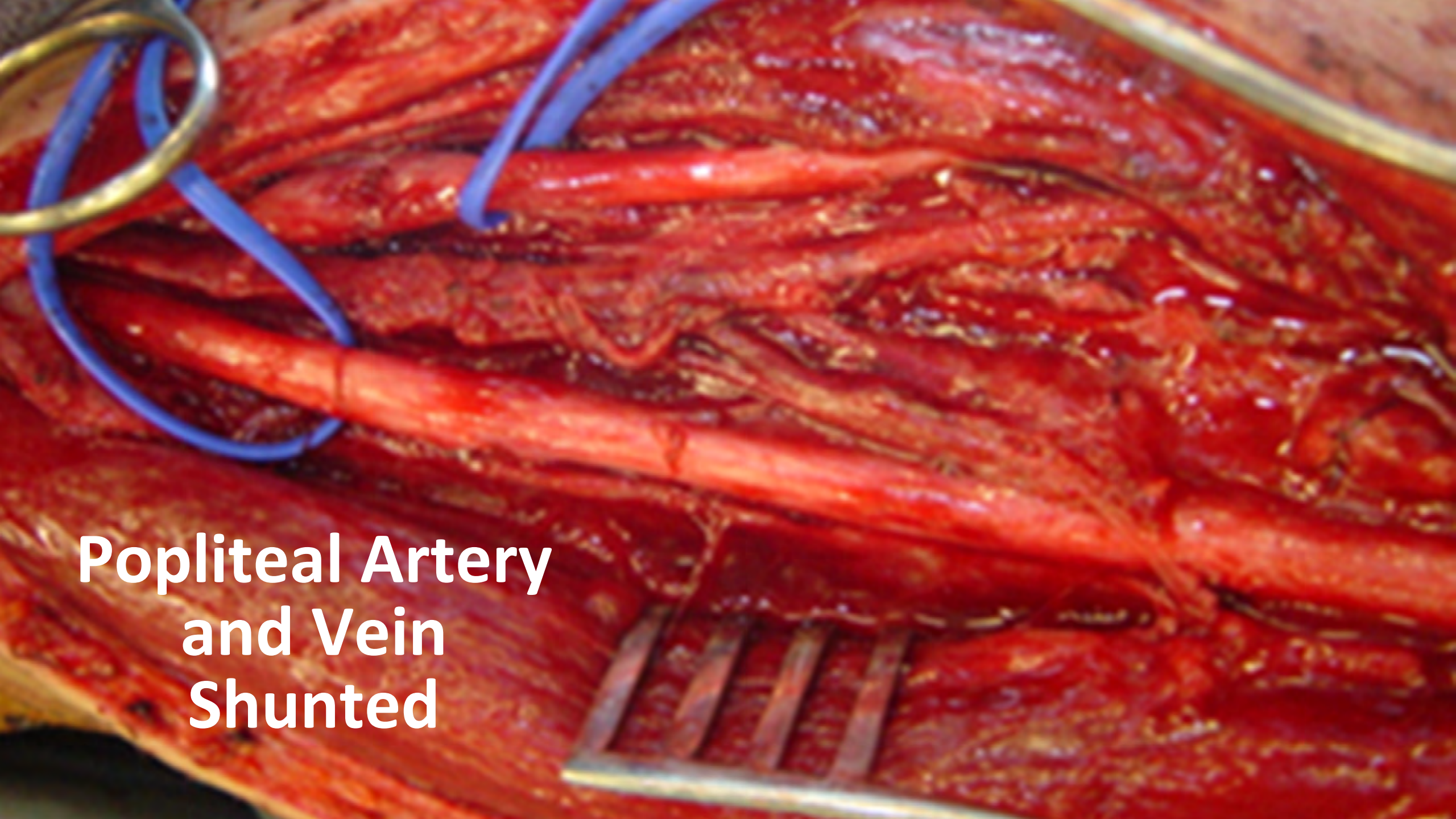
MOI		Points
	Low energy	1
	Medium energy	2
	High energy	3
	Massive Crush	4
Shock		
	Normotensive	0
	Transiently Hypotension	1
	Prolonged Hypotension	2
Ischemia		
	None	1
	Mild	2
	Moderate	3
	Advanced	4
Age		
	Less than 30	0
	30-50	1
	Greater than 50	2

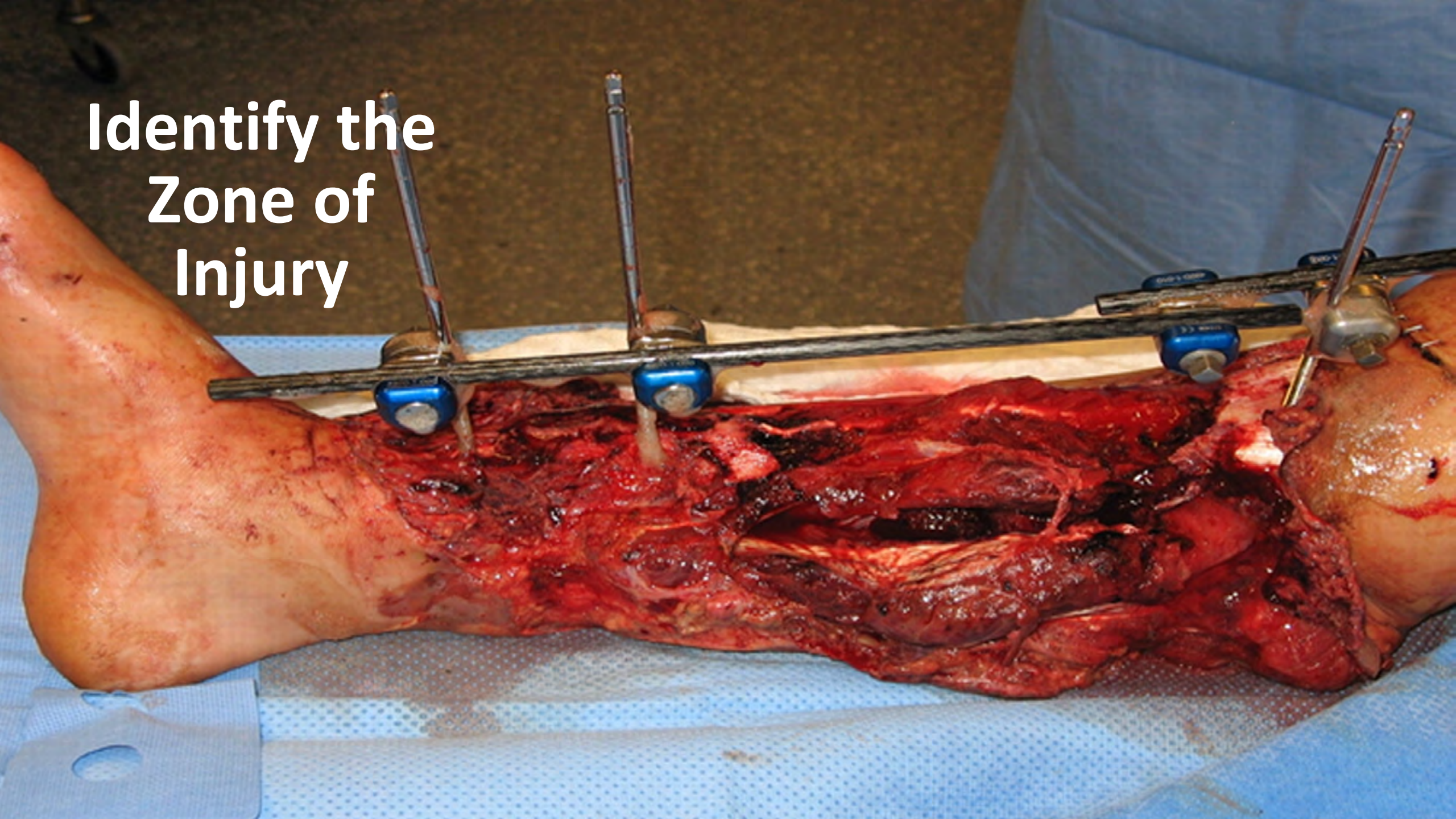
MESS Score

6 or less: consistent with salvageable limb

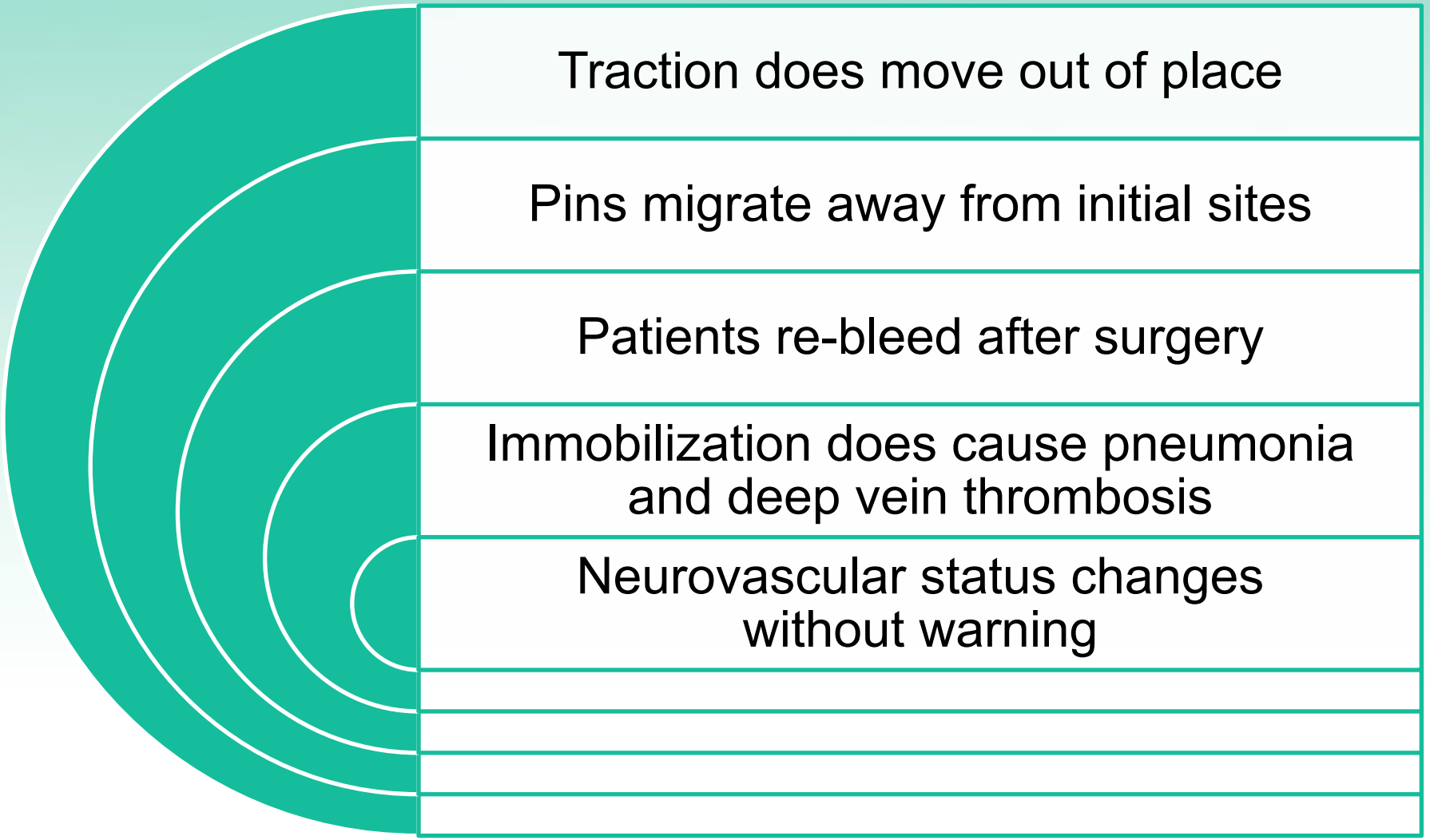
7 or greater: amputation generally eventual result


Mangled
Extremity

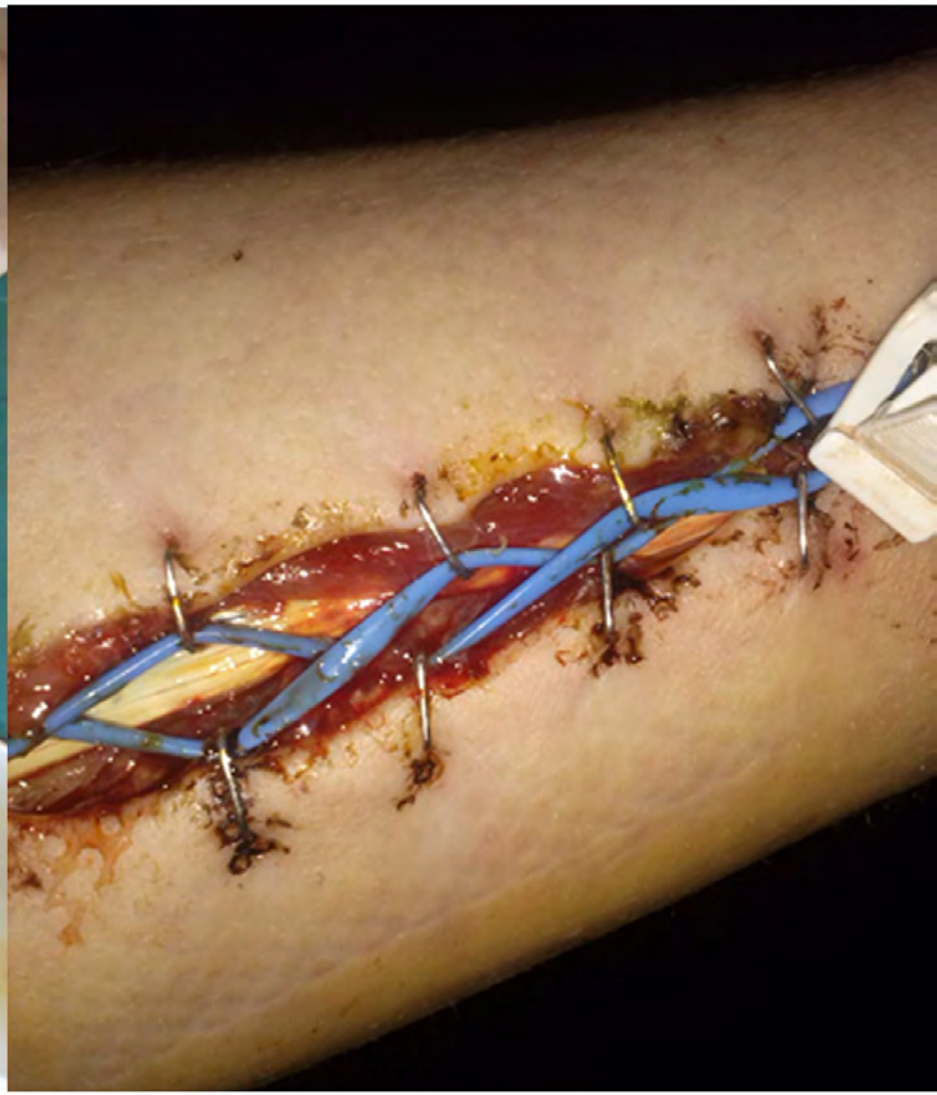

Popliteal Artery
and Vein
Shunted

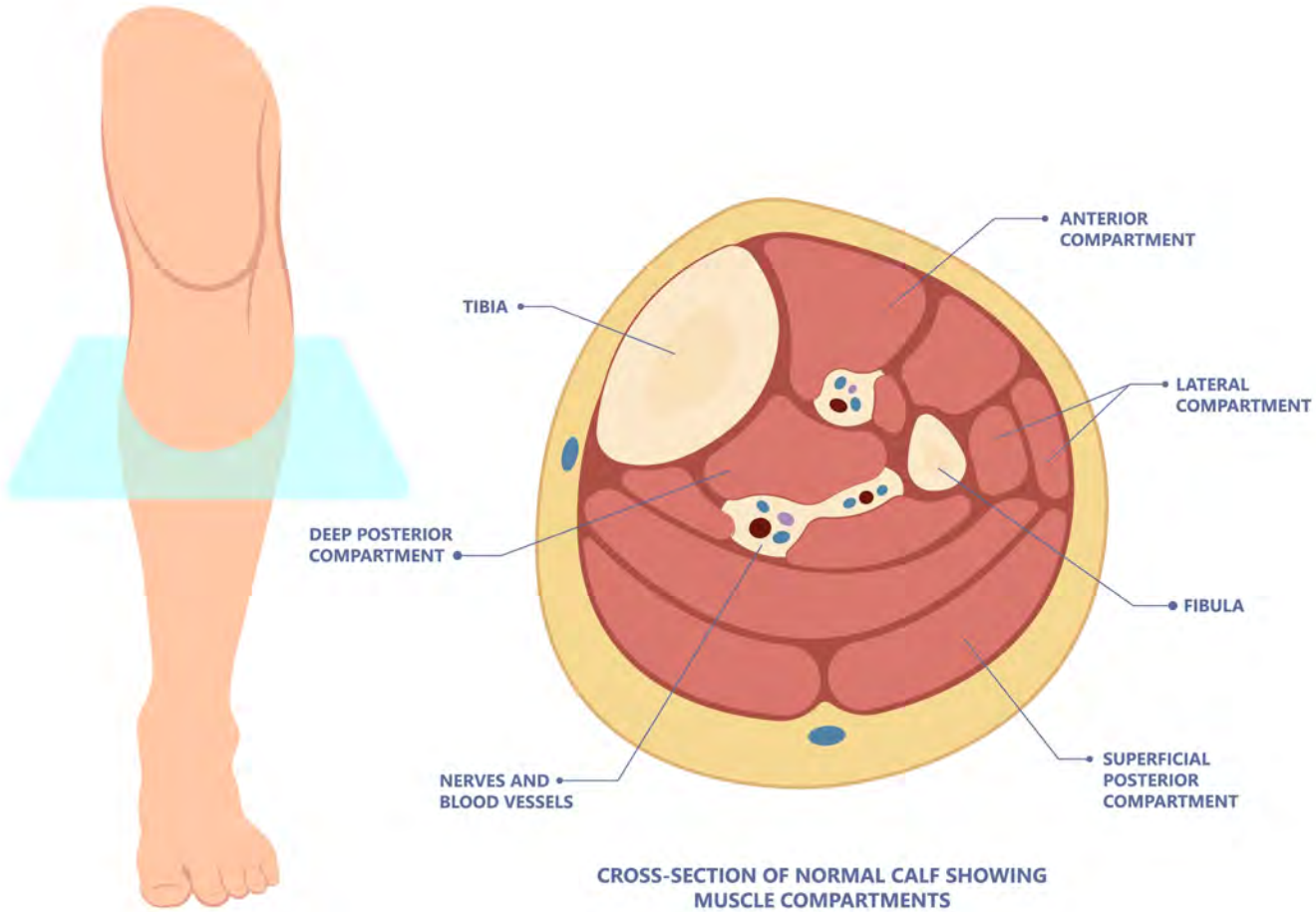

Identify the
Zone of
Injury

Ongoing Assessments

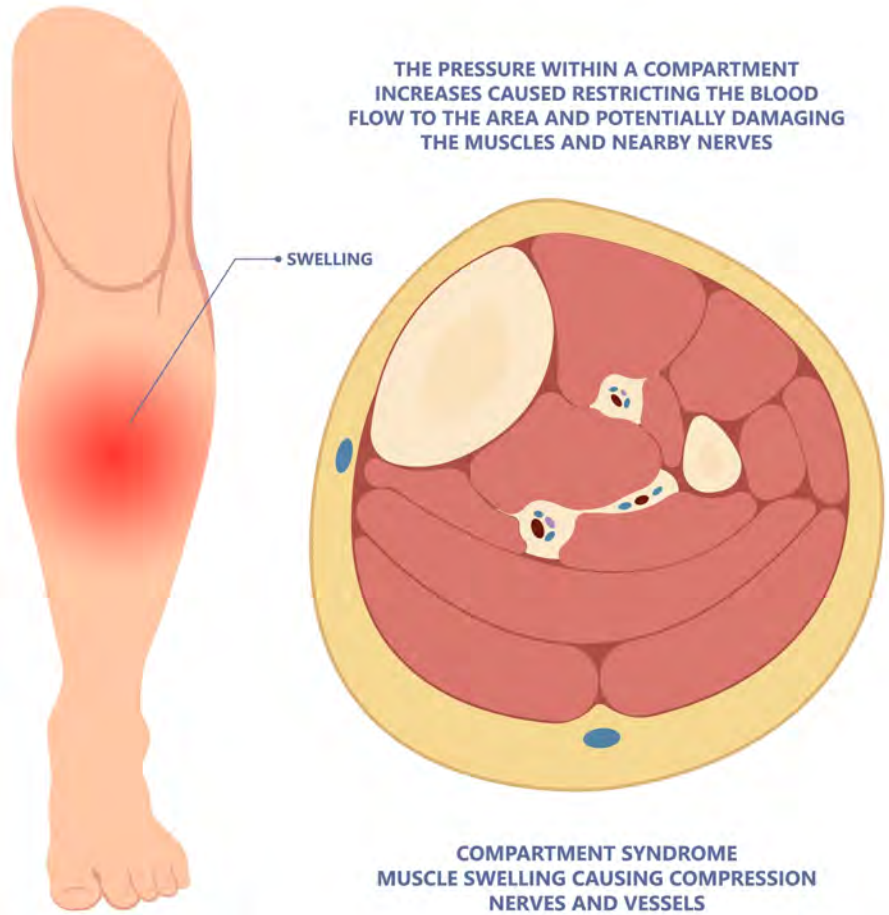


Compartment Syndrome





CROSS-SECTION OF NORMAL CALF SHOWING MUSCLE COMPARTMENTS



COMPARTMENT SYNDROME
MUSCLE SWELLING CAUSING COMPRESSION NERVES AND VESSELS

COMPARTMENT SYNDROME

Ischemia

Vasodilatation

↓

Endothelial cell damage

↓

Increased permeability

↓

Increased interstitial edema and intravascular viscosity

↓

Necrosis

↓

Myoglobin release

Etiology

- Increased fluid content in interstitial space
- Decreased compartment size

https://commons.wikimedia.org/wiki/File:Fasciotomy_leg.jpg

Signs and Symptoms

- Pain disproportionate to injury!
- Pain with passive stretching
- Neuro compromise
- Tenseness
- Unilateral size increase

Interventions

- Supplemental O2
- Level extremity
- Routine trauma resuscitation
- Extra vigilance in some patients
- Hydration
- Diuresis
- Alkalinization of urine

Measurement Compartment Pressures

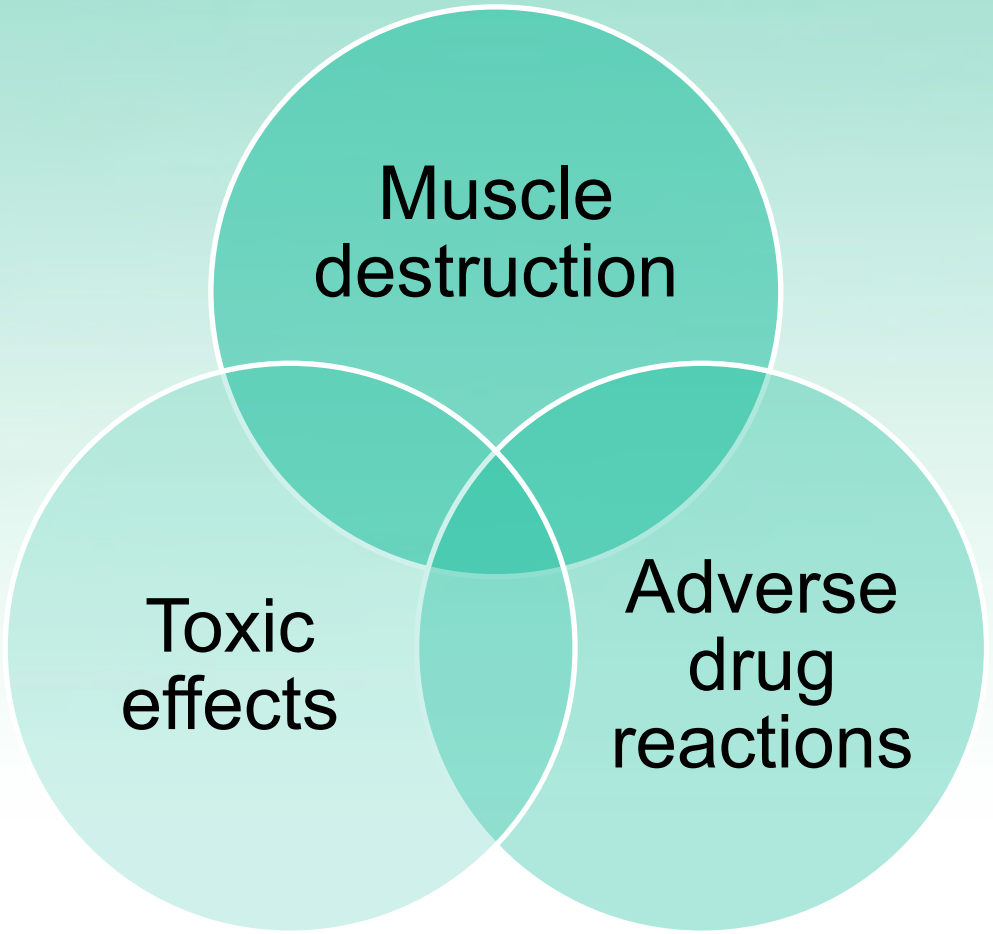
Delta P+ Diastolic Pressure - Compartment Pressure

Compartment >45 Delta P <40

Fasciotomy

- Definitive treatment with limb saving results
- Extends hospital length of stay as it turns a closed injury into an open injury
- Threshold for compartment pressure remains 30 mmHg

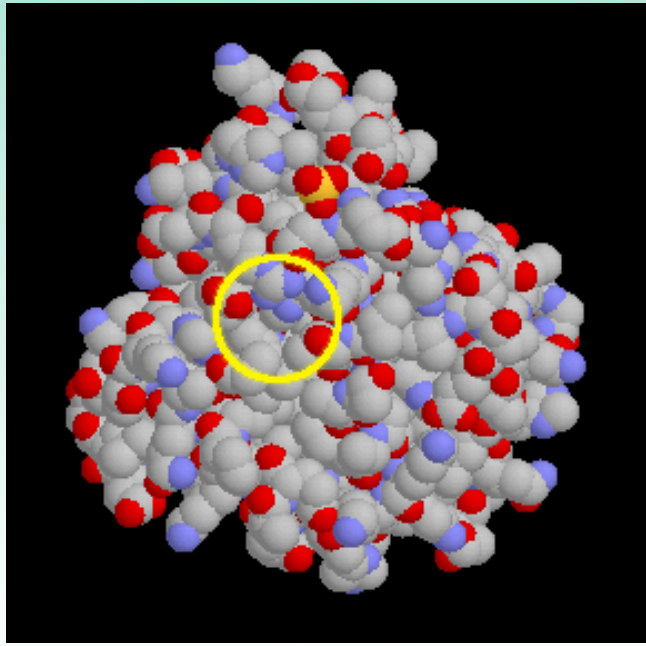
Rhabdomyolysis



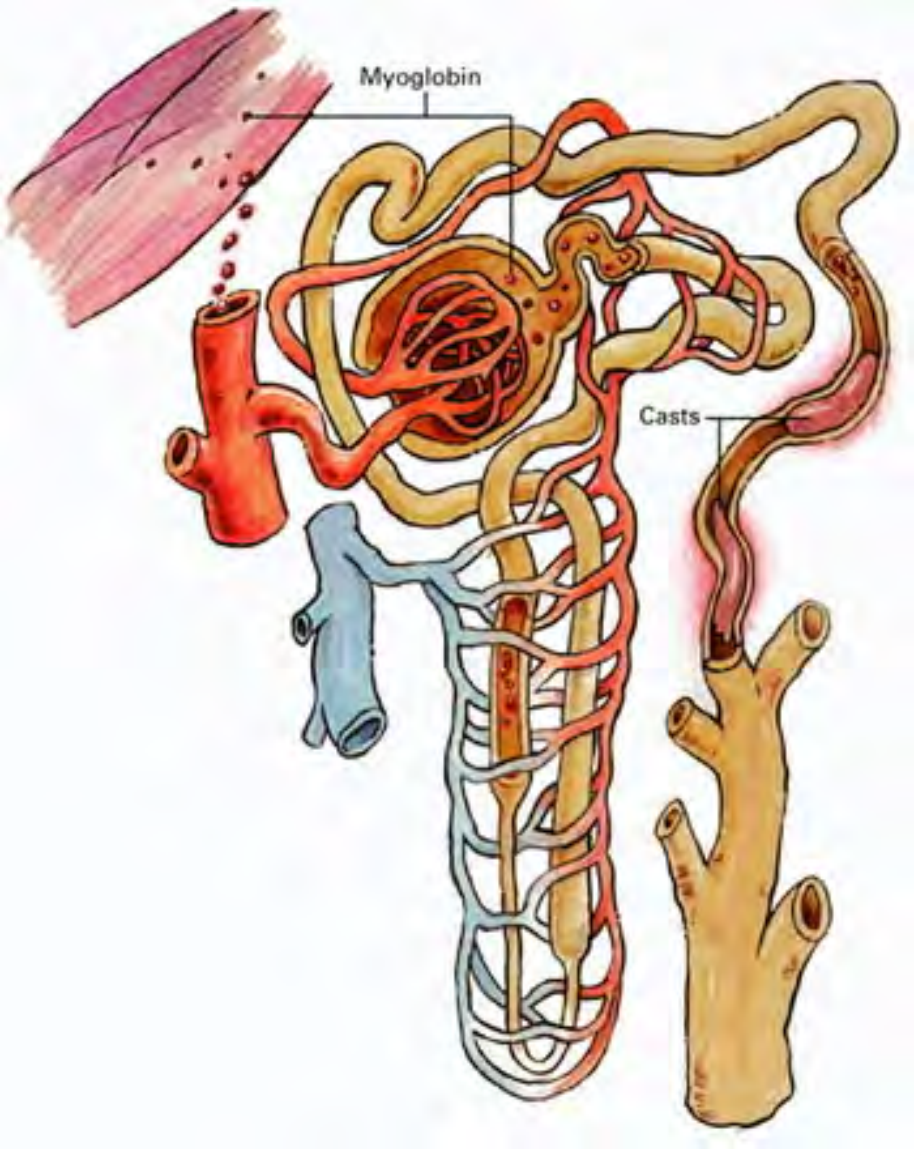
What is Myoglobin?

Iron containing pigment found in skeletal muscle

Especially in those specialized
for sustained contraction



Pathophysiology



- Direct toxicity
- Cast formation
- Mechanical obstruction
- Acid urine causes myoglobin to form a gel
- Hypoperfusion from hemorrhage and fluid shifts
- Reperfusion fluid shifts
- Further hypoperfusion

Causes of Rhabdomyolysis

Rhabdomyolysis

Breakdown of muscle tissue

↓

Results in release of free myoglobin

↓

Myoglobin in the glomerular filtrate precipitates in the tubules and obstructs flow

↓

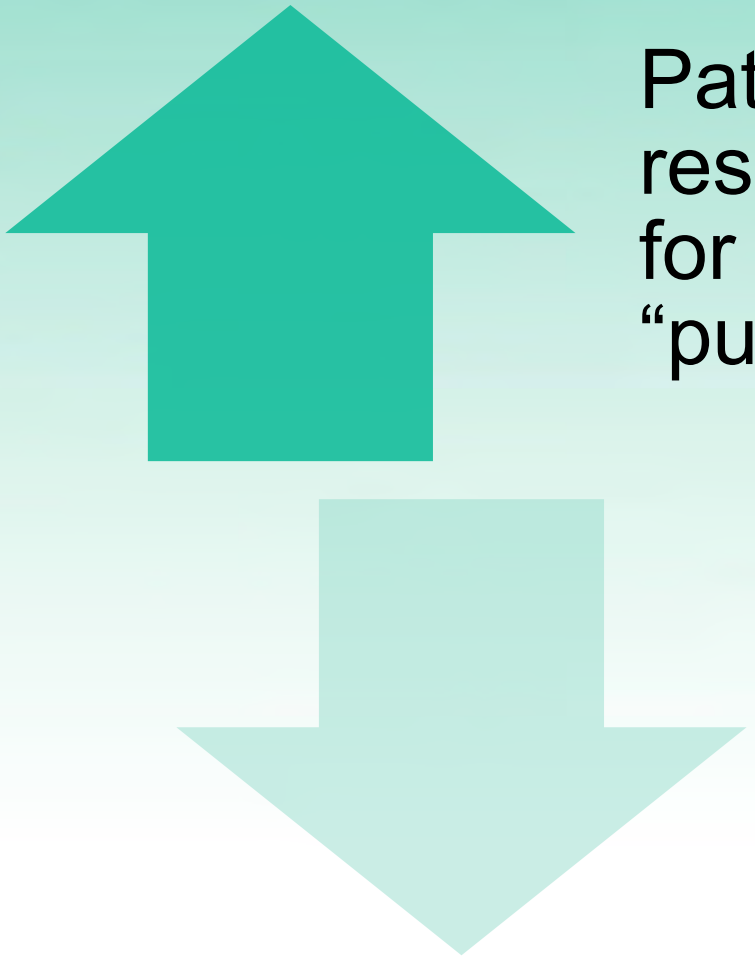
Precipitation is exacerbated by acidic pH of the urine

Treatment of the *Effect* of Rhabdomyolysis

Acute renal failure prevention:

- Monitor CPK, serum and urine myoglobinuria
- Ensure fluid resuscitation
- Ensure hyperdynamic urine output
- Ensure alkaline urine
- May diurese for mechanical lavage
- Carbonic anhydrase inhibitor

Key Point



Patient must be volume resuscitated adequately for appropriate "pushing pressure"

Before administering diuretics and mannitol to exert a "pulling pressure"

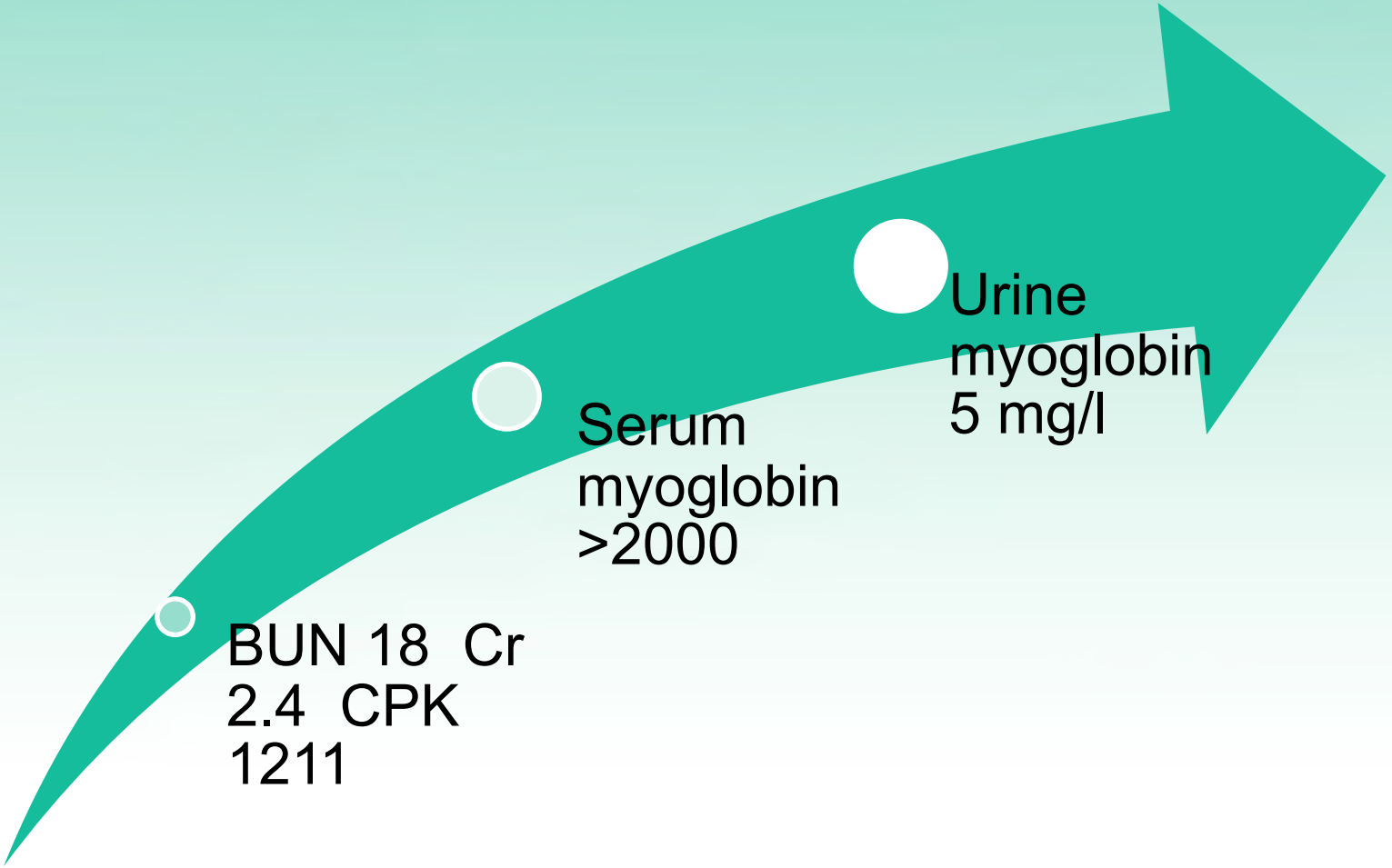
Propofol Infusion Syndrome (PRIS)

- Adverse drug event with high doses
- Not recommended for infusions > 48 hrs
- Signs of PRIS: hyperkalemia, metabolic acidosis, lipemia, renal failure, cardiovascular collapse, hepatomegaly, rhabdomyolysis

Case Study

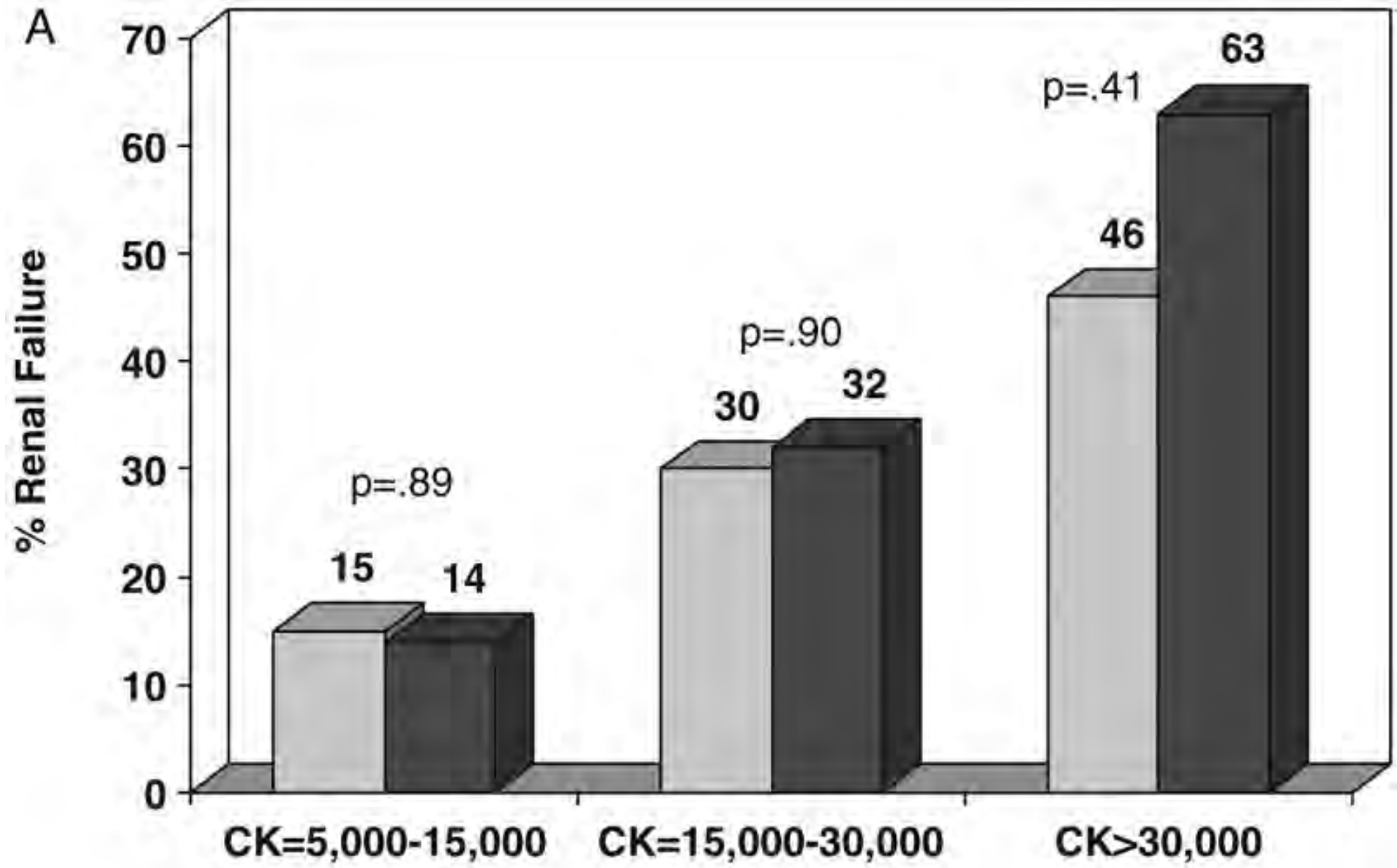
- 18 year old dirt bike vs. car crash
- Previous MVC 12 months ago
  - SVC filter and ORIF left femur
  - On coumadin, nephrogenic DI
  - Hypertrophied bladder, frequent UTI and chronic renal failure
- This admission has fx right femur and bladder rupture along with left ankle injury and closed head injury.

Admission Labs



Diagnosis

- Precipitating factor
- Serum myoglobin
- Urine myoglobin >15 mg/l
- +heme in absence of RBC in yellow urine
- CPK >5000 u/l incidence of ARF becomes significant


A
% Renal Failure
70
60
50
40
30
20
10
0
15
14
p=.89
30
32
p=.90
46
63
p=.41
CK=5,000-15,000
CK=15,000-30,000
CK>30,000

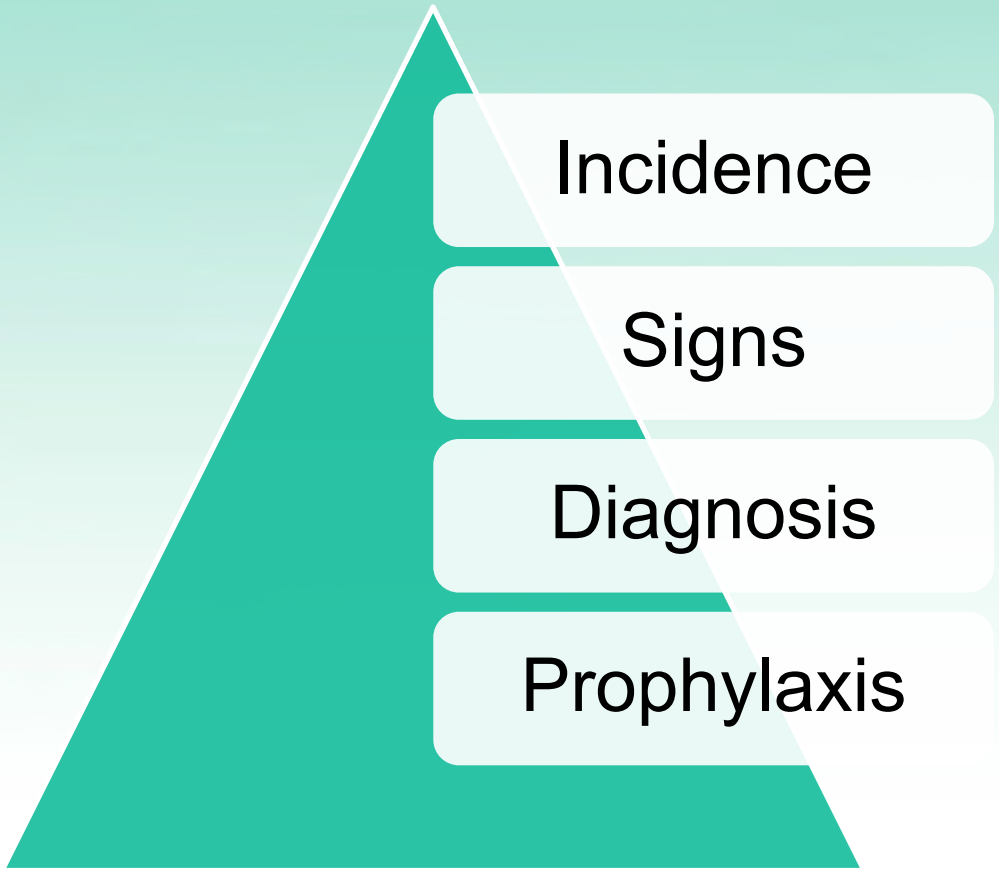
Hospital Course

- PTD 2 BUN 29 Cr 4.5 CPK 5807
- Urine myoglobin 5
- Dialysis begins
- Dialyzed (RRT)
- By PTD 15 creatinine is 1.5
- Discharged on PTD 31

Early Dialysis

- ARF pts who require RRT have increased morbidity and mortality
- Averting continued rises in creatinine might improve outcome in critically injured trauma patients

Deep Vein Thrombosis



SVC Filter?

- IVC filter placement in patients with acute pulmonary embolism (PE) or deep vein thrombosis (DVT) with a contraindication to anticoagulation
- An IVC filter is not advised for patients with recurrent VTE, despite therapeutic anticoagulation, unless the risk for cardiopulmonary deterioration outweighs the risk for IVC filter placement.
- IVC filters should not be placed routinely in patients with acute VTE who are tolerating therapeutic anticoagulation.
- IVC filters can be considered in selected patients with DVT or PE undergoing advanced therapies (e.g., thrombolysis, thrombectomy, and embolectomy).
- Panelists recommended against the use of prophylactic IVC filters in trauma patients or surgical patients without known VTE.

Summary

The priorities of care in a patient with musculoskeletal injury are:

- Stop the bleeding
- Control pain
- Prevent infection
- Prevent complications

Musculoskeletal Trauma

1. A primary nursing responsibility in caring for the patient with skeletal traction is:
    a. Early ambulation
    b. Insertion of inferior vena cava (IVC) Filter
    c. Neurovascular assessment
    d. Incentive spirometry

2. Patients with pelvic and/or femur fractures are at significant risk for developing which post-trauma complication?
    a. Herniation
    b. Infected incision
    c. Deep vein thrombosis
    d. Necrotizing fasciitis

3. A major etiological factor associated with deep vein thrombosis is:
    a. Low platelets
    b. Venous stasis
    c. Increase in the number anticoagulation factors in the venous system
    d. Nerve damage

4. The approximate threshold compartment pressure indicative of a fasciotomy is:
    a. 20 mm/Hg
    b. 30 mm/Hg
    c. 40 mm/Hg
    d. 50 mm/Hg

5. The most common locations for the development of compartment syndrome are:
    a. Shoulder and upper arm
    b. Upper arm and hands
    c. Lower leg
    d. Pelvis and hips

6. Which of the following conditions **do not** require immediate intervention in a patient with traumatic amputation?
    a. Reduced sensation in the affected extremity
    b. Hypothermia
    c. Metabolic acidosis
    d. Coagulopathies

7. During the resuscitative phase of musculoskeletal trauma, what is imperative to recognize early?

a. Potential for ileus
b. Patients at risk for neurologic and vascular compromise
c. Problem with body image
d. Patients at risk for post-traumatic stress syndrome

8. The most appropriate initial treatment for an open or compound tibia/fibula fracture is:

a. Irrigation with betadine solution
b. Splinting the extremity in the position found, above and below the joint while maintaining pedal pulses
c. Application of a "Hare" traction splint or Sager traction device
d. Reduction of the open fracture manually

9. Compartment syndrome is more common in which type of fracture?

a. Distal tibia fracture
b. Colle's fracture
c. Humerus fracture
d. Pelvic ring fracture

10. The two leading cellular components that result in acute tubular necrosis from rhabdomyolysis due to a crush injury are:

a. Myoglobin and potassium
b. Creatinine and BUN
c. Hemoglobin and platelets
d. Magnesium and potassium

Musculoskeletal Trauma

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5th edition

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