

Complications of Trauma

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Take-Home Message

- Early stabilization of long bone fractures significantly decreases the risk of pulmonary complications, ARDS, fat embolism, and thromboembolic disease
- DVT prophylaxis must balance the risk of bleeding with the risk of thromboembolic disease
- No regimen of DVT prophylaxis has been shown to decrease the rate of fatal pulmonary embolism

1 Nonunions

- Arrest in the fracture healing process with no evidence of progression in bone healing over 4–6 months
- Risk factors: inadequate fracture stabilization, poor blood supply (scaphoid, distal tibia, fifth metatarsal, intercalary fragments in segmental fractures), infection, smoking, poor nutritional status, immunocompromise

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- Classification
 - Hypertrophic nonunion: inadequate fracture stability with adequate blood supply, elevated type II collagen, typically heals with improved mechanical stability
 - Oligotrophic nonunion: poor reduction with fracture fragment displacement
 - Atrophic nonunion: inadequate immobilization and inadequate blood supply
 - Septic nonunion
 - Pseudarthrosis
- Presentation
 - Pain with mechanical loading
 - Failure of fracture fixation
 - Radiographs are the primary study to assess fracture healing
 - May consider CT scan if the presence of union is unclear
- Treatment
 - Identify and treat infection, if present
 - May require staged approach
 - Provide stability for hypertrophic nonunions
 - Provide biology for atrophic nonunions
 - Remove dysvascular bone
 - Autologous iliac crest bone graft (gold standard, osteogenic), BMPs (osteoinductive), osteoconductive agents
 - No strong evidence for the use of ultrasound or electromagnetic devices to stimulate bone healing

2 Heterotopic Ossification (HO)

- Ectopic bone that forms in soft tissues
 - Most commonly occurs as a sequelae of trauma or surgical dissection
 - Closed head injury significantly increases the risk of HO
- Risk factors: male, closed head injury, increased ISS, spinal cord injury, ankylosing spondylitis, DISH, Paget's disease
- Common in hip, elbow, and shoulder fractures and any fracture with extensive muscle injury
- Presentation
 - Loss of range of motion, ankylosis, contractures
 - Chronic regional pain syndrome symptoms
 - Inflammation with warm, swollen painful joint or fever
 - Labs: elevated serum alkaline phosphatase, CRP, and CK

- Prophylaxis
 - Radiation: 700 rad 4 h preoperatively or within 72 h postoperatively
 - Inhibits the differentiation and proliferation of osteoprogenitor cells
 - NSAIDs: Indomethacin 75 mg/day ×6 weeks
 - Bisphosphonates: inhibit mineralization but not osteoid matrix formation, HO may become evident with discontinuation of bisphosphonates
- Treatment
 - Sufficiently symptomatic HO may be excised once mature
 - Timing of resection is controversial
 - May consider bone scan or stable appearance of disease on serial radiographs to determine maturity of heterotopic bone
 - Risk of recurrent HO

3 Acute Respiratory Distress Syndrome (ARDS)

- Acute lung injury leads to non-cardiogenic pulmonary edema, respiratory distress, refractory hypoxemia with poor gas exchange, and decreased lung compliance
 - Ultimately results in acute respiratory failure
- Presents with tachypnea, dyspnea, and hypoxemia
- Diagnostic work-up: CXR with bilateral diffuse fluffy infiltrates, arterial blood gas measurements
- Supportive care with high PEEP ventilation and treatment of the underlying pathology
 - Risk of pneumothorax with high PEEP ventilation
 - Steroids not proven to be effective
- Associated with late sepsis and MSOF
- High mortality of 50 % despite critical care
- Early stabilization of long bone fractures significantly decreases the risk of pulmonary complications

4 Fat Embolism

- Inflammatory response to embolized fat and marrow elements
- Incidence: 1–4 % of isolated long bone fractures, 10–15 % of polytrauma patients

- Onset: 24–48 h post-injury
- Diagnostic criteria
 - Major: hypoxemia ($\text{PaO}_2 < 60$), CNS confusion/depression, petechial rash, pulmonary edema
 - Minor: tachycardia, pyrexia, retinal emboli, fat in urine or sputum, thrombocytopenia, decreased hematocrit
- Supportive care with high PEEP ventilation
- 10–15 % mortality rate
- Early stabilization of long bone fractures is the most important factor in prevention

5 Systemic Inflammatory Response Syndrome (SIRS)

- Generalized response to trauma with increased cytokines, complement, and hormones
- SIRS criteria
 - Heart rate >90 bpm
 - WBC <4 or >10
 - Respirations <20 breaths per minute with $\text{PaCO}_2 <32$ mm
 - Temperature <36 °C or >38 °C
- Associated with disseminated intravascular coagulopathy (DIC), ARDS, renal failure, shock, and multisystem organ failure

6 Thromboembolic Disease

- Virchow's Triad: venous stasis, hypercoagulability, intimal injury
- Risk factors: history of thromboembolism, obesity, malignancy, oral contraceptives, smoking, blood disorders that create a hypercoagulable state, immobilization, paralysis, pregnancy
- Thromboplastin triggers the coagulation cascade and is released in large amounts during orthopedic procedures
- High incidence of DVT in trauma patients not receiving prophylaxis
 - Pelvis/acetabular fractures: 20 %
 - Polytrauma patients: 35 %
 - Hip fractures: 60 %
 - Spine fracture with paralysis: 100 %
- Early fracture stabilization lowers incidence

- Prophylaxis
 - Mechanical prophylaxis prevents venous stasis and increases fibrinolytic activity
 - Many options for chemical prophylaxis
 - Prophylactic treatment should be determined by balancing the risk of bleeding with risk of thromboembolic disease
 - Consider vena cava filter in high-risk patients (pelvic trauma, polytrauma, bleeding diathesis) with contraindication to chemical prophylaxis
- Diagnosis
 - Clinical suspicion: extremity pain, swelling, and Homan's sign
 - Assess with venography, duplex ultrasonography, CT scan
- Pulmonary embolus
 - Symptoms: tachypnea 90 %, tachycardia 60 %, ECG changes 25 %, pleuritic chest pain
 - Diagnostic studies: ECG, CXR, arterial blood gas, ventilation-perfusion scan, pulmonary angiography (gold standard)
 - Risk of upper extremity DVT embolization: ~5 %
 - Risk of lower extremity DVT embolization: ~20 %
 - No regimen of DVT prophylaxis has been shown to lower the incidence of *fatal PE*

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