



True Orthopedic Emergencies: Time is Marrow

When a patient with a true orthopedic emergency presents to the emergency department, intervention is required within minutes to avoid irreversible limb loss or systemic complications. The practicing emergency physician must have the most current knowledge in techniques to resolve such emergencies.

- Recognize the most common orthopedic injuries that require immediate intervention to reduce complications.
- Describe the potential complications and early treatment of fractures to the pelvis, dislocations of the hip, knee crush injuries, and recognition of compartment syndrome.
- Explain the best method for the evaluation and treatment of the traumatic pulseless extremity.

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FACULTY

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I. Course description

1. The purpose of this **course** is to discuss orthopedic injuries in which time is a factor in determining an optimal outcome.
2. When a true orthopedic emergency presents **to the emergency department**, it requires timely intervention to avoid irreversible limb loss or systemic complications.
3. The practicing emergency physician must **be able to recognize** these conditions and **respond** appropriately.

II. Course objectives

1. Recognize **the most common orthopedic** injuries that require immediate intervention to reduce complications.
2. Describe **the early treatment** and potential complications of open **fractures, traumatic amputations, dislocations of the hip, knee, and elbow**, compartment syndromes, **and pelvic fractures** with **hemorrhage**.
3. Explain the **best** method for the evaluation and treatment of the traumatic pulse **less** extremity.

III. Amputations and replantations

A Introduction

1. **Replantation** Of an **amputated** digit or limb should be considered a **surgical** emergency.
2. **Success rates** up to 90% for both complete and incomplete amputations.
3. Most **of these** injuries **occur** in patients **between** ages 20 and 40 with **males > females by 4:1**.
4. Distal amputations **occur** more commonly than proximal.
5. Partial and complete amputations **occur** equally often.
6. **Replantation** = reattachment of a completely amputated part,
7. **Revascularization** = **reconstruction** of a partially or incompletely amputated **part**
8. **Revascularization** usually **provides** better functional results.

B. Initial Evaluation and Management

1. The goal is to stabilize the patient and preserve the limb and its components.
2. Treat all amputated limbs as though **they** will be replanted or **revascularized**.
3. The decision should ultimately be made by **the microvascular surgeon** and immediate **consultation** is mandatory:
4. The initial care done by **the EP** is critical in determining the ultimate **success** in **replantation**.

C. Principles of management

1. Aggressively resuscitate the patient and address other life-threatening injuries first.
2. **Apply** a **pressure** dressing, splint, and elevate the arm
3. Do not clamp or ligate **blood** vessels in the ED.

4. **Keep** all parts as they may be used as a donor source **if replantation** is not possible.
 5. Do **not sever tissue** bridges between the proximal stump and amputated part.
 6. The **amputated part** should be wrapped in a **saline** soaked gauze and then placed in a dry plastic bag that is then placed on **ice**.
 7. Tetanus should be given as indicated.
 7. Prophylactic antibiotics should be given.
 8. Radiographs should be taken.
 9. In incomplete amputations any unstable fractures should be splinted to prevent additional injuries.
 10. The **partially** amputated part should be **cooled** if there is no evidence of circulation in the amputated part.
 11. Contact the **microvascular** surgeon immediately to minimize the total ischemic time.
- D. History
1. Important details such as mechanism of **injury**, time and place of **injury**, **condition** of the injured part, hand dominance, and general condition of the patient will directly **influence** whether replantation is attempted.
 2. An amputation from a sharp object has a higher replantation success **rate** than an amputation **from** a blunt or crushing force.
 3. **Avulsion** amputations as with injuries in rollers have a much **poorer** prognosis.
- E. Time element
1. The absolute **length** of time an amputated limb can tolerate ischemia and still undergo **successful replantation** is unknown.
 2. **The** longer the ischemic time the **greater** the likelihood of failure for **replantation**.
 3. Warm ischemia relates to amputated parts kept at or near room temperature and may be tolerated for 6 to 8 hours
 4. When cooled to 4° C 12 to 24 **hours** of ischemia may be tolerated.
 5. Skin, bone, tendons, and ligaments tolerate ischemia much better than do **muscle** and **connective** tissue.
 6. As a general **rule** the more proximal the amputation the less ischemia time the amputated part can tolerate.
- F. Indications for replantation
1. Multiple digits
 2. Thumb
 3. **Wrist** or forearm
 4. Sharp amputations with minimal to moderate **avulsion** proximal to the elbow
 5. Single digits amputated between PIP and DIP joint (distal to flexor **digitorum superficialis** insertion)
 6. Amputations in children
 7. Young stable patient.
- G. Absolute contraindications of replantation
1. Associated **life** threats
 2. Severe **crush** injuries
 3. Inability to withstand prolonged surgery
- **Do not discard amputated parts if replantation is not possible. All amputated parts should be considered potentially valuable tissue as some may serve as donor tissue in grafting procedures and be useful in restoring function to other damaged parts.**

- H. Relative contraindications of replantation
1. Single digit (excluding thumb)
 2. **Avulsion** injury
 3. Prolonged **warm** ischemia (12 hours or more)
 4. **Gross contamination**
 5. Prior injury or **surgery** to part
 6. Emotionally unstable patients
 7. Lower extremity
 8. Multiple-level amputations
 9. Elderly patients.
- I. Complications
1. **Early** -post-operative complications include vascular thrombosis, hemorrhage, **infection**, compartment **syndromes** and reaction to accumulated toxins such as systemic acidosis, **hyperkalemia**, and **rhabdomyolysis**. Ongoing **ischemia** requiring multiple surgeries may be needed to reestablish adequate blood flow.
 2. **Late** - 60% of patients have cold intolerance, limited function, anesthesia, pain, **paresthesias**, **malunions**, and **nonunions**.

IV. Open fractures

- A. Introduction
1. An open **fracture** is one in which a **break** in the skin and underlying soft **tissues** **leads directly** into or **communicates** with the **fracture**.
 2. **Typically** high-energy injuries **caused** most commonly by motorcycle accidents, **MVA's**, and **falls**.
 3. About 40% to **70%** are associated with trauma elsewhere.
 4. **Always** suspect an **open fracture** when a **wound** is near the **fracture** site.
 5. Fat droplets in the **wound** are **pathognomonic** of open **fracture**.
 6. The presence of an air **arthrogram** indicates direct connection and contamination of a joint.
- B. Classification
1. Most system **deal** with the size of the skin defect, the degree of soft tissue injury, and the complexity of the bony **injury**.
 2. **Gustilo** and **Anderson** system
 - Grade I**: skin opening of 1 cm or less, **quite** clean. Simple transverse or **short** oblique fractures. **Minimal** muscle contusion.
 - Grade II**: laceration more than 1 cm long, with extensive soft tissue damage, flaps, or **avulsion**. **Minimal** to **moderate** crushing component. Simple transverse or short oblique **fractures** with minimal **comminution**.
 - Grade III**: **extensive** soft tissue damage including muscles, skin, and **neurovascular** structures. **Often** a high-velocity injury with a severe crushing component.
 - IIIA**. Extensive soft tissue laceration, adequate **bone** coverage. Segmental fractures, gunshot injuries.
 - IIIB**. Extensive soft tissue injury with **periosteal** stripping and bone **exposure**. Usually associated with massive contamination and severe **comminution**.
 - IIIC**. Vascular injury requiring repair.

- C. Treatment
1. Open **fractures** are surgical emergencies.
 2. Any delays **will** jeopardize limb survival and recovery.
 3. The ARC's and life-threatening injuries **must be** addressed **first**.
 4. Prognosis in open fractures is determined by the **amount** of devitalized soft **tissue** and by the level and type of bacterial contamination.
 5. Wound inspection should be done only **once** to prevent infection. Do not explore or **probe** the wound.
 6. The **open fracture** should be splinted without pulling the exposed **bone** back into **soft tissue** except **if vascular** compromise present then apply gentle traction **to** realign the extremity
 7. A sterile compression dressing should be applied **or** if delay in OR flush **wound** gently with **1** to 2 liters of sterile saline.
 8. Antibiotics **such** as a 1st **generation cephalosporin** and **tetanus** prophylaxis are given. **If highly** contaminated may add penicillin to prevent **clostridium or an aminoglycoside**.
 9. Patients should **be** taken to the operating **room** for **copious** irrigation and aggressive **debridement**.
- D. Complications
1. The primary complications are compartment syndromes, necrosis, and **infection such** as osteomyelitis.
 2. Delayed **union** or **nonunion** may **result** with considerable deformity and loss of **function**.

V. Compartment syndromes

- A. Introduction
1. Compartment **syndrome** is a **condition characterized** by raised pressure within a **closed** space **with** a potential to **cause** irreversible damage to the contents of the **dosed space**.
 2. **Increased** tissue **pressure** within a limiting envelope **causes** reduced **myoneural** tissue **circulation resulting** in abnormalities of **neuromuscular function**.
- B. Etiology
1. Many **causes of** elevated **compartment pressures such** as **muscle contusion**, a bleed into the **compartment**, and **occlusion** of venous **outflow** from the **compartment**.
 2. Most often associated **with** acute orthopedic **trauma** but has been described with **prolonged** immobilization. PASG application, **intra osseous infusions**, **vigorous** exercise, **crush injury**, excessive cycling of **noninvasive blood pressure cuffs**, frostbite, snakebite, and blunt **or** penetrating **trauma** to a **circumscribed body** cavity.
- C. Anatomy
1. First described in the lower extremity but has been described in the thigh, **foot**, forearm, amt. hand, **gluteal** compartment, and although somewhat controversial the abdominal and **thoracic** compartments.
 2. Forearm - 2 compartments
 - a. ~-contains the median nerve, **ulnar** nerve, radial artery and **ulnar** artery, and wrist and **finger** flexors.
 - b. **Dorsal compartment** - **extensor** compartment less **often** involved. Contains the posterior **interosseous nerve** and no major vessels.

Lower leg - 4 compartments

- a. **Anterior tibial compartment** - contains the **anterior tibial artery** and **deep peroneal nerve**, **tibialis anterior** and **toe** extensors
- b. **Superficial posterior compartment** - contains the **gastrocnemius** and **soleus** muscles, and **sural** nerve.
- c. **Deep posterior compartment** - contains the posterior **tibial** vessels and nerves and the **peroneal** artery, **tibialis posterior**, and toe flexors.
- d. **Peroneal or lateral compartment** - contains **the** deep and superficial **peroneal** nerves, **peroneus longus** and **brevis** muscles.

D. Signs and symptoms

1. Pain out of proportion to **the** problem is the most reliable finding.
2. The pain is unrelenting and unrelated to the position or immobilization of the extremity.
3. Pain or tenseness on palpation of the swollen compartment is suggestive.
4. Exam for reproduction of symptoms **with** passive **muscle** stretch.
5. **Paresthesias** and **pulselessness** are late and unreliable findings.
6. **Pulses** and capillary refill generally normal unless arterial injury present.
7. Symptoms may develop within **2 hours** or as late as 6 days tier the injury.

E. Tissue pressure measurements

1. If the diagnosis is suspected compartment **pressures must be measured**.
2. Digital manometers such as the **Stryker S.T.I.C. Monitor** and the **ACE intra compartmental pressure monitor** are most efficient and accurate.
3. Check **pressures 2-3 times** with **different** orientations with low **pressures** most reliable.
4. Normal tissue **pressures are usually 0 - 10 mm Hg**.
5. **Perfusion** through capillary network is at risk with **pressures > 20 mm Hg**.
6. **Pressures > 30 mm Hg** may **cause** ischemic necrosis of nerve and **muscle** tissue.
7. May need serial **measurements**.
8. **Correct pressures** for **hypotensive** patient

F. Treatment

1. Early diagnosis and treatment **are** curative but delays may **result** in serious and **permanent** disability.
2. Need to suspect then **confirm** the diagnosis to **expedite** the treatment.
3. If obvious signs and symptoms or compartmental pressure **> 30 to 45 mm Hg** should go straight to fasciotomy.
4. Treatment is surgical decompression of **the** involved **space with** wide fasciotomy of the fascial **compartment** and delayed primary **closure** or skin grafting after swelling has subsided.

G. Complications

1. If **untreated** may acutely develop rhabdomyolysis and **myoglobinuric renal failure**.
2. If **chronic muscle** scarring. **contractures**, and nerve compression.

VI. Elbow dislocations

A. Introduction

1. The elbow is a hinge-like joint and is the second most frequently dislocated **major joint**.
2. These dislocations need **to** be reduced promptly not only to relieve pain but **to** prevent circulatory compromise and cartilaginous damage.

3. A significant force “ceded and 3040% have associated fractures.
 4. The majority (8590%) are **posterior**.
- B. Mechanism of injury
1. A fall on a” **outstretched an”** with the **elbow** extended or **hyper** extended.
 2. The **olecranon acts** as a **fulcrum** to force apart the elbow.
- C. Physical findings
1. The **arm** is held at the side with the elbow in 30 to 40” **flexion** with a prominent **olecranon** process.
 2. The **neurovascular exam** should check the **brachial artery, median** and **ulnar** nerve.
- D. Radiographs
1. Lateral and **AP** views needed.
 2. Check for associated fractures especially the epicondyles which **could** impede the **reduction**.
- E. Treatment
1. Several reduction techniques based on traction followed by anterior translation.
 2. **After** the reduction it is important to **repeat** the **neurovascular** exam and to gently test range of motion passively for stability.
 3. Immobilize the elbow in 90” **flexion** in a posterior long **arm** splint.
 4. Frequent **neurovascular** checks **should** be done over the **first** 24 to 36 **hours** to **assess vascular** compromise and compartment syndrome.
- F. Complications
1. The **brachial** artery, median. and **ulnar** nerves may **be injured**. A compartment syndrome may develop.
 2. Medial **epicondyle fractures** may **occur** and may become entrapped **during** the **reduction**.
 3. **Ectopic calcifications** or **myositis ossificans** also may develop.

VII. Hip dislocations

- A. Introduction
1. The hip is a stable ball and socket joint and great force is needed to dislocate it.
 2. **MVA’s** most **common cause** (70%).
 3. Associated **fractures** are **common**.
 4. Need **prompt reduction** to decrease **avascular** necrosis of the femoral head.
 5. **Types** of dislocation: Anterior, posterior, and central.
 6. The majority **are posterior**.
- B. Mechanism of injury
1. **MVA’s most common cause**.
 2. A force is applied to the flexed knee with the hip in varying **degrees** of **flexion**.
- C. Physical examination
1. The leg. is shortened **internally rotated**. and **adducted** (**PID** = posterior, internal **aD**ducte**d**).
 2. Check sciatic nerve **function** (10% incidence in posterior dislocations).
 3. **Beware** of **ipsilateral** femoral shaft **fracture** may alter classic presentation.
- D. Radiography
1. AP and lateral **views** of the hip and pelvis.
 2. Special views may be “ceded to lwk for associated fractures of the **femur**, femoral head, femoral **neck**, **acetabulum**, and knee.

- E. Treatment
1. A simple dislocation may be done with closed reduction using **conscious sedation** and analgesics.
 2. Multiple attempts **are** discouraged as the use of excessive force as may convert this to a **fracture** dislocation.
 3. **Stimson's maneuver** - patient in prone position with assistant stabilizing the pelvis. The injured hip and knee **are** flexed to 90° and downward traction is applied behind the flexed knee.
 4. **Allis's maneuver** - patient is supine while an assistant stabilizes the pelvis. Traction is applied in direct line of the deformity followed by gentle hip **flexion** to 90°.
 5. **If unsuccessful** the patients **are taking** to the OR and done **under** general anesthesia **usually** with fluoroscopy.
 6. Light skin or buck traction is applied after the reduction with the hip extended and the leg **slightly** abducted and **externally** rotated.
- F. Complications
1. Early complications include associated **fractures**, sciatic nerve injury, tearing of the **iliofemoral** ligament and damage to the **articular surface**.
 2. Late complications include **avascular** necrosis of the femoral head, post-traumatic **osteoarthritis**, heterotopic ossification, and **pulmonary** embolism.

VIII. Knee Dislocations

- A. Introduction
1. The knee is a stable joint reinforced by strong ligaments.
 2. **High association** with **popliteal artery** and **peroneal** nerve **injury**.
 3. **Rare injuries** with anterior being most common.
 4. **Classified** as anterior, posterior, medial, **lateral**, and rotatory.
- B. Mechanism of injury
1. A **significant** force needed **usually** an **MVA**
 2. Anterior dislocations **occur** with a **hyper** extension force.
 3. Posterior knee dislocations **result** from a direct posterior force to the anterior tibia **with** the knee flexed.
- C. Physical exam
1. Injuries **usually** obvious clinically **with** a grossly deformed or **unstable** knee joint
 2. **Peroneal nerve** injury **causes decreased** sensation to **dorsum** of foot and decreased foot **dorsi flexion**.
 3. Absent **pulses** despite a warm foot is a **vascular injury** until proven otherwise.
- D. Radiographs
1. AP and lateral knee view **unless vascular** compromise where immediate reduction is indicated.
 2. Consider x-rays of the hip and pelvis to **rule** out associated injuries.
 3. **Angiography** should be considered in all patients with this **injury**.
- E. Treatment
1. Reduction **using longitudinal** traction.
 2. Easy reductions but **unstable**.
 3. Immobilize in posterior long leg splint at 15 to 20° of flexion.
 4. **Need** hospitalization and surgery.

- F. Complications
1. Major **neurovascular** injuries of **popliteal artery** and **peroneal nerve** as well as **ligamentous injury**.
 2. DVT, compartment syndrome, and amputations may **occur**.
 3. Arthritis is common as well as persistent joint instability.

IX. Pelvic fractures with hemorrhage

- A. Introduction
1. The only immediate life-threatening **aspect** of pelvic **trauma** is hemorrhage.
 2. A significant **amount** of bleeding may **occur** with pelvic **fractures**.
 3. The **retro** peritoneal space may accommodate 4000 **ml** of blood before **venous tamponade occurs**.
 4. The leading **cause** of death in pelvic **fracture** patients.
 5. Patients with a pelvic **fracture** who are **hypotensive** on presentation have a **mortality** of 40 to 50%.
 6. Generally a high-energy injury.
- B. Sources of bleeding
1. Arterial branches of the common **external** or internal iliac vessels.
 2. Venous **plexuses**
 3. **Cancellous bones**
 4. The majority of severe hemorrhage **occurs with crush injuries** or in displaced **fractures** of the posterior pelvic ring.
- C. Diagnosis
1. Pelvic instability on exam.
 2. **Massive** flank, **buttock**, or perineal contusions and swelling.
 3. Signs of potential instability include a” open pelvic **fracture**, **scrotal hematomas**, and **neurologic** injuries to the **lumbosacral plexus**.
 4. **AP** x-my of pelvis mandatory.
 5. Large **volumes** of fluid **or** blood needed to resuscitate the patient.
- D. Treatment
1. **Stabilize** and **resuscitate** the patient (ABC’s, **IV’s x 2**).
 2. Aggressive **blood** replacement.
 3. Stabilization of the pelvis.
 4. Use of MAST **suit** or PASG.
 5. Apply an anterior external fixation frame.
 6. **Angiography** for localizing **source** of bleeding and **type** of therapeutic embolization **necessary**
 7. **Selective embolization** most effective in small diameter vessels.
 8. Operative repair of major arterial and **venous** injuries and open reduction and **external** fixation.
 9. Know your **consultants** and **institutions** capabilities.

X. Vascular Injuries

- A. Introduction
1. Types of **vascular injuries** include **intimal flaps**, disruptions or **subintimal hematomas**, spasms. **wall** defects. complete transections, and **arterio-venous fistulas**.

2. **Most common** in penetrating wounds, open fractures, widely displaced fractures or dislocations. and or in areas where vessels are close to bone.
 3. In **urban** settings **vascular** injuries **are** most commonly caused by handguns.
 4. **Vascular** injuries from blunt orthopedic **trauma** account for only 5 to 30%
- B. Association between certain fractures and arterial injuries
1. **Fracture** of clavicle or first rib - **subclavian** artery
 2. Anterior shoulder dislocation - **axillary** artery
 3. **Humeral** neck fracture - **axillary** artery
 4. **Supracondylar** humeral fracture - **brachial** artery
 5. Elbow dislocation - **brachial** artery
 6. Mid-third of **femur** fracture - superficial femoral artery
 7. **Supracondylar** femur fracture - **popliteal** artery
 8. Knee dislocation - **popliteal** artery
 9. **Proximal** tibia or **fibula** fracture - **popliteal** artery or anterior **tibial** artery.
- C. **Signs** and symptoms
1. **Pain**
 2. **Pallor**
 3. **Pulselessness**
 4. Paralysis
 5. Paresthesia
 6. **Poikilothermia**
 7. Massive or **pulsatile** external bleeding
 8. Rapidly expanding **hematoma**
 9. Palpable thrill or audible **bruit** over a **hematoma**
 10. Soft signs - history of arterial bleeding at the scene, **proximity** of a penetrating **wound** or blunt **injury** to a" artery, a small **nonpulsatile** **hematoma** or a **neurologic** deficit.
- D. Diagnosis
1. **Angiography**, digital **subtraction angiography**, and **ultrasound**.
 2. **Surgical** exploration.
- E. Treatment
1. **Control** hemorrhage **with** direct compression
 2. Early splinting or immediate reduction.
 3. Nonoperative **treatment** occasionally **of** **vessel** occlusion below the elbow or knee
 4. Operative management with either lateral **arteriorrhaphy** or **venorrhaphy**, patch **angioplasty**, resection of **injured** segment with either end-to-end **anastomosis** or interposition graft, bypass **graft**, or ligation,
 - a. Liberal **use** of **fasciotomy**
 5. Blood flow to a" **ischemic** extremity should ideally be corrected **within** 6 to 8 **hours** to prevent permanent **injury**.
- F. Complications
1. **Early** occlusion of arterial repair, delay in diagnosis, infection, and late occlusion of arterial repair.
 2. **Ischemia**, compartment syndrome, amputation.

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